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Performance of Agronomic Crop Varieties in Alaska 1978 –2002

Robert M. Van Veldhuizen and Charles W. Knight

FLAVIO GASSEN

Dedication

This bulletin is dedicated to the late Dr. Frank J. Wooding, Professor Emeritus of Agronomy, Agricultural and Forestry Experiment Station, School of Agriculture and Land Resources Management, University of Alaska Fairbanks.

Frank J. Wooding February 1941–March 1994
Photo courtesy of Josie Bautista Wooding,

Frank J. Wooding came to the Universty of Alaska Fairbanks in 1970 as an assistant professor of agronomy at what was then the Institute of Agricultural Science, now the Agricultural and Forestry Experiment Station. He retired in August1993 with the rank of professor and professor emeritus of agronomy.

During his 23 years at UAF, professor Wooding made numerous contributions to the knowledge of appropriate crop and soil management practices under subarctic conditions, and his many recommendations on cereal grain and turfgrass varieties, fertilizer management practices, and other crop and soil management practices are widely used. His work verified that vast areas of Alaka, stretching from Bristal Bay to the Upper Yukon River Valley, have soils and climate suitable for agriculture. He was the first to show boron responses on agronomic crops in Alaska. Through his teaching, Frank influenced numerous students, and he served for six years as the head of the Department of Plant, Animal, and Soil Sciences.

Frank Wooding was born February 1, 1941 in Pontiac, Illinois, and grew up on a family farm near Chenoa. He earned a B.S. in agronomy at the University of Illinois in 1963. At Kansas State University, he earned an M.S. in 1966 and a Ph.D. in soil science in 1969. Before moving to Fairbanks, Alaka, he completed a post-doctoral fellowship at University Park, Pennsylvania.

Publisher's Note

Cover Photo: The image of ripe wheat was provided by Brazilian agronomist and photographer Flavio Gassen. His work may be seen elsewhere in this document and in color at Farmphoto.com.

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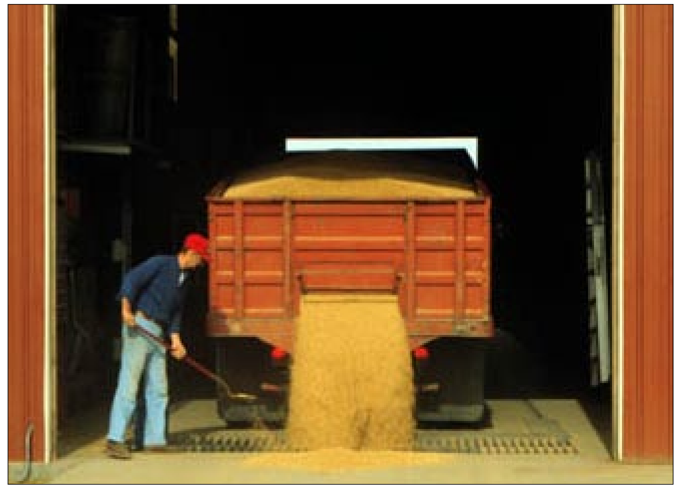
Introduction

There is no such thing as the perfect variety for Alaska. Some varieties are adapted to a wide range of climatic and geographic locations, while others are more specific in their adaptation. The change in elevation of a few hundred feet or a move of a few miles can have a considerable effect on the performance of any variety. Also, cultural practices such as tillage, fertilizer rates, planting date, seeding rate, pest control, and a multitude of other factors can also influence crop yields. This is especially noticeable in northern environments such as Alaska. For example, date-of-planting studies done by F.J. Wooding (1973) and C.W. Knight (1989) found that any date after the middle of May for planting an agronomic crop can result in delayed maturity, low yields, and low quality grain, even for the best adapted varieties for Alaska.

Another problem in northern environments is photoperiod, or the length of sunlight and darkness in one 24-hour period. Soybeans, for example, will germinate and grow well in Alaska, but do not flower until there is about 10 hours of daily darkness. This does not occur until mid-August, which does not give the plant much time to develop and reach maturity before the first killing frost. As a result, soybean varieties are not adapted for northern environments. Less obvious, but of equal importance, are many winter grains, such as winter wheat and winter rye. These are typically planted in late summer to early fall (mid-August), produce a small rosette of vegetative growth to build up root reserves, go dormant in the winter, then next spring produce a seedhead similar to spring grains that are harvested in the fall.

Testing winter rye varieties at the AFES Matanuska Experiment Farm in Palmer, L.J. Klebesadel (1969) found that long daylength caused nonadapted varieties to grow more rapidly as seedlings. This resulted in a low buildup of root reserves and consequently, a low winter survival rate. Klebesadel (1971) also determined that covering perennial grass varieties to simulate a dark period in the fall would increase winter survival and thus forage yields the next season. Of course this is impractical on a large scale, but it shows the importance of variety testing and selection in the northern environment.

Crop breeding programs from around the circumpolar north have developed new varieties to improve yields, disease resistance, fertilizer use efficiency, and overall crop quality. As this work continues, testing varieties of traditional and nontraditional crops determines which variety is best adapted to any particular climatic, soil, and geographic location within the state of Alaska. The performance of new varieties are evaluated against the known performance of standard varieties. These standard varieties are ones that



Grain delivery at the Alaska Farmer's Cooperative in Delta Junctiion. AFES file photo.

have consistently performed at a given geographic location over several years.

Characteristics that are evaluated against those of the standard varieties are yield (pounds/acre), plant growth characteristics (percent lodging and plant height), quality (test weight in pounds/bushel), and maturity (growing degree days and days to 50% mature). Growing degree days (GDD), are calculated from the average daily temperature minus a standard low temperature at which there can be no continued crop growth. That low temperature point for crops in this report is the freezing point of water, 32 degrees (F). The GDD calculation for each day is then added to the preceding GDD value to determine the cumulative value over a given time period. This cumulative value is then used to determine the needed heat units for a particular crop or variety to reach a specific physiological growth stage. The time required for any variety to reach a specific physiologic growth stage can vary greatly from one year to another and from one location to another. This time frame however, is correlated to the number of warm days or heat units received during each growing season.

New varieties with a wide range of characteristics are selected for testing, with emphasis on early maturity because of Alaska's short growing season. Secondary characteristics that are used to select varieties for testing are the reported high yield and quality, because these characteristics reduce input costs and increase value of the final product for the producer. As a result, older varieties are constantly being replaced with newer varieties that have been shown to be better adapted to a particular geographic location. The current recommended varieties are described in detail within each section. Evaluations of experimental lines from plant breeders are not presented here unless those lines eventually were released as a specific cultivar.

The recommended varieties within each section are those varieties that have consistently performed well over time for that particular location. They are high-yielding, high-quality, early maturing varieties for which certified seed is available. Lack of successful maturity and yield for a specific variety or crop indicates that it is not well adapted to the climatic or geographic location in which it was tested. However, just because there was a crop failure of a specific variety does not mean that it might not be able to be successfully grown somewhere within the state. The old Alaska adage about the weather of "If you don't like the weather here, wait five minutes or move five miles" holds true for the production of crops as well. Therefore, the reader is not discouraged from trying any of the crops or varieties not recommended. However, the probability of success in attempting to produce those crops or varieties will likely be low. Along with being the grower, any producer will most likely have to become their own processor and marketer as well, because there are very few commercial processing facilities in Alaska set up to accept niche crops. There are however, many small-scale flour mills and oil presses that could be set up on-farm for local processing and marketing by the producer.

This publication is not a crop production manual. Its main purpose is to provide basic information on small grain and oilseed variety testing, along with information on successful cultural practices identified by research conducted from 1978 through 2002. Each crop is presented in separate sections with general cultural information on fertilization, tillage, pest control, harvest, and storage, followed by tables listing yields and maturity for all known varieties tested at each location within the state. In each section there is also a list, description, and seed source for all recommended varieties. Because many different crops may have similar cultural requirements, the information will tend to be repetitive among sections, but each section can be reviewed separately from others. There have been many previous publications that describe grain and oilseed variety testing in Alaska during this period. Most important was the "Performance of Cereal Crops in the Tanana River Valley of Alaska" series by F.J. Wooding and others that ran from 1979 to 1986. Information on barley, oat, and wheat varieties presented in those publications are not repeated here, except the list of varieties. Summarized here are reports on grain and oilseed varieties tested during that period but unreported due to such factors as poor crop performance, extreme weather conditions, and budget reductions. All small grain, oilseed, and alternative crop variety trials done after 1986 are also summarized in this publication.

Fairbanks Test Site Characteristics

The Fairbanks test site was located on the lower fields of the University of Alaska Fairbanks (UAF), Agricultural and Forestry Experiment Station (AFES) Fairbanks Experiment Farm on West Tanana Drive of the UAF campus. The elevation of this test site is approximately 500 feet. This is a Tanana silt loam that has been conventionally farmed for about 70 years.

All crops were planted into soil that had been summer fallowed the previous season. Also, large quantities of animal manures have been added to the fields over the years, which has made the soil quite uniform with high levels of available nitrogen, phosphorus, and potassium. There is a perched water table above the permafrost at about 27 feet deep and the main water table is located about 65 feet deep. This is an alluvial soil in the flood plain of the Tanana River. As a result, there is a high concentration of calcium carbonate and calcium sulfate salts dissolved in the ground water. These salts are brought to the surface by capillary rise due to the evaporation rate being greater than the precipitation of the area. These salts make the soil slightly alkaline to neutral in acidity. This soil has a pH range of about 7.0– 7.5.

The average planting date for Fairbanks for the years 1978–2002 was May 10. As mentioned previously, date of planting and fertilizer rate studies done by F.J. Wooding (1973) and C.W. Knight (1989) found that late May to early June planting dates can cause delayed maturity and reduced yields and test weights. On the other hand, it is important not to work this soil too early when it is still too wet, because a hard surface crust can result, impeding emergence. Also, soil temperatures in early May are around 40° F. Wet soils tend to be even colder. This causes delayed and uneven germination, resulting in poor stands. Preparing the seedbed as soon as the soil has dried out enough to work without forming clods results in better maturity and higher yields.

For the Fairbanks area, the average total precipitation for the month of May for the years 1978–2002 was only 0.55 inches, with most of that falling in the last half of the month (Fig. 1). This means that most of the soil moisture needed for successful seed germination and seedling establishment comes from spring snowmelt or residual moisture from the previous year. It becomes important therefore, to have a rough soil surface, or leave last season's stubble standing throughout the winter to trap snow and reduce spring runoff. This allows for greater water infiltration into the soil profile before seedbed preparation.

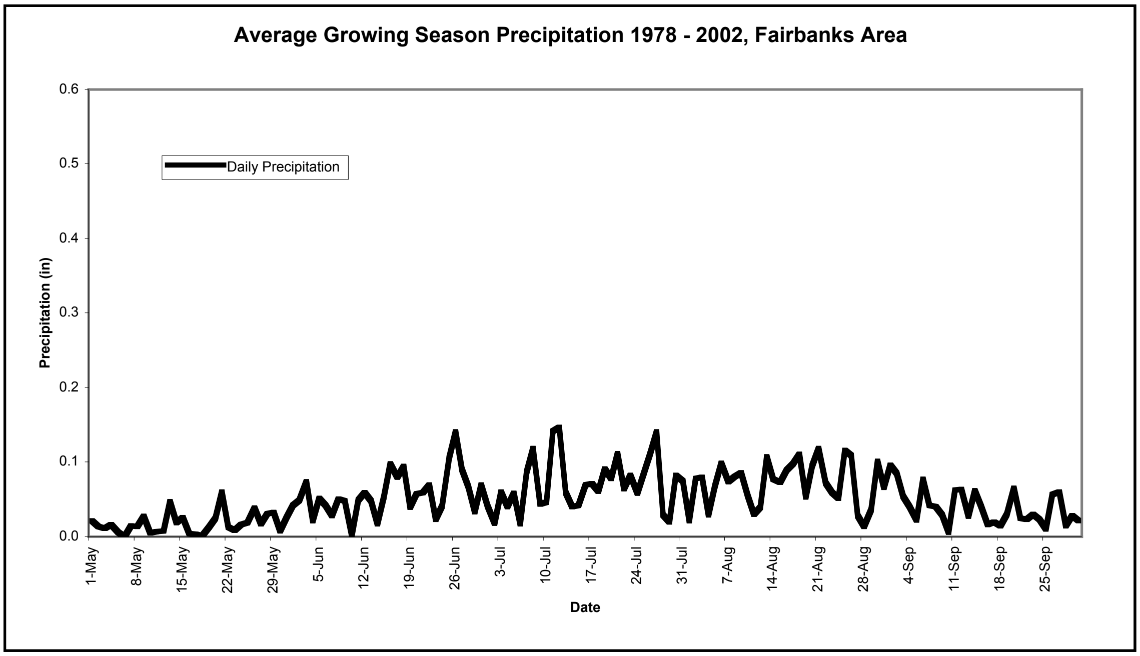


Figure 1. Average daily growing season precipitation for the Fairbanks area, 1978–2002.

A packer pulled behind the tillage implement helps to seal in soil moisture, and a drill equipped with press wheels also helps conserve moisture. Another method for conserving soil moisture and nutrients is to include a year of mechanical summer fallow in the field rotation. Summer fallow helps incorporate the previous season's stubble, straw, and this year's weeds, speeding the breakdown and decomposition of organic matter. This decomposing organic matter binds the soil particles together to increase tilth, moisture retention, and nutrient availability. The only drawback is that there will not be any standing stubble left to trap snowmelt. Also, in areas prone to high winds over the winter, significant soil erosion can occur unless the soil surface is left in a rough condition from the last tillage, with many ridges and furrows to trap blowing snow and soil particles.

The average cumulative GDD for the month of May in the Fairbanks area was 509 (degrees F) (Fig. 2). This is sufficient for germination and emergence of most cool-season small grains and oilseeds. Planting and germination are delayed in a cool, wet May because soil conditions are too cold and wet for early tillage. This happened in the 1992 season, which had only 306 cumulative GDD and a total precipitation of 1.15 inches. That year, planting was delayed until May 28.

Estimates of germination uniformity were taken by determining the number of plants by counting the number of seed leaves, from germinated seed, emerging from the soil within a measured distance in each drill strip. Under average soil and weather conditions, 50% emergence usually occurs 7 to 10 days after planting. For the 1992 season, 50% emergence occurred about 10 days after planting on June 7. In contrast, planting can occur on the average date or earlier during a warm dry spring, but there may be a delay in germination due to insufficient soil moisture. This occurred during the 1981 season, which had 655 cumulative GDD and only 0.40 inches of total precipitation. Planting for that year was on May 12, but 50% emergence did not occur until 14 days after planting on May 26. Average June rainfall for the study period was 1.71 inches with the precipitation events evenly scattered throughout the whole month (Fig. 1).

Average cumulative GDD to the end of June were 1323 (Fig. 2). Among years, June does not appear to be as variable in GDD as May. For example, the 1992 season continued its cool, wet trend with only 1118 cumulative GDD and 2.69 inches of total precipitation. In comparison, the 1981 season had 1370 cumulative GDD with an above-average total precipitation of 2.84 inches. By the last week of June through the first week in July, grain varieties usually have heads fully emerged from the flag leaf. The seed begins to fill as nutrients are translocated. Average time to 50% headed for the study period was July 4 with 1452 cumulative GDD. Even years that had a delay in germination and emergence reached the 50% headed physiologic growth stage during this time period. For example, the average 50% heading for 1992 occurred on July 5 with 1290 cumulative GDD; the average 50% heading for the 1981 season occurred on July 7 with 1526 cumulative GDD.

July and August are the rainiest months for the study area. The average total precipitation was 2.19 inches for July and 2.22 inches for August (Fig. 1). By the end of July, an average of 2244 cumulative GDD had accumulated and at the end of August 2962 cumulative GDD (Fig. 2). The accumulation of GDD for this time period is relatively low because the average daily temperature is decreasing.

Compared with previous months, by the end of August there is even less variation between years in GDD. For example, the 1992 season's cool, wet trend continued, with only 2820 cumulative GDD and 2.34 inches total precipitation, while the 1981 season had 2786 cumulative GDD and below-average total precipitation of 1.47 inches.

By late July to early August, most crops have reached the 50% maturity physiologic growth stage. This is when the seed is mature enough to germinate but not yet ripe enough for harvest. Heavy precipitation events accompanied with high wind during this time period can cause severe lodging of tall, weak-stemmed varieties. Lodging is the bending or breaking of grain stems that puts the heads near the ground, making harvest difficult.

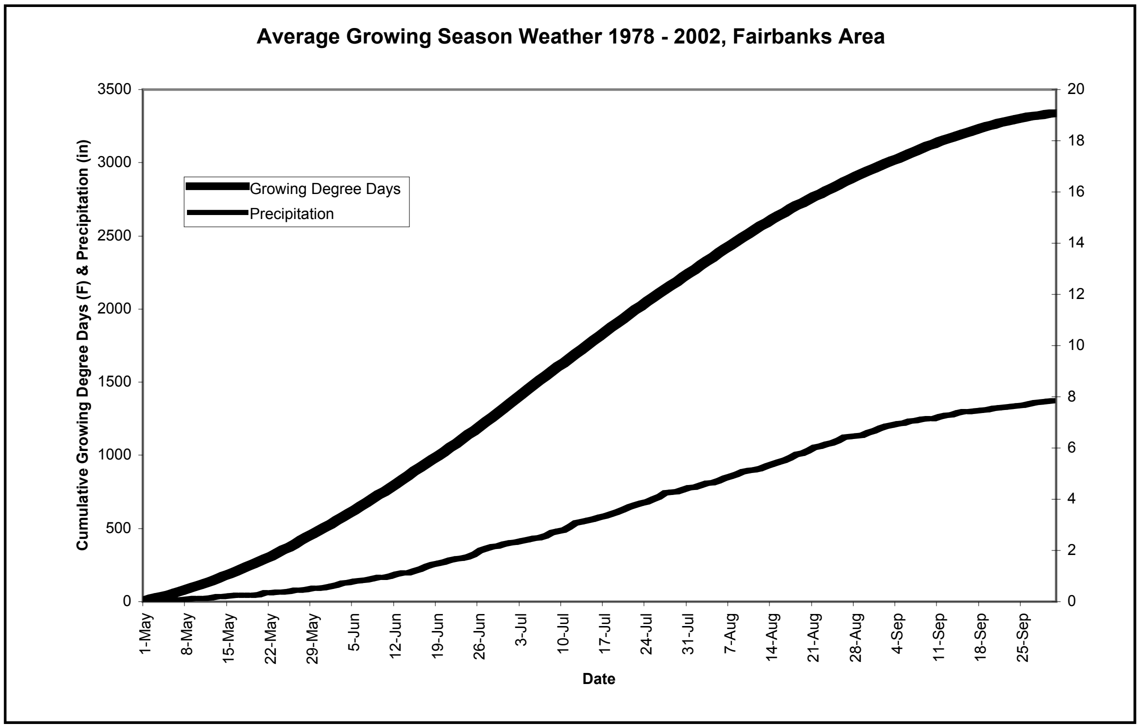


Figure 2. Average cumulative growing degree days and precipitation for the Fairbanks area, 1978–2002.

The average time to 50% maturity for the Fairbanks area was August 4 with 2355 cumulative GDD. The average 50% maturity for 1992 occurred on August 2 with 2138 cumulative GDD. By contrast, the 1981 season was cooler in late July and early August. These cooler temperatures caused most grain to reach 50% maturity two weeks later than average, on August 18 with a higher than average 2520 cumulative GDD.

September's average total precipitation for this period (1978–2002) was 1.18 inches, with the greatest portion falling during the first half of the month (Fig. 1). An average of 3338 cumulative GDD occurred in September (Fig. 2).

Geese glean grain in a field at the AFES Fairbanks Experiment Farm. AFES file photo.

During late August to early September, the seed is ripening and losing moisture. Harvest can be scheduled when the seed has reached ripeness and has low moisture content. Individual precipitation events can delay harvest, but care must be taken not to delay too long because a precipitation event near the end of the month can be a wet, heavy snow that causes excessive lodging and makes harvest impossible. Late August to early September is also when the first killing frosts can occur (temperatures below the freezing point of water). With late maturing varieties or those that produce an abundance of late tillers, this can result in green, high-moisture seed at harvest. Green seed can be removed at harvest by increasing the airflow through the combine or by precleaning before drying grain. This can result in lower total yields.

The last month of the 1992 season had only 2955 cumulative GDD and total precipitation of 0.01 inches. To add to the season's difficulties, there was a killing frost on September 10, significantly reducing total yields. The 1981 season had a near-normal 3123 cumulative GDD and a total precipitation of 1.11 inches for September. There was an early killing frost on August 17 of that season, but temperatures warmed up after that, which helped speed ripening and harvest. Total yields were higher than averages for that season.

Eielson Area Test Site Characteristics

The Eielson test site was located on a private farm in the Eielson Agricultural Project, six miles south and two miles west of North Pole. The elevation of this test site is approximately 540 feet. The soil is a Jarvis fine sandy loam that has been conventionally farmed for about ten years. Jarvis soil is usually ten to forty inches of fine sandy loam over sands and gravels, although that depth is highly variable; sand and gravels may be near or even at the surface.

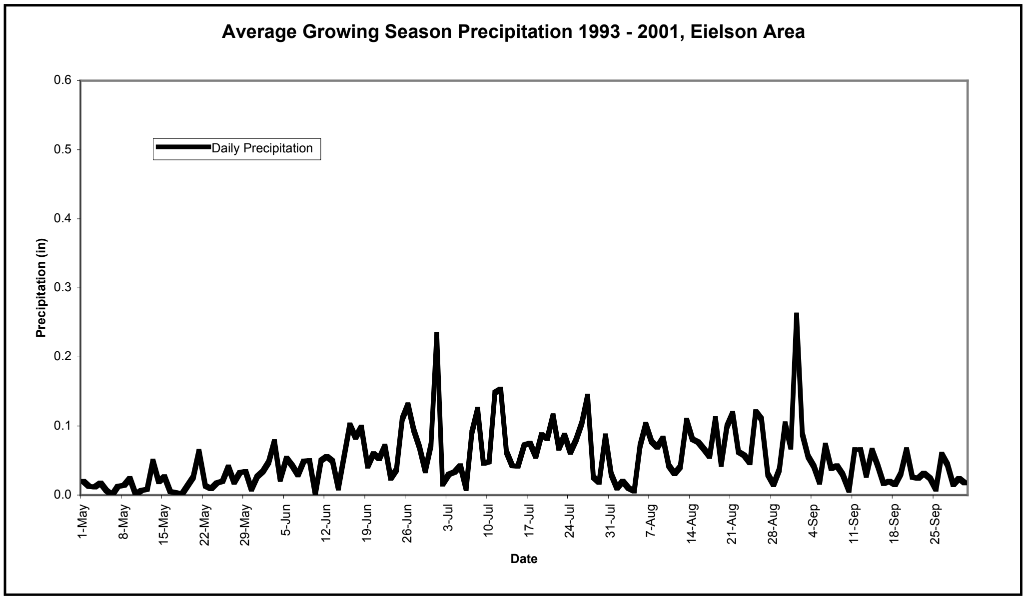


Figure 3. Average daily growing season precipitation for the Eielson area, 1993–2001.

Tillage practices at this site were identical to those at the Fairbanks site. All crops were planted into soil that had been summer fallowed the previous season. This recently cleared soil still contains large amounts of organic matter in the form of woody material and moss. This type of organic matter is more resistant to decomposition than grain straw, adding to soil variability. This soil is very low in available nitrogen and phosphorus, but has moderate potassium levels. Like that of the Fairbanks site, this alluvial soil is in the floodplain of the Tanana River. The distance from the river is less than a mile, and the elevational difference from the river is only a few feet. The water table is about five feet deep. The ground water contains a high concentration of calcium carbonate and calcium sulfate salts that are brought to the surface by capillary rise. These salts make the soil slightly alkaline to neutral in acidity with a pH range of about 7.0–7.5.

The Eielson Agricultural Project was started in the mid 1980s. Small grain, oilseed, and alternative crop variety evaluations were started in 1993 to determine the performance characteristics of crops for the area. Even though this soil is sandier than the silt loam soil at the Fairbanks site, the low elevation in relation to the Tanana River and seasonally frozen soil results in large areas of standing water in the fields in early May. This resulted in an average planting date of May 12 for the years 1993–2001, which is two days later than the Fairbanks area. Uneven topography in this area causes marked differences in soil moisture during the growing season. The sandier texture allows the higher portions of a field to dry out quickly, while the lower portions remain wet. This uneven soil characteristic translates into uneven germination and emergence. Field leveling would greatly reduce this tendency. As with the Fairbanks site, preparing the seedbed as soon as the soil has dried out enough to work without forming clods results in better germination, earlier maturity, and higher yields.

The Eielson Agricultural Project is only twenty miles southeast of the Fairbanks site, and weather patterns are similar. The average total precipitation for the month of May for this area (1993–2001) was 0.66 inches, with most of that falling in the last two-thirds of the month (Fig. 3). Average cumulative GDD for May were 505 (degrees F) (Fig. 4). Conservation of soil moisture is important because the soils are sandy and tend to lose moisture rapidly. Soil moisture conservation practices similar to those employed at the Fairbanks site should be followed here as well. Because of the variability in soil organic matter and moisture, germination and emergence was spotty, sometimes extending into June. In most years, this variability in germination resulted in uneven ripening in the field at harvest.

The average total precipitation for June (1.71 inches) was similar to the Fairbanks site, with precipitation events scattered throughout the month (Fig. 3). Average cumulative GDD for the end of June (1323) were also similar (Fig. 4). Although germination and emergence were uneven, the crops still reached 50% headed physiologic growth stage close to the same time period as at the Fairbanks site. Average time to 50% headed for the study period was July 7 with 1546 cumulative GDD. One result of the uneven emergence was an increased number of late tillers emerging during this period. Where gaps in the plant canopy due to the lack of emergence allowed increased sunlight to reach the base of the small grain plants, tillering was stimulated.

July and August were also rainy months for the Eielson area, with an average total precipitation of 2.31 inches for July and 1.97 inches for August (Fig. 3). The average cumulative GDD for the end of July at this site were 2249 and 2973 for August (Fig. 4). These values are similar to those at Fairbanks for this time period. The average 50% maturity physiologic growth stage was reached at this site on August 10 with 2515 cumulative GDD. However, due to the large number of late tillers that formed, a large portion of the crop was still green, not physiologically mature, and did not mature before the first killing frost. Lower nitrogen levels at this site also tended to result in shorter than normal plant heights. Low nitrogen coupled with moderate levels of potassium resulted in low incidences of lodging.

Average total precipitation for September was 1.08 inches distributed throughout the month (Fig. 3), and average cumulative GDD at the end of this month were 3353 (Fig. 4). As in July and August, both of these values are similar to the long-term averages for Fairbanks. Due to the uneven soil conditions, spotty germination and emergence, and abundance of late tillers, crops were late maturing and still had high moisture content late into September. Over time, with continued tillage and cropping, the soils in the Eielson area should become more uniform. This should reduce incidence of spotty germination and emergence, as well as the number of late tillers, producing a more uniform, evenly maturing grain crop. With the lower precipitation level, an evenly maturing grain crop would be ripe and ready to harvest sooner than at the Fairbanks site.

Delta Junction Area Test Site Characteristics

There were a number of short-term test sites within the Delta Junction area. Before the 1978 growing season and through the 1981 season, research plots were located on a private farm off of Remington Road, two miles north and eight miles east of Delta Junction. The elevation of this test site is approximately 1125 feet. The soil in this area is a Richardson silt loam that before 1978 had been conventionally farmed for about twenty years. Richardson soils are deep (four to five feet) silt loams over sands and gravels. Because of the long-term history of conventional farming practices, this soil is quite uniform, with high levels of good quality organic matter that speeds up decomposition and nutrient release. There are also moderate levels of available nitrogen and potassium in this soil and low levels of available phosphorus. The water table is about sixty feet. The pH range is slightly acidic at about 5.5–6.5.

From 1994–1996 a field pea study was done on a private farm in the Tanana Loop area, five miles north and four miles east from Delta Junction. The elevation of this test site is approximately 1050 feet. The soils in this area are Tanana silt loams similar in characteristics to those described for the Fairbanks site. It was conventionally farmed for about fifteen years with annual applications of dairy manures. The site tested relatively high in available nitrogen, phosphorus, and potassium, but because of the uneven application of animal wastes the field was not uniform. The water table in the area is about thirty feet. The pH range of the soil is about 6.2–6.8.

Studies to determine the importance of irrigation were done from 1998–2000 on a private farm off of Sawmill Creek Road in the Delta I Agricultural Project, nineteen miles southeast from Delta Junction. The elevation of this test site is approximately 1170 feet. The soil in this area is a Volkmar silt loam that had been cleared and conventionally farmed for about fifteen years. Volkmar soils are similar to Richardson soils, except that they are much shallower, with depths to sands and gravels of two feet or less. This soil does not contain high levels of organic matter and tends to be rather dry. It lacks uniformity because high ridges tend to be sandy and dry, while other areas are stony. This soil is low in available nitrogen and is moderate in available phosphorus and potassium. The depth of the water table is about 100 feet. The fairly acidic pH (5.1–6.0) limits the availability of phosphorus through fixation of the phosphate ion with free iron and aluminum ions. It is recommended that phosphorus fertilizers be banded with the seed to compensate for this.

From 1981 to the present, the largest portion of variety testing was done at the UAF Agriculture and Forestry Experiment Station Delta Field Research Site at mile 1408 of the Alaska Highway, fourteen miles southeast from Delta Junction. The elevation of this test site is approximately 1220 feet. This location is the original test clearing site for the Delta I Agricultural Project. Until 1990 all variety testing was done on a Nenana silt loam soil. Nenana silt loam is similar to both the Richardson and Volkmar soils. It is a shallow silt loam over sand and gravels like the Volkmar soils, and fairly acidic, with a pH range of about 5.1–5.5. It had been cleared in 1978 and put into production with conventional farming practices in 1979. Tillage practices on this site were identical to those at the Fairbanks and Eielson sites. Similar to the Eielson site, the soil had been recently cleared and still contained large amounts of woody and moss organic matter. The variability of soil organic matter coupled with the thin, sandy texture of the soil resulted in a variable and ununiform study site. The soil tends to be dry, is low in available nitrogen, and has moderate availability of phosphorus and potassium. The depth to the water table is about 150 feet.

After 1990, the variety testing area was moved to another site on the same farm (with the same elevation) with Volkmar soils. This area was also cleared in 1978 and conventionally farmed. By 1990, when the variety testing plots were moved there, most of the woody organic material had been removed or broken down and decomposed. However, due to the variability in soil depth and the thin, sandy texture of the soil, the new site is still not uniform. This soil is low in available nitrogen and moderate in available phosphorus and potassium. Tillage practices on this site were identical to those done on the Nenana silt loam. The soil tends to be dry because of the sandy texture and does not hold water well. The depth to the water table is about 120 feet. The sandy soils at this site have a lower moisture-holding capacity. This, along with lower nitrogen and moderate potassium levels, tended to produce shorter than normal plant heights, resulting in low incidences of lodging and early maturity, which produces low yields with correspondingly low test weights.

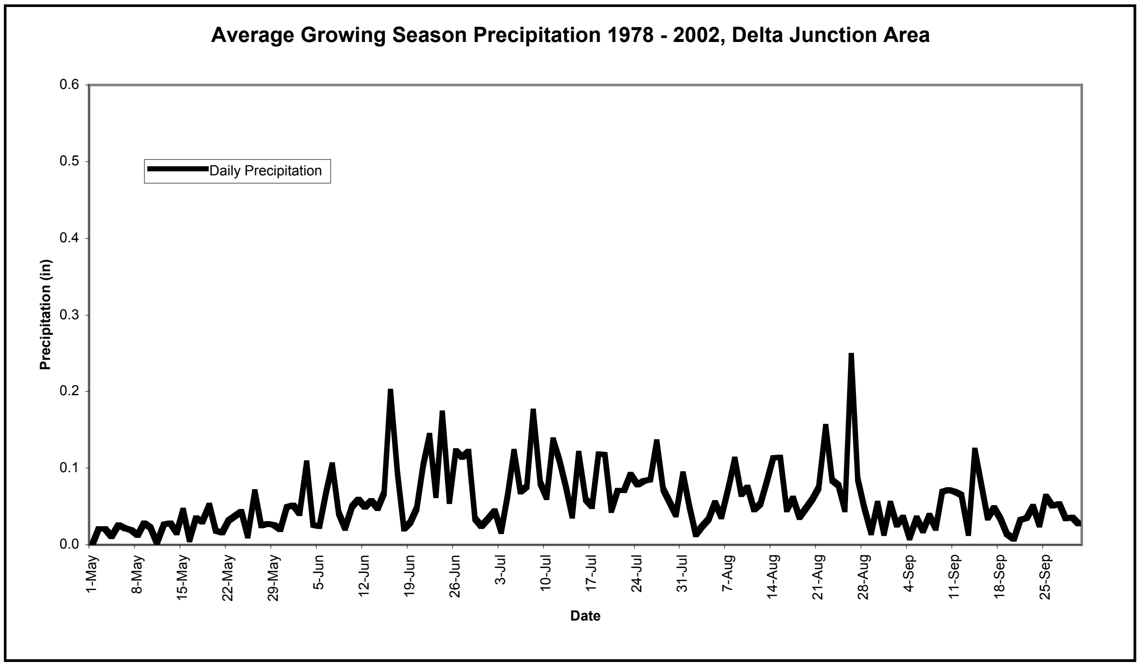


Figure 5. Average daily growing season precipitation for the Delta Junction area, 1978–2002.

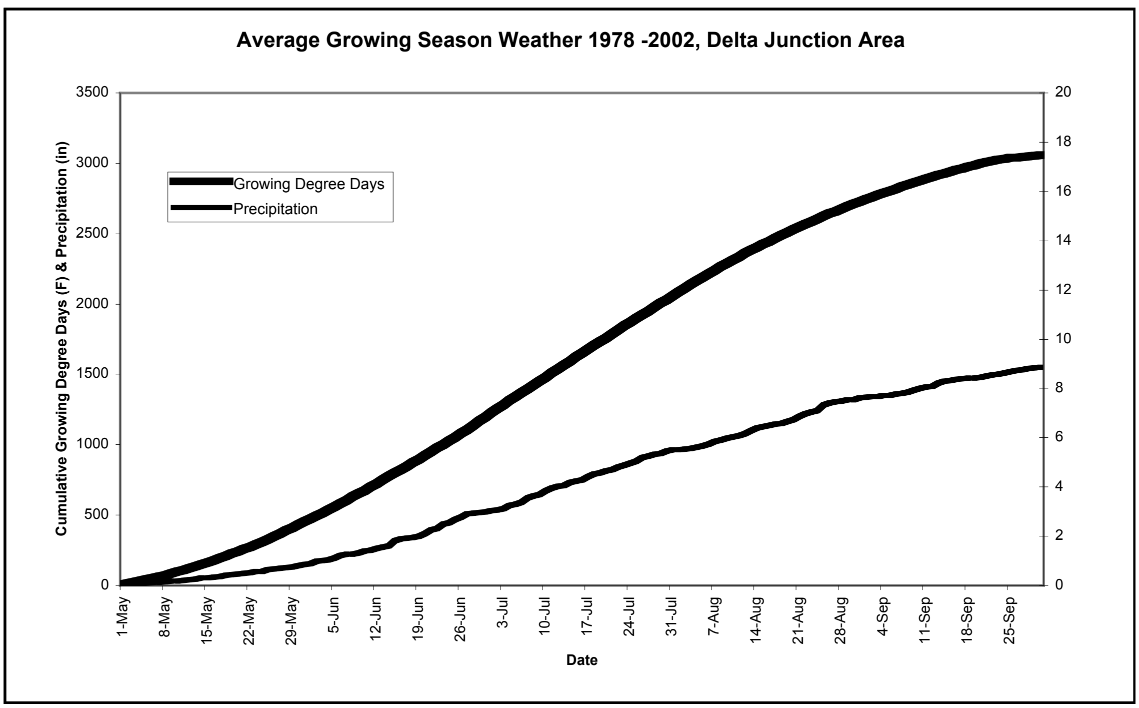


Figure 6. Average cumulative growing degree days and precipitation for the Delta Junction area, 1978–2002.

In the Delta Junction area, high winter winds can blow snow off of fields that lack stubble or sufficient soil roughness to trap the snow. Since crops rely on spring snowmelt to provide sufficient soil moisture for germination, it is important to leave standing stubble after harvest, or to leave the soil surface rough after fallowing to trap the snow and keep it from blowing off. Since the soils of the Delta Junction area tend to be coarser in texture than soils at the other sites, it is even more important to conserve soil moisture during seedbed preparation and planting. As in the Fairbanks area, a packer pulled behind the tillage implement helps to seal in soil moisture. A drill equipped with press wheels can also help conserve moisture. Leaving standing stubble in the fall or leaving a rough soil surface with fallow tillage provides the added benefit of reducing soil erosion over the fall and winter months by reducing wind force and anchoring the soil against movement. This is especially important with fine-textured silt loams, which are easily moved by wind erosion. Since many of the soils in the Delta Junction area are thin layers of silt loam over sands and gravels, any loss can be significant.

Because of the Delta Junction site's higher elevation compared with the Fairbanks and Eielson sites (1200 ft. vs. 500 ft.), there are fewer GDD over a typical growing season. Spring planting in May is usually later than in Fairbanks because of cooler, wetter conditions. The average date of planting for the Delta Junction area, in the years 1978–2002 was May 15. The first killing frost usually occurs near the end of August to the first of September. With this shortened growing season, planting as soon as equipment can get into the fields to work the seedbed results in better maturity and higher yields.

A fairly large distance separates the Delta Junction test sites. It is almost forty miles from the farthest north test site near the Tanana River to the farthest south test site near the Granite Mountains. This large variation in distance and topography leads to a large variation in weather conditions at each site. However, not all test sites were run all years during the 1978–2002 period. Most of the variety evaluation and testing was performed at the UAF Agriculture and Forestry Experiment Station's Delta Field Research Site at mile 1408 of the Alaska Highway. Weather data presented here is from the official FAA observatory at the Delta airport, about midway between all the test sites.

For the Delta Junction area, the average total precipitation for the month of May was 0.85 inches, with most of that falling in the last half of the month (Fig. 5). Average cumulative GDD for this month were 453 (degrees F) (Fig. 6). Compared with the Fairbanks and Eielson areas, the Delta Junction area is generally drier and cooler during May. The lower precipitation and cooler temperatures often result in poor germination and delayed or spotty emergence. Therefore, ensuring adequate soil moisture during seedbed preparation is very important in this area. Leave standing stubble after harvest, or leave the soil surface rough after fallowing to trap snow that will help recharge soil moisture in the spring. Avoid overtillage, or pull a packer behind the tillage implement and use a drill equipped with press wheels. This promotes formation of a crust, sealing the soil surface and slowing evaporation. Even with proper precautions to slow down soil moisture loss, average 50% emergence does not occur until 12–14 days after planting.

June precipitation averaged 2.15 inches with precipitation events scattered evenly throughout the month (Fig. 5) and average cumulative GDD of 1198 (Fig. 6). As in the Fairbanks and Eielson areas, the end of June to the first of July is the time when most varieties reach the 50% headed physiologic growth stage. Compared with the Fairbanks site, the cooler temperatures in the Delta Junction area caused a slight lag time of three to four days in the average time to reach 50% maturity. Average time to 50% headed for the study period was July 8 with 1575 cumulative GDD. During this time, as at the Eielson site, uneven emergence resulted in increased emergence of late tillers.

July and August are also the rainy months for the Delta Junction area, with an average total precipitation of 2.50 inches in July and 2.11 inches for August (Fig. 5). At the Delta Junction site, the average cumulative GDD July were 2058 for the end of July and 2727 for the end of August (Fig. 6). The combination of sandier soils, lower precipitation, cooler temperatures, poor germination, and spotty emergence can lead to an abundance of green tillers at this time. This can delay the 50% physiologic maturity growth stage by one to two weeks compared to the Fairbanks and Eielson areas. In the Delta Junction area, mid- to late August is usually when most crops reach the 50% physiologic maturity growth stage; the average time to 50% maturity is August 14 with 2616 cumulative GDD.

Average total precipitation for September was 1.26 inches (Fig. 5), and average cumulative GDD were 3059 (Fig. 6). With average precipitation events scattered throughout the month of September, it is difficult to harvest for low seed moisture, which usually means that extra grain drying before storage is required. There can be an early killing frost at any time between late August through September, which can result in lower than average yields. Yields can also be reduced because of the high amount of immature tillers present at the time of a killing frost.

Granite Mountain, photographed from a field at the Delta Junction field research site by AFES professor Stephen Sparrow.

Palmer Area Test Site Characteristics

The Palmer test site is on Trunk Road, seven miles southwest of Palmer, on the upper bench of the UAF Agriculture and Forestry Experiment Station's Matanuska Experiment Farm. The site elevation is approximately 200 feet. The soil is a Knik silt loam that has been conventionally farmed for about sixty years, during which large quantities of animal manures have been added to the fields. This has made the soil quite uniform, with high levels of available nitrogen and potassium. This is also a moderate allophane soil, which means that it contains moderate levels of available aluminum. Because the aluminum bonds with soil phosphates, making the phosphorus unavailable, it is recommended that phosphorus fertilizers be banded with the seed to compensate. Knik soils are shallow silt loams over sands and gravels at average depths of one to three feet. The gravels in this area are glacially deposited. There are many small lakes in the lower elevations left from the last glacial retreat, indicating that the water table is at about 150 feet deep. The pH range of this soil is slightly acidic at 5.0–6.0.

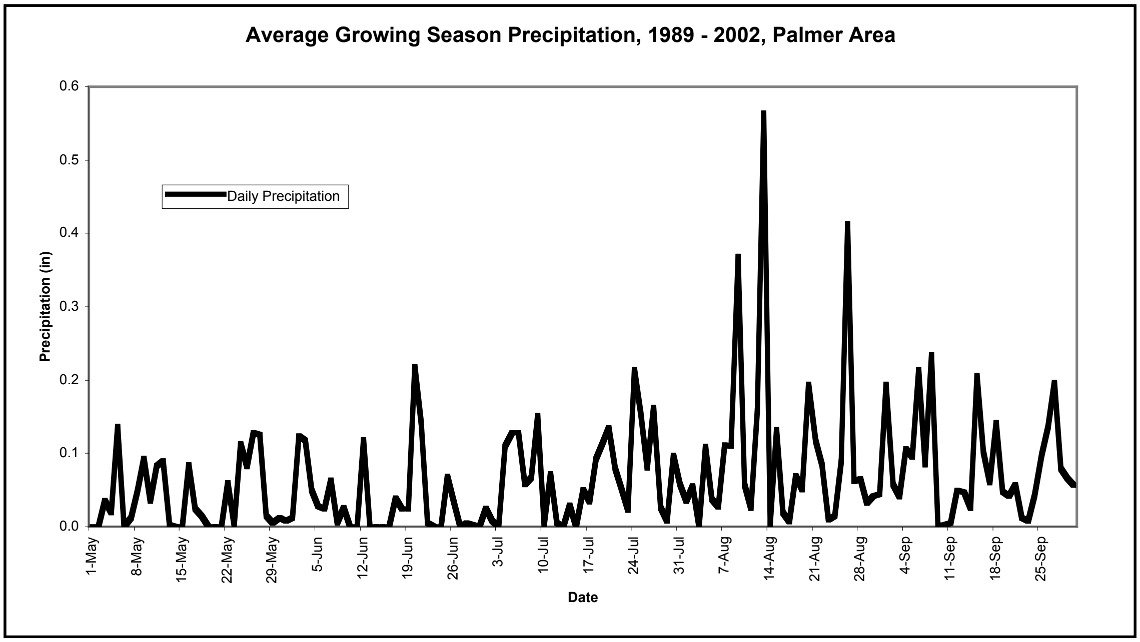


Figure 7. Average cumulative and daily growing season precipitation for the Palmer area, 1989–2002.

As in the Delta Junction area, high winter winds can occur in the Palmer area, so it is important to leave standing stubble after harvest or a rough soil surface after fallowing to trap the snow that is vital to early season soil moisture. Similar to the Fairbanks and Delta Junction areas, a packer pulled behind the tillage implement and a drill equipped with press wheels helps conserve moisture. The standing stubble from the fall or a rough soil surface from fallow tillage reduces soil erosion over the fall and winter months by reducing the the wind force and anchoring the soil against movement. This is especially important with fine textured silt loams that are easily moved by wind erosion. Because the Knik soils of the Palmer area are thin layers of silt loam over sands and gravels, any soil loss can be significant.

Since the early 1950s, the Palmer Research and Extension Center has been the location of all of the small grain plant breeding programs. Experimental breeding lines were tested against the standard varieties at the Palmer, Fairbanks, and Delta Junction sites for a number of years. This resulted in the eventual release of 'Lidal' feed barley (1972), 'Weal' hooded barley (1972), 'Otal' feed barley (1981), 'Datal' feed barley (1981), 'Thual' hulless barley (1981), and 'Finaska' feed barley (2000). Also released during this period were 'Toral' oat (1972), 'Ceal' oat (1972), 'Gasser' hard red spring wheat (1953), 'Ingal' hard red spring wheat (1981), 'Nogal' hard red spring wheat (1981), and 'Vidal' hard red spring wheat (1981). Variety testing and evaluation was done at this site primarily to determine plant breeding material. Beginning in the late 1980s with the hiring of a new plant breeder, small grain variety evaluations were done at the Palmer, Fairbanks, and Delta Junction sites with an emphasis on determining the genetic diversity of small grains from around the circumpolar north. The data presented in this publication is therefore limited to the 1989–2002 period.

Average planting date for this period was May 13. Average total precipitation for May for this test site was 1.28 inches (Fig. 7), which is wetter than any of the other areas. Generally, the first week of the month is drier than the remaining three weeks. The average cumulative GDD for the month of May was 450 (degrees F) (Fig. 8). This is cooler than the Fairbanks and Eielson areas, but about as warm as the Delta Junction area. The uniformity of the soil and sufficient soil moisture ensures that uniform germination and emergence occurs seven to ten days after planting. As at the other sites, any variation from the average soil moisture or soil temperatures due to drier or colder conditions can delay germination and emergence.

June's total precipitation, 1.14 inches more than May, fell mostly in a few heavy showers (Fig. 7). Most of the month is normally dry. Average cumulative GDD to the end of June was 1181 (Fig. 8). The end of June to the first of July is still when most varieties reached the 50% headed physiologic growth stage, even though temperatures for this area are cooler than those of the Fairbanks, Eielson, and Delta Junction areas. Compared to Fairbanks, there is a slight lag time of three to four days, which is similar to the Delta Junction site. Average 50% headed for the study period was July 7 with 1375 cumulative GDD. Even in years with delayed germination and emergence, crops reached the 50% headed physiologic growth stage during this period.

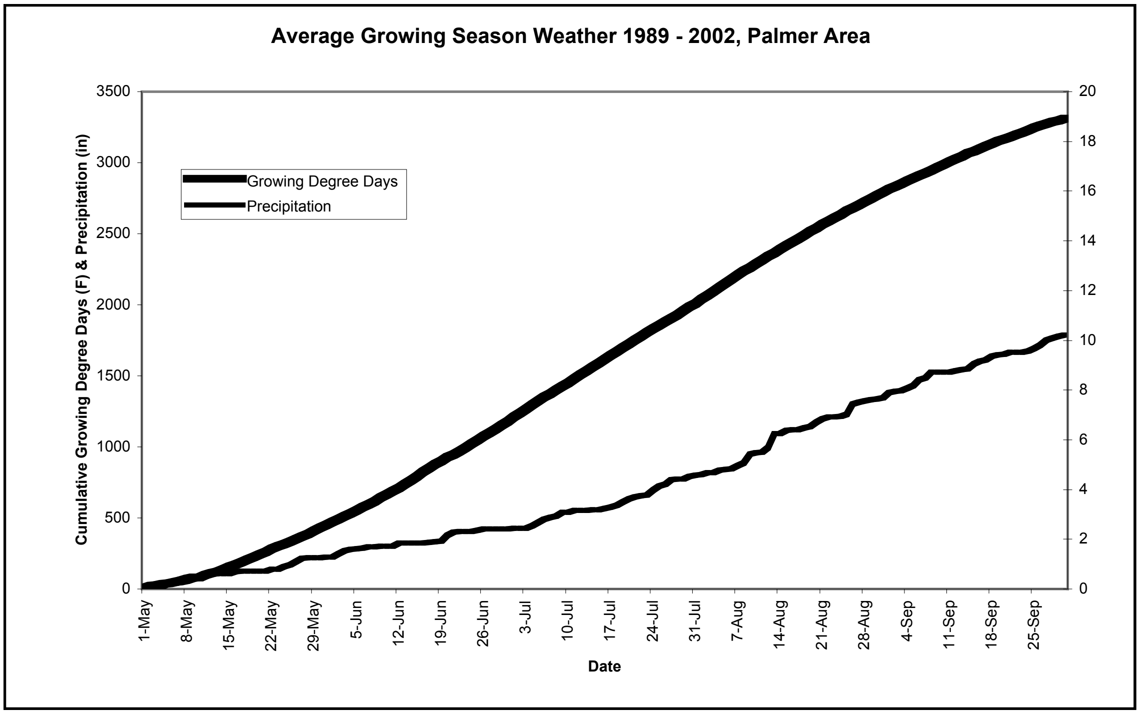


Figure 8. Average cumulative growing degree days and precipitation for the Palmer area, 1989–2002.

Precipitation at the Palmer site during July and August is generally greater than May and June, but unlike the Fairbanks, Eielson, and Delta Junction sites, these months are not the rainy season. The month of July received an average of 2.16 inches and August received 3.12 inches, with precipitation events scattered evenly throughout each month (Fig. 7). The end of July had 2011 cumulative GDD and the end of August had 2793 cumulative GDD (Fig. 8). As with the other sites, this is the period when most varieties reach the 50% maturity physiologic growth stage, although at Palmer this point is reached two to three days later than at Fairbanks. Cool and wet conditions can cause the 50% maturity dates for some late maturing varieties to occur as much as a week later than in the Fairbanks area. The average time to 50% maturity for the Palmer area was August 7 with 2210 cumulative GDD. High levels of available nitrogen coupled with high precipitation results in tall plant heights during this period. In weak-stemmed varieties, occasional high winds in August can then cause serious lodging.

The AFES Matanuska Research Farm. Photo by Connie Harris.

Average total precipitation for September was 2.51 inches (Fig. 7). The average cumulative GDD were 3309 (Fig. 8). Even though this month has much more total precipitation than any other month during the growing season, most of this precipitation comes in individual storm events. This allows time between storms for grain ripening and harvest. Unlike the Fairbanks, Eielson, and Delta Junction sites, there may not be a killing frost until much later in the month.

Depending on the amount and severity of lodging, as well as variety characteristics, many green tillers can occur this late in the growing season. Because there are not enough GDD to mature these tillers in September, grain from them is high in moisture at harvest. This reduces both the yield and test weights of the crop.

Barley Performance Trials

Spring Feed Barley

Barley is the most important grain crop grown in Alaska, and is well adapted to the state's long day length and short growing season. Although it is used primarily as an animal feed, some types, such as malting and hulless varieties, could fill fast-growing niche markets. There are two common species of barley that are differentiated by the shape of the seed heads. Six-rowed barley (*Hordeum vulgare* L.) has a long, round-shaped seed head with kernels forming six rows evenly around all sides. Two-rowed barley (*Hordeum distichum* L.) has a flat seed head with kernels forming two rows on opposite sides. Most barley varieties have a long awn attached to the hull surrounding the kernel. The awns of some varieties are smooth, but most are rough or bearded. These rough awns are barbed in one direction, a holdover genetic trait from wild barley that may have helped to ensure seed dispersal by animals. Unfortunately, the rough awns can work into the soft tissues around animals' mouths, nostrils, and eyes, causing potentially serious infections. If left on grain or found in straw, these rough awns make the crop undesirable for use as feed or bedding. When most varieties of barley are ripe (the kernel can't be dented with a thumbnail) and harvested at proper moisture conditions, these awns break off during the harvesting process. Except for hulless varieties, the fibrous hull remains on the kernel.

Most barley varieties grown in Alaska have been the six-row types, which usually mature earlier and are more uniform at harvest than the two-rowed types. Early-maturing six-row barley varieties usually produce three to four tillers per plant. Each tiller is an additional stem with its own seed head that often reaches maturity and ripens to increase yields at harvest. Two-row varieties, which mature later, often produce many tillers, even late into the growing season (late July to early August). These late tillers may be immature at harvest when the main head is ripe. They also tie up plant nutrients important in filling and ripening seed, and at harvest produce wet plant material mixed with the ripe seed, increasing drying costs.

Besides plant variety, a number of other factors can contribute to the formation of tillers: plant genetics, plant population density, soil fertility, the amount of light penetrating the canopy, etc. If the grain has lodged and fallen over due to high levels of nitrogen fertilizer, weak stems, or a strong wind or rainstorm late in the season, then more light can reach the plant base. This light and any extra moisture (from a rain storm, for example) stimulates tiller formation. Proper fertilization and planting rates can help reduce this.

Six-row barley varieties usually contain higher levels of protein and lower levels of carbohydrates compared to the two-row varieties. Although high protein content is an advantage in animal feed, barley is usually used as an energy source, added mainly for the carbohydrate content. Supplemental proteins are then added to feed from such sources as soybean meal, canola meal, fish meal, etc.

Barley photo by Jack Dykinga courtesy of the USDA Agricultural Service Photo Unit.

Date of planting and fertilizer rate studies done by F.J. Wooding (1973) and C.W. Knight (1989) found that combining late planting dates with high nitrogen fertilization produces barley that is higher in protein concentration. However, total yields and grain quality measures such as fiber content and test weights were significantly reduced. Two-row barley varieties often contain lower levels of protein and higher levels of carbohydrates. This is important in the malting industry, where low protein levels prevent cloudy precipitates and high carbohydrate levels are needed for conversion into alcohol. Two-row varieties that produce protein levels unsuitable for malting make excellent animal feed. For animal feed, the grain is usually ground or rolled and fed with the hull attached.

Because proper fertilization is important for producing high yields of high-quality barley, soil should be tested to determine which plant nutrients are limiting and how to correct for those deficiencies. Test soil in the fall on the field in which next year's crop will be grown. In general, all soils should receive a complete mix of nitrogen, phosphorus, potassium, sulfur, and boron. Complete fertilizer blends consisting of ammonium sulfate, urea, monoammonium phosphate, potassium chloride, and sodium borate work well in the soil conditions described previously. If ammonium sulfate is not available, a substitution of potassium sulfate for potassium chloride would work to provide the needed sulfur. Soils that have existing moderate to high levels of available nitrogen, phosphorus, and potassium should have a complete fertilizer blend consisting of the following: 15–18% N, 15–20% P_2O_5, 15–18% K_2O, 5–8% S, and 0.3–0.5% B. Actual percentages of each material and application rates vary according to specific soil test results. The fertilizer can be broadcast and incorporated with the spring tillage, or portions of it can be banded at planting.

Pure nitrogen fertilizers should be broadcast applied, especially at high rates, and should never be banded with the seed. Most forms, like urea, are hygroscopic and draw soil water away from the seed. This hinders germination and "burns" the seedlings. A general rule is to not place with the seed any more than 15 to 20 pounds per acre of nitrogen (as monoammonium phosphate for example). It is better to band these fertilizers 1 inch below and 1 inch to the side of the seed row. Newly cleared soils are usually low in available nitrogen and application rates should be increased to compensate for this. When a lot of plant residue (stubble and straw) is to be tilled in with the fertilizer, extra nitrogen should be applied to compensate for the microbial decomposition that competes with the crop for the available nitrogen. An extra 25 pounds of nitrogen per acre should be applied for each 2000 pounds of dry crop residue incorporated during spring tillage. Summer fallowed fields require less nitrogen than fields planted the previous year. This is especially true if the previous crop was a heavily fertilized one such as potatoes. It is easy to apply too high a nitrogen rate as many phosphorus carriers also contain nitrogen. Too high of a nitrogen application causes excessive plant heights which leads to lodging problems, late tillers, delayed maturity, and reduced total yields.

Where possible, phosphorus fertilizers should be banded with the seed. Many soils in Alaska have a low pH and high levels of free iron or aluminum ions. These conditions tend to fix phosphorus and make it unavailable for plant use. Banding a phosphorus fertilizer such as monoammonium phosphate with the seed allows the plant quick access and reduces overall soil fixation of phosphorus. If the fertilizer material is broadcast, application rates for phosphorus should be 20–25% higher.

Potassium fertilizers should be broadcast-applied with the nitrogen. As with potassium chloride, banding potassium with the seed causes serious salt problems, leading to poor germination and seedling damage. Proper potassium levels help reduce the incidence of plant lodging by increasing straw strength. Most soils in Alaska have moderate levels of potassium and good crop yields may be obtained without addition of this nutrient. Therefore, cropping systems where straw and stubble are added back to the soil, or where summer fallow is utilized, may be adequate to sustain yields over a long time. However, when all plant residues are removed or continuous cropping has occurred, about three times the amount of potassium is lost, so an increase in the potassium rate is needed.

Sulfur is deficient in many Alaska soils. Lack of sufficient sulfur decreases total yields and reduces overall grain quality. This is especially noticeable on older fields that have been in continuous production for five or more years. On summer fallow land, the crop response to sulfur is not as strong. Fertilizer blends containing ammonium sulfate or potassium sulfate should provide sufficient levels of sulfur when blended for nitrogen or potassium. Soils in the Tanana River floodplain are not deficient in sulfur due to the high concentration of calcium carbonate and calcium sulfate salts dissolved in the groundwater. These salts are brought into the root zone by capillary rise because the evaporation rate is greater than precipitation.

The micronutrient boron also is deficient in many Alaska soils. Studies by F.J. Wooding (1985) found that application rates of 0.5 to 1.0 pounds per acre of actual boron can increase yields by 10–15% and improve disease resistance. Care must be taken in applying boron, because too high a rate can produce toxic levels in the soil. Barley is especially sensitive to high boron levels. Rates higher than 2 to 3 pounds per acre can cause toxicity symptoms: small light brown spots near the edges of the upper leaves of barley. This can produce lower overall total yields than the 0.5 to 1.0 pounds per acre rates.

As previously mentioned, tillage practices that conserve the most soil moisture should be used. Broadcast fertilizer should be applied to the soil surface before tillage and incorporated along with any plant residues from the previous year. A packer should be pulled behind the tillage implement to form a weak crust on the surface. This helps to slow the soil moisture evaporation rate and keeps moisture within the root zone. Also, a drill equipped with press wheels helps to keep soil moisture in next to the seeds. Avoid tillage and soil packing when conditions are too wet, because this causes the soil to develop a hard crust that impedes emergence.

Use of certified seed is strongly recommended. This helps ensure good germination and emergence and reduces weed and disease infestations. Heavy seeding rates of 90 to 100 pounds per acre of pure live seed are important to help reduce late tillering and ensure uniform ripening. Barley should be planted at a depth of 1½ to 2½ inches so it is in contact with moist soil. Deeper seeding slows emergence, produces thin stands, and reduces yields.

Pest control practices for high-quality, high-yielding barley is also important. Assess each field for all pests (weeds, diseases, and insects) and plan control measures accordingly. Identification of potential pests before they become a serious problem is the first step in producing good crops. There are many excellent published identification and control guides for common crop weeds, insects, and diseases. Meister Media Worldwide publishing company's books, *Weed Control Manual* and *Insect and Disease Control Guide* are good examples. Consult the local area Cooperative Extension Agent for more information.

Weed control for this study was a combination of mechanical and chemical summer fallow to reduce the number and species of weeds for the following year and an application of a post-emergence herbicide. Common annual broadleafed weeds in Alaska fields are chickweed (*Stellaria media* L.), corn spurry (*Spergula arvensis* L.), hawksbeard (*Crepis tectorum* L.), lambsquarter (*Chenopodium album* L.), Pennsylvania smartweed (*Polygonum pensylvanicum* L.), shepherd's purse (*Capsella bursa-pastoris* (L.) Medic.), tansy mustard (*Descurainia sophioides* Fisch.), and wild buckwheat (*Polygonum convolvlus* L.). Good results for control of these broadleaf weeds were obtained using a tank mix of Bromoxynil and MCPA or a 2,4-D amine. These herbicides must be applied after the barley has reached the three-leaf stage, but before it reaches the boot stage, and when the weeds are small and free from drought stress. If a choice of herbicides is available, it is best to use the one that causes the least stress to the crop.

Common grassy weeds are bluejoint reed grass (*Calamogrostis canadensis* (Michx.) Beauv.), foxtail barley (*Hordeum jubatum* L.), and quackgrass (*Agropyron repens* (L.) Beauv.). Best control of grassy weeds is a combination of mechanical and chemical summer fallow. To eliminate grassy weeds with chemical fallow, a broad-spectrum post-emergence herbicide such as glyphosphate (Roundup) was used. Higher than recommended application rates can injure the crop, leading to increased tillering and reduced yields. Also, studies done by C.W. Knight and C.E. Lewis (1981) and J.S. Conn (1990) have found that in cold soils some herbicides can be persistent and take many years to break down, resulting in potential detrimental effects on subsequent rotational crops. Remember to always read the pesticide label and follow the directions on mixing, application, and disposal.

Net blotch (*Pyrenophorea teres*), spot blotch (*Cochliobolus sativus*), and barley scald (*Rhynchosporium secalis*) are the most prevalent fungal diseases found on barley in Alaska. All of these diseases produce brown spots on the leaves. Net blotch produces light brown blotches of irregular size and shape with dark brown net-like patterns within. Spot blotch produces round or oblong spots that later combine to form irregular brown stripes. Barley scald produces water-soaked lesions that later appear scalded. The spotted leaves have reduced photosynthetic ability, which reduces yields. All of these diseases develop in the cool, moist environmental conditions that often exist in Alaska just before and during the 50% maturity growth stage. Because these diseases over-winter on plant residues, they are most prevalent in barley after barley rotations. If infection levels are high, yield and grain quality reductions can be significant. To reduce disease in following seasons, a year of summer fallow or another crop in the rotation is recommended.

Other fungal diseases such as barley stripe mosaic (*Pyrenophora graminea*) and loose smut (*Ustilago nuda*) have also been found in Alaska. Although not as prevalent as net blotch, spot blotch, and scald, a 1.0% infection of barley stripe can cause a 0.75% reduction in yield. Stripe causes long white or yellow stripes along the leaves that later run together and turn brown. The plants are stunted and the seed heads may not emerge. Loose smut forms loose, powdery brown masses in place of the seed head and earlier than normal heads. These fungal spores are then blown around the field to infect the forming seed on the rest of the crop. These diseases are seed borne and can be controlled with a seed treatment. To prevent disease infections due to seed-borne fungal attacks, seed should be treated with a seed protectant such as carboxin (Vitavax).

Many different species of Fusarium fungi (*Fusarium graminearum* and others) that cause Fusarium blight have been found on barley. They are easily identified by the pinkish color of the fungal mass on diseased kernels. They form on seed heads during seasons of high precipitation and can increase in storage if moisture and temperature levels are higher than optimum. Fusarium molds may reduce yields and can produce mycotoxins. If infected barley is used for feed, it can cause unpalatability may be toxic to animals, especially swine. Because this disease overwinters on plant residues, it is most prevalent in barley after barley rotations. A year of summer fallow or another crop in the rotation is recommended to reduce the level of disease in following years.

There are two important virus diseases of barley: barley stripe mosaic virus (BSMV) and barley yellow dwarf virus (BYDV). Both cause stunted plants. Stripe mosaic causes light green or yellow leaves, while yellow dwarf causes bright golden yellow leaves. These viruses are both seed-borne, and the only control is to plant clean seed or resistant varieties. Yellow dwarf can be transmitted from plant to plant by several species of aphids (family Aphididae). This can become especially problematic during years of heavy aphid infestation. However, most aphid population booms occur late in the barley growing season so yellow dwarf is not a serious disease problem. Stripe mosaic differs from fungal barley stripe; a barley plant with stripe mosaic remains light green or yellow; it turns brown with fungal barley stripe.

Other than aphids, the most serious insect pests for barley are grasshoppers, including the lesser migratory grasshopper (*Melanoplus sanguinipes* Fabricias), the northern grasshopper (*Melanoplus borealis* Fieber), and the clear-winged grasshopper (*Camnula pellucida* Scudder). Grasshoppers in Alaska usually have a two-year growth cycle, becoming pests every other year. Weather, soil conditions, and previous cropping practices can affect the cycle and extend the time between infestations. Although tillage practices such as summer fallow destroy eggs in the soil, any eggs laid in fence rows, ditches, or nearby untilled fields may overwinter, hatch, and emerge as nymphs in June. Young grasshoppers start moving into grain fields when the plants are at the three- to five-leaf stage. Heavy infestations at this time can severely defoliate the crop. Grasshoppers can damage the crop at any plant growth stage by eating leaves or even the green awns after heading has occurred. This reduces yields by reducing the plants' ability to photosynthesize. Diazinon or carbaryl (Sevin) sprays or baits help control heavy infestations. Remember to always read the pesticide label and follow the directions on mixing, application, and disposal.

Migratory waterfowl can inflict heavy crop damage in both the spring and the fall. In spring, early germinating barley varieties such as the malting cultivars are especially susceptible to predation. Because malting barley is genetically adapted to germinate early and uniformly for malt production, it is the first of the barley varieties variety to emerge in the spring after planting. Large flocks of returning migratory waterfowl can cause serious damage to these varieties merely by walking down the row and pecking out each newly emerged plant. In some years of our research, many small plots were completely wiped out. In the fall, migrating waterfowl often prefer the hulless barley varieties. If the grain is significantly lodged, damage can increase dramatically. Otherwise, they usually work the edges of fields where they have a large field of vision. Propane scare cannons, designed to swivel in different directions and go off at uneven time intervals, seem to work best at keeping birds out of fields. Check with and inform the neighbors before setting up cannons. For more information contact the local office of the Alaska Department of Fish and Game.

Barley stops growing when it reaches the hard dough stage. The heads are light yellow in color and the kernels can't be dented when pressed with a thumbnail. The typical moisture content of the gain at this stage is 25–35%. Barley can be harvested at this moisture content, but artificial drying is required and a significant loss of germination ability can occur. Continued ripening reduces moisture in the seed heads. Barley must be around 14% moisture for safe, long-term storage. Moisture content higher than 14% can result in the grain germinating or molding; significantly lower moisture content can result in embryo damage, reducing germination ability. Both situations reduce the quality of the stored grain. Grain harvested before or at the hard dough stage has a fair amount of green, high-moisture heads. This underdeveloped grain is low in yield, test weights, starch content, and market value.

It is important then to harvest barley at the optimum grain moisture content and degree of ripeness. No field is completely uniform in ripeness, so timing of combine harvest is usually set around weather events, with supplemental grain drying after harvest. If such conditions as weather and field uniformity are right, standing barley dries faster and suffers less damage from moisture. Swathers are often used in fields having significant amounts of green tillers or weeds that would raise grain moisture content at harvest. The swather windrows the grain on stubble that is about one-third the total height of the grain. The excess moisture dries off in about seven to ten days after swathing in cool moist conditions and in three to four days in hot dry weather. The windrows are then picked up with a combine that has a pick-up attachment.

Care must be taken in swathing or combining to prevent or reduce losses from improper cutting height, shattering, crinkling and weathering. If the cutter bar is too high, then short-stemmed heads fall to the ground and do not get picked up by the combine. Light windrows also have a tendency to settle into the stubble, where the grain may start to sprout. Head shatter, or loss of the grain due to physical contact, occurs on overripe barley. Some varieties are more susceptible to this than others, and six-row varieties are more susceptible than two-row varieties. Crinkling is when the heads bend over and "nod" towards the ground. Such stems may break soon after maturity, especially in damp weather. In weathering, or sun bleaching, the grain swells when damp and does not shrink after drying. These kernels are less dense and thus have a lower test weight, although other quality measurements are unaffected.

Combine settings should be adjusted so that the concave clearance and cylinder speed produces the highest amount of clean seed. Awns should be completely broken off of the kernels without cracking the kernels. To reduce the incidence of peeling or skinning the hull, augers should be run full, or if not full, then at slower speeds. When the hull is peeled the embryo becomes exposed and thus subject to potential damage during handling. Any damage to the embryo lowers the seed's germination ability. Every time grain is handled, more damage to the kernels occurs. This is less important when grain is grown for animal feed than when grown for seed. The highest quality barley brings the highest price.

Although it's best to leave barley standing in the field until the optimum 14% moisture level is reached, then direct combine or swath the grain, weather and field conditions do not always work out that way, so the crop is often harvested at higher moisture levels. There are two things that should be done to optimize moisture levels and prevent damage to seed after threshing. First, clean the seed. Removing weed seeds and other plant material with high moisture content makes the drying process much easier and cheaper and improves overall crop quality. Second, provide supplemental drying. If the outside air has low humidity, forcing it through the seed removes a lot of mositure. If the outside air has high humidity, heat must be applied when aerating the seed to draw moisture away. Care must be taken not to provide too much heat during the drying or storage process, because this can literally cook the seed, damaging the embryo and severely reducing germination ability. Heat-damaged kernels exhibit a dark brown or black discoloration on either the basal or awn end of the kernel, or both. Heat damange is not as significant in barley grown only for feed.

In Alaska there is a strong market for barley as an animal feed supplement, and there is a seed production industry to provide local farmers with certified seed. The market for barley straw for bedding is limited because it contains the rough awns removed from the seed during harvest. In livestoock, awns can penetrate soft tissues around eyes, mouth, nose, and ears, causing irritation and possibly infection.

Recommended Variety Descriptions for Spring Feed Barley

Note: See Appendix 1 for the addresses of seed suppliers.

'Otal' is an early maturing, mid-tall, stiff-strawed, rough-awned, six-row, high-yielding spring barley. It was released in 1981 by the USDA plant breeding program at the AFES Palmer Research and Extension Center. It is a cross between a six-rowed Finnish cultivar, 'Otra' and an unnamed early maturing two-rowed selection from Sweden. In this report, 'Otal' performance is the standard against which all other varieties were compared. Direct inquiries about seed sources to the Alaska Seed Growers Association or the Alaska Plant Materials Center.

'Albright' is an early maturing, tall, stiff-strawed, rough-awned, six-row, high-yielding spring barley released in 1992 by Agriculture Canada in Beaverlodge, Alberta. Selected from 'Otal,' it has many of the same characteristics, although 'Albright' is slightly taller, more uniform, and consistently produces higher test weights than 'Otal'. Direct inquiries about seed sources to the SeCan Association, Agricore United, or the Alaska Farmers Coop elevator in Delta Junction.

'Arra' is an early maturing, tall, stiff-strawed, rough-awned, six-row, high-yielding spring barley released in 1982 by the Department of Plant Breeding, Agriculture Research Centre at Jokioinen, Finland. It is a cross between the six-rowed varieties 'Varde' and 'Otra.' Before release it was tested as 'Jo 1184'. 'Arra' has a higher lysine content than most other barley varieties, making it a good choice for swine diets. Direct inquiries about seed sources to the Alaska Seed Growers Association or the Alaska Plant Materials Center.

'Datal' is an early maturing, mid-tall, stiff-strawed, rough-awned, six-row, high-yielding spring barley released in 1981 by the USDA plant breeding program at the AFES Palmer Research and Extension Center. It is a cross between a six-rowed Swedish cultivar, 'Edda' and an unnamed early maturing two-rowed selection from Sweden. 'Datal' is more susceptible to yield reductions from early season drought conditions than 'Otal.' Direct inquiries about seed sources to the Alaska Seed Growers Association or the Alaska Plant Materials Center.

'Finaska' is an early maturing, short, stiff-strawed, rough-awned, six-row, high-yielding spring barley released in 2000 by the plant breeding program at the AFES Palmer Research and Extension Center. It is a cross between two six-rowed Finnish cultivars, 'Jo 1632' and 'Jo 1599'. 'Finaska' has better lodging resistance than 'Otal,' but lower test weights. Direct inquiries about seed sources to AFES Fairbanks Experiment Farm or the Alaska Plant Materials Center.

'Lidal' is an early maturing, mid-tall, stiff-strawed, rough-awned, six-row, high-yielding spring barley released in 1972 by the USDA plant breeding program at the AFES Palmer Research and Extension Center. It is a cross between a six-rowed Swedish cultivar, 'Edda' and the early maturing six-rowed cultivar 'Olli' from Finland. 'Lidal' has only a fair resistance to lodging and head shattering compared with 'Otal'. 'Lidal' is a good yielding variety for later planting dates (late May). Direct inquiries about seed sources to the Alaska Seed Growers Association or the Alaska Plant Materials Center.

'Svendal' is an early maturing, mid-tall, stiff-strawed, rough-awned, six-row, high-yielding spring barley released in 1982 by Alamasu, Inc. of Delta Junction, Alaska. It is a cross between the six-rowed Alaska cultivar 'Lidal' and the early maturing six-rowed Swedish cultivar, 'Edda'. 'Svendal' is consistently earlier maturing than 'Otal' by two to four days. Direct inquiries about seed sources to Alamasu, Inc.

'Eero 80' is an early maturing, semidwarf, stiff-strawed, rough-awned, six-row, high-yielding spring barley developed and released in 1975 by the Hankkija Plant Breeding Institute in Finland. It is a cross between the six-rowed 'Otra' and the two-rowed cutivar 'Mari'. It averages only 24 inches in height and has resistance to lodging under high fertilization rates. Low straw yields plus response to high fertilization may make this variety important in minimum or no tillage practices. Direct inquiries about seed sources to the Alaska Seed Growers Association or the Alaska Plant Materials Center.

'Weal' is an early maturing, tall, stiff-strawed, hooded, six-row, high-yielding spring barley released in 1972 by the USDA plant breeding program at the AFES Palmer Research and Extension Center. Because hooded barley awns are winged and hollow rather than rough and spiked,'Weal' was

developed primarily for use as a forage crop, although dry matter yields are slightly less than the best oat varieties. It is fairly resistant to lodging and can withstand high winds. 'Weal' is subject to yield reductions from early season drought conditions compared with 'Otal'. It also averages about seven days later in maturity than 'Otal'. Direct inquiries about seed sources to the Alaska Seed Growers Association or the Alaska Plant Materials Center.

Winter Feed Barley

Winter feed barley, like spring feed barley, is either six-rowed (*Hordeum vulgare* L.) or two-rowed (*Hordeum distichum* L.). Winter barley, like winter wheat and winter rye, is usually planted in late summer to early fall. To build up winter reserves, it usually requires as much as two more weeks of growth than other winter grains and so is planted earlier. It produces a small, low rosette of vegetative growth that builds up root reserves before winter dormancy. The next spring it assumes an upright growth form with a seed head similar in appearance to other annual grains. Winter barley will produce more tillers than other winter grains, but suffers from weak straw and significant lodging. In Alaska winter barley production is problematic. First, winter barley is adapted to more southern climates and is primarily grown no farther north than southern New York and the Great Lake states. Second, there is a thirteen-month growing season compared to the three-month season for an annual grain crop. Also, winter barley, like all winter grains in Alaska, is susceptible to winter kill from freezing injury to the rosette, desiccation and freeze-drying of the rosette, and attacks of snowmold fungi, including white snowmold (*Sclerotinia borealis*) and pink snowmold (*Gerlachia nivalis*).

The cost in time of thirteen months verses three months, the susceptibility to snowmolds, very late maturity, and the high probability of winter kill detracts from the economic viability of this crop in Alaska. Due to the lack of consistent success with other winter grains in Alaska, no winter barley varieties were tested during the period of this study. Before this study, F.J. Wooding and others tested two varieties of winter barley ('Dicktoo' and 'Kearney') in the Fairbanks area with no success. Due to these cultural problems, no varieties of winter barley are recommended.

Yields and Test Weights by Location for Feed Barley

Most agronomic crops, including barley, are bought and sold by weight, usually by the ton. On the other hand, storage facilities (truck beds, bins, elevators, etc.) are measured in units of volume, usually the bushel. Therefore, a standardized density measurement of weight per unit volume or test weight was developed to use as the legal unit for selling the crop. The standard test weight for clean, dry, and undamaged barley is 48 pounds per bushel. Test weights are taken at the grain elevator and used to determine crop quality. Low test weights can reflect the presence of foreign material, lack of maturity, high nitrogen fertilizer application, or severe drought during the growing season. Any low test weight reduces crop value. Test weights can differ between cultivars and can change within a single cultivar, depending on cultural practices, weather conditions, and location where grown. Weight is used here as a measure of grain quality to determine maturity. In tables 1 through 5, yields are expressed in pounds per acre. Bushels per acre can be determined by dividing the yield of any specific cultivar by the standard test weight.

Tables 1 through 5 list barley yields and quality measurements for all test locations: Fairbanks, Eielson, Delta Junction and Palmer. All sites in the Delta Junction area have been combined into either the Delta dryland site (Table 3) or, if grown under irrigation, the Delta irrigated site (Table 4). Each table also contains information on barley type (six-row, two-row, hooded, etc.), the source or the location of where it was bred, and the years it was tested at each location. Maturity in this study was considered to be when 50% of the heads for each plot were at the hard dough stage. The heads were a light yellow in color and the kernels did not dent when pressed with a thumbnail. Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued crop growth. The low temperature point for barley in this report is the freezing point of water, 32° F. The GDD calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. All varieties were compared with 'Otal' as the standard variety. Yield as a percent of 'Otal' were determined by dividing the average yield of each variety by the average yield of 'Otal'. Maturity vs. 'Otal' is the number of days each variety reached 50% maturity either before or after the number of days that 'Otal' reached 50% maturity.

These alternating plots of canola (rapeseed) and barley are part of no-till experiments carried out at the AFES Delta Junction Field Research Site. AFES file photo.

Table 1. Average yields and quality measurements from barley variety test plots in the Fairbanks area, 1978 – 2002.

Barley Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Otal)	Est. Wt. (lbs/ bu)	Lodging (%)	Average Maturity Date	Maturity vs. Otal (days)	Average Maturity (GDD)*
6-row feed									
Agneta	(Sweden)	3	6008	151	47	18	1-Aug	1	2273
Albright	(Alberta)	6	5363	135	50	42	1-Aug	1	2273
Arra	(Finland)	8	4338	109	46	31	29-Jul	-1	2189
Arve	(Finland)	4	5769	145	47	14	31-Jul	0	2244
Azure	(Idaho)	2	3469	87	46	33	2-Aug	2	2301
Bamse	(Sweden)	3	6114	153	48	8	2-Aug	2	2301
Bode	(Norway)	3	4027	101	44	28	1-Aug	1	2273
Brier	(Saskatchewan)	3	5625	141	45	43	8-Aug	8	2464
Cougbar	(Washington)	2	3542	89	44	44	2-Aug	2	2301
Datal	(Alaska)	6	4092	103	45	36	28-Jul	-2	2162
Duke	(Saskatchewan)	1	3321	83	44	0	1-Aug	1	2273
Edda	(Sweden)	3	5061	127	48	32	1-Aug	1	2273
Finaska	(Alaska)	4	5143	129	47	33	31-Jul	0	2244
Galt	(Alberta)	3	3819	96	47	35	31-Jul	0	2244
Heartland	(Manitoba)	1	2001	50	45	0	3-Aug	3	2328
Jackson	(Alberta)	3	3036	76	46	24	27-Jul	-3	2134
Jo 1599	(Finland)	4	6871	172	47	31	2-Aug	2	2301
Jo 1632	(Finland)	5	4794	120	47	30	1-Aug	1	2273
Karin	(Sweden)	3	5498	138	46	8	31-Jul	0	2244
Lacombe	(Alberta)	3	5892	148	46	27	5-Aug	5	2383
Lidal	(Alaska)	3	5321	134	48	25	31-Jul	0	2244
Loviisa	(Finland)	4	5978	150	48	15	3-Aug	3	2328
Nobel	(Alberta)	2	3962	99	47	35	31-Jul	0	2244
Nordlys	(Norway)	3	4508	113	45	33	29-Jul	-1	2189
Olli	(Finland)	3	4371	110	45	42	31-Jul	0	2244
Olsok	(Norway)	3	5014	126	48	25	31-Jul	0	2244
Otal	(Alaska)	16	3985	100	48	27	31-Jul	0	2244
Otra	(Finland)	3	2266	57	41	54	27-Jul	-3	2134
Pohto	(Finland)	4	5766	145	48	30	4-Aug	4	2355
Pokko	(Finland)	6	4572	115	45	17	31-Jul	1	2244
Ripa	(Sweden)	3	5744	144	48	17	2-Aug	2	2301
Stacey	(Alberta)	3	5249	132	46	22	6-Aug	6	2411
Steptoe	(Washington)	2	4339	109	44	82	2-Aug	2	2301
Svendal	(Alaska)	7	3152	79	47	14	26-Jul	-4	2107
Thule	(Norway)	3	6257	157	48	8	7-Aug	7	2438
Verner	(Sweden)	3	5368	135	49	3	4-Aug	4	2355

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Table 2. Average yields and quality measurements from barley variety test plots in the Eielson area, 1993 – 2001.

Barley Variety Name	Source	Years Tested	Yield (lbs/acre)	Yield (% of Otal)	Est Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Otal (days)	Average Maturity (GDD)*
6-row feed									
Arra	(Finland)	1	1993	92	48	0	5-Aug	2	2388
Otal	(Alaska)	6	2179	100	46	0	3-Aug	0	2334
Pokko	(Finland)	1	1822	84	45	0	7-Aug	4	2444
Svendal	(Alaska)	3	2856	131	46	0	29-Jul	-5	2194
6-row feed, semidwarf									
Eero 80	(Finland)	4	2602	119	47	0	2-Aug	-1	2306
Stetson	(Alberta)	3	2504	115	39	0	13-Aug	10	2599

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Table 3. Average yields and quality measurements from barley variety test plots in the Delta Junction area, 1978–2002 dryland site.

Barley Variety Name	Source	Years Tested	Yield (lbs/acre)	Yield (% of Otal)	Est. Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Otal (days)	Average Maturity (GDD)*
(6-row feed)									
Agneta	(Sweden)	2	2412	100	45	0	5-Aug	1	2190
Albright	(Alberta)	5	2773	115	48	0	1-Aug	-3	2085
Arra	(Finland)	8	2401	100	46	0	6-Aug	2	2217
Arve	(Finland)	3	2650	110	45	0	1-Aug	-3	2085
Azure	(Idaho)	2	3002	125	46	0	1-Sep	28	2744
Bamse	(Sweden)	1	3246	135	45	0	2-Aug	-2	2112
Bode	(Norway)	1	2826	118	43	0	30-Jul	-5	2032
Brier	(Saskatchewan)	1	3110	129	41	0	2-Aug	-2	2112
Cougbar	(Washington)	2	3231	134	48	0	1-Sep	28	2744
Datal	(Alaska)	5	3215	134	48	0	9-Aug	5	2289
Duke	(Saskatchewan)	1	2244	93	46	0	29-Jul	-6	2005
Edda	(Sweden)	1	2681	112	46	0	31-Jul	-4	2058
Finaska	(Alaska)	4	2320	97	43	0	1-Aug	-3	2085
Galt	(Alberta)	3	3082	128	48	0	14-Aug	10	2404
Heartland	(Manitoba)	1	2029	84	47	0	29-Jul	-6	2005
Jackson	(Alberta)	3	3311	138	51	0	12-Aug	8	2361
Jo 1599	(Finland)	3	2604	108	44	0	5-Aug	1	2190

Table 3 continued on next page

Table 3. Average yields and quality measurements from barley variety test plots in the Delta Junction area, 1978–2002 dryland site.

Barley Variety Name	Source	Years Tested	Yield (lbs/acre)	Yield (% of Otal)	Est. Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Otal (days)	Average Maturity (GDD)*
Jo 1632	(Finland)	5	2115	88	44	0	6-Aug	2	2217
Karin	(Sweden)	1	3074	128	44	0	3-Aug	-1	2138
Lacombe	(Alberta)	2	2047	85	42	0	31-Jul	-4	2058
Lidal	(Alaska)	1	3221	134	47	0	3-Aug	-1	2138
Loviisa	(Finland)	2	3202	133	45	0	3-Aug	-1	2138
Nobel	(Alberta)	2	3546	148	48	0	24-Aug	20	2604
Nordlys	(Norway)	1	2881	120	43	0	30-Jul	-5	2032
Olli	(Finland)	1	2844	118	44	0	31-Jul	-4	2058
Olsok	(Norway)	1	3243	135	48	0	29-Jul	-6	2005
Otal	(Alaska)	16	2403	100	47	3	4-Aug	0	2165
Otra	(Finland)	3	3404	142	49	28	9-Aug	5	2289
Pohto	(Finland)	3	2845	118	45	0	3-Aug	-1	2138
Pokko	(Finland)	5	3103	129	46	0	10-Aug	6	2313
Ripa	(Sweden)	2	2389	99	46	0	30-Jul	-5	2032
Stacey	(Alberta)	1	2997	125	41	0	4-Aug	0	2165
Steptoe	(Washington)	2	3095	129	46	0	30-Aug	26	2710
Svendal	(Alaska)	7	2464	103	48	4	2-Aug	-2	2112
Thule	(Norway)	1	3520	146	44	0	5-Aug	1	2190
Verner	(Sweden)	2	2517	105	47	0	2-Aug	-2	2112
6-row feed, semidwarf									
Eero 80	(Finland)	10	2564	107	46	0	9-Aug	5	2289
Kasota	(Alberta)	3	1848	77	41	0	3-Aug	-1	2138
Stetson	(Alberta)	3	1414	59	41	0	2-Aug	-2	2111
Winchester	(Alberta)	2	3338	139	50	0	24-Aug	20	2604
2-row feed									
Andre	(Washington)	1	2204	92	49	0	1-Aug	-3	2085
Dolly	(Alberta)	1	1808	75	39	0	10-Aug	6	2313
Duece	(Saskatchewan)	3	3373	140	52	0	16-Aug	12	2446
Gallatin	(Montana)	2	3569	149	55	0	25-Aug	21	2624
Lewis	(Montana)	2	3771	157	55	0	29-Aug	25	2693
Valier	(Montana)	1	2955	123	43	0	10-Aug	6	2313
(6-row hooded)									
Weal	(Alaska)	3	3338	139	44	0	15-Aug	11	2425

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Table 4. Average yields and quality measurements from barley variety test plots in the Delta Junction area, 1998 – 2000, irrigated site.

Barley Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Otal)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Otal (days)	Average Maturity (GDD)*
6-row feed									
Agneta	(Sweden)	2	3718	101	48	0	31-Jul	-2	2058
Albright	(Alberta)	3	3931	106	49	0	5-Aug	3	2190
Arra	(Finland)	3	3887	105	47	0	2-Aug	0	2112
Arve	(Finland)	3	3628	98	46	0	4-Aug	2	2165
Bamse	(Sweden)	1	3718	101	46	0	31-Jul	-2	2058
Bode	(Norway)	1	3520	95	44	0	30-Jul	-3	2032
Brier	(Saskatchewan)	1	4394	119	43	0	7-Aug	5	2241
Datal	(Alaska)	1	3387	92	48	0	1-Aug	-2	2085
Earl	(Saskatchewan)	1	4391	119	39	0	31-Jul	-2	2058
Edda	(Sweden)	1	3582	97	46	0	4-Aug	2	2165
Finaska	(Alaska)	2	4051	110	44	0	5-Aug	3	2190
Jo 1599	(Finland)	3	4151	112	46	0	9-Aug	7	2289
Jo 1632	(Finland)	2	3793	103	45	0	2-Aug	0	2112
Karin	(Sweden)	1	3275	89	44	0	31-Jul	-2	2058
Lacombe	(Alberta)	2	4088	111	45	0	4-Aug	2	2165
Lidal	(Alaska)	1	3629	98	46	0	31-Jul	-2	2058
Loviisa	(Finland)	2	3966	107	46	0	5-Aug	3	2190
Nordlys	(Norway)	1	3506	95	44	0	31-Jul	-2	2058
Olli	(Finland)	1	3605	97	45	0	30-Jul	-3	2032
Olsok	(Norway)	1	3914	106	46	0	2-Aug	0	2112
Otal	(Alaska)	3	3700	100	49	0	2-Aug	0	2112
Pohto	(Finland)	3	4222	114	47	0	5-Aug	3	2190
Pokko	(Finland)	1	4385	119	45	0	3-Aug	1	2138
Ripa	(Sweden)	2	3574	97	48	0	29-Jul	-4	2005
Stacey	(Alberta)	1	4734	128	43	0	6-Aug	4	2217
Svendal	(Alaska)	2	3597	97	48	0	31-Jul	-2	2058
Thule	(Norway)	1	4035	109	45	0	5-Aug	3	2190
Verner	(Sweden)	2	3552	96	50	0	4-Aug	2	2165
6-row feed, semidwarf									
Eero 80	(Finland)	3	4158	112	46	0	7-Aug	5	2241
Kasota	(Alberta)	2	4136	112	48	0	1-Aug	-1	2085
Stetson	(Alberta)	2	3111	84	44	0	1-Aug	-1	2085
2-row feed									
Dolly	(Alberta)	2	3471	94	45	0	11-Aug	9	2337

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Table 5. Average yields and quality measurements from barley variety test plots in the Palmer area 1989–2002.

Barley Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Otal)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Otal (days)	Average Maturity (GDD)*
6-row feed									
Agneta	(Sweden)	3	4091	122	48	20	15-Aug	7	2417
Albright	(Alberta)	6	4311	128	47	24	6-Aug	-2	2182
Arra	(Finland)	6	3944	117	48	23	8-Aug	0	2238
Arve	(Finland)	4	4222	125	50	14	13-Aug	5	2366
Azure	(Idaho)	1	2987	89	50	0	28-Aug	20	2726
Bamse	(Sweden)	3	4342	129	49	18	15-Aug	7	2417
Bode	(Norway)	3	3980	118	46	17	11-Aug	3	2314
Brier	(Saskatchewan)	3	3645	108	45	33	21-Aug	13	2566
Cougbar	(Washington)	1	3303	98	50	0	28-Aug	20	2726
Datal	(Alaska)	3	3855	115	49	45	13-Aug	5	2366
Edda	(Sweden)	3	3566	106	50	43	13-Aug	5	2366
Finaska	(Alaska)	7	3990	119	46	3	5-Aug	-3	2155
Galt	(Alberta)	1	3476	103	51	0	21-Aug	13	2566
Jackson	(Alberta)	1	3326	99	54	85	16-Aug	8	2440
Jo 1599	(Finland)	4	4544	135	46	9	19-Aug	11	2519
Jo 1632	(Finland)	5	4312	128	47	17	9-Aug	1	2262
Karin	(Sweden)	3	3865	115	47	18	13-Aug	5	2366
Lacombe	(Alberta)	3	4042	120	47	18	17-Aug	9	2464
Lidal	(Alaska)	3	3667	109	48	35	11-Aug	3	2314
Loviisa	(Finland)	4	4573	136	49	21	14-Aug	6	2393
Nobel	(Alberta)	1	3243	96	51	0	28-Aug	20	2726
Nordlys	(Norway)	3	3603	107	45	18	9-Aug	1	2262
Olli	(Finland)	3	3154	94	47	55	9-Aug	1	2262
Olsok	(Norway)	3	4496	134	51	13	11-Aug	3	2314
Otal	(Alaska)	10	3365	100	47	19	8-Aug	0	2238
Otra	(Finland)	1	3581	106	47	75	12-Aug	4	2340
Pohto	(Finland)	4	4739	141	49	19	16-Aug	8	2440
Pokko	(Finland)	4	4378	130	45	34	16-Aug	8	2440
Ripa	(Sweden)	3	3921	117	49	18	12-Aug	4	2340
Stacey	(Alberta)	3	3630	108	45	48	18-Aug	10	2492
Steptoe	(Washington)	1	3615	107	50	0	28-Aug	20	2726
Svendal	(Alaska)	1	3105	92	50	75	11-Aug	3	2314
Thule	(Norway)	3	3859	115	46	12	19-Aug	11	2519
Verner	(Sweden)	3	4405	131	51	13	16-Aug	8	2440
6-row feed, semidwarf									
Eero 80	(Finland)	7	3760	112	48	21	17-Aug	9	2464
Kasota	(Alberta)	4	3781	112	46	5	14-Aug	6	2393
Winchester	(Alberta)	1	2583	77	50	0	28-Aug	20	2726
(2-row feed)									
Dolly	(Alberta)	1	4881	145	48	25	28-Aug	20	2726
Duece	(Saskatchewan)	1	3296	98	56	0	28-Aug	20	2726
Gallatin	(Montana)	1	3617	107	55	0	29-Aug	21	2748
Lewis	(Montana)	1	4305	128	55	0	29-Aug	21	2748
Valier	(Montana)	1	1700	51	40	0	16-Aug	8	2440
(6-row hooded)									
Weal	(Alaska)	1	3291	98	42	0	20-Aug	12	2543

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Hulless (Naked) Barley

There are both two-row (*Hordeum distichum* L.) and six-row (*Hordeum vulgare* L.) hulless barley varieties. In hulless barley varieties, the outside hull detaches from the kernel when harvested, exposing the embryo and leaving a hulless or naked kernel. There are two types of hulless barley, normal and waxy. In normal hulless barley the ratio of amylose to amylopectin starch fractions is the same as that found in regular hulled barley, (about 25% amylose and 75% amylopectin). In waxy barley there is a higher percentage of amylopectin starch and beta-glucans, (95–100% amylopectin). Although both starches are polysaccharide glucose chains, amylopectin has a greater temperature stability range, making it better suited for industrial uses. In recent years there has been an increased interest in producing hulless barley, not only for diets of nonruminant animals that can't digest the fibrous hulls of hulled barley, but also for human consumption in items such as breakfast cereals, food thickeners, and health foods. Before hulled barley can be consumed by humans, the outer hull and bran must be removed through an abrasion process called pearling. Hulless varieties sold to niche markets, such as for human consumption, bring higher prices.

In swine and poultry diets, hulless barley has many advantages over hulled varieties. Hulless barley has a one to two percent higher level of nutrients and crude protein than hulled barley. There is improved digestibility and available energy that is close to that of wheat. In poultry diets this is improved if enzymatic feed supplements are used. Waxy barley varieties, because of the high beta-glucans, should never be used for poultry diets. If used in swine diets, enzymes should be added to improve digestibility. Because hulless barley contains less fiber, its use results in less manure to handle. Also, the lack of an outer hull also produces less fines and dust during handling. Fines in swine and poultry diets make them less acceptable.

Several factors have reduced the popularity of hulless barley: most varieties are late or very late maturing; they are lower yielding than hulled varieties; if there is no established niche market for the crop, it will sell at a lower price than regular feed barley; and the exposed embryo can be damaged in handling, which can reduce the germination ability of any seed lot. It is not uncommon to have hulless barley seed lots with less than 90% germination. With a lower percent of pure live seed in any seed lot, a greater volume of seed is required to achieve the same stand density.

Fertilization, tillage practices, and seeding depths are the same as for regular hulled barley. Avoid excessive nitrogen fertilization because most hulless varieties are late maturing and weak stemmed; too much nitrogen can delay maturity and induce lodging. Because the hulls are loose on hulless varieties, any seed heads that lodge severely enough to touch the ground can quickly sprout while still in the head. When selecting a field to plant, check the cropping history and pick one where it is unlikely that volunteer hulled barley will germinate. A year of summer fallow before planting helps reduce the incidence of both volunteer barley and barley diseases transmitted by crop residues.

As mentioned previously, the exposed embryo can be damaged in handling, which reduces germination ability. Improved germination comes from seed lots where the combine operator did not set the combine to thresh all the hulls from the seed at harvest. Seeding rates similar to that of hulled barley are recommended (90 to 100 pounds per acre of pure live seed). However, hulless barley has smaller kernels than hulled barley, higher bushel weights, and flows faster through seeder metering systems, so seeding rates must be adjusted accordingly.

Pest control measures are the same as for regular hulled barley. Best weed control is a combination of mechanical and chemical summer fallow to reduce the number and species of weeds for the following season and an application of a post-emergence herbicide. Good results for control of annual broadleaf weeds were obtained using a tank mix of Bromoxynil and MCPA or a 2,4-D amine. These herbicides must be applied after the barley has reached the three-leaf stage (but before it reaches the boot stage) and when the weeds are small and free from drought stress. To eliminate grassy weeds with chemical fallow, a broad spectrum post-emergence herbicide such as glyphosphate (Roundup) was used. Loose smut (*Ustilago nuda*) and Fusarium blight (*Fusarium graminearum* and others) are the biggest fungal disease problems on hulless barley. Food grade hulless barley can't contain any diseased kernels. Use of clean certified seed and a seed protectant such as carboxin (Vitavax) is recommended. Insect pests and their control is the same as for feed barley. Remember to always read the pesticide label and follow the directions on mixing, application, and disposal. Because hulless barley is usually later maturing and susceptible to lodging, it may still be in the fields when waterfowl begin fall migration. With its higher nutrient content and easier digestibility it is a strong favorite for migrating waterfowl. Use of the propane scare cannons is recommended. For more information contact the local office of the Alaska Department of Fish and Game.

Like hulled barley, hulless varieties stop growing at the hard dough stage and can be harvested using the same methods. However, 14.8% or lower moisture is considered good for safe, long-term storage conditions. For the human food industry, a reading of 14.5% or less moisture is required. The highest quality grain can be achieved when swathing or combining at the lowest moisture content.

For proper threshing and hull removal during combining, slow down the feeding rate by reducing the front concave opening and cylinder speed, and increase the airflow to improve hull removal. To reduce embryo damage, run augers at full capacity or slow them down. For food-grade seed that can have only 4% cracked hulls, it is important to continually check for hulls left on the seed or cracked seeds and adjust combining methods accordingly. For seed grade, a higher percentage of hulls (not more than 15%) can be left on to reduce the possibility of embryo damage. Exceeding 15% results in a lower price paid to the producer. Food grades must be at least 95% free of hulls, which is difficult to achieve when combining. It is better to leave a higher percentage on during harvest and remove excess hulls during additional buffing before shipping to market. Food grade hulless barley can't contain any diseased kernels, other crops, or foreign material. On-farm cleaning and sizing of the seed lot to food grade standards before shipment results in higher prices paid to the producer. Clean-outs can be used on-farm or sold as feed grade.

Currently in Alaska there is a limited market for hulless barley and no commercial size mills to produce food grade flour and no elevators set up to accept these varieties. Although there are a number of small-scale on-farm mills, hulless barley is sold at present primarily as whole grain in local health food markets. Hulless barley is also grown here for on-farm use as a supplement for animal feed. Similar to hulled barley, there is a limited market for hulless barley straw due to the rough awns that remain after harvest.

Recommended Variety Descriptions for Hulless Barley

Note: See Appendix 1 for the addresses of seed suppliers.

'Thual' is an early maturing, mid-tall, moderately stiff-strawed, rough-awned, six-row, naked-kerneled spring barley released in 1981 by the USDA plant breeding program at the AFES Palmer Research and Extension Center. It is a cross between the Finnish cultivar 'Otra', and an unnamed hulless line from Ireland. 'Thual' is one of the first released hulless varieties to mature and produce yields comparable with hulled varieties such as 'Otal'. In most years, its moderate straw strength causes a higher percentage of lodging when compared with 'Otal'. Direct inquiries about seed sources to the Alaska Seed Growers Association or the Alaska Plant Materials Center.

'Falcon' is an early maturing, short, stiff-strawed, rough-awned, six-row, naked-kerneled, spring barley released in 1992 by Alberta Agriculture Food and Rural Development in Lacombe. It is about equal in maturity with 'Thual,' but higher yielding. Its stiff straw has high lodging resistance. It is susceptible to loose smut and Fusarium blight, which can be controlled with seed treatments. This variety is protected by Canadian plant breeders' rights. Producers may save seed for their own use on their own farms, but sale or transfer of seed is prohibited without written permission and a payment of royalities to the breeder. Direct inquiries about seed sources to the SeCan Association or Progressive Seeds Ltd.

Malting Barley

Like feed and hulless barley, there are both two-row (*Hordeum distichum* L.) and six-row (*Hordeum vulgare* L.) malting barley varieties. Almost any barley variety can be malted, but not every variety produces an acceptable malt. Malting barley varieties have high levels of alpha and beta-amylase enzymes that help produce the necessary chemical changes needed to hydrolize starch into the malt sugars needed for high-quality beer. For these special characteristics, there are many differences among malting varieties, and the market sets the demand for specific ones. Large beer manufactures have their own malting facilities that contract with malting barley producers to grow specific varieties. Although the local homebrewer or microbrew facility may not have such a specific requirement, they demand a quality malt product. Check with local malting facilities for specific varieties grown in the area. In the malting and brewing niche markets, prices paid to the producer for high quality malting barley are much higher than that for regular hulled varieties.

According to K. Panchuk and others (1997), there are several necessary characteristics for high-quality malting barley:

- A pure lot of an acceptable variety—any contamination from other barley, even other malting barley varieties, results in rejection of the lot. It must also be free from other crops, insects, diseased heads, treated barley, and odor.
- Full and even maturity—immature barley germinates slowly if at all. This is important because malting requires uniform, quick, and vigorous germination (95% or better and occuring within three days). Malt is actually barley that has been seeped in water to germinate it, grown four days, kiln dried, and cleaned to remove the rootlets—all with precise temperature and moisture controls. Anything that changes these procedures reduces malt product quality.
- The grain must be disease free. Any fungal spores propagate along with the malt during the malting process, reducing malt quality. Also, loose smut spores carried through the malting process can affect beer flavor.
- Anything else that may affect quick, even germination results in rejection of the seed lot. This includes frost or excessive heat damage, weathering and staining, and peeled or broken kernels. These are directly related to the producer's ability to grow a successful crop. Planting early with the correct variety to avoid frost, direct combining instead of leaving the grain in a swath to collect mold spores or sprout, and setting the concave and cylinder speed on the combine to reduce kernel damage produces a higher quality barley. Only 5% broken kernels are allowed in high-quality malting barley.

- Grain should be free from heat-damaged kernels. No desiccants and no extra high heat can be used to reach the proper moisture of 13.5%. Any high heat may lower the germination ability and change the levels of the special enzymes needed to make high-quality malt.
- The barley must have plump, uniform kernels. Uniform kernels tend to germinate uniformly. Plump kernels contain more starch, which produces more malt extract, and in turn, more beer. Yield of malt extract is as important to a brewer as yield of grain is to the barley producer.
- Low to moderate protein concentration. Six-row malt barley must have 10.5–13.0% protein and two-row malt barley 10.5–12.5% protein. High-protein barley is difficult to malt efficiently because it produces a low amount of malt extract and cloudy beer.

Fertilization, tillage practices, and seeding are identical with that of regular hulled and hulless barley. Nitrogen fertilization requirements should be monitored closely, because with higher levels of nitrogen fertilizer, all malting varieties produce higher protein concentrations. The protein concentration and grain yields are determined by the amount of available nitrogen and the precipitation during the growing season, all other things being equal. If total precipitation is high, protein concentration is generally low and vice versa, and low rainfall during the grain filling stage results in higher protein levels and fewer plump kernels. Because most malting varieties mature later than regular hulled feed barleys, it's likely that some immature seed will be harvested. Protein is more concentrated in immature seed, lowering malt quality. Over fertilization with nitrogen or a late planting date almost certainly results in an immature, high-protein barley unsuitable for malting. When selecting a field to plant, check the cropping history and pick one that does not have the likelihood of any volunteer barley or other crops coming up in the field. As with all barley crops, a year of summer fallow before planting helps to reduce the incidence of both volunteer barley and barley diseases transmitted by crop residues. Seeding rates are identical to that of regular barley (90 to 100 pounds per acre of pure live seed).

Pest control measures are the same as for regular hulled and hulless barley. Best weed control is a combination of mechanical and chemical summer fallow to reduce the number and weed species for the following season and an application of a post-emergence herbicide. Good results for controlling annual broadleaf weeds were obtained using a tank mix of Bromoxynil and MCPA or a 2,4-D amine. These herbicides must be applied after the barley has reached the three-leaf stage but before it reaches the boot stage and when the weeds are small and free from drought stress. To eliminate grassy weeds with chemical fallow, a broad spectrum post-emergence herbicide such as glyphosphate (Roundup) was used. Malting barley can't contain any diseased kernels. Loose smut (*Ustilago nuda*) and Fusarium blight (*Fusarium graminearum* and others) are the biggest fungal disease problems occurring on the seed of malting barley. Use of clean certified seed and a seed protectant such as carboxin (Vitavax) is recommended. Net blotch (*Pyrenophorea teres*), spot blotch (*Cochliobolus sativus*), and barley scald (*Rhynchosporium secalis*) on the leaves of malting barley reduces yields and kernel plumpness. These can be controlled by not planting malting barley in fields that had barley in them the previous year. Insect pests and their control is the same as for feed barley. Remember to always read the pesticide label and follow the directions on mixing, application, and disposal. In the spring, early germinating malting barley varieties, the first to emerge, are especially susceptible to predation by returning migratory waterfowl. Large flocks of migratory waterfowl can cause serious damage to these varieties by walking down the row and pecking out each newly emerging plant. Use of the propane scare cannons is recommended. For more information contact the local office of the Alaska Department of Fish and Game.

The malting industry wants plump, mature, even kernels. Also, it wants grain that is not artificially dried with high heat that reduces germination. Therefore, malting barley should be swathed or combined when the grain is at 13.5% moisture or less. Malting barley can be swathed at any time after it has reached the hard dough growth stage. Good, well-formed windrows cure in three or four days in hot, dry weather and in up to a week days in cool, wet weather. Because cool and wet conditions predominate at harvest time in Alaska, the swathed grain can weather and stain or fungal spores can spread in the windrow, reducing malt quality. In either swathing or direct combining, avoid green or weedy patches; the presence of immature seed or weed seed causes the seed lot to be rejected. Studies done in Canada by K. Panchuk and others (1997) have found that threshing at a moisture content of 16% or greater and then air drying significantly reduces germination. Therefore, do not direct combine or pick up windrows until the grain is below 16% moisture. If moisture is not at 13.5% after harvest, forced air drying with low heat is required.

In combining malting barley, increase the concave clearance, slow down the cylinder speed, and maintain low volumes in the return. This helps to reduce peeling of the hull and broken kernels. Maltsters want a bit of the awn left on the kernel. Awns of about ¼ to ⅛ inch are acceptable. Continual checking for awns left on the seed or cracked seeds and adjusting combining methods is important. Run augers at full capacity or slow them down to reduce peeling. Remember that anything less than the acceptable quality standards for malting barley causes that seed lot to be rejected for malting. On-farm cleaning and sizing of the seed lot to malting grade standards before shipment results in higher prices paid to the producer. Clean-outs can be used on-farm or sold as feed grade.

There are a number of microbreweries and home

Seeding and fertilizing in a Delta Junction area field. AFES file photo.

brewers throughout Alaska. In order for them to consistently produce a quality product they require a consistent supply of quality malt. Currently, all malt used to produce beer in Alaska is imported. At the present time, there are not any malting facilities in Alaska large enough to supply the demand for quality malt and no elevators are set up to accept malting varieties. Therefore, there currently is no significant market for locally produced malting barley in the state. Any producer wishing to grow malting barley should only do so on contract with a local malting facility or brewery.

Recommended Variety Descriptions for Malting Barley

Note: See Appendix 1 for the addresses of seed suppliers.

'Harrington' is a mid to late maturing, mid-tall, stiff-strawed, rough-awned, two-row, high-yielding spring malt barley released in 1981 from the plant breeding program at the University of Saskatchewan in Saskatoon. It is a cross between 'Klages' and 'Gazelle'/'Beltzes'/'Centennial'. 'Harrington' is much later in maturity than 'Otal' feed barley, but in good years yields about the same. Because of its later maturity, there is a strong likelihood of immature seed at harvest. This variety is eligible for the top grades for two-row malting barley. There is an established demand for this variety in North American markets. Direct inquiries about seed sources to the SeCan Association.

'B 1602' is a mid to late maturing, mid-tall, stiff-strawed, rough-awned, six-row, high-yielding white spring malt barley released in 1989 from the plant breeding program at Busch Agricultural Resources Inc. in Colorado. 'B 1602' is much later in maturity than 'Otal' feed barley, but on good years yields better than 'Otal'. Because of its later maturity there is a strong likelihood of immature seed at harvest. This variety is eligible for the top grades for six-row malting barley. There is an established demand for this variety in North American markets. Direct inquiries about seed sources to Agricore United or the Brewing and Malting Barley Research Institute.

Yields and Test Weights by Location for Hulless and Malting Barley

Like feed barley, both hulless and malting barley are bought and sold by weight. Standard test weights for both are used as the legal unit for crop sales. The standard test weight for clean, dry, and undamaged hulless barley is 60 pounds per bushel, similar to spring wheat. Similar condition malting barley has a test weight of 48 pounds per bushel like that of regular hulled barley. Higher prices are paid to the producer for these niche crops, but only if they meet the quality criteria mentioned previously. Other than test weights, additional samples should be taken on-farm to determine quality. Any seed lots not meeting food grade for hulless barley, or not meeting malt quality for malting barley, should be used as feed grade. It is important then for the producer to clean and size all seed lots before delivery to any niche markets. Test weight can differ between cultivars and can change within a single cultivar depending on cultural practices, weather conditions, and location where grown. It is used in tables 6–10 as a measure of grain quality to determine maturity. Yields are expressed in pounds per acre. Bushels per acre can be determined by dividing the yield of any specific cultivar by the standard test weight.

Tables 6–10 list hulless and malting barley yields and quality measurements for all test locations: Fairbanks, Eielson, Delta Junction, and Palmer. All sites in the Delta Junction area have been combined into either the Delta dryland site (Table 8) or if grown under irrigation, the Delta irrigated site (Table 9). Each table also contains information on barley type (six-row, two-row, etc.), the source or the location where it was bred, and the years it was tested at each location. Maturity in this study was considered to be when 50% of the heads for each plot were at the hard dough stage. The heads were a light yellow in color and the kernels did not dent when pressed with a thumbnail. Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued crop growth. The low temperature point for barley in this report is the freezing point of water, 32° F. The GDD calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. All varieties were compared with 'Otal' as the standard variety. Yield as a percent of 'Otal' was determined by dividing the average yield of each variety by the average yield of 'Otal'. Maturity vs. 'Otal' is the number of days each variety reached 50% maturity, either before or after the number of days that 'Otal' reached 50% maturity.

Table 6. Average yields and quality measurements from hulless and malting barley variety test plots in the Fairbanks area, 1978 – 2002.

Barley Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Otal)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Otal (days)	Average Maturity (GDD)*
6-row hulless									
CDC Buck	Saskatchewan	3	3523	88	54	27	1-Aug	1	2273
Falcon	Alberta	3	4814	121	54	3	1-Aug	1	2273
HB 3433	Alberta	2	5032	126	55	2	6-Aug	6	2411
Silky	Saskatchewan	1	4002	100	51	7	5-Aug	5	2383
Thual	Alaska	10	3053	77	56	56	30-Jul	-1	2217
2-row hulless									
CDC Richard	Saskatchewan	4	3136	79	60	47	3-Aug	3	2328
6-row malting									
B 1602	Colorado	1	5010	126	41	0	9-Aug	9	2490
Dual	Colorado	1	5405	136	39	0	9-Aug	9	2490
Morex	Minnesota	2	3475	87	47	32	30-Jul	-1	2217
Stander	Minnesota	1	4967	125	45	0	12-Aug	12	2566
2-row malting									
B 1215	Colorado	2	4690	118	48	0	10-Aug	10	2515
Ellice	Manitoba	3	4000	100	49	7	30-Jul	-1	2217
Harrington	Saskatchewan	5	4089	103	46	3	18-Aug	19	2707
Klages	Idaho	3	3922	98	50	12	31-Jul	0	2244

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Table 7. Average yields and quality measurements from hulless and malting barley variety test plots in the Eielson area, 1993 – 2001.

Barley Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Otal)	Test Wt. (lbs/ bu)	Lodging (%)	Average Maturity Date	Maturity vs. Otal (days)	Average Maturity (GDD)*
6-row hulless									
CDC Buck	Saskatchewan	3	3135	144	54	0	2-Aug	-1	2306
Thual	Alaska	4	2423	111	54	0	4-Aug	1	2361
2-row hulless									
CDC Richard	Saskatchewan	3	3206	147	57	0	4-Aug	1	2361
6-row malting									
B 1602	Colorado	3	3696	170	42	0	14-Aug	11	2624
Dual	Colorado	3	3425	157	40	0	14-Aug	11	2624
Stander	Minnesota	3	3516	161	42	0	13-Aug	10	2599
2-row malting									
B 1215	Colorado	3	2673	123	44	0	18-Aug	15	2716
Harrington	Saskatchewan	3	3002	138	41	0	17-Aug	14	2627

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Table 8. Average yields and quality measurements from hulless and malting barley variety test plots in the Delta Junction area, 1978 – 2002, dryland site.

Barley Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Otal)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Otal (days)	Average Maturity (GDD)*
6-row hulless									
CDC Buck	(Saskatchewan)	4	1779	74	52	0	6-Aug	2	2217
Falcon	(Alberta)	3	2377	99	48	0	4-Aug	0	2165
HB 3433	(Alberta)	1	1736	72	45	0	9-Aug	4	2289
Silky	(Saskatchewan)	1	2089	87	37	0	10-Aug	6	2313
Thual	(Alaska)	13	1752	73	55	10	7-Aug	3	2241
2-row hulless									
CDC Richard	(Saskatchewan)	5	1737	72	52	0	6-Aug	2	2217
6-row malting									
B 1602	(Colorado)	3	1762	73	43	0	3-Aug	-1	2138
Dual	(Colorado)	3	2054	85	41	0	5-Aug	1	2190
Morex	(Minnesota)	2	3089	129	50	0	30-Aug	26	2710
Stander	(Minnesota)	3	1567	65	43	0	5-Aug	1	2190
2-row malting									
B 1215	(Colorado)	4	1787	74	43	0	8-Aug	4	2265
Ellice	(Manitoba)	3	3640	151	52	0	17-Aug	13	2469
Harrington	(Saskatchewan)	6	1571	65	43	0	11-Aug	7	2337
Klages	(Idaho)	3	3217	134	52	0	21-Aug	17	2548

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Table 9. Average yields and quality measurements from hulless and malting barley variety test plots in the Delta Junction area, 1998 – 2000, irrigated site.

Barley Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Otal)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Otal (days)	Average Maturity (GDD)*
6-row hulless									
Falcon	(Alberta)	2	2814	76	50	0	4-Aug	2	2165
HB 3433	(Alberta)	1	2805	76	46	0	11-Aug	9	2337
Silky	(Saskatchewan)	1	3091	84	51	0	3-Aug	1	2138
Thual	(Alaska)	3	2524	68	54	10	4-Aug	2	2165
6-row malting									
B 1602	(Colorado)	2	3638	98	46	0	31-Jul	-2	2058
Dual	(Colorado)	2	4269	115	45	0	3-Aug	1	2138
Stander	(Minnesota)	2	3623	98	47	0	3-Aug	1	2138
2-row malting									
B 1202	(Colorado)	1	3719	101	48	0	3-Aug	1	2138
B 1215	(Colorado)	3	3719	101	45	0	9-Aug	7	2289
Crest	(Washington)	1	3877	105	47	0	7-Aug	5	2241
Galena	(Colorado)	1	4031	109	47	0	3-Aug	1	2138
Harrington	(Saskatchewan)	3	3646	99	45	0	8-Aug	6	2265
M 14	(Colorado)	1	3162	89	47	0	3-Aug	1	2138

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Table 10. Average yields and quality measurements from hulless and malting barley variety test plots in the Palmer area, 1989 – 2002.

Barley Variety Name	Source	Years Tested	Yield (lbs/acre)	Yield (% of Otal)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Otal (days)	Average Maturity (GDD)*
6-row hulless									
Falcon	Alberta	2	2730	81	53	13	7-Aug	-1	2211
HB 3433	Alberta	2	3995	119	56	2	8-Aug	0	2238
Silky	Saskatchewan	1	1262	37	49	0	20-Aug	12	2543
Thual	Alaska	4	2814	84	55	31	7-Aug	-1	2211
2-row hulless									
Richard	Saskatchewan	1	1614	48	50	0	19-Aug	11	2519
6-row malting									
Morex	Minnesota	1	3647	108	50	0	28-Aug	17	2464
2-row malting									
B 1215	Colorado	1	4801	143	46	25	18-Aug	7	2211
Ellice	Manitoba	1	3847	114	53	0	28-Aug	17	2464
Harrington	Saskatchewan	4	3812	113	46	6	18-Aug	7	2211
Klages	Idaho)	1	3589	107	54	0	28-Aug	17	2464

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Hordeum vulgare *L., common barley. Image courtesy of the USDA-NRCS PLANTS Database / Hitchcock, A.S. (rev. A. Chase). 1950.* Manual of the grasses of the United States. *USDA Misc. Publ. No. 200. Washington, DC.*

Avena sativa *L., common oat. Image courtesy of the USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913.* Illustrated flora of the northern states and Canada, *Vol. 1:218.*

Oat Performance Trials

Spring Feed Oats

Oats are the second most important grain crop for Alaska, after barley, and are well adapted to the state's long day length and short growing season. Oats are seven to ten days later in maturing than the early season barley varieties. Because oat seed germinates well in cold and wet soils, oats grown for seed can be planted early in the season in areas that are poorly drained. Oats are also more tolerant of acidic soils than barley or wheat and can produce high yields when soil pH values range between 5.0 and 5.5. Oats are also planted for hay or in other forage mixes where seed production is not critical. In this case, planting can occur after all other spring cereal grains have been planted. Date of planting and fertilizer rate trials done at the Fairbanks test site have found that oats planted between June 1 and June 15 grow taller and produce greater forage biomass than earlier planting dates. This quick increase in growth is due to greater precipitation and warmer soil temperatures that occur in early June at the Fairbanks site, as opposed to lower precipitation and colder soil temperatures of May. Oats combined for seed also produce a high-quality bedding straw because they don't have the rough awns found in barley.

Three main types of feed oats have been tested in Alaska. The first and most widely tested is the common or white oat (*Avena sativa* L.). Seed from the common oat is white or yellow with the hulls still attached. The second most important oat for Alaska is the black oat (*Avena strigosa* L.). The outer hull is black or dark brown in color. It is not to be confused with the wild oat, which is also black in color. Wild oats (*Avena fatua* L.) are taller, more vigorous plants with widely spaced equilateral, spreading panicles. The seed has long, twisted awns and shatters easily when ripe, making this weed difficult to control in other grain crops. The last feed oat is the red oat (*Avena byzantina* C. Koch). Red oats are usually grown as an early maturing winter grain in central California and reach maturity before the summer drought season begins. In Alaska, however, red oats are ten to fourteen days later in maturity, with lower yields and test weights than the standard yellow oat varieties. For this reason there are no recommended red oat varieties for Alaska. Oats grown for animal feed are fed either whole, ground, or rolled.

Fertilization, tillage practices, and seeding depths are identical to barley. As with barley, soils with moderate to high levels of available nutrients should receive a complete fertilizer blend of nitrogen, phosphorus, potassium, sulfur, and boron. Actual percentages of each nutrient and the application rate vary according to specific soil test results. The fertilizer can be broadcast before spring tillage or portions

*Oat (*Avena *L.). Photo copyright Robert Soreng at USDA-NRCS PLANTS Database (courtesy of Smithsonian Institution, Dept. of Systematic Biology-Botany).*

can be banded at planting. Avoid excess nitrogen fertilizer because it can induce lodging. However, when oats are grown as a forage, nitrogen becomes the most limiting nutrient. In certain rare situations, excess nitrogen and slow growing conditions with reduced phosphate uptake can produce forage with nitrate levels high enough to poison livestock. Proper phosphate applications can reduce this occurrence. Since the straw is as valuable as the grain, it too is removed from the field. This tends to reduce available potassium levels in the soil. Therefore, an increase in the potassium rate is needed when removal of all plant residues or continuous cropping has occurred. In all cases, follow the specific fertilizer recommendations from soil tests.

To conserve soil moisture, minimum tillage is recommended for incorporating fertilizer material and plant residue and preparing the seedbed. Pulling a packer behind the tillage implement and using a seed drill equipped with press wheels, ensures that the seed is in contact with moist soil during the time needed for germination. Seeding depth and rate is the same as that for barley, 1½ to 2½ inches, or to moisture, and 90 to 100 pounds of pure live seed per acre.

To reduce late tillering, the heavier seeding rate should be used when oats are to be produced for seed. Lighter rates can be used for hay production and rates can be cut to one-quarter less when interseeded with legumes for forage production. Use of certified seed is strongly recommended. Some varieties of oats have high seed dormancy requirements, especially the red oat varieties. If fresh seed is used without satisfying the dormancy requirement, poor germination and emergence results. Seed dormancy requirements can be met by storing seed in an unheated area over the winter.

Weed control in oats is the same as for barley, a combination of mechanical and chemical summer fallow to reduce number and species of weeds for the following year and an application of a post-emergence herbicide. Oats are more susceptible than barley to injury from 2,4-D compounds and residual herbicides from previous years. Best broadleaved weed control has been with Bromoxynil and MCPA tank mixes applied when the oats were 4 to 6 inches tall but before the boot stage. Best control of wild oats and other grassy weeds was with crop rotations. Weeds were sprayed with an herbicide such as glyphosphate (Roundup) and mechanical summer fallow was used. Seeds in the soil were brought to the surface to germinate, then plants were tilled under to kill them. Remember to always read the pesticide label and follow the directions on mixing, application, and disposal.

Oat loose smut (*Ustilago avenae*), leaf blotch (*Scolecotrichum graminis*), and Alternaria blotch (*Alternaria* sp.) are fungal diseases that have been found on oats in Alaska. Barley yellow dwarf virus (BYDV) has also been found on oats. Yield loss to these diseases has been minimal over the years. They can be controlled by using clean certified seed or disease-resistant varieties. The same insect pests that affect barley also affect oats. The most serious insect pests for oats are aphids (family Aphididae) and grasshoppers, including the lesser migratory grasshopper (*Melanoplus sanguinipes* Fabricias), the northern grasshopper (*Melanoplus borealis* Fieber), and the clear-winged grasshopper (*Camnula pellucida* Scudder). Oats however, are less subject to insect predation than either barley or wheat. Diazinon or carbaryl (Sevin) sprays or baits help control heavy infestations. Remember to always read the pesticide label and follow the directions on mixing, application, and disposal.

As with barley, oats stop growing when the seed reaches the hard dough stage (the kernels can't be dented when pressed with a thumbnail). The typical seed moisture content at this stage is between 25–35%. Oats can be harvested at this moisture content, but significant losses in germination occur during storage. The grain must be around 12 to 13% moisture for safe, long-term storage. Higher moisture contents can germinate or mold the stored seed and lower moisture contents can damage the embryo, reducing germination ability. Both situations reduce the quality of the stored grain. Harvesting before or at the hard dough stage results in a fair amount of green, high-moisture heads. This underdeveloped grain is low in yield, test weights, and market value. Also, harvesting before the hard dough stage results in a reduction in yield of both grain and straw. Oats grown for hay should be mowed in the soft dough stage for the best quality, highest protein content hay.

Oats can be swathed and allowed to air dry in windrows until the seed reaches 13% moisture, or they can be combined directly. Similar to barley, care must be taken in swathing or combining to prevent or reduce losses from shattering, crinkling, and weathering. Head shatter usually occurs on over-ripe oats, although some varieties are more susceptible than others. Crinkling occurs when the heads bend over and nod towards the ground. The stems may break soon after maturity, especially in damp weather. Weathering, or sun bleaching, occurs when the grain swells when damp but doesn't shrink back after drying. The kernels are less dense and thus have a lower test weight, although other quality measurements are unaffected.

Combine settings should be adjusted so that the concave clearance and cylinder speed produces the highest amount of clean seed without cracking the kernels. To reduce the incidence of peeling or skinning the hull and exposing the embryo, augers should be run full, or at slower speeds if not full. Any embryo damage during this process lowers the germination ability of that seed for next year. Every time grain is handled, kernel damage occurs. This is not as important in grain grown for animal feed as it is in seed crops. The highest price paid to the producer is for the highest quality oats.

In Alaska there is a strong market for both oat seed and hay, which are primarily grown as animal feed supplements. There is also a seed production industry to provide local farmers with certified seed. Lacking the rough awns of barley straw, oat straw is in high demand for use as animal bedding, especially with local dog mushers. In many years, the value of the straw is close to or equal to the value of the seed produced per acre.

Recommended Variety Descriptions for Spring Feed Oats

Note: See Appendix 1 for the addresses of seed suppliers.

'Cascade' is a relatively mid to late maturing, tall, stiff-strawed, high-yielding, yellow glumed, spring feed oat developed at the Canada Agriculture Research Station at Lacombe, Alberta in 1979. It is a cross between 'Random' and 'Forward'. Since it is a late maturing variety, there is a high risk of low yields and immature seed when planted late. Despite being late maturing, this oat has consistently been a high-yielding variety for both seed and forage production in our trials. This was the standard variety against which

all other oat varieties were compared in this report. Direct inquiries about seed sources to the SeCan Association or Agricore United.

'Athabasca' is an early maturing, medium height, stiff-strawed, high-yielding, yellow glumed, spring feed oat selection made at the Canada Agriculture Research Station at Lacombe, Alberta in 1966. It is 2 to 3 days earlier than 'Cascade' but lower yielding in both seed and forage. It does have a high resistance to lodging and shattering. Direct inquiries about seed sources to the SeCan Association or Agricore United.

'Nip' is an early maturing, tall, stiff-strawed, high-yielding, black glumed, spring feed oat selected in Sweden in the late 1950s. It has good resistance to lodging and produces good yields of both seed and forage. It can be planted late and still produce good seed yields. It also has fairly good tolerance to late summer or early fall frosts. 'Nip' is 2 to 3 days later than 'Cascade' and slightly lower in seed yields but higher in forage yields. Seed sources for 'Nip' are only available in Alaska. Direct inquiries about seed sources to the Alaska Seed Growers Association or the Alaska Plant Materials Center.

'Toral' is a midseason, tall, stiff-strawed, high-yielding, yellow glumed, spring feed oat released in 1972 by the USDA plant breeding program at the AFES Palmer Research and Extension Center. It was selected from a cross between an early maturing black glumed oat from Sweden, 'Orion III', and a later maturing, high-yielding, yellow glumed Polish oat, 'Tatrzanski'. 'Toral' is a good general purpose oat with consistently high yields for both seed and forage. It is 2 to 3 days earlier in maturity and slightly lower in seed yields than 'Cascade'. Direct inquiries about seed sources to the Alaska Seed Growers Association or the Alaska Plant Materials Center.

Hulless (Naked) Oats

As with hulless barley, the outside hull of hulless oat (*Avena nuda* L.) varieties detaches from the kernel when harvested, exposing the embryo and leaving a hulless or naked kernel. In recent years there has been an increased interest in producing hulless oats, not only for diets of nonruminant animals, which can't digest the fibrous hulls of hulled oats, but also for human consumption in items such as breakfast cereals and health foods. Oat flour contains agents that retard rancidity in fats and is used as an antioxidant and a stabilizer for dairy products. When included in human diets, oats may lower blood cholesterol levels. To be consumed by humans, hulled oat varieties must be dehulled and have the bran removed through an abrasion process called pearling, or must be processed into a flake. Oat flakes are made from hulled oats, cleaned, sized, and dried to 6% moisture, dehulled, steamed, and pressed between steel rollers. Quick oats are small, thin flakes cut from the groats and then rolled. Prices paid to the producer for hulless oats are much higher than for hulled varieties when used for human consumption niche markets.

The same major drawbacks in producing hulless barley exist for producing hulless oats. Most varieties are late or very late maturing, are low yielding, and producers need an established niche market to obtain a high price for the crop. The exposed embryo on hulless oats can be damaged during handling, and embryo damage reduces the germination ability of any seed lot. With a lower percent of pure live seed, a greater volume of seed must be purchased for planting. For seed grade, a higher percentage of hulls can be left on to reduce the possibility of embryo damage. Feed grade hulless oats can't retain more than 15% of the hulls. More than this results in a lower price paid to the producer. For food grades, no more than 5% of the hulls can remain. This is difficult to achieve when combining. It is better to harvest with a higher percentage of hulls retained and remove them during handling processes. Hulls can be removed by additional buffing of the seed before shipping to market. Any seed lot not meeting the higher food grades is purchased at lower feed grade prices.

Fertilization, tillage practices, and seeding depths are identical to those for regular hulled oats. Avoid excessive nitrogen fertilization because most hulless varieties are late maturing and weak stemmed. Too much nitrogen can delay maturity further and induce lodging. When selecting a field to plant, check the cropping history and pick one in which volunteer hulled oats or wild oats are unlikely to come up in the crop. A year of summer fallow before planting helps to reduce the incidence of both volunteer oats and fungal diseases transmitted by crop residues.

As mentioned previously, because the embryo is exposed on hulless oats it can be damaged in handling which reduces the germination ability of the seed. It is not uncommon to have certified seed lots with less than 90% germination. Improved germination comes from seed lots where the combine operator did not set the combine to thresh all the hulls from the seed at harvest. Seeding rates similar to that of hulled oats are desirable (90 to 100 pounds per acre of pure live seed). However, hulless oats have smaller kernels than hulled oats and higher bushel weights. It also flows faster through seeder metering systems. Adjust seeding rates accordingly.

Pest control measures were the same as that for regular hulled oats. Weed control was a combination of mechanical and chemical summer fallow to reduce the number and species of weeds the following year and an application of a post-emergence herbicide. Food grade hulless oats can't contain any diseased kernels. Use of clean certified seed is recommended. Insect pests and their control is the same as for regular oats. Remember to always read the pesticide label and follow the directions on mixing, application, and disposal. Hulless oats are usually later maturing so the crop may still be in the fields when waterfowl begin their fall migrations. As with hulless barley, hulless oats are a favorite energy food for migrating waterfowl. Use of propane scare cannons is recommended. For more information contact the local office of the Alaska Department of Fish and Game.

Hulless oats stop growing when they reach the hard dough stage, the same as for hulled oats. They can be harvested using the same methods as hulled oats. However, 12% or lower moisture is considered good for safe, long-term storage conditions and when used for the human food industry. Higher quality grain can be achieved when swathing or combining at the lowest moisture content. To slow down the feeding rate when combining hulless oats, reduce the front concave opening and cylinder speed for proper threshing and hull removal. Increase the air flow to improve hull removal. To reduce embryo damage, run augers at full capacity or slow them down. Hulless oats do not flow well during handling, which can cause an increase in cracked kernels and damaged embryos. Continual checking for hulls left on the seed or cracked seeds and adjusting combining methods is important, because food grade seed can contain only 4% cracked hulls. Food grade hulless oats can't contain any diseased kernels, other crops, or foreign material. On-farm cleaning and sizing of the seed lot to food grade standards before shipment results in higher prices paid to the producer. Clean-outs can be used on-farm or sold as feed grade.

There is at present a limited market for hulless oats in Alaska. There are no commercial size flour or flaking mills in the state and no elevators are set up to accept hulless oats. There is only a limited acreage presently grown for on-farm use as a supplement for livestock feed. Like hulled oats, hulless oat straw lacks the rough awns of barley straw so there could be a high demand for use as animal bedding.

Recommended Variety Descriptions for Hulless Oats

Note: See Appendix 1 for the addresses of seed suppliers.

'Belmont' is a late maturing, mid-tall, stiff-strawed, mid-yielding, naked kerneled spring oat released in 1992 by Agriculture Canada in Winnipeg, Manitoba. It is much later in maturity and lower yielding than 'Cascade'. It does have good resistance to lodging and oat loose smut. Up to 12% non-hulless kernels are common. This variety is protected by Canadian plant breeders rights. Producers may save seed for their own use on their own farms, but sale or transfer of seed is prohibited without written permission and a payment of royalties to the breeder. Direct inquiries about seed sources to the SeCan Association.

Yields and Test Weights by Location for Spring Feed and Hulless Oats

Both common and hulless oats are bought and sold by weight. Standard test weights for both are used as the legal unit for crop sales. The standard test weight for clean, dry, and undamaged common oats is 32 pounds per bushel. Similar condition hulless oats have a test weight of 44 pounds per bushel. Higher prices are paid to the producer for these niche crops, but only if they meet the quality criteria mentioned above. Other than test weights, additional samples are taken at the elevator for common oats to determine quality. For hulless oats, additional samples should be taken on-farm to determine quality. Any seed lots not meeting food grade for hulless oats should be used as feed grade. It is important then for the producer to clean and size all seed lots before delivery to the elevator or a niche market. Test weights can differ between cultivars and can change within a single cultivar depending on cultural practices, weather conditions, and location where grown. Test weight is used here as a measure of grain quality to determine maturity. Yields are expressed here in pounds per acre. Bushels per acre can be determined by dividing the yield of any specific cultivar by the standard test weight.

Tables 11 through 15 list feed and hulless oat yields and quality measurements for all test locations: Fairbanks, Eielson, Delta Junction, and Palmer. All sites in the Delta Junction area have been combined into either the Delta dryland site (Table 13) or, if grown under irrigation, the Delta irrigated site (Table 14). Each table also contains information on oat type (yellow feed, black feed, hulless, etc.), the source or the location where it was bred, and the years it was tested at each location. Maturity in this study was considered to be when 50% of the heads for each plot were at the hard dough stage (light yellow heads with kernels that did not dent when pressed with a thumbnail). Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued growth of the crop. The low temperature point for all oats in this report is the freezing point of water, 32° F. The GDD day calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. All varieties were compared with 'Cascade' as the standard variety. Yield as a percent of 'Cascade' were determined by dividing the average yield of each variety by the average yield of 'Cascade'. Maturity vs. 'Cascade' are the number of days each variety reached 50% maturity either before or after the number of days that 'Cascade' reached 50% maturity.

Table 11. Average yields and quality measurements from feed and hulless oat variety test plots in the Fairbanks area, 1978 – 2002.

Oat Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Cascade)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Cascade (days)	Average Maturity (GDD)*
yellow feed									
Athabasca	(Alberta)	10	3322	80	38	1	4-Aug	-1	2355
Calibre	(Saskatchewan)	7	3955	96	40	1	6-Aug	1	2411
Cascade	(Alberta)	9	4139	100	36	0	5-Aug	0	2383
Derby	(Alberta)	1	3654	88	38	0	10-Aug	5	2515
Jasper	(Alberta)	3	3676	89	39	2	1-Aug	-4	2273
OT 238	(Alberta)	2	3161	76	34	0	4-Aug	-1	2355
OT 736	(Alberta)	1	3103	75	34	0	1-Aug	-4	2273
OT 745	(Alberta)	1	3553	86	38	0	1-Aug	-4	2273
OT 755	(Alberta)	2	4010	97	32	0	4-Aug	-1	2355
Pol	(Sweden)	3	3285	79	30	0	1-Aug	-4	2273
Proat	(Minnesota)	1	2193	53	38	0	30-Jul	-6	2217
Riel	(Manitoba)	3	3977	96	39	0	3-Aug	-2	2328
Toral	(Alaska)	9	3791	92	39	1	4-Aug	-1	2355
red feed									
Bates 89	(California)	1	2535	61	34	0	17-Aug	12	2685
Kanota	(California)	1	1515	37	30	0	15-Aug	10	2639
Montezuma	(California)	1	2178	53	28	0	15-Aug	10	2639
Pert	(California)	1	2696	65	32	0	21-Aug	16	2769
Sierra	(California)	1	2902	70	28	0	20-Aug	15	2748
black feed									
Nip	(Sweden)	6	3539	86	35	1	6-Aug	1	2411
hulless									
Belmont	(Manitoba)	1	1969	48	41	0	11-Aug	6	2541
Freedom	(Maine)	5	2851	69	42	0	5-Aug	0	2383
Pennuda	(Pennsylvania)	3	1201	29	41	0	2-Aug	-3	2301
Tibor	(Alberta)	2	2508	61	44	0	5-Aug	0	2383

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Table 12. Average yields and quality measurements from feed and hulless oat variety test plots in the Eielson area, 1993 – 2001.

Oat Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Cascade)	Test Wt. (lbs/ bu)	Lodging (%)	Average Maturity Date	Maturity vs. Cascade (days)	Average Maturity (GDD)*
yellow feed									
Athabasca	(Alberta)	4	2491	70	41	0	8-Aug	-4	2470
Calibre	(Saskatchewan)	4	3045	86	42	0	13-Aug	1	2599
Cascade	(Alberta)	4	3561	100	41	0	12-Aug	0	2574
Toral	(Alaska)	4	2724	47	42	0	9-Aug	-3	2496
black feed									
Nip	(Sweden)	1	1205	34	38	0	13-Aug	1	2599
hulless									
Freedom	(Maine)	4	1897	53	43	0	15-Aug	3	2647
Pennuda	(Pennsylvania)	3	1500	42	43	0	9-Aug	-3	2496

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Table 13. Average yields and quality measurements from feed and hulless oat variety test plots in the Delta Junction area, 1978 – 2002, dryland site.

Oat Variety Name	Source	Years Tested	Yield (lbs/acre)	Yield (% of Cas- cade)	Test Wt. (lbs/ bu)	Lodging (%)	Average Maturity Date	Maturity vs. Cascade (days)	Average Maturity (GDD)*
yellow feed									
Athabasca	(Alberta)	13	2401	84	38	0	15-Aug	-2	2425
Calibre	(Saskatchewan)	8	2486	87	41	0	18-Aug	1	2489
Cascade	(Alberta)	12	2867	100	39	0	17-Aug	0	2469
Ceal	(Alaska)	1	N/D	N/D	N/D	0	26-Aug	9	2642
Derby	(Alberta)	1	460	16	26	0	13-Aug	-4	2383
Jasper	(Alberta)	3	3340	117	41	0	31-Aug	14	2727
OT 238	(Alberta)	2	3412	119	36	0	30-Aug	13	2710
OT 736	(Alberta)	1	3122	109	35	0	1-Sep	15	2744
OT 745	(Alberta)	1	2654	93	38	0	1-Sep	15	2744
OT 755	(Alberta)	2	4458	155	39	0	30-Aug	13	2710
Pol	(Sweden)	3	2922	102	36	0	29-Aug	12	2693
Proat	(Minnesota)	1	1992	69	41	0	29-Aug	12	2693

Table 13 continued on next page

Table 13. Average yields and quality measurements from feed and hulless oat variety test plots in the Delta Junction area, 1978 – 2002, dryland site.

Oat Variety Name	Source	Years Tested	Yield (lbs/acre)	Yield (% of Cas-cade)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Cascade (days)	Average Maturity (GDD)*
Riel	(Manitoba)	3	3145	110	37	0	31-Aug	14	2727
Toral	(Alaska)	12	2564	89	39	0	15-Aug	-2	2425
red feed									
Bates 89	(California)	2	876	31	39	0	27-Aug	10	2660
Kanota	(California)	2	802	28	37	0	26-Aug	9	2642
Montezuma	(California)	2	746	26	39	0	25-Aug	8	2624
Pert	(California)	2	857	30	42	0	28-Aug	11	2677
Sierra	(California)	2	703	25	37	0	29-Aug	12	2693
black feed									
Nip	(Sweden)	9	2341	82	37	0	20-Aug	3	2529
hulless									
Belmont	(Manitoba)	2	2721	95	39	0	11-Aug	-6	2337
Freedom	(Maine)	7	1815	63	42	0	18-Aug	1	2489
Pennuda	(Pennsylvania)	4	802	28	41	0	6-Aug	-11	2217
Tibor	(Alberta)	2	1895	66	44	0	30-Aug	13	2710

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
N/D = No Data.

Table 14. Average yields and quality measurements from feed and hulless oat variety test plots in the Delta Junction area, 1998 – 2000, irrigated site.

Oat Variety Name	Source	Years Tested	Yield (lbs/acre)	Yield (% of Cascade)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Cascade (days)	Average Maturity (GDD)*
yellow feed									
Athabasca	(Alberta)	3	3676	78	40	0	7-Aug	-6	2241
Cascade	(Alberta)	3	4738	100	38	0	13-Aug	0	2383
Toral	(Alaska)	3	4132	87	39	0	12-Aug	-1	2361
black feed									
Nip	(Sweden)	3	3959	84	39	0	9-Aug	-4	2289
hulless									
Belmont	(Manitoba)	1	3666	77	43	0	17-Aug	4	2469
Freedom	(Maine)	1	3566	75	45	0	17-Aug	4	2469

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Table 15. Average yields and quality measurements from feed and hulless oat variety test plots in the Palmer area, 1989 – 2002.

Oat Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Cascade)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Cascade (days)	Average Maturity (GDD)*
				yellow feed					
Athabasca	(Alberta)	4	3366	75	38	6	11-Aug	-4	2314
Calibre	(Saskatch-ewan)	1	3988	88	40	0	28-Aug	13	2726
Cascade	(Alberta)	3	4510	100	38	8	15-Aug	0	2417
Jasper	(Alberta)	1	3918	87	40	0	28-Aug	13	2726
OT 238	(Alberta)	1	2517	56	36	0	29-Aug	14	2748
OT 755	(Alberta)	1	4147	92	38	0	29-Aug	14	2748
Pol	(Sweden)	1	3386	75	34	0	13-Aug	-2	2366
Riel	(Manitoba)	1	3641	81	37	0	23-Aug	8	2613
Toral	(Alaska)	3	4012	89	38	8	13-Aug	-2	2366
				black feed					
Nip	(Sweden)	3	3759	83	37	8	11-Aug	-4	2314
				hulless					
Belmont	(Manitoba)	1	778	17	41	0	12-Aug	-3	2340
Freedom	(Maine)	1	2013	45	42	0	29-Aug	14	2748
Pennuda	(Pennsyl-vania)	1	324	7	42	0	12-Aug	-3	2340
Tibor	(Alberta)	1	1882	42	43	0	29-Aug	14	2748

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Wheat Performance Trials

Spring Wheat

Wheat is of limited importance as a grain crop for Alaska due to its long growing season requirement. Two species of spring wheat were tested in Alaska as part of this study. The bread wheat varieties (*Triticum aesitivum* subspecies *vulgare* L.) are made up of the hard red spring wheats (true bread flour wheat) and the soft white wheats (pastry flour wheat). The other spring wheat species tested in Alaska has been the macaroni or durum wheat (*Triticum durum* Desf.). These are also divided into two types. The white or amber (most common pasta flour wheat), and red durum wheats (rarely grown). Most of the wheat varieties tested in this study were obtained from Canadian sources. Canadian wheat grades subdivide hard red spring wheat further into the hard red spring bread wheats, the prairie hard red spring wheats or semidwarf varieties, and the extra strong or utility hard red spring wheats. The seed heads of hard red spring wheat can be awnless, tip awned or fully awned, depending on the variety. Durum wheats have long stiff awns and compact seed heads. All other things being equal, kernels of awned varieties photosynthesize more than varieties without awns, resulting in higher levels of carbohydrates, higher test weights, and quicker drying during ripening.

The main uses for wheat in Alaska are in niche markets for human consumption as flour for baked products, breakfast foods, pasta, and health foods. Secondary uses are for nonruminant animal feed where wheat is cracked or rolled and for poultry diets where it is fed whole. High test weight wheat produces higher percentages of flour than lower test weight wheat. The average flour return for standard test weight wheat (60 pounds per bushel) is 72%. The remaining 28% consists of bran and shorts removed in the milling process. The bran is the outer covering of the wheat kernel removed before milling and the shorts (or standard middlings) are the coarse particles of the endosperm left after milling. These byproducts are used in dairy, swine, and poultry feeds. The highest prices paid to the producer is for the human-consumption quality wheat.

Wheat is much later maturing than barley or oats and maturity is highly dependent on climate. If the weather is warm and dry for a month after pollination, it matures on average 10 days later than barley. If the weather for that same period is cool and wet, an additional 10 to 15 days are required. Light frosts during heading can cause sterility, while light frosts before the plant reaches full maturity stops any further grain development. Early maturing hard red spring wheat varieties are the best adapted for Alaska growing conditions, but are considered somewhat marginal. White and durum wheats required a longer frost-free growing season to reach maturity than the hard red spring wheats, and thus are not recommended for Alaska.

Fertilization, tillage practices, and seeding depths are identical to barley and oats. Soils with moderate to high levels of available nutrients should receive a complete fertilizer blend of nitrogen, phosphorus, potassium, sulfur, and boron. Actual percentages of each nutrient and the application rate varies according to specific soil test results. The fertilizer can be broadcast before spring tillage or portions can be banded at planting. High gluten protein content in the seed is needed for high-quality bread flour. The ratio of starch to protein in the seed is a factor of temperature, soil moisture, and available nitrogen during the flowering growth stage. Cool wet weather during this growth stage produces a plump kernel that is high in starch and low in protein. Hot dry weather produces small, dark, hard kernels high in gluten and low in starch. Lack of sufficient available nitrogen produces starchy, soft "yellow berry" kernels. Excess nitrogen fertilizer should be avoided as it can induce lodging and delay maturity. Differences in protein content and quality among varieties affect flour quality.

To conserve soil moisture, minimum tillage is recommended for incorporating fertilizer material and plant residue and preparing the seedbed. Pulling a packer behind the tillage implement and using a seed drill equipped with press wheels ensures that the seed is in contact with moist soil during the time needed for germination. Seeding depth and rate is the same as that for barley and oats, 1½ to 2½ inches, or to moisture, and 90 to 100 pounds of pure live seed per acre. To reduce late tillering, the heavier seeding rates are to be used when wheat is to be produced for seed. Early planting dates are recommended to utilize as much of the short growing season as possible. Use of certified seed is strongly recommended.

Pest control in wheat is the same as for barley and oats. Weed control is a combination of mechanical and chemical summer fallow to reduce the number and species of weeds for the following season and an application of a post-emergence herbicide. Best broadleaved weed control has been with Bromoxynil and MCPA tank mixes or a 2,4-D amine applied when the wheat was four to six inches tall, but before the boot stage. Best control of grassy weeds was through a combination of mechanical and chemical summer fallow. To eliminate grassy weeds with chemical fallow, a broad spectrum post-emergence herbicide such as glyphosphate (Roundup) was used. Wheat loose smut *(Ustilago tritici)*, bacterial mosaic *(Corynebacterium tessellaria)*, and barley stripe mosaic *(Pyrenophora graminea)* are diseases that have been found on wheat in Alaska. Yield loss to these diseases has been minimal over the years. They can be controlled by using clean certified seed or disease resistant varieties. The same insect pests that affect barley and oats also affect wheat. The most serious insect pests for wheat are aphids (family Aphididae) and grasshoppers, including the lesser migratory grasshopper (*Melanoplus sanguinipes* Fabricias), the northern grasshopper (*Melanoplus borealis* Fieber), and the clear-winged grasshopper (*Camnula pellucida* Scudder). Diazinon or carbaryl (Sevin) sprays or baits help control heavy infestations. Remember to always read the pesticide label and follow the directions on mixing, application, and disposal. Wheat is later maturing than barley or oats, so the crop may still be in the fields when waterfowl begin fall migrations. As with hulless barley and hulless oats, wheat is a favorite energy food for migrating waterfowl. Using propane scare cannons is recommended. For more information contact the local office of the Alaska Department of Fish and Game.

As with barley and oats, wheat stops growing when the seed reaches the hard dough stage (the kernels can't be dented when pressed with a thumbnail). The typical seed moisture content at this stage is 25–35%. Although wheat can be harvested at this moisture content, significant loss of germination ability occurs during storage. The grain must be around 12–13% moisture for safe, long-term storage. Higher moisture contents can germinate or mold the stored seed, and lower moisture contents can damage the embryo, reducing germination ability. Both situations reduce the quality of the stored grain. Harvesting before or at the hard dough stage results in a fair amount of green, high-moisture heads. This underdeveloped grain is low in yield, test weights, and market value. Highest quality grain can be achieved by swathing or combining at the lowest moisture content. Because wheat seed is about the same size and shape as hulless barley and hulless oats with heavy test weights, harvest wheat using the same combine settings. When combining wheat, slow down the feeding rate by reducing the front concave opening and cylinder speed for proper threshing and hull removal. An increase of the air flow can improve hull removal. To reduce embryo damage, run augers at full capacity or slow them down. Because food-grade seed only allows 4% cracked hulls, continual checking for hulls left on the seed or cracked seeds and adjusting combining methods is important. Early maturing wheat also has a tendency to head shatter and lodge. Waiting for the grain to field dry to 13% moisture can result in significant yield reductions due to shattering of the seed. To reduce head shattering, harvest grain at a higher than optimal moisture content, then use on-farm drying to get stored grain to 13% moisture.

Many of the drawbacks in producing wheat are the same as for hulless barley and hulless oats. Most wheat varieties are late or very late maturing, are relatively lower yielding, and require an established niche market for the producer to obtain a premium price for the crop. No more than 15% of the hulls can be left on for producing food grade wheat. More than this results in a lower price paid to the producer. Food grade wheat can retain no more than 5% of the hulls, which are easily removed during combining. If needed, additional seed buffing can be done to remove hulls before shipping to market. Food-grade wheat can't contain any more than 4% diseased kernels, other crops, or foreign material. Any seed lot not meeting the higher food grades is purchased at lower feed-grade prices. On-farm cleaning and sizing of the seed lot to food-grade standards before shipment results in higher prices paid to the producer. Clean-outs can be used on-farm or sold as feed grade.

The Alaska market for wheat is limited. There are no commercial, in-state mills to process food-grade flour and no elevator is set up to accept wheat. A number of small-scale on-farm mills exist. Alaska wheat is sold primarily as whole grain wheat flour in local health food markets, or is grown for on-farm use as an animal feed. A limited seed production industry provides local farmers with certified seed. Like oat straw, wheat straw could be used for animal bedding because it lacks the rough awns of barley straw.

Recommended Variety Descriptions for Spring Wheat

Note: See Appendix 1 for the addresses of seed suppliers.

'Ingal' is an early maturing, semidwarf (Canadian prairie spring wheat), stiff-strawed, red-glumed, red-kerneled, awned, hard red spring wheat released in 1981 by the USDA plant breeding program at the AFES Palmer Research and Extension Center. It was selected from a cross between a variety developed in Alaska, 'Gasser' and 'Morin No. 16' from the USDA World Wheat Collection. Seed kernels of 'Ingal' are smaller than average, requiring modifications to drill seed metering and to combine settings at harvest. Also, 'Ingal' is prone to head shatter at harvest in adverse weather conditions, such as heavy rains or high winds. 'Ingal' is satisfactory for milling and baking. This was the standard variety against which all other wheat, rye, and triticale varieties were compared in this report. Direct inquiries about seed sources to the Alaska Seed Growers Association or the Alaska Plant Materials Center.

'Cutler' is an early maturing, semidwarf (Canadian prairie spring wheat), stiff-strawed, red-glumed, red-kerneled, hard red spring wheat released in 1990 by the breeding program of the Department of Natural Resources at the University of Alberta in Edmonton. It is resistant to lodging and head shatter and also is tolerant of acidic soils. Average maturity is three days later than 'Ingal', but yield is about equal. 'Cutler' is susceptible to wheat smut and is not drought tolerant. It is satisfactory for milling and baking. Direct inquiries about seed sources to the University of Alberta.

Winter Wheat

Winter wheat varieties are also bread wheats (*Triticum aestivum* subspecies *vulgare* L.). They are made up of two types: the hard red and the soft red varieties. Hard red winter wheats are adapted to areas of low precipitation (less than 35 inches annually), while soft red winter wheats are usually grown in areas of higher annual precipitation. Winter wheat is usually planted in early fall. In its first year, it produces a small, low rosette of vegetative growth to build up root reserves before winter dormancy. The next spring it produces an upright plant with a seedhead similar in appearance to annual grains. No winter grains (barley, wheat, or rye) have performed well in Alaska for many reasons. To build up enough root reserves to survive the winter, the grain must be planted in late July to early August. This leads to a thirteen-month season for winter grains because they can't be harvested until the following August. An annual grain crop can be planted and harvested in about three months and a new crop planted the following year.

In Alaska the photoperiod, even in late July to early August, can lead to other problems. L.J. Klebesadel (1969) found in tests on winter rye varieties that long daylength caused nonadapted varieties to grow more rapidly as seedlings, which results in the buildup of fewer root reserves and consequently, a high rate of winter kill, which is the second and most serious problem. Some varieties of winter grain can tolerate low temperatures quite well; certain winter wheat varieties have been known to survive -40° F temperature, and winter temperatures under the snowpack are almost always warmer than that. If the snowpack blows off the field, unadapted varieties can die when temperatures get too low and the rosette suffers freezing injury. After the snowpack has melted and the rosettes green up, there are still many days of potential freezing temperatures. If the snowpack is thin or absent, low humidity can dessicate rosettes. With the snowpack in place, humidity under it is high and snowmold fungi, including white snowmold *(Sclerotinia borealis)*, sclerotial Low Temperature Basidiomycetes (sLTB), and pink snowmold *(Gerlachia nivalis)* can attack the plants and kill the rosettes. These snowmold fungi are present on the plant tissue before winter and only grow and spread in the spring when temperature and moisture conditions are right. Studies by F.J. Wooding and J.H. McBeath (1984) found that applying a low-cost organic fungicide like pentachloronitrobenzene (Terraclor) in the fall is effective against the white snowmold, but not pink snowmold.

Because the Fairbanks site is the only one where snow cover typically is not blown off of the fields, winter grains were only tested there. Only hard red winter wheat varieties were tested due to the low annual precipitation (around 11 inches). For the variety trial tests, no fungicides to prevent snowmold were applied. Few plants of any of the tested varieties survived the winter consistently over the years. Those varieties that had some survival had poor yields, often only returning the same yield as the volume of seed that was originally planted. The extreme differences in yields between winter wheat and spring wheat, the cost in time of thirteen months verses three months, and the high probability of winter kill make winter wheat an economically unviable crop for Alaska. Due to these cultural problems, no varieties of winter wheat are recommended.

Spelt Wheat

Spelt wheat (*Triticum spelta* L.) is considered a genetic parent of common wheat. It is a primitive form of wheat that more closely resembles the wheatgrass (*Agropyron* sp.) family than true bread wheat. The seedhead is long, slender, and awnless. Most of the hulls remain on the kernel after threshing. It is very late maturing, but continues to ripen even under cool wet conditions when most bread wheats do not. Its primary use is as livestock feed, although there is some limited traditional use for human consumption. For digestibility, the hull must be removed before incorporating spelt wheat into any nonruminant or human diet. Spelt wheat is not accepted as a class of bread wheat.

There is a limited niche market for spelt wheat in the United States that is currently undeveloped in Alaska. Spelt wheat production practices are identical to common wheat, except for the longer growing period. The late maturity, extra de-hulling cost for human consumption, greater availability of other grains for livestock feed, limited or nonexistent markets, and the difficulty in obtaining seed make this crop economically unviable for Alaska. For these reasons, no spelt wheat varieties are recommended.

Yields and Test Weights by Location for Spring, Winter, and Spelt Wheat

Wheat grain is bought and sold by weight. Similar to other small grains, a standard test weight for wheat is used as the legal unit for crop sales. This standard test weight for clean, dry, and undamaged wheat is 60 pounds per bushel. There is no standard test weight for spelt wheat. Highest prices are paid to the producer for this niche crop, but only if it meets the quality criteria mentioned previously. Other than test weights, additional samples should be taken on-farm to determine quality. Any seed lots not meeting food grade for wheat should be used as feed grade. It is important then for the producer to clean and size all seed lots before delivery to a niche market. Test weights can differ between cultivars and can change within a single cultivar, depending on cultural practices, weather conditions, and location where grown. It is used here as a measure of grain quality to determine maturity. Yields are expressed here in pounds per acre. Bushels per acre can be determined by dividing the yield of any specific cultivar by the standard test weight.

Tables 16 through 21 list yields and quality measurements for wheat varieties for all test locations: Fairbanks, Eielson, Delta Junction, and Palmer. All sites in the Delta Junction area have been combined into either the Delta dryland site (Table 19) or, if grown under irregation, the Delta irrigated site (Table 20). Each table also contains information on wheat type (hard red spring, semidwarf, etc.), the source or the location of where it was bred, and the years it was tested at each location. Maturity in this study was considered to be when 50% of the heads for each plot were at the hard dough stage. The heads were a light yellow in color and the kernels did not dent when pressed with a thumbnail. Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued growth of the crop. The low temperature point for wheat in this report is the freezing point of water, 32° F. The GDD calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. For winter wheat varieties, the cumulative GDD values were based on an average of 375 days after planting. All varieties were compared with 'Ingal' as the standard variety. "Yield as a percent of 'Ingal'" was determined by dividing the average yield of each variety by the average yield of 'Ingal'. "Maturity vs. 'Ingal'" is the number of days each variety reached 50% maturity either before or after the number of days that 'Ingal' reached 50% maturity.

Table 16. Average yields and quality measurements from hard red spring wheat and spelt variety test plots in the Fairbanks area, 1978 – 2002.

Wheat Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Ingal)	Test Wt. (lbs/ bu)	Lodging (%)	Average Maturity Date	Maturity vs. Ingal (days)	Average Maturity (GDD)*
				hard red spring					
Canuck	(Manitoba)	1	2860	97	62	0	5-Aug	3	2383
Chena (experi-mental)	(Alaska)	3	4112	140	58	18	3-Aug	1	2328
Conway	(Saskatchewan)	1	3285	111	61	0	5-Aug	3	2383
Gasser	(Alaska)	3	2847	97	55	45	3-Aug	1	2328
Katepwa	(Manitoba)	1	3528	120	61	0	5-Aug	3	2383
Kenyon	(Saskatchewan)	2	4881	166	63	0	5-Aug	3	2383
Laura	(Saskatchewan)	2	5065	101	63	0	6-Aug	4	2411
Nogal	(Alaska)	5	3373	114	57	2	4-Aug	2	2355
Park	(Alberta)	3	3681	125	60	2	4-Aug	2	2355
Roblin	(Manitoba)	4	3766	128	60	0	8-Aug	6	2464
Tapio	(Finland)	3	5032	171	60	0	5-Aug	3	2383
Ulla	(Finland)	1	3403	115	57	0	3-Aug	1	2328
Vidal	(Alaska)	5	2892	98	53	0	4-Aug	2	2355
				hard red spring, semidwarf					
Cutler	(Alberta)	3	2518	85	57	0	5-Aug	3	2383
HY 320	(Saskatchewan)	2	5546	188	62	0	6-Aug	4	2411
Ingal	(Alaska)	7	2947	100	57	1	2-Aug	0	2301
Oslo	(Colorado)	2	4169	141	60	0	5-Aug	3	2383

Table 16 continued on next page

Table 16. Average yields and quality measurements from hard red spring wheat and spelt variety test plots in the Fairbanks area, 1978 – 2002.

Wheat Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Ingal)	Test Wt. (lbs/ bu)	Lodging (%)	Average Maturity Date	Maturity vs. Ingal (days)	Average Maturity (GDD)*
hard red spring, utility									
Blue Sky	(Alberta)	2	5105	173	61	0	6-Aug	4	2411
Wildcat	(Alberta)	2	4659	158	59	0	5-Aug	3	2383
spelt									
Speltz	(South Dakota)	1	3420	116	N/D	0	21-Aug	19	2769

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Table 17. Average yields and quality measurements from hard red winter wheat variety test plots in the Fairbanks area, 1978 – 2002.

Wheat Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Ingal)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Ingal (days)	Average Maturity (GDD)*
hard red winter									
Blackhawk	(Nebraska)	1	136	5	47	0	17-Aug	15	3750
Cheyenne	(Nebraska)	2	122	4	48	0	17-Aug	15	3750
Froid	(Montana)	7	2004	68	55	0	10-Aug	8	3581
Kharkov	(Quebec)	1	445	15	50	0	15-Aug	13	3704
Lancer	(Colorado)	2	336	11	48	0	15-Aug	13	3704
NB 66403	(Nebraska)	2	2020	69	50	0	10-Aug	8	3581
Norstar	(Alberta)	2	779	26	64	0	10-Aug	8	3581
Omaha	(Nebraska)	3	859	29	51	0	10-Aug	8	3581
Roughrider	(North Dakota)	2	649	22	64	0	10-Aug	8	3581
Sawmont	(US)	3	1905	65	55	0	10-Aug	8	3581
Scout 66	(Nebraska)	2	59	2	49	0	17-Aug	15	3750
Shoshoni	(Nebraska)	3	1652	56	55	0	10-Aug	8	3581
Sundance	(Alberta)	2	653	22	63	0	10-Aug	8	3581
Trader	(US)	2	360	12	49	0	15-Aug	13	3704
Trapper	(US)	3	1411	48	51	0	10-Aug	8	3581
Warrior	(Nebraska)	2	304	10	49	0	15-Aug	13	3704
Winalta	(Alberta)	2	206	7	48	0	15-Aug	13	3704

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity based on an average of 375 days after planting.

Table 18. Average yields and quality measurements from hard red spring wheat variety test plots in the Eielson area, 1993 – 2001.

Wheat Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Ingal)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Ingal (days)	Average Maturity (GDD)*
				hard red spring					
Nogal	(Alaska)	1	N/D	N/D	N/D	0	13-Aug	8	2599
Roblin	(Manitoba)	2	2623	128	54	0	17-Aug	12	2693
Vidal	(Alaska)	2	824	40	52	0	17-Aug	12	2693
				hard red spring, semidwarf					
Cutler	(Alberta)	3	2147	104	54	0	15-Aug	10	2647
Ingal	(Alaska)	3	2058	100	56	0	5-Aug	0	2388

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity. N/D = No Data.

Table 19. Average yields and quality measurements from hard red spring wheat and spelt variety test plots in the Delta Junction area, 1978 – 2002, dryland site.

Wheat Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Ingal)	Test Wt. (lbs/ bu)	Lodging (%)	Average Maturity Date	Maturity vs. Ingal (days)	Average Maturity (GDD)*
				hard red spring					
Canuck	(Manitoba)	1	2515	134	60	0	29-Aug	15	2693
Chena (experimental)	(Alaska)	3	3951	211	59	0	29-Aug	15	2693
Conway	(Saskatchewan)	1	2830	151	60	0	27-Aug	13	2660
Gasser	(Alaska)	3	3092	165	60	0	29-Aug	15	2693
Katepwa	(Manitoba)	1	3046	163	60	0	29-Aug	15	2693
Kenyon	(Saskatchewan)	2	3567	190	58	0	30-Aug	16	2710
Laura	(Saskatchewan)	2	3448	184	56	0	30-Aug	16	2710
Nogal	(Alaska)	5	3138	168	58	0	21-Aug	7	2548
Park	(Alberta)	3	3317	177	59	0	30-Aug	16	2508
Roblin	(Manitoba)	5	2234	119	54	0	21-Aug	7	2548
Tapio	(Finland)	3	3902	208	55	0	31-Aug	17	2727
Ulla	(Finland)	1	3115	166	60	0	1-Sep	18	2744
Vidal	(Alaska)	6	2209	118	52	0	23-Aug	9	2585
				hard red spring, semidwarf					
Cutler	(Alberta)	3	1170	62	51	0	7-Aug	-7	2241
HY 320	(Saskatchewan)	2	4507	241	57	0	30-Aug	16	2710

Table 19 continued on next page

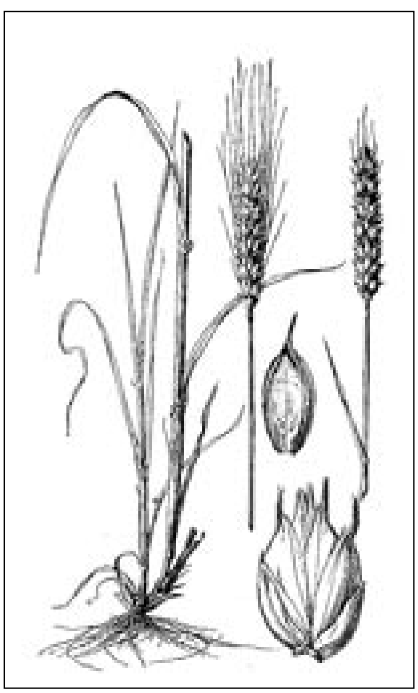
Table 19. Average yields and quality measurements from hard red spring wheat and spelt variety test plots in the Delta Junction area, 1978 – 2002, dryland site.									
Wheat Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Ingal)	Test Wt. (lbs/ bu)	Lodging (%)	Average Maturity Date	Maturity vs. Ingal (days)	Average Maturity (GDD)*
Ingal	(Alaska)	10	1873	100	55	0	14-Aug	0	2404
Oslo	(Colorado)	2	3419	183	56	0	30-Aug	16	2710
hard red spring, utillity									
Blue Sky	(Alberta)	2	4059	217	57	0	30-Aug	16	2710
Wildcat	(Alberta)	2	4271	228	57	0	30-Aug	16	2710
spelt									
Speltz	(South Dakota)	2	2400	128	N/D	0	23-Aug	9	2585

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity. N/D = No Data.

Table 20. Average yields and quality measurements from hard red spring wheat variety test plots in the Delta Junction area, 1998 – 2000, irrigated site.

Wheat Variety Name	Source	Years Tested	Yield (lbs/acre)	Yield (% of Ingal)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Ingal (days)	Average Maturity (GDD)*
hard red spring, semidwarf									
Cutler	(Alberta)	1	2695	104	58	0	13-Aug	7	2383
Ingal	(Alaska)	3	2597	100	54	0	6-Aug	0	2217
hard red spring, utility									
Lazer	(Alberta)	1	2834	109	56	0	17-Aug	11	2469

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.



At left: Triticum aestivum *L., common wheat. Image courtesy of the USDA-NRCS PLANTS Database / Hitchcock, A.S. (rev. A. Chase). 1950.* Manual of the grasses of the United States. *USDA Misc. Publ. No. 200. Washington, DC. Above: newly sprouted wheat photographed by Flavio Gassen.*

Table 21. Average yields and quality measurements from hard red spring wheat variety test plots in the Palmer area, 1989 – 2002.

Wheat Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Ingal)	Test Wt. (lbs/ bu)	Lodging (%)	Average Maturity Date	Maturity vs. Ingal (days)	Average Maturity (GDD)*
hard red spring									
Chena (experi-mental)	(Finland)	1	3398	140	61	0	29-Aug	10	2748
Gasser	(Alaska)	1	2678	111	59	0	29-Aug	10	2748
Kenyon	(Saskatchewan)	1	2939	121	62	0	29-Aug	10	2748
Laura	(Saskatchewan)	1	3105	128	63	0	29-Aug	10	2748
Nogal	(Alaska)	1	2360	98	60	0	29-Aug	10	2748
Park	(Alberta)	1	2970	123	63	0	29-Aug	10	2748
Roblin	(Manitoba)	1	3129	129	63	0	29-Aug	10	2748
Tapio	(Finland)	1	2984	123	62	0	29-Aug	10	2748
Vidal	(Alaska)	1	3067	127	60	0	29-Aug	10	2748
hard red spring, semidwarf									
HY 320	(Saskatchewan)	1	3237	134	62	0	29-Aug	10	2748
Ingal	(Alaska)	2	2421	100	57	13	19-Aug	0	2372
Oslo	(Colorado)	1	2239	93	60	0	29-Aug	10	2748
hard red spring, utility									
Blue Sky	(Alberta)	1	3354	139	61	0	29-Aug	10	2748
Wildcat	(Alberta)	1	2525	104	60	0	29-Aug	10	2748

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

*Above, a field of ripening wheat in Alaska (AFES file photo). At right, wheat ear with bug (*Diabrotica speciosa*) photographed in Brazil by Flavio Gassen.*

Rye and Triticale Performance Trials

Spring Rye

Rye (*Secale cereale* L.) has been shown to be even less adapted for Alaska than wheat. Similar to wheat, rye has a long growing season requirement but yields less than many wheat varieties. M.B. McLelland (2001) found that rye has lower digestibility and palatability when fed to livestock and thus must be blended with other grains and should make up less than one-third of the feed mix. Rye is susceptible to head shatter, making it difficult to harvest and resulting in the emergence in the field of many volunteer plants the next season. However, the biggest problem with rye is its susceptibility to ergot disease *(Claviceps purpurea)*. Ergot is a fungal disease that can be toxic to livestock and humans. Rye seed lots containing 0.5% or more ergot are rejected as food-grade quality for human consumption. Seed lots containing between 0.3 and 0.5% are considered "ergoty" and must be cleaned before milling. Ergot is the most prevalent fungal disease that has been found on rye in Alaska. The weather conditions best suited for producing ergot are warm, moist spring weather followed by warm dry conditions during the flowering growth stage. Ergot forms on the plant during the flowering growth stage, later producing sclerotia when the plant matures. The sclerotia can fall to the ground with regular rye seed when head shatter occurs or be in with the seed at harvest. It overwinters in the soil and can infect plants grown the following year. Ergot can also infect other small grains with the following order of susceptibility: rye, triticale, barley, durum wheat, common wheat, and oats.

*Cereal Rye (*Secale cereale *L.). USDA-NRCS PLANTS Database. Hitchcock, A.S. (rev. A. Chase). 1950.* Manual of the grasses of the United States*. USDA Misc. Publ. No. 200. Washington, DC.*

The primary use of rye is as bread flour. The protein concentration of rye is less than that of wheat. Rye flour does not have true gluten proteins but it contains proteins that make a nutritious, dark, heavy leavened bread. Secondary uses are in the distillation of rye whisky and as a livestock feed. Rye is also used as an annual forage crop either by itself or with legumes. Also, it is used as a green manure crop to help smother annual weeds and increase soil organic matter content.

Fertilization, tillage practices, and seeding depths are identical to that of wheat. Soils with moderate to high levels of available nutrients should receive a complete fertilizer blend of nitrogen, phosphorus, potassium, sulfur, and boron. Actual percentages of each nutrient and the application rate varies according to specific soil test results. The fertilizer can be broadcast before spring tillage or portions can be banded at planting. Avoid excess nitrogen fertilizer because it can induce lodging and delay maturity. Rye can be more productive on poor soils than other small grains becasuse it is tolerant of acidic and sandy soil conditions.

To conserve soil moisture, minimum tillage is recommended for incorporating fertilizer material and plant residue and preparing the seedbed. Pulling a packer behind the tillage implement and using a seed drill equipped with press wheels ensures that the seed is in contact with moist soil during the time needed for germination. Seeding depth and rate is the same as that for wheat, 1 1/2 to 2 1/2 inches, or to moisture, and 90 to 100 pounds of pure live seed per acre. The heavier seeding rates should be used to reduce late tillering. Early planting dates are recommended to utilize as much of the short growing season as possible. Use of certified seed is strongly recommended. Rye is an open pollinated crop, unlike most other small grains, which are self pollinated. If two distinct varieties are planted in close proximity to each other, cross pollination results. Cross-pollinated seed cannot be sold as either of the original seed varieties.

Pest control in rye is the same as for other grains. Weed control is a combination of mechanical and chemical summer fallow to reduce the number and species of weeds for the following season and an application of a post-emergence herbicide. The best broadleaved weed control has been with Bromoxynil and MCPA tank mixes or a 2,4-D amine applied when the rye was 4 to 6 inches tall but before the boot stage. The best control of grassy weeds was through a combination of mechanical and chemical summer fallow. To eliminate grassy weeds with chemical fallow, a broad spectrum post-emergence herbicide such as glyphosphate (Roundup) was used. Ergot is controlled by planting clean seed in soil that has not shown signs of ergot for at least the previous two years. Ergoty rye can also be mown for forage or grazed before flowering occurs. The same insect pests that affect barley, oats, and wheat also affect rye.

The most serious insect pests for rye are aphids (family Aphididae) and grasshoppers, including the lesser migratory grasshopper (*Melanoplus sanguinipes* Fabricias), the northern grasshopper (*Melanoplus borealis* Fieber), and the clear-winged grasshopper (*Camnula pellucida* Scudder). Diazinon or carbaryl (Sevin) sprays or baits help control heavy infestations. Remember to always read the pesticide label and follow the directions on mixing, application, and disposal. Rye is even later maturing than wheat, so the crop may still be in the fields when waterfowl begin fall migrations. Rye however, is not preferred by waterfowl as an energy source, especially if wheat or hulless barley is present nearby. When rye is the only crop in the field, using propane scare cannons is recommended to keep migratory waterfowl away. For more information contact the local office of the Alaska Department of Fish and Game.

As with wheat, rye stops growing when the seed reaches the hard dough stage (the kernels can't be dented when pressed with a thumbnail). The typical seed moisture content at this stage is 25–35%. Rye can be harvested at this moisture content, but significant losses in germination occur during storage. Rye seed must be around 2–13% moisture for safe, long-term storage. Higher moisture contents can germinate or mold the stored seed; lower moisture contents can damage the embryo, reducing germination ability. Both situations reduce the quality of the stored grain. Harvesting before or at the hard dough stage results in a fair amount of green, high-moisture heads. This underdeveloped grain is low in yield, test weights, and market value. Higher quality grain can be achieved when swathing or combining at the lowest moisture content. The same combine settings used for wheat should be used to harvest rye. When combining rye, reduce the front concave opening and cylinder speed for proper threshing and hull removal. This slows down the feeding rate. Increase the air flow to improve hull removal. Run augers at full capacity or slow them down to reduce embryo damage. Because food-grade seed allows only 4% cracked hulls, continual checking for hulls left on the seed or cracked seeds and adjusting combining methods is important. Due to rye's strong tendency to head shatter, waiting for the grain to field dry to 13% moisture can result in significant yield reductions. To reduce this, the grain should be harvested at a higher than optimal moisture content. This requires on-farm drying to get stored grain to 12% moisture. Spring rye can have deceptively high yields, because it is very late maturing and a large portion of the seed harvested can be immature and not ripe.

Rye production has the same major drawbacks as wheat production. All rye varieties are late or very late maturing, are lower yielding than wheat, and there lacks an established Alaska niche market where the producer can obtain a high price for the crop. For feed grade, no more than 15% of the hulls can remain without lowering the crop's value. For food grades no more than 5% of the hulls can remain. When harvesting rye, the hulls are easily removed during the combining process. Additional buffing of the seed to remove hulls can be done, if needed, before shipping to market. Food grade rye can't contain more than 0.3% ergot-diseased kernels and 4% or less of other crops or foreign material. Any seed lot not meeting the higher food grades is purchased at the lower feed-grade prices and any seed lots with more than 0.5% ergot are rejected. On-farm cleaning and sizing of the seed lot to food-grade standards before shipment results in higher prices paid to the producer. Clean-outs can be used on-farm or sold as feed grade. Ergot can be removed with air aspiration seed cleaners or infected seed can be soaked in a 20% salt water solution. Ergot floats to the top and can be skimmed off. The seed must then be washed in clean water and dried back to 12% moisture content before feeding or storage. Ergot sclerotia must be destroyed to prevent any further contamination in following years.

In Alaska there is even less of a market for rye than for wheat. Although there are no commercial mills in the state to process food-grade flour, there are a number of small scale on-farm mills. There are no elevators currently set up to accept rye grain in Alaska. Rye is sold primarily as whole grain flour in local health food markets. Rye lacks the rough awns of barley straw and is suitable for animal bedding.

Recommended Variety Descriptions for Spring Rye

Note: See Appendix 1 for the addresses of seed suppliers.

'Gazelle' is a late maturing, tall, stiff-strawed, moderately high-yielding, spring rye released in 1974 from the plant breeding program of the University of Saskatchewan in Saskatoon. It was a selection out of a German strain. It is two to three weeks later in maturity than 'Ingal' wheat, but in favorable years has out-yielded 'Ingal'. In Alaska, it is highly susceptible to ergot, with average contamination levels between 0.01 and 5.10%. Direct inquiries about seed sources to the Canadian Seed Growers Association, Stock Seed Distribution Committee.

Winter Rye

Winter rye varieties are in the same species as spring rye (*Secale cereale* L.). Winter rye is generally better adapted than winter wheat to cold growing conditions. Winter rye, like winter wheat, is usually planted in early fall. It produces a small, low rosette of vegetative growth that builds up root reserves before undergoing winter dormancy. The next spring it produces an upright plant with a seedhead similar in appearance to annual grains. The same problems encountered in Alaska for winter wheat production are also found for winter rye. Winter rye should be planted in late July to early August for harvest the following August. This leads to a thirteen-month growing season, compared to an annual grain crop that can be planted and harvested in around three months with an additional crop planted the following year. L.J. Klebesadel (1969) found in tests on winter rye varieties that long day length caused nonadapted varieties to grow more rapidly as seedlings; a low amount of root reserves were built up, resulting in a high rate of winter kill. When the snowpack blows or melts off the field, nonadapted varieties can be killed if the temperatures get low enough to cause freezing injury to the rosette. Winter humidity levels are quite low, causing sublimation from the top soil layers and plants into the snowpack and then into the atmosphere. This causes the rosettes to desiccate, in effect, freeze drying them. When moisture conditions under the snowpack are high enough, certain species of snowmold fungi, including white snowmold *(Sclerotinia borealis)* and pink snowmold *(Gerlachia nivalis)*, can attack the plants and kill them. These snowmold fungi are present on the plant tissue before winter and only grow and spread in the spring when temperature and moisture conditions are right. Studies by F.J. Wooding and J.H. McBeath (1984) found that a low-cost organic fungicide like pentachloronitrobenzene (Terraclor) applied in the fall was effective against white snowmold, but not pink snowmold. The most important problem is the susceptibility of this crop to ergot *(Claviceps purpurea)* fungal disease and its difficult control. The best methods are the same as those for controlling ergot in spring rye.

The Fairbanks site was the only location where winter rye was tested, because the snow cover is generally not blown off of the fields. For the variety trial tests no fungicides to prevent snowmold were applied. The first few years of testing produced excellent results, with winter rye producing on average 70% higher yields than spring rye. However, long-term testing found little consistency in winter survival and poor yields resulted in years where winter kill was greatest. The cost in time of thirteen versus three months, the susceptibility to ergot and snowmolds, very late maturity, and the high probability of winter kill reduce the economic viability of winter rye as a crop for Alaska. Since spring rye produced higher and more consistent yields, there seems little reason to grow winter rye. Due to these cultural problems, no varieties of winter rye are recommended.

Spring Triticale

Triticale (X *Triticosecale* Whittmack) is a manmade crop, a cross between wheat *(Triticum)* and rye *(Secale)*. Most of these crosses have been with durum wheat varieties. The crop was developed to combine the winter hardiness characteristics of rye with the breadmaking characteristics of wheat. Even though this crop has been around for more than 100 years, it is still in the experimental stages of development. Little acreage is grown in North America and only small areas for testing have been grown in Alaska. Like the rye varieties, triticale is very late maturing and highly susceptible to ergot. Triticale kernels are larger than those of wheat and have a higher lysine (sulfur-containing amino acid) content for improved nutrition. Triticale has higher seed yields and better drought resistance than wheat. It is highly resistant to head shatter and lodging.

The primary use of triticale is for bread flour. The protein concentration of triticale is about that of wheat but with a higher lysine content. A secondary use is livestock feed. Triticale can be used as the only grain in poultry diets and has a similar value to a barley and wheat mixture in swine diets. Triticale is also used as an annual forage crop either by itself or interseeded with legumes. It has about a 10% higher forage yield than either barley or oats. The quality of the forage ranks between that of barley and oats.

Fertilization, tillage practices, and seeding depths are identical with that of rye. Soils with moderate to high levels of available nutrients should receive a complete fertilizer blend of nitrogen, phosphorus, potassium, sulfur, and boron. Actual percentages of each nutrient and the application rate varies according to specific soil test results. The fertilizer can be broadcast before spring tillage or portions can be banded at planting. Avoid excess nitrogen fertilizer because it can induce lodging and delay maturity.

To conserve soil moisture, minimum tillage is recommended for incorporating fertilizer material and plant residue and preparing the seedbed. Pulling a packer behind the tillage implement and using a seed drill equipped with press wheels ensures that the seed is in contact with moist soil during the time needed for germination. Seeding depth and rate is the same as that for rye, 1½ to 2½ inches, or to moisture, and 90 to 100 pounds of pure live seed per acre is used to reduce late tillering. The heavier seeding rates are recommended when triticale is grown for forage. Early planting dates are recommended to utilize as much of the short growing season as possible. Use of certified seed is strongly recommended.

Pest control in triticale is the same as for wheat and rye. Weed control is a combination of mechanical and chemical summer fallow to reduce the number and species of weeds for the following season and an application of a post-emergence herbicide. The best broadleaved weed control has been with Bromoxynil and MCPA tank mixes, or a 2,4-D amine applied when the triticale was 4 to 6 inches tall, but before the boot stage. To eliminate grassy weeds with chemical fallow, a broad spectrum post-emergence herbicide such as glyphosphate (Roundup) was used. Ergot *(Claviceps purpurea)* is the most prevalent fungal disease that has been found on triticale in Alaska. The weather conditions best suited for ergot are warm, moist spring weather followed by warm, dry conditions during the flowering growth stage. Ergot forms on the plant during the flowering growth stage, later producing sclerotia when the plant matures. It can survive over winter in the soil and can infect plants grown in the following year. Control of ergot is by planting clean seed in soil that has not shown signs of ergot for at least the previous two years. As with rye, ergoty triticale can also be mown for forage or grazed before flowering occurs. The same insect pests that affect rye and wheat also affect triticale. The most serious insect pests are aphids (family Aphididae) and grasshoppers, including the lesser migratory grasshopper (*Melanoplus sanguinipes* Fabricias), the northern grasshopper (*Melanoplus borealis* Fieber), and the clear-winged grasshopper (*Camnula pellucida* Scudder). Diazinon or carbaryl (Sevin) sprays or baits help control heavy infestations. Remember to always read the pesticide label and follow the directions on mixing, application, and disposal. Triticale, like rye, is even later maturing than wheat, so the crop may still be in the fields when waterfowl begin fall migrations. Triticale, like wheat, is preferred to rye by waterfowl as an energy source. Using propane scare cannons is recommended to keep migratory waterfowl away. For more information contact the local office of the Alaska Department of Fish and Game.

Like wheat and rye, triticale stops growing when the seed reaches the hard dough stage (the kernels can't be dented when pressed with a thumbnail). The typical seed moisture content at this stage is 25–35%. Triticale can be harvested at this moisture content, but significant losses in germination occur during storage. The seed must be 12–13% moisture for safe, long-term storage. Higher moisture content can result in germination or molding of the stored seed, and lower moisture content can damage the embryo, reducing germination ability. Both situations reduce the quality of the stored grain. Harvesting before or at the hard dough stage results in a fair amount of green, high-moisture heads. This underdeveloped grain is low in yield, test weights, and market value. The highest quality grain can be achieved when swathing or combining at the lowest possible moisture content. Because triticale is resistant to head shatter and lodging, it can remain standing in the field until it reaches a low percent moisture and then be direct combined. If it is swathed, there is a high possibility of sprouting in the windrow. The same combine settings as for wheat should be used to harvest triticale. For proper threshing and hull removal when combining triticale, reduce the front concave opening and cylinder speed, which slows the feeding rate accordingly. Increase the air flow to improve hull removal. Run augers at full capacity or slow them down to reduce the embryo damage. Because food-grade seed can contain only 4% cracked hulls, continual checking for hulls left on the seed or cracked seeds and adjusting combining methods is important. Triticale can have deceptively high yields because it is very late maturing and a large portion of the seed harvested is immature and not ripe. On-farm drying of the seed is necessary to reduce the moisture content.

There are major drawbacks in Alaska triticale production. All varieties are late or very late maturing and an established niche market is required for the producer to obtain the highest crop price. For feed grade more than 15% of the hulls left on the kernels will lower the price paid to the producer. For food grades, no more than 5% of the hulls can be left on. When harvesting triticale, the hulls are not as easily removed during the combining process as they are for either wheat or rye. Additional buffing of the seed to remove hulls can be done, if needed, before shipping to market. Food-grade triticale can contain no more than 0.3% ergot-diseased kernels and 4% or less other crops or foreign material. Any seed lot not meeting the higher food grades is purchased at lower feed-grade prices and any seed lots with more than 0.5% ergot are rejected. On-farm cleaning and sizing of the seed lot to food-grade standards before shipment results in higher prices paid to the producer. Ergot can be removed using the same methods described for rye. Clean-outs can be used on-farm or sold as feed grade.

Similar to rye, triticale has a limited market in Alaska. There are no commercial mills in the state to process food grade flour, although there are a number of small scale, on-farm mills. Currently there are no elevators set up to accept triticale in Alaska. Triticale is sold primarily as whole grain flour in local health food markets, with secondary use as a forage crop. Like rye and wheat straw, triticale straw lacks the rough awns of barley straw and could be used for animal bedding.

Recommended Variety Descriptions for Spring Triticale

Note: See Appendix 1 for the addresses of seed suppliers.

'Carman' is a late maturing, mid-tall, stiff-strawed, moderately high-yielding, spring triticale released in 1980 from the Department of Plant Science of the University of Manitoba. It was a selection from a cross between a Canadian triticale line and a Mexican line. It is two to three weeks later in maturity than 'Ingal' wheat but under favorable conditions can out- yield 'Ingal'. In Alaska, it is susceptible to ergot, with average contamination levels between 0.01 and 0.91%. This variety has been deregistered and is now in the public domain. Direct inquiries about seed sources to the SeCan Association or the University of Manitoba.

*A field of cereal rye (*Secale cereale L.*). Photo by Martin van der Grinten at USDA-NRCS PLANTS Database.*

Winter Triticale

Winter triticale varieties are members of the same species as spring triticale (X *Triticosecale* Whittmack). Winter triticale, like winter wheat and winter rye, is usually planted in early fall. It produces a small, low rosette of vegetative growth that builds up root reserves before winter dormancy. The next spring it assumes an upright growth form with a seedhead similar in appearance to other annual grains. The same problems for producing winter rye exist for producing winter triticale. First there is a thirteen-month growing season rather than the three-month season for an annual grain crop. Further, winter triticale, like all winter grains in Alaska, is susceptible to winter kill from freezing injury to the rosette, desiccation and freeze drying of the rosette, and attacks of snowmold fungi, including white snowmold *(Sclerotinia borealis)* and pink snowmold *(Gerlachia nivalis)*. Another important problem is the susceptibility of this crop to ergot *(Claviceps purpurea)* fungal disease and the difficulty of controlling it. These factors all detract from the economic viability of this crop in Alaska. Due to the lack of consistent success with other winter grains in Alaska, no winter triticale varieties were tested during this time period. However, F.J. Wooding and others tested an experimental line of winter triticale ('6TA131') in the Fairbanks area before this study with no success. Due to these cultural problems, no varieties of winter triticale are recommended.

Yields and Test Weights by Location for Spring Rye, Winter Rye, and Triticale

Rye and triticale are bought and sold by weight. Similar to other small grains, there is a standard test weight for both rye and triticale that is used as the legal unit for crop sales. This standard test weight for clean, dry, and undamaged rye and triticale is 56 pounds per bushel. Highest prices are paid to the producer for these niche crops when they meet the quality criteria mentioned previously. Other than test weights, additional samples should be taken on-farm to determine quality. Because seed lots not meeting food grade for either rye or triticale should be used as feed grade, it is important for the producer to clean and size all seed lots before delivery to a niche market. Test weights can differ between cultivars and can change within a single cultivar, depending on cultural practices, weather conditions, and location where grown. Test weight is used here as a measure of grain quality to determine maturity. Yields are expressed here in pounds per acre. Bushels per acre can be determined by dividing the yield of any specific cultivar by the standard test weight.

Tables 22–23 list yields and quality measurements for rye and triticale varieties for two test locations: Fairbanks and Delta Junction. All sites in the Delta Junction area have been combined into the Delta dryland site (Table 23). There were no irrigation studies done for either rye or triticale. Each table also contains information on grain type (spring or winter), the source or the location of where it was bred, and the years it was tested at each location. Maturity in this study was considered to be when 50% of the heads for each plot were at the hard dough stage with light-yellow heads and kernals that did not dent when pressed with a thumbnail.

Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued crop. The low temperature point for both rye and triticale in this report is the freezing point of water, 32° F. The GDD calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. For winter rye and triticale varieties, the cumulative GDD values were based on an average of 375 days after planting. All varieties were compared with 'Ingal' wheat as the standard variety. Yield as a percent of 'Ingal' were determined by dividing the average yield of each variety by the average yield of 'Ingal'. "Maturity vs. 'Ingal'" is the number of days each variety reached 50% maturity either before or after the number of days that 'Ingal' reached 50% maturity.


From left: images of cereal rye in bloom and ripened. Photo courtesy of USDA-NRCS PLANTS Database, photographer unknown).

Table 22. Average yields and quality measurements from spring rye, winter rye and spring triticale variety test plots in the Fairbanks area, 1978 – 2002.

Rye & Triticale Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Ingal)	Test Wt. (lbs/ bu)	Lodging (%)	Average Maturity Date	Maturity vs. Ingal (days)	Average Maturity (GDD)*
Rye, spring									
Gazelle	(Saskatchewan)	3	5208	177	55	0	21-Aug	19	2769
Karlshulder	(Germany)	1	N/D	N/D	N/D	0	N/D	N/D	N/D
Norwegian	(Norway)	1	1867	63	51	0	21-Aug	19	2769
Petkusser	(Germany)	1	N/D	N/D	N/D	0	N/D	N/D	N/D
Prolific	(Canada)	5	2599	88	52	0	21-Aug	19	2769
Rye, winter									
Jussi	(Finland)	1	28	1	49	0	17-Aug	15	3751
Saskatoon	(Saskatchewan)	5	674	23	56	0	17-Aug	15	3751
Triticale, spring									
Carman	(Manitoba)	1	6024	204	50	0	21-Aug	19	2769
Welsh	(Manitoba)	2	3823	130	46	0	21-Aug	19	2769

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity based on an average of 375 days after planting. N/D = No Data.

Table 23. Average yields and quality measurements from spring rye and spring triticale variety test plots in the Delta Junction area, 1978 – 2002, dryland site.

Rye & Triticale Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Ingal)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Ingal (days)	Average Maturity (GDD)*
Rye, spring									
Gazelle	(Saskatchewan)	3	1703.3	90.9	49	0	23-Aug	9	2585
Norwegian	(Norway)	1	2768.5	147.8	48	0	23-Aug	9	2585
Prolific	(Canada)	2	872.6	46.6	37	0	23-Aug	9	2585
Triticale, spring									
Carman	(Manitoba)	1	3091.2	165.0	39	0	23-Aug	9	2585
Welsh	(Manitoba)	2	2133.8	113.9	40	0	23-Aug	9	2585

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Wild Rice Performance Trials

Wild rice (*Zizania aquatica* L.) has been evaluated several times in a number of locations throughout interior Alaska. G.H. Whiting and others (1978) and D. Smith (1995) have reported yields from trials that have been low and inconsistent. Wild rice is found only as far north as Canada's Lake Winnipeg. Wild rice can grow in shallow, clear, nonturbid water from six inches to four feet deep but does the best at two feet. It requires the presence of a slow moving current, doing best along shallow lake shores where inlets or outlets of small streams are present. Wild rice should be broadcast seeded into shallow water on saturated, fine-textured silt at rates of 20 to 30 pounds per acre, depending on variety and growth habit. Germination requires water temperature of around 45° F and full sunlight. Turbidity, floating weeds, or trash that filter available sunlight limit its growth. After germination, the first leaves to emerge need shallow water to float beneath the surface. Subsequent leaves eventually reach the surface to float on top of the water. If the water is too shallow during this time, the first leaves may dry out; if it is too deep, the secondary leaves may not reach the surface to float. In both cases the plants die. As the stems develop, new leaves eventually stand upright above the water. Wild rice can grow three to eleven feet tall. At the top of the plant, the female flowers (eventual grain) are on a spike above the spikelets of the male flowers. Cross pollination is necessary for grain development. The grain matures from the top of the plant down and easily shatters, making multiple harvests necessary. This also facilitates reseeding, because not all of the seed can be harvested efficiently. Traditional harvest methods consist of knocking the seed heads with a stick or boat paddle so the seed shatters out into the bottom of a boat where it can then be collected. Seed that is kept for planting the following year must be kept constantly moist and at 34° F for 180 days to break dormancy. At no time must this seed be allowed to dry to below 27% moisture before planting or be allowed to freeze because the embryo can be killed. Processing seed for food use must be done quickly after harvest, because green seed can spoil rapidly. This seed must be dried, dehulled, and cleaned before sale as food-grade wild rice.

There are many problems associated with production of wild rice in Alaska. There are very few privately owned small lakes or ponds in which to raise this crop and introduction of this nonnative plant into state-owned lakes or ponds is prohibited by numerous state and federal resource agencies. The Alaska environment is also not well suited for wild rice production. The water is slow to reach the optimum germination temperatures, often not reaching 45° F until midsummer. This shortens the actual growing season of a crop that requires a fairly long one. Wild rice does not compete well with native aquatic plants, such as pond lilies, that can out-compete germinating seedlings. Migratory waterfowl such as ducks and Canada geese eat seeds and germinating seedlings, while moose and muskrat eat whatever plants manage to survive the waterfowl. Producing this crop is labor intensive, and it is difficult to grow commercially. A small niche market in Alaska for wild rice commands a high price paid to producers. It is usually sold in small quantities in health food stores or grocery chains. However, due to the high cost of production and the unlikelihood of consistently producing a large-quantity, high-value crop (even in artificial paddies) wild rice is not an economically viable crop for Alaska. Due to these cultural problems, no varieties of wild rice are recommended.

Yields and Test Weights by Location for Wild Rice

Tables 24–26 list yields and quality measurements for wild rice varieties for three test locations: Fairbanks, Eielson, and Delta Junction. Plots were planted in artificial paddies, private gravel pits, and nearby small lakes. Each table also contains information on the source or location where it was bred and the years it was tested at each location. Maturity in this study was considered to be when 50% of the heads for each plot were at the hard dough stage. The seeds were a dark green or dark brown in color and did not dent when pressed with a thumbnail. Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued growth of the crop. The low temperature point for wild rice in this report is the freezing point of water, 32° F. The GDD calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. Only one variety of wild rice ('Franklin' from Minnesota) reached maturity in an artificial paddy at the Fairbanks site. No yields were taken as the crop was consumed by local wildlife before a harvest could be attempted. D. Smith (1995) reported that another unnamed variety from the eco-region of La Ronge, Saskatchewan, reached maturity in local gravel pits and small lakes near Fort Yukon and managed to reseed itself for at least three years. However, it too had a lot of predation by muskrats and no significant yield data was collected. Attempts to grow wild rice from the same eco-region in a private gravel pit at the Eielson site were of little success as no plants reached maturity. Because there are no standard varieties for wild rice in Alaska, there were no comparisons other than among varieties. Wild rice is cross pollinated, so any two specific varieties planted in close proximity would produce hybrid seed, which then could not be sold as either of the parent varieties. Therefore, in recent years wild rice seed has been sold from an "eco-region" rather than as a specific named variety. Any attempt at producing wild rice in Alaska should use seed ordered from an eco-region that is from latitudes and under climatic conditions as similar as possible to the area being planted.

Table 24. Average yields and quality measurements from wild rice variety test plots in the Fairbanks area.

Wildrice Variety Name	Source	Years Tested	Yield (lbs/acre)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*
food grade							
Canadian K	(Saskatchewan)	1	N/D	N/D	0	N/D	N/D
Franklin	(Minnesota)	2	N/D	N/D	0	21-Sep	3272
K2	(Minnesota)	1	N/D	N/D	0	N/D	N/D
M1	(Minnesota)	1	N/D	N/D	0	N/D	N/D

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
N/D = No Data.

Table 25. Average yields and quality measurements from wild rice variety test plots in the Eielson area.

Wildrice Variety Name	Source	Years Tested	Yield (lbs/acre)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*
eco-region, food grade							
La Ronge	(Saskatchewan)	1	N/D	N/D	0	N/D	N/D

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
N/D = No Data.

Table 26. Average yields and quality measurements from wild rice variety test plots in the Delta Junction area.

Wildrice Variety Name	Source	Years Tested	Yield (lbs/acre)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*
food grade							
Canadian K	(Saskatchewan)	1	N/D	N/D	0	N/D	N/D
Franklin	(Minnesota)	1	N/D	N/D	0	N/D	N/D
K2	(Minnesota)	1	N/D	N/D	0	N/D	N/D
M1	(Minnesota)	1	N/D	N/D	0	N/D	N/D

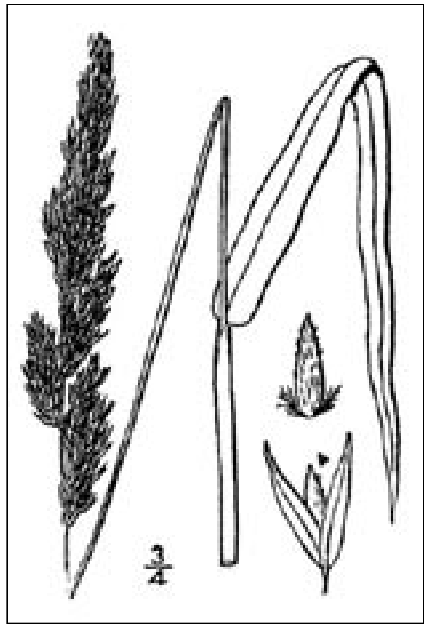
*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
N/D = No Data.

Canarygrass Performance Trials

Annual canarygrass or canaryseed (*Phalaris canariensis* L.) is a relatively new niche crop for Alaska. It is a major portion of commercial feed mixes for caged and wild birds. Other portions of typical bird feed mix include; proso millet, safflower, sunflower, flax, and canola. Each of these other seed portions are discussed individually in separate sections in this publication. Annual canarygrass should not be confused with a close relative, reed canarygrass (*Phalaris arundinacea* L.). Reed canarygrass is a perennial forage grass, and is much taller (2 to 8 feet) with broad leaves and the seed heads are little spikelets 2 to 8 inches long containing several quite small seeds. Canarygrass, on the other hand, is an annual grass that grows 2 to 3 feet tall. It has fine, narrow leaves that are purple or red at the base of the stem. The stems are tough and wiry and can be difficult to combine unless they are fully mature. If harvested before maturity, they can wrap up in the pick-up reels, the feed augers, and the cylinders, reducing threshing efficiency and possibly even necessitating shutting down the combine to clean out plant residues. The seed heads are small and dense, about 1½ to 2 inches long. These seed heads remain on the stem after threshing and the seed does not shatter out of the heads when mature. The seed is small and similar in size and shape to flax seed. The hulls, which should be left on for birdseed, are shiny and golden yellow in color. Dehulled seed is a dark reddish-brown. There are small sharp silica hairs at the base of the seed. Dust produced during combining and processing the seed can irritate the skin and respiratory system. Gloves and dust masks should be worn when handling this crop. New varieties without silicacious, irritating seed have been developed in Canada. They have higher test weights but lower yields. They are called "itchless" or "glabrous" varieties and are marketed under the term Canario.

Fertilization, tillage practices, and seeding depths are similar to small grains. However, canarygrass is regularly lower yielding than small grains (average yields are around 800 pounds per acre) and so require lower levels of available nitrogen. Soils with moderate to low levels of available nutrients should receive a complete fertilizer blend of nitrogen, phosphorus, potassium, sulfur, and boron. Actual percentages of each nutrient and the application rate varies according to specific soil test results. The fertilizer can be broadcast before spring tillage or portions can be banded at planting. Care should be taken when banding nitrogen carriers with the seed because canarygrass seed has a low tolerance to placement with nitrogen fertilizers. Avoid excess nitrogen fertilizer because it can induce lodging and delay maturity.

To conserve soil moisture, minimum tillage is recommended for incorporating fertilizer material and plant residue and preparing the seedbed. Pulling a packer behind the tillage implement and using a seed drill equipped with press wheels ensures that the seed is in contact with moist soil during the time needed for germination. Seeding depth is the same as that for small grains, 1½ to 2½ inches, or to moisture. Seeding rate is 25 to 35 pounds of pure live seed per acre. Because canarygrass tillers profusely, the higher rate should be used to reduce late tillering. Early planting dates are recommended to utilize as much of the short growing season as possible and get the straw as mature as possible before harvest. Use of certified seed is strongly recommended.



Phalaris arundinacea *L., reed canarygrass. Image courtesy of the USDA-NRCS PLANTS Database, from Britton, N.L., and A. Brown. 1913.* Illustrated flora of the northern states and Canada. *Vol. 1:170.*

Pest control in canarygrass is the same as for small grains. Weed control is a combination of mechanical and chemical summer fallow to reduce the number and species of weeds for the following year and an application of a post-emergence herbicide. Best broadleaved weed control has been with Bromoxynil and MCPA tank mixes applied when the canarygrass was 4 to 6 inches tall, but before the boot stage. R. McVicar and others (2000) found that in Canada a 2,4-D ester formulation can cause stunted, irregular growth and reduced yields and should be avoided. Pennsylvania smartweed (*Polygonum pensylvanicum* L.) and volunteer flax both have seed similar to canarygrass in size, shape, and weight, making them difficult to clean out. Seed lots containing these weed seeds are rejected by purchasers. Planting in clean ground helps to control these weeds. To eliminate grassy weeds with chemical fallow, a broad spectrum post-emergence herbicide such as glyphosphate (Roundup) was used. No serious diseases have yet been found on canarygrass in Alaska. The same insect pests that affect small grains also affect canarygrass. The most serious insect pests are aphids (family Aphididae) and grasshoppers, including the lesser migratory grasshopper (*Melanoplus sanguinipes* Fabricias), the northern grasshopper (*Melanoplus borealis* Fieber), and the clear-winged grasshopper (*Camnula pellucida* Scudder). Diazinon or carbaryl (Sevin) sprays or baits help control heavy infestations. Remember to always read the pesticide label and follow the directions on mixing, application, and disposal. Canarygrass is grown specifically for use as birdseed and is later maturing than most small grains so the crop may still be in the fields when waterfowl migration begins. Because waterfowl have difficulty removing canarygrass seed from the seed heads, large flocks can cause serious lodging while trying to get at the seed. Using a propane scare cannon is recommended to keep migratory waterfowl away. For more information contact the local office of the Alaska Department of Fish and Game.

Similar to small grains, canarygrass stops growing when the seed reaches the hard dough stage (the kernels can't be dented when pressed with a thumbnail). Canarygrass seed must be around 13% moisture for safe, long-term storage. Higher moisture contents can germinate or mold the stored seed and lower moisture contents can damage the embryo, reducing germination ability. Both situations reduce the quality of the stored seed. The highest quality seed can be achieved when swathing or combining at the lowest moisture content. The same combine settings used to harvest small grains should be used to harvest canarygrass. Cylinder speeds need to be reduced for proper threshing. This slows down the feeding rate accordingly. Air flow settings should be reduced because of the smaller seed size to settings similar to those for flax. Run augers at full capacity or slow them down to reduce the potential of dehulling the seed. Continual checking for hulls left on the seed or cracked seeds and adjusting combining methods is important as birdseed acceptance standards only allows 4% hulled seed. Because of the small seed size, all cracks and holes in the combine, augers, trucks, and bins should be sealed to prevent seed loss during handling. Canarygrass does not head shatter so combine operations can wait for the seed to field dry to 13% moisture. This also allows the straw to reach full maturity for easier harvesting. Swathing can be used as the seed continues to dry in the windrow. However, do not swath unless the straw is mature. Green straw, even though dry, is still tough and wiry, impeding the combining process. to meet birdseed quality standards, canarygrass can contain no more than 4% dehulled seed, other crops, or foreign material. Any seed lot not meeting the higher birdseed grades are purchased at lower feed prices. On-farm cleaning and sizing of the seed lot to birdseed standards before shipment results in higher prices paid to the producer. Clean-outs can be used on-farm or sold as lower grade seed.

At present, there are no birdseed processing facilities in Alaska nor are there any elevators set up to accept canarygrass seed. There is however, a large niche market of imported, pre-packaged birdseed sold for both wild and caged birds. This imported seed is sold as either pure or mixed seed blends in feed stores to grocery stores throughout Alaska. Because of the difficulty of producing, handling, and marketing a consistently high quality canarygrass seed product in Alaska, there is only a limited amount of acreage presently grown and sold on-farm to consumers.

Recommended Variety Descriptions for Canarygrass

Note: See Appendix 1 for the addresses of seed suppliers.

'Elias' is an early maturing, mid-tall, high-yielding annual canarygrass developed at the Minnesota Agricultural Experiment Station in St. Paul and registered by the Crop Development Centre at the University of Saskatchewan in Saskatoon in 1988. 'Elias' has a large seed head and long straw, making it susceptible to lodging. Test weights are usually higher than the standard test weight for canarygrass seed. Average crude protein level for Alaska-produced seed is 17.3%. This variety has been deregistered and is now in the public domain. Direct inquiries about seed sources to the Crop Development Centre at the University of Saskatchewan in Saskatoon.

Yields and Test Weights by Location for Canarygrass

Canarygrass seed, as is all birdseed, is bought and sold by weight. Similar to small grains, there is a standard test weight for canarygrass that is used as the legal unit for purchase or sale of the crop. This standard test weight for clean, dry, and undamaged canarygrass is 50 pounds per bushel. Highest prices are paid to the producer for these niche crops but only if they meet the quality criteria mentioned previously. Other than test weights, additional samples should be taken on-farm to determine quality. Any seed lots not meeting high quality birdseed standards should be used as lower feed grades. It is important then for the producer to clean and size all seed lots before delivery to a niche market. Test weights are used here as a measure of seed quality to determine maturity. Yields are expressed here in pounds per acre. Bushels per acre can be determined by dividing the yield of any specific cultivar by the standard test weight.

Tables 27–29 list yields and quality measurements for one canarygrass variety for three test locations: Fairbanks, Eielson, and Delta Junction. All sites in the Delta Junction area have been combined into Delta dryland site (Table 29). There were no irrigation studies done with canarygrass. Each table also contains information on the source or the location of where it was bred and the years it was tested at each location. Maturity in this study was considered to be when 50% of the heads for each plot were at the hard dough stage.

The seed, with hulls, were a golden yellow in color and did not dent when pressed with a thumbnail. Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued growth of the crop. The low temperature point for canarygrass in this report is the freezing point of water, 32° F. The GDD calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. As there was only one variety tested there was no standard variety with which to compare results.

Table 27. Average yields and quality measurements from canarygrass variety test plots in the Fairbanks area, 1978 – 2002.

Canary Grass Variety Name	Source	Years Tested	Yield (lbs/acre)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*
Canarygrass (birdseed)							
Elias	(Minnesota)	3	641	47	20	1-Sep	2980

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Table 28. Average yields and quality measurements from canarygrass variety test plots in the Eielson area, 1993 – 2001.

Canary Grass Variety Name	Source	Years Tested	Yield (lbs/acre)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*
Canarygrass (birdseed)							
Elias	(Minnesota)	3	584	49	0	10-Sep	3139

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Table 29. Average yields and quality measurements from canarygrass variety test plots in the Delta Junction area, 1978 – 2002, dryland site.

Canary Grass Variety Name	Source	Years Tested	Yield (lbs/acre)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*
Canarygrass (birdseed)							
Elias	(Minnesota)	3	208	48	0	2-Sep	2760

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Phalaris arundinacea *L., reed canarygrass. Photograph by Robert H. Mohlenbrock at USDA-NRCS PLANTS Database / USDA SCS. 1989.* Midwest wetland flora: Field office illustrated guide to plant species. *Midwest National Technical Center, Lincoln, NE.*

Millet Performance Trials

Proso, Foxtail, and Japanese Millet

Millet is an annual grass that matures in 60 to 80 days for most cultivated varieties. It is efficient at using soil moisture due to its shallow but widespread root system and can produce a crop under drought conditions when most small grains can't. For these reasons, it was tried in Alaska. Unfortunately, it does not germinate when soil temperatures are below 65° F and can be easily killed by light frosts at any time during the growing season. Millet is used primarily as portion of commercial feed mixes for caged and wild birds. For the birdseed markets, hulls must be left on, with no more than 4% hulls removed. Reddish, plump-seeded varieties are in highest demand by the birdseed markets. Millet is also ground for use as a livestock feed, although it only has 90–95% of the feeding value of barley. Only 40% of the protein is digestible by nonruminants. If harvested before or at the flowering stage, some varieties can produce a high-quality forage crop.

Proso millet (*Panicum miliaceum* L.) has a coarse, hollow stem about two feet high and similiar in diameter to a pencil. The stem and leaves are covered with fine hairs that reduce its palatability as a forage crop, especially when harvested after the flowering growth stage. Because the fine hairs on the plant are an irritant and can cause lump jaw and sore eyes in cattle, millet is considered a weed in eastern Canada. Seed heads are about five inches long and consist of many spikelets. They are grouped into varieties based on the shape of the seed head: spreading, loose or one-sided, and compact. Seeds do not mature simultaneously within the seed head and plants are prone to head shatter when ripe. The hulls remain on the seed after threshing and are colored various shades of white, yellow, red, gray, and black. The seed coat is creamy white after the hulls have been removed.

Foxtail millet (*Setaria italica* (L.) Beauv.) has slender, erect leafy stems and grows from one to five feet tall, depending on variety. Foxtail millet can make a high-quality forage crop when it is harvested before heading. If it is to be fed to horses, timing of the forage harvest is critical for hay quality. If cut too early, it can have a laxative effect; if cut too late, it can have a diuretic effect. Seed head length varies from 6 inches to well over 1½ feet, depending on variety. The head consists of many compressed spikelets held close to the main stem. Seeds do not mature simultaneously within the seed head and plants are prone to head shatter when ripe. The hulls remain on the seed after threshing and are colored various shades of white, yellow, orange, red-orange, green, and dark purple.

Japanese or barnyard millet (*Echinochloa frumentacea* W.F. Wright) is a slender plant with a thick and leafy stem that grows two to four feet tall. If used as a forage crop, it can be difficult to cure effectively because of the thick stems. The best quality hay is obtained when it is cut before heading. It is primarily a pasture crop, having much smaller seed heads than either proso or foxtail millets. Each seed head is made up of five to fifteen brownish or purple spikelets. Seed size and shape are similar to both proso and foxtail millets, with a light brown hull color.

Japanese, or barnyard millet (Echinochloa frumentacea). Courtesy of the *USDA-NRCS PLANTS Database, Hitchcock, A.S. (rev. A. Chase). 1950.* Manual of the grasses of the United States. *USDA Misc. Publ. No. 200. Washington, DC.*

Fertilization and tillage practices are similar to those for small grains. Millet is regularly lower yielding than small grains, but grows better under low moisture soil conditions. Therefore, it requires lower levels of available nitrogen to produce an acceptable crop. It competes against weeds better if sufficient nutrients are present. Soils with moderate levels of available nutrients should receive a complete fertilizer blend of nitrogen, phosphorus, potassium, sulfur, and boron. Actual percentages of each nutrient and the application rate varies according to specific soil test results. The fertilizer can be broadcast before spring tillage or portions can be banded at planting. Millet does not usually respond to high levels of available nutrients, especially under dryland conditions. If millet follows summer fallow, fertilization may not be required. Millet grown for forage should have higher amount of nitrogen applied for higher quality hay production. Avoid excess nitrogen fertilizer that can induce lodging and delay maturity.

To conserve soil moisture, minimum tillage is recommended for incorporating fertilizer material and plant residue and preparing the seedbed. Pulling a packer behind the tillage implement and using a seed drill equipped with press wheels ensures that the seed is in contact with moist soil during the time needed for germination. Because of the small seed size, seeding depth is 1 to $1^1/_2$ inches, or to moisture. Seeding rate for proso millet is 8 to 15 pounds of pure live seed per acre, for foxtail and Japanese millet it is 6 pounds per acre planted with a seed drill. If millet is to be grown for forage it can be broadcast seeded at 25 to 30 pounds per acre. The higher seeding rates helps to reduce competition from weeds, shorten plant heights, and reduce lodging for both seed and forage production. A late planting date of the third week on May is recommended to avoid the possibility of a late spring frost. Using certified seed is strongly recommended.

Weed control in millet is extremely important. Millet seedlings are small, thin, and do not compete well with weeds. Weed control is a combination of mechanical and chemical fallow performed the summer before planting to reduce the number and species of weeds for the following season and proper fertilization and seeding rates. To eliminate all weeds with chemical fallow, a broad spectrum post-emergence herbicide such as glyphosphate (Roundup) was used. Because many millet varieties and types are quite sensitive to herbicides, no one chemical is effective for weed control for all varieties. Millet is relatively free from diseases and none have been found on varieties grown in Alaska. The same insect pests that attack small grains also attack millet although to lesser degrees. The most serious insect pests are aphids (family Aphididae) and grasshoppers, including the lesser migratory grasshopper (*Melanoplus sanguinipes* Fabricias), the northern grasshopper (*Melanoplus borealis* Fieber), and the clear-winged grasshopper (*Camnula pellucida* Scudder). Diazinon or carbaryl (Sevin) sprays or baits help control heavy infestations. Remember to always read the pesticide label and follow the directions on mixing, application, and disposal. Millet, like canarygrass, is grown specifically for use as birdseed, and because of its later planting date, the crop may still be in the fields when waterfowl begin fall migrations. Millet seed is highly susceptible to head shatter when ripe and can be easily eaten by waterfowl. Large flocks can also cause serious lodging while trying to get at the seed. Using a propane scare cannons is recommended to keep migratory waterfowl away. For more information contact the local office of the Alaska Department of Fish and Game.

All millet varieties have some yield losses due to head shatter. Harvest should therefore begin when the seeds at the top of the head are mature and ripe. The lower seeds should have lost their green color, but should be in the dough stage. The leaves and stems of proso millet are still green at this stage. Proso millet is susceptible to lodging when ripe. Because the straw of all millet varieties is high in moisture when the seed is ready to harvest, millet should be swathed to dry the straw in windrows before harvest. This also reduces the amount of loss due to head shatter when combined. Millet is killed with the first light frost, so field combining and accepting a higher seed loss from head shatter may be the only option. The same combine settings used to harvest canarygrass should be used to harvest millet. For proper threshing, reduce cylinder speeds to slow the feeding rate. Reduce air flow settings (similar to those for flax) because of the small seed size. Run augers at full capacity or slow them down to reduce the incidence of seed dehulling. Because of the small seed size, all cracks and holes in the combine, augers, trucks, and bins should be sealed to prevent seed loss during handling. Because birdseed acceptance standards only allow 4% hulled seed, continual checking for hulled or cracked seeds and adjusting combining methods is important. Any seed lot not meeting the higher birdseed grades is purchased at lower feed prices. On-farm cleaning and sizing of the seed lot to birdseed standards before shipment results in higher prices paid to the producer. Clean-outs can be used on-farm or sold as lower grade seed.

There are many problems in producing millet in Alaska. Even though it is a short-season crop that does well in semi-arid regions, it is a warm-season crop that needs warm soil to germinate and is highly susceptible to light frosts. This necessitates late planting and early harvest. Light frosts, which would cause total crop failure, can occur at any time during the Alaska growing season. It does not compete well with spring weeds and can be completely shaded out in bad years. Harvest is difficult and losses due to head shatter and predation by migratory waterfowl are high. At present in Alaska, there are no birdseed processing facilities or elevators set up to accept millet. Although a large niche market for imported, prepackaged birdseed for both wild and caged birds commands a high price to producers outside Alaska, high production costs and the unlikelihood of consistently producing a large, high-value crop make millet economically unviable for Alaska. Due to these cultural problems, no varieties of millet are recommended.

Yields and Test Weights by Location for Proso, Foxtail, and Japanese Millet

Tables 30–31 list yields and quality measurements for millet varieties for two test locations: Fairbanks and Delta Junction. All sites in the Delta Junction area have been combined into the Delta dryland site (Table 31). No irrigation studies were done for millet. Each table also contains information on seed type, the source or the location of where it was bred, and the years it was tested at each location. Maturity in this study was considered to be when 50% of the heads for each plot were at the hard dough stage. The seed did not dent when pressed with a thumbnail. Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued growth of the crop. The low temperature point for millet in this report is the freezing point of water, 32° F. The GDD calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. Maturity was not reached for any variety due to severe weed competition and seasonal frosts and is represented by N/D (No Data) in the tables. Because there are no standard varieties for millet in Alaska, there were only comparisons among varieties. Forage quality data is presented without statistical differences and solely for the reader's benefit. Methods for determing forage quality are standard laboratory methods used for feed and forage by the University of Alaska Fairbanks Soil and Plant Analysis Laboratory in Palmer, Alaska (see Appendix 1 for address).

Table 30. Average yields and quality measurements from millet variety test plots in the Fairbanks area, 1978 – 2002.

Millet Variety Name	Source	Years Tested	Yield (lbs/acre)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*	Biomass Crude Protein (%)
Proso (birdseed)								
Abarr	(Colorado)	1	N/D	N/D	0	N/D	N/D	N/D
Big Red	(Nebraska)	1	N/D	N/D	0	N/D	N/D	N/D
Common White	(Colorado)	1	N/D	N/D	0	N/D	N/D	26.51
Dawn	(Nebraska)	1	N/D	N/D	0	N/D	N/D	N/D
Leonard	(Colorado)	1	N/D	N/D	0	N/D	N/D	N/D
Turgahi	(Japan)	1	N/D	N/D	0	N/D	N/D	N/D
Foxtail (birdseed)								
Golden German	(Colorado)	1	N/D	N/D	0	N/D	N/D	22.85
Manta	(South Dakota)	1	N/D	N/D	0	N/D	N/D	N/D
Japanese (birdseed)								
Japanese	(Japan)	1	N/D	N/D	0	N/D	N/D	22.63

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity. N/D = No Data.

Table 31. Average yields and quality measurements from millet variety test plots in the Delta Junction area, 1978 – 2002, dryland site.

Millet Variety Name	Source	Years Tested	Yield (lbs/acre)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*	Biomass Crude Protein (%)
Proso (birdseed)								
Abarr	(Colorado)	1	N/D	N/D	0	N/D	N/D	N/D
Big Red	(Nebraska)	1	N/D	N/D	0	N/D	N/D	N/D
Common White	(Colorado)	1	N/D	N/D	0	N/D	N/D	19.12
Dawn	(Nebraska)	1	N/D	N/D	0	N/D	N/D	N/D
Leonard	(Colorado)	1	N/D	N/D	0	N/D	N/D	N/D
Turgahi	(Japan)	1	N/D	N/D	0	N/D	N/D	N/D
Foxtail (birdseed)								
Golden German	(Colorado)	1	N/D	N/D	0	N/D	N/D	18.41
Manta	(South Dakota)	1	N/D	N/D	0	N/D	N/D	N/D
Japanese (birdseed)								
Japanese	(Japan)	1	N/D	N/D	0	N/D	N/D	18.36

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
N/D = No Data.

A farmer plants foxtail millet, which is a summer annual forage with low water needs. In Alaska, high production costs and the unlikelihood of a consistently large, high-value crop make millet economically unviable. Elsewhere, one use of the crop is to conserve water for subsequent crops. Photo by Scott Bauer, courtesy of the USDA Agricultural Resesarch Service Photo Unit.

Buckwheat Performance Trials

Buckwheat has been grown in Alaska since European colonization, but never in large acreages. There are two distinct types of buckwheat, the common or Japanese (*Fagopyrum esculentum* Moench) and the tartary or mountain (*Fagopyrum tataricum* Gaertn.). They are differentiated by the size of the triangular seeds, with common buckwheat having larger seeds.

Buckwheat, an annual broadleaved plant with many branches, grows two to five feet tall. The stems are succulent and highly susceptible to both late spring and early fall frost damage. It is also highly susceptible to lodging and seed shatter, especially after severe fall frosts. The growth habit is indeterminate, with small clumps of flowers continuously opening about four weeks after seeding until the first killing frost. If harvested for seed, buckwheat requires either swathing or field drying after a killing frost so that the plants can dry for efficient combining. Ripe seed, green seed, and flowers are present, increasing the moisture content at harvest and necessitating seed drying before storage.

Buckwheat is usually handled as a grain crop. After dehulling, seed from the common, large-seeded varieties can be processed into a baking flour, while the smaller seeded tartary varieties are usually used for animal feeds. Although buckwheat flour is higher in lysine content than other small grains used for flour, it is lower in glutens, which limits its use to pancake flours, buckwheat cakes, and health food niche markets.

The average flour return for buckwheat is 70%. The remaining 20% hulls and 10% shorts are removed in the milling process. Buckwheat flour is generally darker than wheat flour because some hull is processed with the flour. If pure white flour is desired, the average flour return is only 52%.

An individual allergic to the proteins in buckwheat can develop a skin rash after consuming large amounts of the flour. This can occur also in white-haired animals that are exposed to high levels of sunlight after consuming buckwheat. Buckwheat is fed whole in poultry diets, but for livestock is dehulled and fed along with the shorts from the milling process. Secondary uses for buckwheat are as a green manure cover crop in rotations before planting potatoes, as a smother crop to reduce weeds, and as an annual crop for honey production. Buckwheat honey has a strong, dark flavor that many people do not like, limiting its value. Bees do not usually use the tartary type of buckwheat for nectar collection.

Fertilization, tillage practices, and seeding depths are identical to those for small grains. Because buckwheat is extremely efficient at obtaining mineral nutrients, due in part to the fast-growing, shallow-rooted growth habit, it is often seeded in unfertilized ground. Its response to fertilizers is less than that of small grains, and it can produce well on infertile, acidic, poorly tilled silt loams, although better competition with weeds and higher seed yield is obtained with fertilizer application. Soils with moderate to low levels of available nutrients should receive a complete fertilizer blend of nitrogen, phosphorus, potassium, and boron. Buckwheat may require a higher level of phosphorus in the fertilizer blend with a 1:2:1 ratio of N, P_2O_5, and K_2O, due to the acidic pH levels of many Alaska soils. Boron helps to induce flowering and should be applied at 0.5 to 1.0 pounds per acre. Actual percentages of each nutrient and the application rate varies according to specific soil test results. The fertilizer should be broadcast before spring tillage. Excess nitrogen fertilizer should be avoided as it can induce lodging and delay maturity.

To conserve soil moisture, minimum tillage is recommended for incorporating fertilizer material and plant residue and preparing the seedbed. Pulling a packer behind the tillage implement and using a seed drill equipped with press wheels ensures that the seed is in contact with moist soil during the time needed for germination. Seeding depth is the same as that for small grains at 1 to 2 inches, or to moisture. Seeding rate is 40 to 60 pounds of pure live seed per acre with the higher rates used for cover or green manure crops. Lower seeding rates of 24 pounds per acre are used for the tartary varieties. Late seeding is recommended to avoid the possibility of serious damage from late spring frosts. Date of planting studies by F.J. Wooding (1980) and C.W. Knight (1994) found that average planting dates of around the third week of May have produced reasonable yields in Alaska. Certified seed is strongly recommended.

There are no herbicides registered for use on buckwheat. The best weed control method is to seed heavy and let the crop shade out other plants. Also, weed control should use mechanical and chemical fallow in the previous season to reduce the number and species of weeds for the following season. To eliminate all weeds with chemical fallow, a broad spectrum post-emergence herbicide such as glyphosphate (Roundup) was used. There are few disease or insects pests that attack buckwheat. If the crop lodges severely in the fall, there may be enough time before harvest for various molds to form on the seeds. Prompt harvest and on-farm drying can reduce mold formation.

Buckwheat seeds are mature when they are a dark brown and in the hard dough stage (the seed can't be dented when pressed with a thumbnail). Because buckwheat is an indeterminate plant, there are ripe seed, green seed, and flowers until the first frost. The seed is susceptible to shatter after a severe frost. To reduce seed loss from shatter, it may be better to swath when 75% of the seeds have reached maturity. Buckwheat has succulent stems that, unless dry when combined, can present problems at harvest, such as wrapping up in the pick-up reels, feed augers, and cylinders. This reduces threshing efficiency and could necessitate shutting down the combine to clean out plant residues. Therefore, soon after a killing frost buckwheat should either be swathed or allowed to field dry, if it does not lodge, to dry the plants for efficient combining. There are no desiccants registered for use on buckwheat. The seed continues to fill in the windrow for about three days after swathing. Combine settings are the same as for small grains. Cylinder speed and concave settings need to be properly set to reduce the amount of cracked seed. Continual checking for cracked seeds and adjusting combining methods is important because food-grade seed only allows 4% cracked hulls. The mixture of mature seed, green seed, and flowers increase the moisture content at harvest, requiring seed drying to 16% moisture content before storage. Only high-quality, large-seeded varieties are purchased by millers for food-grade buckwheat, which can't contain any diseased kernels, other crops, or foreign material. Any seed lot not meeting the higher food grades is purchased at lower feed-grade prices. On-farm cleaning and sizing of the seed lot to food-grade standards before shipment results in higher prices paid to the producer. Clean-outs can be used on-farm or sold as feed grade.

Buckwheat has a limited market in Alaska. Although there are a number of small-scale, on-farm mills in Alaska, there are no commercial-size mills to produce food-grade flour, and no elevators are set up to accept buckwheat. In Alaska it is primarily used as a green manure crop with limited secondary use by honey producers for dark specialty honey.

Recommended Variety Descriptions for Buckwheat

Note: See Appendix 1 for the addresses of seed suppliers.

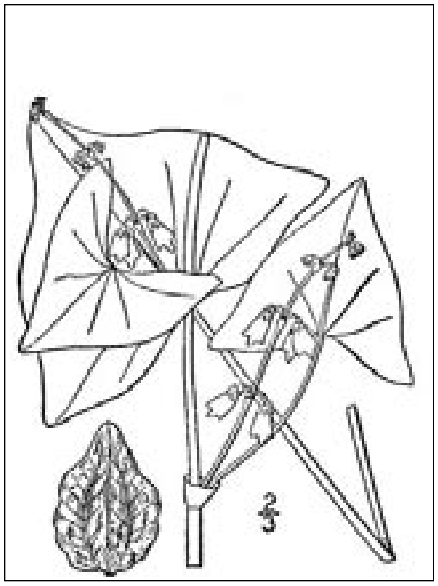
'Pennquad' is an early maturing (to 75% mature seed), uniform, high-yielding, large-seeded, tetraploid variety developed in 1966 by the USDA plant breeding program at the Pennsylvania State University Agricultural Experiment Station in University Park, Pennsylvania. Its uniformity and high-yielding characteristics make it an acceptable milling variety. This was the standard variety against which all other buckwheat varieties were compared in this report. Direct inquiries about seed sources to the Pennsylvania State University.

'CM – 15' is an early maturing (to 75% mature seed), uniform, high-yielding, small-seeded experimental line developed by the Agriculture and Agri-Food Canada Research Centre at Morden, Manitoba. Its small seed make it less acceptable as a milling grade buckwheat, but its uniformity and early maturing characteristics have produced consistent high yields. It is about equal with 'Pennquad' in maturity and yield on good sites, but outproduces 'Pennquad' on poorer sites. Direct inquiries about seed sources to the Agriculture and Agri-Food Canada Research Centre at Morden, Manitoba.

Yields and Test Weights by Location for Buckwheat

Buckwheat seed is bought and sold by weight. Similar to small grains, a standard test weight is used as the legal unit for crop sales. Standard test weight for clean, dry, and undamaged buckwheat is 48 pounds per bushel. Highest prices are paid to the producer for these niche crops only if they meet the quality criteria mentioned previously. Other than test weights, additional samples should be taken on-farm to determine quality. Any seed lots not meeting food-grade buckwheat standards should be used as feed grade. It is important then for the producer to clean and size all seed lots before delivery to any market. Test weights differ between cultivars and can change within a single cultivar depending on cultural practices, weather conditions, and location where grown. It is used here as a measure of grain quality to determine maturity. Yields are expressed here in pounds per acre. Bushels per acre can be determined by dividing the yield of any specific cultivar by the standard test weight.

Tables 32–34 list yields and quality measurements for buckwheat varieties for three test locations: Fairbanks, Eielson, and Delta Junction. All sites in the Delta Junction area have been combined into the Delta dryland site (Table 34). There were no irrigation studies done with buckwheat. Each table also contains information on seed type (large or small), the source or the location of where it was bred, and the years it was tested at each location. Maturity in this study was considered to be when 75% of the heads for each plot were at the hard dough stage. Seed color was light to dark brown and seed did not dent when pressed with a thumbnail. Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued growth of the crop. The low temperature point for buckwheat in this report is the freezing point of water, 32° F. The GDD calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. All varieties were compared with 'Pennquad' as the standard variety. Yield as a percent of 'Pennquad' was determined by dividing the average yield of each variety by the average yield of 'Pennquad'. Maturity vs. 'Pennquad' is the number of days each variety reached 50% maturity either before or after the number of days that 'Pennquad' reached 50% maturity.



*At left, tartary or mountain buckwheat (*Fagopyrum tataricum *Gaertn.) At right, common or Japanese buckwheat (*Fagopyrum esculentum *Moench). Drawings from the USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913.* Illustrated flora of the northern states and Canada. *Vol. 1: 672.*

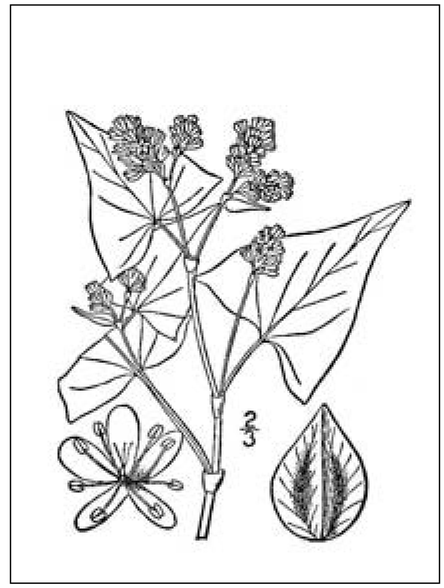


Table 32. Average yields and quality measurements from buckwheat variety test plots in the Fairbanks area, 1978 – 2002.

Buckwheat Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Pennquad)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Pennquad (days)	Average Maturity (GDD)*
				small seeded					
CM-15	(Manitoba)	4	1502	68	43	85	6-Sep	-11	3063
				large seeded					
Botan Soba	(Hokkaido)	1	564	26	40	80	25-Sep	8	3308
Common	(Minnesota)	1	1356	62	40	85	25-Sep	8	3308
Common	(New York)	1	1344	61	40	85	25-Sep	8	3308
Japanese	(Illinois)	1	1408	64	40	80	25-Sep	8	3308
Mancan	(Manitoba)	2	554	21	37	80	17-Sep	0	3224
Manor	(Manitoba)	1	247	11	38	80	17-Sep	0	3224
PA Composite	(Pennsylvania)	1	868	39	40	85	25-Sep	8	3308
PA-158	(Pennsylvania)	1	708	32	40	85	25-Sep	8	3308
Pennquad	(Pennsylvania)	4	2205	100	40	80	17-Sep	0	3224
Tempest	(Canada)	1	1096	50	40	75	25-Sep	8	3308
Tokyo	(Canada)	1	1388	63	40	75	25-Sep	8	3308
Winsor Royal	(Minnesota)	3	825	37	34	85	17-Sep	0	3224

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Table 33. Average yields and quality measurements from buckwheat variety test plots in the Eielson area, 1993 – 2001.

Buckwheat Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Pennquad)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Pennquad (days)	Average Maturity (GDD)*
large seeded									
Mancan	(Manitoba)	1	131	6	25	25	21-Sep	4	3286
Manor	(Manitoba)	1	103	5	29	30	21-Sep	4	3286
Winsor Royal	(Minnesota)	3	517	23	36	35	11-Sep	-6	3155

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Table 34. Average yields and quality measurements from buckwheat variety test plots in the Delta Junction area, 1978 – 2002, dryland site.

Buckwheat Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Pennquad)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Pennquad (days)	Average Maturity (GDD)*
small seeded									
CM-15	(Manitoba)	4	1093	199	43	10	5-Sep	0	2805
large seeded									
Botan Soba	(Hokkaido)	1	160	29	40	10	5-Sep	0	2805
Common	(Minnesota)	1	296	54	40	10	5-Sep	0	2805
Japanese	(Illinois)	1	784	143	40	10	5-Sep	0	2805
Mancan	(Manitoba)	2	653	116	38	10	1-Sep	-4	2744
Manor	(Manitoba)	1	132	24	38	10	1-Sep	-4	2744
PA Composite	(Pennsylvania)	1	192	35	40	10	5-Sep	0	2805
PA-158	(Pennsylvania)	1	208	38	40	10	5-Sep	0	2805
Pennquad	(Pennsylvania)	4	549	100	40	10	5-Sep	0	2805
Tempest	(Canada)	1	432	79	40	10	5-Sep	0	2805
Tokyo	(Canada)	1	336	61	40	10	5-Sep	0	2805
Winsor Royal	(Minnesota)	3	100	18	40	10	5-Sep	0	2805

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Amaranth Performance Trials

Grain and Forage Amaranth

Amaranth (*Amaranthus cruentus* L.) is an annual, pseudo-cereal broadleafed plant that is used as a high-protein grain, leafy vegetable, or forage crop. It is closely resembles the introduced weed, lambsquarters (*Chenopodium album* L.). Amaranth is drought tolerant if there is enough soil moisture to establish the crop after planting. Warm growing conditions, including soil temperatures of 65° to 75° F for germination, are necessary for the best growth. It also requires a long growing season to fully mature and produce a high seed yield. Amaranth produces large colorful seed heads (green, red, or purple) at the top of leafy, thick stems five to seven foot tall. The seed is tiny (less than 0.1 inch diameter), and white or tan. Amaranth grain has 12–17% protein, is higher in the essential amino acid lysine than small grains, is high in fiber, and low in saturated fats. The grain can be ground into a baking flour, popped like popcorn, or flaked like oatmeal. The leaves can be harvested when the plant is immature and either eaten raw in salads or cooked like spinach. Varieties have been specifically developed for either grain production or leafy vegetable production. If harvested before flowering, amaranth makes an acceptable livestock forage. There is a limited health food niche market for amaranth, mostly for grain-producing varieties.

Fertilization and tillage practices are similar to those for small grain production. Amaranth, however, requires lower levels of available nitrogen to produce an acceptable grain crop and it can grow better under arid conditions. It is a good competitor against weeds, has light frost tolerance, and produces high grain yields when sufficient nutrients are present. Soils with moderate levels of available nutrients should receive a complete fertilizer blend of nitrogen, phosphorus, potassium, sulfur, and boron. Actual percentages of each nutrient and the application rate varies according to specific soil test results. The fertilizer can be broadcast before spring tillage or portions can be banded at planting. Amaranth does not usually respond to high levels of available nutrients, especially under dryland conditions. However, if it is grown for forage, a higher amount of nitrogen is required for higher quality forage production. Irrigation is recommended for complete nutrient use in forage production. If amaranth follows summer fallow, fertilization may not be required. Avoid excess nitrogen fertilizer because it can delay maturity.

To conserve soil moisture, minimum tillage is recommended for incorporating fertilizer material and plant residue and preparing the seedbed. Seedbed preparation is extremely important as a firm seedbed is needed to ensure seed contact with moist soil. Pulling a packer behind the tillage implement and using a seed drill equipped with press wheels ensures that the seed is in contact with moist soil during the time needed for germination. Regular grain drills must have the drill speed reduced with a reducer sprocket due to the tiny seed size. Other options would be to use a grass seed attachment or horticultural vegetable seeders. Because of the tiny seed size, seeding depth is only ¼ to ½ inch. The seeding rate for amaranth is 1 to 2 pounds of pure live seed per acre. Higher seeding rates help reduce competition from weeds. A late planting date of the third week on May is recommended to avoid any late spring frost. Certified seed is strongly recommended.

Amaranthus hybridus *L., slim amaranth. Image courtesy of USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913.* Illustrated flora of the northern states and Canada. *Vol. 2:2.*

Weed control in amaranth is extremely important. Amaranth germination requires warm soil temperatures, which gives weeds a head start in the spring. Therefore, best weed control is a combination of mechanical and chemical summer fallow to reduce the number and weed species for the following year; wait for any weeds to germinate in the spring, then performing seedbed tillage and use proper fertilization and seeding rates. To eliminate all weeds with chemical fallow, a broad spectrum post-emergence herbicide such as glyphosphate (Roundup) was used. There are no herbicides registered for amaranth. Amaranth is relatively free from diseases and none have been found on varieties grown in Alaska. There are no known major insect pests that attack amaranth in Alaska.

The stems and leaves of amaranth are thick and high in moisture, even late into the season. Lower leaves start to turn brown and curl as the plant reaches maturity, while the upper portion of the plant (including the seedhead) remains green. At this stage there is mature seed present. A killing fall frost followed by sufficient good weather to dry the plant is usually required for combine harvesting. Because of thick stems, combine ground speed should be slower than for small grains. Concave clearances should be opened to accommodate the thicker stems. Reduce cylinder speeds and air flow to avoid seed loss. Use clover or alfalfa screens for maximum separation of seed from dirt and chaff, after which excess chaff and other plant residues will remain. Because this material attracts moisture, molds, and insects, remove it using an alfalfa scarifier before grain drying. Because of the tiny seed size, all cracks and holes in the combine, augers, trucks, and bins should be sealed to prevent seed loss during handling. Optimum moisture content for safe, long-term storage of grain amaranth is 10–12%. Typical grain dryers have perforated floor openings that are too large for the small seeds. A five-mesh nylon sheet over the floor prevents seed loss. Improper seed cleaning or drying leaves undesirable flavors in milled flour (from other plant residues and molds). On-farm cleaning of the seed before shipment results in higher prices paid to the producer.

Amaranth grain production in Alaska is problematic. It is a warm-season crop that needs warm soil to germinate and requires a long growing season. This necessitates a late planting date and an even later harvest date. It does not compete well with spring weeds and can be completely shaded out in bad years. Harvest is difficult due to the thick plant material and tiny seed size. There is a small health food niche market for amaranth seed that commands a high price paid to producers. However, high production costs and the unlikelihood of consistently producing a high-quality, high-value crop make it economically unviable for Alaska. Due to these cultural problems, no varieties of grain amaranth are recommended.

Yields and Test Weights by Location for Grain and Forage Amaranth

Table 35 shows yields and quality measurements for grain amaranth varieties for the Fairbanks test location. The table also contains information on the source or the location where it was bred, biomass yields, and the years it was tested at each location. Maturity in this study was considered to be when 50% of the seed for each plot were at the hard dough stage. The seed did not dent when pressed with a thumbnail. Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued growth of the crop. The low temperature point for amaranth in this report is the freezing point of water, 32° F. The GDD calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. However, maturity was not reached for any variety due to severe weed competition and seasonal frosts and is represented by N/D (No Data) in the table. As there are no standard varieties for amaranth in Alaska, the only comparison is among varieties. Standard laboratory methods were used by the UAF Soil and Plant Analysis Laboratory in Palmer, Alaska, to determine feed and forage quality (see Appendix 1 for addresses).

Table 35. Average yields and quality measurements from grain amaranth test plots in the Fairbanks area, 1978 – 2002.

Amaranth Variety Name	Source	Years Tested	Yield (lbs/acre)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*	Plot Biomass (lbs/acre)	Crude Protein (%)
				grain & forage					
1011	(Nebraska)	2	5	N/D	0	N/D	N/D	6026	18.69
477914	(Nebraska)	2	N/D	N/D	0	N/D	N/D	5213	18.38
K343	(Nebraska)	2	N/D	N/D	0	N/D	N/D	5739	12.38
R158	(Pennsylvania)	2	N/D	N/D	0	N/D	N/D	4400	24.63

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
N/D = No Data.

Field Pea Performance Trials

Green and Yellow Dry Pea

For many years in Alaska, field peas (*Pisum sativum* L.) have been successfully grown as a forage crop. They are a cool-season, late-maturing crop that can survive late frosts, but become stressed under high temperatures. As legumes, peas are capable of fixing atmospheric nitrogen and produce high forage yields with high protein concentrations without high levels of nitrogen fertilizer. Field peas are an annual herbaceous plant with slender succulent stems two to four feet long. Field peas can be divided into two types. The "normal" type has one to three pairs of leaflets with terminal branched tendrils, and the semi-leafless type has tendrils instead of the leaflets. The semi-leafless varieties intertwine for better lodging resistance, faster crop drying at harvest, and they yield better under droughty conditions. Both types can be further divided into green-seeded types having green seed coats and cotyledons and yellow-seeded types having yellow or white seed coats and yellow cotyledons. The seeds can be round, angular, smooth, or wrinkled. There is no specific distinction between garden peas and field peas, other than garden peas tend to be sweeter and more wrinkled. Seed are contained in pods averaging three inches long and bearing four to nine seeds.

Field pea seed is used for human and livestock consumption. For human consumption it is sold primarily as split pea. Split peas have had the outer seed coat and inner embryo removed and separated in a burr mill. The seed coat and embryo can be combined with other whole peas and ground for livestock feed to be fed either whole or mixed with other grains. Field pea is a low-cost protein and energy source for swine diets, especially when combined with canola meal. Peas and pea byproducts are a popular feed for caged pigeons.

Field peas can be used for forage. Forage quality is maximized if peas are harvested after the pods are well formed, but before they reach maturity. Field peas are often interseeded with barley or oats to produce a more nutritionally balanced forage. The cereal grain stems also help to support the pea vines, making the forage easier to harvest. Field peas can also be grown as a green manure crop to be turned under before the pods reach maturity. Field pea plant residues break down faster than small grain straw or canola plant residues. This high-quality plant matter increases subsequent nitrogen availability and improves soil tilth and organic matter content.

Except for nitrogen, fertilization requirements for field peas are similar to those for small grains. In ideal growing conditions, a properly inoculated field pea can obtain most of its nitrogen requirement from atmospheric nitrogen, with the remaining requirement met by available soil nitrogen. Nitrogen fixing nodules on the plant roots are sensitive to soil-based nitrogen sources. As available soil nitrogen increases, nodule formation and nitrogen fixation decreases. Nodule reduction occurs when the available soil nitrogen level is around 25 to 35 pounds per acre or higher. On the other hand, if available soil nitrogen levels are below about 10 pounds per acre, then early plant growth is limited due to the nitrogen deficiency. This is because it can take ten days to two weeks for the root nodules to begin functioning efficiently. This can be corrected at planting by adding a small amount of starter nitrogen, such as monoammonium phosphate. Avoid excess nitrogen fertilizer, which can induce lodging and delay maturity.

Field peas require a relatively large amount of phosphorus and potassium to promote root and nodule development. This also improves disease resistance and tolerance for frost and drought. Alaska soils are generally acidic, which tends to make phosphorus unavailable for plant uptake. Banding the phosphorus carrier with or next to the seed at planting increases the available phosphorus. The safe maximum level of phosphorus that can be banded with the seed is 15 pounds per acre.

Sulfur and boron are needed by field peas to promote flowering and seed set. Soils low in available sulfur should have sulfate in the form of sulfur broadcast applied with nitrogen as ammonium sulfate or with the potassium as potassium sulfate. Boron application rates of 0.5 to 1.0 pounds per acre of actual boron can be sufficient to correct most soil deficiencies. Actual percentages of all nutrients and the application rates vary according to specific soil test results. All fertilizer can be broadcast before spring tillage or portions can be banded at planting.

To conserve soil moisture, minimum tillage is recommended for incorporating fertilizer material and plant residue and preparing the seedbed. Pulling a packer behind the tillage implement and using a seed drill equipped with press wheels ensures that the seed is in contact with moist soil during the time needed for germination. Seeding depth is the same as that for small grains, 1½ to 2½ inches, or to moisture. Seeding rates depends on seed size. Generally, recommended rates are 45 to 180 pounds per acre of pure live seed for the small seed types and 80 to 180 pounds per acre for the large seed types. Lighter seeding rates are recommended when field peas are interseeded with small grains for forage and in areas of low soil moisture. Early planting dates are recommended to utilize as much of the short growing season as possible. However, planting into seedbeds that are too cold or wet delays germination and promotes fungal attacks on the seed. Seed treatment with a fungicide helps to reduce losses due to fungal attack. Care must be taken in choosing the appropriate fungicide to ensure that there is no adverse effect with the inoculant. Certified seed is strongly recommended.

To induce nodule formation, field peas should be inoculated before planting with the appropriate strain of *Rhizobium* bacteria *(Rhizobium leguminsarium)*. Inoculants are highly sensitive to high temperatures, drying winds, direct sunlight, some seed-applied fungicides, and granular fertilizer. Treat the inoculant and the inoculated seed with care and plant the seed as soon after treatment as possible. *Rhizobium* bacteria can live in the soil for a number of years and can thus infect successive field pea crops. However, the most efficient bacteria may not be the ones that survive, so fresh inoculant should be used each year.

Weed control in field peas was a combination of mechanical and chemical summer fallow to reduce the number and species of weeds for the following season and an application of a post-emergence herbicide. Field peas, especially the semi-leafless types, are poor competitors against weeds, particularly in the early growth stages. Best broadleaved weed control has been with MCPA applied before the field peas were in the five node stage; later applications result in crop injury. To eliminate grassy weeds with chemical fallow, a broad spectrum post-emergence herbicide such as glyphosphate (Roundup) was used. Gray molds (*Botrytis* sp.) can infect field peas late in the season when the canopy has closed and the crop lodges. High precipitation and low temperatures in late summer are not enough to completely dry the crop, creating an environment ideal for gray molds. However, gray molds do not usually occur in high enough concentrations to warrant treatment for every growing season. Grasshoppers, including the lesser migratory grasshopper (*Melanoplus sanguinipes* Fabricias), the northern grasshopper (*Melanoplus borealis* Fieber), and the clear-winged grasshopper (*Camnula pellucida* Scudder), can attack young field peas, often severely enough to seriously affect yield, sometimes completely consuming entire fields. Diazinon or carbaryl (Sevin) sprays or baits help control heavy infestations. Remember to always read the pesticide label and follow the directions on mixing, application, and disposal. Large flocks of pigeons and migratory waterfowl can seriously reduce yield and cause serious lodging while trying to get at the seed. Using a propane scare cannons is recommended to keep birds away. For more information contact the local office of the Alaska Department of Fish and Game.

Field pea ripening progresses from the bottom of the plant up. The seed is ripe when it can't be dented with a thumbnail. The crop should be swathed when the bottom 30% of the pods are ripe, the middle 40% of the pods are yellow, and the upper 30% of the pods are turning yellow. Before combining, the seed must be 18–20% moisture. To thresh properly during field combining, the crop must be at full maturity. Green, wet vines can wrap up in the pickup reels, the feed augers, and the cylinders. This reduces threshing efficiency and could necessitate shutting down the combine to clean out plant residues. For easier harvest of the tangled crop, equip combines with vine lifters and pickup reels, especially for the intertwining, semi-leafless varieties. Dry field pea pods can shatter or crack easily when very dry. Use lower reel and cylinder speeds than for small grains and set the concave openings to just larger than the seed size, with a larger opening in the front than the rear. To reduce cracked seed, run augers full or at lower speeds. Because food-grade standards only allow 4% cracked seed, continual checking for cracked seeds and adjusting combining methods is important. Food-grade field peas can't contain any other crops or foreign material and only 2% bleached seed. Bleached seed is caused by high humidity, bright sunshine, and warm temperatures. This is most important on the green seed types. When moisture conditions cause soil to stick to the seed during harvest, dirty seed, or "earth tag" results. Any seed lot not meeting higher food grades is purchased at lower feed prices. On-farm cleaning and sizing to food-grade standards before shipment results in higher prices paid to the producer. Clean-outs can be used on-farm or sold as lower grade feed seed. Moisture content of field pea seed for safe, long-term storage is 16%. Dry on-farm any crop harvested at higher moisture conditions. To avoid reduced germination of seed, drying heat should not exceed 110° F. For feed, temperatures at or below 160° F can be used.

Most field peas in Alaska are grown for forage either alone or interseeded with oats. A limited acreage is grown for seed production. All field pea production is intended for on-farm use as a protein supplement in livestock feed diets. Although there is a small health food niche market in Alaska for processed whole or split peas, at present there are no processing facilities or elevators in Alaska set up to accept field peas. The cost of importing certified field pea seed into Alaska is high due to seed weight. Therefore, another small niche market exists certified seed, but it is difficult to consistently produce a mature, evenly dry seed crop.

Recommended Variety Descriptions for Green and Yellow Dry Pea

Note: See Appendix 1 for the addresses of seed suppliers.

'Express' is an early maturing, short, high-yielding, normal-leafed, yellow-seeded field pea registered in 1978 in Canada. It is suitable for seed and forage production with high yields and high protein content. This was the standard variety against which all other field pea varieties were compared. This variety has been deregistered and is now in the pub-

lic domain. Direct inquiries about seed sources to the Crop Diversification Centre South, in Brooks, Alberta.

'Carneval' is an early maturing, short, semi-leafless, strong-stemmed, high-yielding, yellow-seeded field pea developed by Svalof Weibull AB in Sweden. 'Carneval' has superior stem strength and standability. It is suitable for seed and forage production with high yields and high protein content. This variety is protected by Canadian plant breeders rights. Producers may save seed for their own use on their own farms, but sale or transfer of seed is prohibited without written permission and a payment of royalties to the breeder. Direct inquiries about seed sources to the Saskatchewan Wheat Pool.

Yields and Test Weights by Location for Green and Yellow Dry Pea

All field peas (green and yellow seeded) are bought and sold by weight. The standard test weight for field peas is used as the legal unit for crop sales. The standard test weight for clean, dry, and undamaged field peas is 60 pounds per bushel. Highest prices are paid to the producer for niche crops markets only if they meet the quality criteria mentioned previously. Other than test weights, additional samples should be taken on-farm to determine quality. Because seed lots not meeting high quality standards should be used as lower feed grades, it is important for the producer to clean and size all seed lots before delivery to a niche market. Test weights are used here as a measure of seed quality to determine maturity. Yields are expressed here in pounds per acre. Bushels per acre can be determined by dividing the yield of any specific cultivar by the standard test weight.

Tables 36–41 list yields and quality measurements for field pea varieties at three test locations: Fairbanks, Eielson, and Delta Junction. All sites in the Delta Junction area have been combined into either the Delta dryland site (Table 40) or, if grown under irrigation, the Delta irrigated site (Table 41). Each table also contains information on seed type (green or yellow), biomass yield, heights, nutritive composition from the biomass, and the years it was tested at each location. Varieties with a (NL) designation after the name are normal leafed, all others are semi-leafless varieties. Maturity in this study was considered to have occurred when 50% of the pods for each plot were yellow and the seed could not be dented with a thumbnail. Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued growth of the crop. The low temperature point for field peas in this report is the freezing point of water, 32° F. The GDD calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. All varieties were compared with 'Express' as the standard variety. Yield as a percent of 'Express' was determined by dividing the average yield of each variety by the average yield of 'Express'. Maturity vs. 'Express' is the number of days each variety reached 50% maturity either before or after the number of days that 'Express' reached 50% maturity. Forage data (biomass quality) from Fairbanks (Table 37) and Eielson (Table 39) are presented without statistical differences and solely for the reader's benefit. In the tables, N/D (No Data) indicates that the variety was grown, but not analyzed. Methods for forage quality determination are standard laboratory methods used for feed and forage by the UAF Soil and Plant Analysis Laboratory in Palmer, Alaska. The seed source for all varieties tested was the Crop Diversification Centre in Brooks, Alberta (see Appendix 1 for addresses).

Table 36. Average yields and quality measurements from field pea variety test plots in the Fairbanks area, 1978–2002.

Field Pea Variety Name	Years Tested	Seed Yield (lbs/acre)	Yield (% of Express)	Test Wt. (lbs/bu)	Biomass Yield (lbs/acre)	Lodging (%)	Canopy Height (in)	Average Maturity Date	Maturity vs. Express (days)	Average Maturity (GDD)*
green seed										
Ascona	2	N/D	N/D	N/D	6499	25	19	14-Aug	11	2616
Danto	2	1896	117	62	12379	25	19	7-Aug	4	2438
Clipper (NL)	1	N/D	N/D	N/D	10432	75	21	3-Aug	0	2328
Keoma	2	2239	138	62	9299	50	18	8-Aug	5	2464
Majoret	3	1835	113	62	10816	25	23	13-Aug	10	2592
Patriot (NL)	2	1987	122	63	N/D	50	15	31-Jul	-3	2244

Table 36, continued

Table 36. Average yields and quality measurements from field pea variety test plots in the Fairbanks area, 1978–2002.

Field Pea Variety Name	Years Tested	Seed Yield (lbs/acre)	Yield (% of Express)	Test Wt. (lbs/bu)	Biomass Yield (lbs/acre)	Lodging (%)	Canopy Height (in)	Average Maturity Date	Maturity vs. Express (days)	Average Maturity (GDD)*
Phantom	1	N/D	N/D	N/D	9861	50	18	4-Aug	1	2355
Promar	2	1532	94	63	8006	50	17	10-Aug	7	2515
Radley	1	2395	147	63	N/D	25	22	7-Aug	4	2438
Totem	1	N/D	N/D	N/D	11270	50	17	8-Aug	5	2464
yellow seed										
Anno	2	1986	122	63	10398	50	20	4-Aug	1	2355
Baroness	2	1715	106	62	7922	25	22	9-Aug	6	2490
Carneval	3	2813	173	62	9433	25	23	11-Aug	8	2541
Celeste	3	2677	165	62	11084	50	18	6-Aug	3	2411
Century	1	N/D	N/D	N/D	N/D	50	N/D	23-Aug	20	2808
Choque	2	2882	177	64	7307	25	22	7-Aug	4	2438
Concorde (NL)	1	N/D	N/D	N/D	7391	75	14	4-Aug	1	2355
Discovery (NL)	1	N/D	N/D	N/D	8824	50	24	8-Aug	5	2464
Endeavor (NL)	1	N/D	N/D	N/D	8145	50	22	6-Aug	3	2411
Express (NL)	3	1625	100	63	9286	50	18	3-Aug	0	2328
Fluo	2	2913	179	63	11395	25	17	5-Aug	2	2383
Grande (NL)	2	3316	204	62	9812	25	26	6-Aug	3	2411
Highlight	3	2968	183	52	7472	50	20	6-Aug	3	2411
Impala	2	524	32	63	9405	25	17	8-Aug	5	2464
Miranda	1	1224	75	62	N/D	75	11	9-Aug	6	2490
Montana	2	2479	153	61	10742	50	17	5-Aug	2	2383
Mustang	1	N/D	N/D	N/D	8680	25	20	28-Jul	-6	2162
Orb	2	2654	163	62	N/D	50	17	29-Jul	-5	2189
Profi	2	N/D	N/D	N/D	11171	50	23	4-Aug	1	2355
Ricardo	1	1847	114	62	N/D	75	11	10-Aug	7	2515
Scorpio	2	2610	161	64	10963	75	16	4-Aug	1	2355
Spitfire	1	N/D	N/D	N/D	11554	50	22	5-Aug	2	2383
Spring	1	2839	175	63	N/D	0	21	5-Aug	2	2383
Stehgolt	1	1897	117	63	N/D	50	19	8-Aug	5	2464
Trump	1	1521	94	62	N/D	75	10	9-Aug	4	2490
Voyageur	1	N/D	N/D	N/D	10766	50	20	5-Aug	2	2383
Yorkton	1	N/D	N/D	N/D	10825	50	26	1-Aug	-2	2273

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity, NL = Normal leafed. N/D = No Data.

Table 37. Average quality measurements for biomass from field pea variety test plots in the Fairbanks area, 1978 – 2002.

Field Pea Variey Name	Crude Protein (%)	P (%)	K (%)	Ca (%)	Mg (%)	Cu ppm	Zn ppm	Mn ppm	Fe ppm	Fat (%)	Dry Matter (%)	NDF (%)	ADF (%)	Relative Feed Value	Cellu-lose (%)	Lignin (%)
green seed																
Ascona	15.96	0.12	1.73	2.49	0.36	5	15	61	183	1.25	94.36	39.39	25.67	162.72	22.30	3.37
Danto	13.09	0.13	1.84	1.88	0.41	5	77	96	99	1.20	95.05	45.95	33.81	126.65	28.69	5.12
Clipper (NL)	15.39	0.16	1.60	2.21	0.38	5	45	80	90	0.74	94.58	45.30	29.40	135.53	24.91	4.50
Keoma	14.07	0.14	1.43	2.72	0.46	5	40	125	204	1.27	94.19	38.22	21.87	174.91	18.69	3.18
Majoret	12.02	0.12	1.44	2.40	0.46	3	78	169	119	1.27	94.13	29.67	20.31	229.12	19.67	2.84
Patriot (NL)	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Phantom	12.49	0.13	1.50	2.01	0.36	5	77	139	166	1.10	94.55	40.89	28.57	151.61	23.58	4.99
Promar	19.14	0.16	1.96	2.35	0.45	7	41	51	185	1.23	94.35	39.16	27.41	160.46	21.46	5.95
Radley	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Totem	18.14	0.18	1.68	2.18	0.40	7	47	47	147	1.12	94.42	36.87	25.09	174.98	21.51	3.58
yellow seed																
Anno	9.29	0.11	1.02	1.71	0.30	3	33	76	102	0.87	94.79	35.78	22.77	185.01	19.33	3.43
Baroness	9.74	0.11	1.04	1.56	0.26	2	22	42	100	0.99	95.01	41.35	28.05	150.84	22.68	5.37
Carneval	12.37	0.13	1.30	2.23	0.36	1	15	34	137	0.83	94.50	34.52	24.00	189.18	19.59	4.41
Celeste	10.24	0.11	1.24	2.36	0.41	3	22	90	87	1.42	94.59	38.63	26.27	164.80	22.25	4.02
Century	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Choque	12.82	0.11	1.33	2.17	0.32	3	21	41	117	0.93	94.62	44.23	30.61	136.82	25.84	4.77
Concorde (NL)	12.55	0.13	1.39	2.98	0.51	3	28	84	145	1.30	94.09	41.52	28.81	148.89	22.96	5.85
Discovery (NL)	8.44	0.12	0.91	1.77	0.28	4	20	50	117	0.93	94.80	45.69	31.83	130.51	26.42	5.40
Endeavor (NL)	13.71	0.12	1.28	2.13	0.32	2	19	40	125	1.00	94.38	41.83	24.47	155.31	20.36	4.11
Express (NL)	12.25	0.11	1.07	2.29	0.36	4	29	68	188	0.99	94.56	45.85	30.55	132.08	25.43	5.13
Fluo	14.70	0.12	1.74	2.37	0.39	5	95	95	245	1.31	94.43	34.77	22.81	190.30	20.10	2.71
Grande (NL)	10.02	0.11	1.08	1.48	0.27	3	21	28	93	1.18	94.79	32.24	21.47	208.25	17.90	3.56
Highlight	11.19	0.08	1.17	2.59	0.47	3	39	192	160	0.81	94.37	34.64	24.01	188.51	20.68	3.33
Impala	11.12	0.12	1.12	2.76	0.45	3	22	40	103	0.87	93.90	40.94	26.64	154.84	21.02	5.62
Miranda	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Montana	13.41	0.12	1.25	2.11	0.35	6	47	55	121	1.48	94.82	43.47	34.22	133.20	29.47	4.75

Table 37, continued on next page

Table 37. Average quality measurements for biomass from field pea variety test plots in the Fairbanks area, 1978 – 2002.

Field Pea Variey Name	Crude Protein (%)	P (%)	K (%)	Ca (%)	Mg (%)	Cu ppm	Zn ppm	Mn ppm	Fe ppm	Fat (%)	Dry Matter (%)	NDF (%)	ADF (%)	Relative Feed Value	Cellu-lose (%)	Lignin (%)
Mustang	13.25	0.12	1.09	2.21	0.35	3	28	61	127	1.02	93.92	32.59	20.11	209.04	17.79	2.32
Orb	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Profi	12.37	0.14	1.29	1.87	0.34	4	58	202	101	0.88	94.47	36.79	24.47	176.58	20.87	3.59
Ricardo	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Scorpio	13.93	0.13	1.27	2.33	0.37	3	33	45	136	1.06	94.27	34.52	22.13	193.11	19.56	2.57
Spitfire	14.11	0.12	1.57	2.53	0.37	5	53	99	157	1.08	94.35	32.72	22.77	202.31	19.20	3.57
Spring	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Stehgolt	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Trump	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Voyageur	12.78	0.13	1.54	2.71	0.40	3	55	171	163	1.12	94.39	37.51	25.55	171.11	22.20	3.36
Yorkton	10.23	0.10	0.94	1.84	0.35	3	39	71	94	1.06	94.73	31.09	19.81	219.82	15.96	3.84

NL = Normal Leafed. N/D = No Data.

Table 38. Average yields and quality measurements from field pea variety test plots in the Eielson area, 1993 – 2001.

Field Pea Variety Name	Years Tested	Seed Yield (lbs/acre)	Yield (% of Express)	Test Wt. (lbs/bu)	Biomass Yield (lbs/acre)	Lodging (%)	Canopy Height (in)	Average Maturity Date	Maturity vs. Express (days)	Average Maturity (GDD)*
					green seed					
Ascona	2	4382	129	56	16258	50	30	21-Aug	0	2778
Danto	2	3954	116	59	13178	50	27	21-Aug	0	2778
Clipper (NL)	1	4364	129	57	18514	75	30	13-Aug	-8	2599
Keoma	2	3506	103	60	13009	50	27	22-Aug	1	2798
Majoret	3	2628	77	58	14241	25	30	23-Aug	2	2818
Patriot (NL)	2	2310	68	60	N/D	0	26	16-Aug	-5	2670
Phantom	1	4699	138	58	11531	50	27	17-Aug	-4	2693
Promar	2	2968	87	59	13943	25	23	25-Aug	4	2858
Radley	1	2036	60	59	N/D	25	22	11-Aug	-10	2548

Table 38 continued on next page

Table 38. Average yields and quality measurements from field pea variety test plots in the Eielson area, 1993 – 2001.

Totem	1	5073	149	56	15988	50	29	22-Aug	1	2798
					yellow seed					
Anno	2	3334	98	60	10027	75	25	20-Aug	-1	2757
Baroness	2	4473	132	60	11544	25	31	21-Aug	0	2778
Carneval	3	3766	111	56	19426	25	36	19-Aug	-2	2737
Celeste	3	3396	100	56	12948	75	22	22-Aug	1	2798
Century	1	442	13	45	N/D	25	N/D	25-Aug	4	2858
Choque	2	3068	90	60	12605	50	31	19-Aug	-2	2737
Concorde (NL)	1	4468	132	58	10937	75	24	13-Aug	-8	2599
Discovery (NL)	1	6780	200	58	19746	50	32	16-Aug	-5	2670
Endeavor (NL)	1	4027	119	59	14550	75	32	14-Aug	-7	2624
Express (NL)	3	3396	100	58	17055	50	22	21-Aug	0	2778
Fluo	2	3285	97	60	13873	50	21	17-Aug	-4	2693
Grande (NL)	2	4867	143	57	14183	75	24	19-Aug	-2	2737
Highlight	3	3328	98	57	17386	50	31	25-Aug	4	2858
Impala	2	3054	90	58	20273	75	24	22-Aug	1	2798
Miranda	1	1402	41	60	N/D	75	16	20-Aug	-1	2757
Montana	2	3996	118	59	10377	50	24	16-Aug	-5	2670
Mustang	1	4195	124	58	15940	50	33	12-Aug	-9	2574
Orb	2	2281	67	60	N/D	75	20	16-Aug	-5	2670
Profi	2	3098	91	56	16478	50	36	18-Aug	-3	2716
Ricardo	1	1607	47	61	N/D	50	17	31-Aug	10	2973
Scorpio	2	3116	92	60	11707	75	21	11-Aug	-10	2548
Spitfire	1	6055	178	58	16301	75	32	17-Aug	-4	2693
Spring	1	2433	72	60	N/D	25	24	22-Aug	1	2798
Stehgolt	1	1783	53	62	N/D	25	21	28-Aug	7	2918
Trump	1	1481	44	59	N/D	50	16	27-Aug	10	2899
Voyageur	1	5876	173	58	13038	50	31	18-Aug	-3	2716
Yorkton	1	5679	167	58	22006	75	28	15-Aug	-6	2647

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity, NL = Normal Leafed. N/D = No Data.

Table 39. Average quality measurements for biomass from field pea variety test plots in the Elelson arrea, 1993 – 2001.

Field Pea Variety Name	Crude Protein (%)	P (%)	K (%)	Ca (%)	Mg (%)	Cu (ppm)	Zn (ppm)	Mn (ppm)	Fe (ppm)	Fat (%)	Dry Matter (%)	NDF (%)	ADF (%)	Relative Feed Value	Cellu-lose (%)	Lignin (%)
green seed																
Ascona	21.57	0.27	0.91	3.77	1.03	3	31	31	132	0.97	93.03	37.86	19.13	181.81	16.23	2.91
Danto	14.50	0.15	0.74	3.39	0.97	8	29	42	104	1.20	93.08	41.85	26.93	150.97	22.92	4.01
Clipper (NL)	10.39	0.11	0.64	3.86	1.13	3	28	38	128	0.95	92.72	43.67	26.33	145.68	22.03	4.30
Keoma	15.98	0.10	0.68	4.03	1.12	1	24	35	119	1.08	92.65	33.08	20.53	205.02	15.23	5.30
Majoret	20.74	0.26	0.84	3.64	1.21	4	22	33	151	1.29	92.90	33.96	21.65	197.32	18.48	3.17
Patriot (NL)	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Phantom	11.73	0.10	0.63	5.36	1.52	2	35	59	158	1.17	92.15	34.83	19.52	196.82	16.05	3.48
Promar	12.56	0.13	0.73	3.29	0.95	16	31	29	136	1.20	93.06	38.90	21.55	172.45	18.36	3.19
Radley	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Totem	15.62	0.12	0.72	3.81	1.09	4	28	29	114	0.65	92.81	36.62	22.60	181.10	20.04	2.56
yellow seed																
Anno	17.31	0.17	0.94	2.65	0.72	2	30	20	148	0.92	93.87	40.86	25.30	157.52	21.15	4.16
Baroness	11.50	0.14	0.68	2.84	0.96	2	28	31	129	1.20	92.99	40.73	28.15	152.96	22.39	5.75
Carneval	19.24	0.24	0.91	2.99	0.92	3	26	31	104	0.60	93.36	37.19	21.14	181.17	18.05	3.09
Celeste	18.07	0.25	0.83	2.46	0.75	3	18	22	93	1.09	93.57	41.31	26.68	153.39	22.17	4.51
Century	24.55	0.38	1.01	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Choque	15.08	0.11	0.64	3.85	1.27	2	14	31	96	1.43	92.47	35.51	22.76	186.44	19.65	3.12
Concorde (NL)	12.31	0.12	0.62	2.75	0.88	2	16	20	88	1.09	93.42	42.13	26.02	151.54	21.76	4.27

Table 39 continued on next page

Table 39. Average quality measurements for biomass from field pea variety test plots in the Elelson arrea, 1993 – 2001.

Field Pea Variety Name	Crude Protein (%)	P (%)	K (%)	Ca (%)	Mg (%)	Cu (ppm)	Zn (ppm)	Mn (ppm)	Fe (ppm)	Fat (%)	Dry Matter (%)	NDF (%)	ADF (%)	Relative Feed Value	Cellu-lose (%)	Lignin (%)
Discovery (NL)	14.90	0.15	0.67	2.98	0.97	4	33	40	115	1.12	93.15	39.07	25.23	164.87	21.78	3.45
Endeavor (NL)	17.59	0.15	0.78	3.04	0.88	2	20	23	76	0.73	93.11	41.32	21.24	162.89	17.23	4.01
Express (NL)	15.79	0.13	0.53	3.52	1.23	3	22	24	113	1.06	92.66	31.35	21.67	213.70	18.64	3.03
Fluo	17.46	0.20	0.77	2.63	0.76	3	29	28	135	1.22	93.09	39.40	21.92	169.58	18.79	3.13
Grande (NL)	11.37	0.13	0.66	2.80	0.97	3	27	44	109	1.14	92.86	38.34	24.82	168.78	21.50	3.31
Highlight	19.88	0.24	0.89	4.23	1.14	4	21	35	114	1.43	92.41	30.33	18.14	229.32	16.03	2.10
Impala	15.17	0.18	0.66	2.63	0.99	3	30	38	126	0.91	92.68	37.22	20.14	182.97	18.32	1.82
Miranda	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Montana	18.35	0.18	0.80	2.93	0.95	4	26	26	103	1.48	92.99	38.67	22.95	170.85	19.61	3.34
Mustang	14.79	0.14	0.58	3.06	1.01	2	17	26	80	0.95	92.96	39.27	24.39	165.58	20.85	3.54
Orb	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Profi	19.20	0.23	0.86	4.04	1.16	3	20	27	94	1.12	92.92	38.22	22.68	173.37	19.49	3.19
Ricardo	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Scorpio	16.79	0.16	0.78	3.40	1.00	6	30	30	105	1.32	92.70	36.31	18.73	190.37	16.59	2.13
Spitfire	12.74	0.14	0.59	3.33	1.25	2	24	38	126	1.08	92.24	38.66	24.39	168.19	18.97	5.42
Spring	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Stehgolt	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Trump	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Voyageur	17.21	0.16	0.70	2.99	1.01	3	23	34	113	1.05	92.95	37.99	21.89	175.93	18.61	3.27
Yorkton	12.58	0.13	0.60	3.51	1.27	6	24	42	115	1.05	92.95	37.97	23.15	173.62	20.09	3.06

NL = Normal Leafed. N/D = No Data.

Table 40. Average yields and quality measurements from field pea variety test plots in the Delta Junction area, 1978 – 2002, dryland site.

Field Pea Variety Name	Years Tested	Seed Yield (lbs/acre)	Yield (% of Express)	Test Wt. (lbs/bu)	Biomass Yield (lbs/acre)	Lodging (%)	Canopy Height (in)	Average Maturity Date	Maturity vs. Express (days)	Average Maturity (GDD)*
green seed										
Ascona	3	N/D	N/D	N/D	N/D	0	N/D	11-Aug	2	2337
Danto	1	717	286	62	N/D	0	14	5-Aug	-4	2190
Keoma	2	436	174	65	N/D	25	15	4-Aug	-5	2165
Majoret	2	510	203	63	N/D	25	15	8-Aug	-1	2265
Orb	2	544	217	62	N/D	25	13	13-Aug	4	2383
Patriot (NL)	3	584	233	62	N/D	25	14	9-Aug	0	2289
Radley	1	693	276	62	N/D	0	12	5-Aug	-4	2190
yellow seed										
Anno	2	700	279	64	N/D	25	18	8-Aug	-1	2265
Baroness	2	426	170	63	N/D	25	15	5-Aug	-4	2190
Carneval	4	591	236	62	N/D	25	N/D	11-Aug	2	2337
Celeste	2	597	238	64	N/D	25	11	7-Aug	-2	2241
Choque	2	823	328	61	N/D	25	14	6-Aug	-3	2217
Express (NL)	4	251	100	62	N/D	25	15	9-Aug	0	2289
Fluo	2	663	264	64	N/D	50	10	4-Aug	-5	2165
Grande (NL)	2	796	317	64	N/D	0	20	10-Aug	1	2313
Highlight	2	584	233	62	N/D	0	15	5-Aug	-4	2190
Impala	2	312	124	64	N/D	25	15	13-Aug	4	2383
Miranda	1	299	119	63	N/D	50	9	6-Aug	-3	2217
Montana	2	715	285	63	N/D	25	13	8-Aug	-1	2265
Promar	2	402	160	62	N/D	25	13	5-Aug	-4	2190
Ricardo	1	503	201	65	N/D	25	12	4-Aug	-5	2165
Scorpio	2	458	183	63	N/D	25	13	6-Aug	-3	2217
Spring	1	782	312	63	N/D	0	16	6-Aug	-3	2217
Stehgolt	1	439	175	63	N/D	25	13	7-Aug	-2	2241
Trump	1	472	188	65	N/D	25	13	5-Aug	-4	2190

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
NL = Normal Leafed. N/D = No Data.

Table 41. Average yields and quality measurements from field pea variety test plots in the Delta Junction area, 1978 – 2000, irrigated site.

Field Pea Variety Name	Years Tested	Seed Yield (lbs/acre)	Yield (% of Express)	Test Wt. (lbs/bu)	Biomass Yield (lbs/acre)	Lodging (%)	Canopy height (in)	Average Maturity Date	Maturity vs. Express (days)	Average Maturity (GDD)*
green seed										
Patriot (NL)	1	N/D	N/D	N/D	N/D	75	N/D	27-Aug	18	2660
yellow seed										
Carneval	2	N/D	N/D	N/D	N/D	25	N/D	18-Aug	9	2489
Express (NL)	1	N/D	N/D	N/D	N/D	75	N/D	28-Aug	19	2677

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
NL = Normal Leafed. N/D = No Data.

Canola Performance Trials

Polish and Argentine Canola

Rapeseed (from the Latin *rapum*, meaning turnip) is an oilseed crop specifically developed for the lubrication market. Rapeseed contains over 40% oil by weight. The oil contains high levels of erucic acid that can cause heart lesions and high levels of glucosinolates that can cause goiters when fed to animals. Rapeseed oil is valuable as a lubricant for underwater applications and on steam-washed surfaces, but is unsuitable for food and feed markets. There are two types of rapeseed, Polish or turnip rape (*Brassica campestris* L.) and Argentine rape (*Brassica napus* L.).

Canola is an edible oilseed crop specifically selected and bred from both Polish and Argentine rapeseed to be low in erucic acid and glucosinolates. Canola seed, like rapeseed, contains over 40% oil by weight. Canola and rapeseed oil are obtained by a combination of expressing and solvent extraction. Canola oil for the edible market can't contain more than 2% green seed. Green seed are immature seed that contain chlorophyll that imparts a green color to the oil and shortens the shelf life by turning rancid quickly. The canola meal that remains after processing is a high-protein supplement for animal diets. Canola plant residues contain high levels of glucosinolates. These glucosinolates have an allelochemical effect that inhibits growth of some species of weeds, nematodes, insects, and soil-borne plant diseases in the field the following year.

Polish canola is a mid-tall (one and one-half to three feet) multibranched, broadleaved oilseed plant. It is earlier maturing than the Argentine type by two to three weeks and requires about the same growing season length as barley. It is more resistant to early spring frosts, outproduces Argentine varieties under drought conditions, and is more resistant to shattering at harvest. It is almost completely open pollinated, so seed producers can't grow two different varieties within a mile (the distance insect pollinators such as honey bees would travel from their hive to a nectar and pollen source) of any other variety. Cross pollination would result from any two varieties grown closer together. Seed from cross pollination would contain characteristics of both parents. It would not be true to either original type and could not be sold as either original variety. The small seed (about 1/16 inch diameter and about half the size of Argentine varieties) is reddish brown to black when mature.

Argentine canola is a tall (two and one-half to four feet) multibranched, broadleaved oilseed plant. It is a long season crop that matures in about the same period as wheat. It is more susceptible than the Polish type to early and late spring frosts and shatters readily when ripe. It outyields the Polish varieties by 15–20% under adequate soil moisture conditions. Argentine canola is only about 30% cross pollinated, but seed producers should still not plant two varieties close together. The seed is large (about ⅛ inch diameter) and dark brown to black when mature.

Most canola is planted as a spring annual to be harvested after the first frost. Studies done by S.D. Sparrow, J.S. Conn and C.W. Knight (1990) have found that fall tillage after harvest of a canola crop results in a fairly high amount of volunteer canola the following season. This is because shatter losses are fairly high, seed buried in the soil over the winter survives, and spring soil moisture is higher in the untilled soil. If sufficient stubble and surface plant residues remain after fall tillage, trapped snow results in increased spring soil moisture, reduced erosion, and minimal soil crusting. This provides an even better environment for volunteer canola germination in the spring. Canadian research into this phenomenon has led to the development of fall-seeded canola varieties. The seed are treated with a polymer that prevents fall germination and breaks down over the winter to ensure early spring germination.

Fertilization practices for canola are similar to those for small grains. Canola requires more nitrogen than any other nutrient. Nitrogen is essential for increased leaf production, which increases yield if sufficient available soil moisture is present during the growing season. With proper soil moisture conditions, a maximum of 20 pounds per acre of nitrogen can be banded with the seed. Because soil moisture conditions are rarely sufficient in Alaska unless irrigation is used, most if not all nitrogen carriers should be broadcast applied. In low soil-moisture conditions, germinating seeds and seedlings can be injured by nitrogen fertilizers. Avoid excess nitrogen fertilizer above soil test recommendations because it can induce lodging, delay maturity, and cause an increased risk of fungal attacks at harvest. About half of the available soil nitrogen is removed with the seed at harvest. If plant residues are incorporated with tillage the next spring, a large amount of nitrogen remaining in the straw and stubble is returned and becomes available.

Canola requires relatively moderate to high phosphorus and potassium levels, which improve disease resistance and tolerance for frost and drought. Because Alaska soils are generally acidic, they tend to fix phosphorus, making it unavailable for plant uptake, so banding the phosphorus carrier with or next to the seed at planting would not help increase available phosphorus. Canola's small seed is planted shallow, where soil moisture is usually less than optimum, which renders the phosphorus unavailable for plant use. Thus, phosphorus and potassium fertilizers should be broadcast with the nitrogen fertilizers. About two-thirds of the phosphorus and one-third of the potassium are removed with the seed.

If plant residues are incorporated with tillage next spring, a large amount of potassium remaining in the straw and stubble is returned and becomes available for crops.

Sulfur and boron are needed by canola to promote flowering and seed set. Soils low in available sulfur should have a sulfate form of sulfur broadcast applied as ammonium sulfate or as potassium sulfate. Studies done by F.J. Wooding (1985) found that boron application rates of 0.5 to 1.0 pounds per acre of actual boron are sufficient to correct most soil deficiencies. About half of the available soil sulfur is removed with the seed at harvest. If plant residues are incorporated with tillage the next spring, a large amount of sulfur remaining in the straw and stubble becomes available. A ratio of 3:1:2:0.5 of N, P_2O_5, K_2O, and S have produced acceptable yields of canola. Actual percentages of all nutrients and application rates vary according to specific soil test results. All fertilizer must be broadcast before spring tillage.

Choice of the field for canola production is important. It should not have been cropped to canola in the previous three years. Studies done by L. Harrison and others (1997) in Canada found that some canola diseases can survive on canola plant residues for more than three years. Canola production should follow a year of summer fallow to help reduce the likelihood of plant disease, broadleaved weeds, and volunteer canola. This also increases available soil moisture and reduces the amount of fertilizer required. To conserve soil moisture, minimum tillage is recommended for incorporating fertilizer material and plant residue and preparing the seedbed. Pulling a packer behind the tillage implement and using a seed drill equipped with press wheels ensures that the seed is in contact with moist soil during the time needed for germination. Seeding depth is shallow, ½ to 1½ inches, or to moisture. Seeding deeper than 2 inches may result in delayed germination and emergence. Seeding rate depends on seed size. Generally, 6 to 12 pounds per acre of pure live seed for the larger Argentine types and slightly less than or equal to that rate for the smaller-seed Polish types are recommended. Heavier seeding rates produce thick stands that ripen more uniformly and reduce the possibility of green seeds at harvest. Lighter seeding rates compensate in yields because side branches develop, thicker and stronger stems reduce lodging, and better air movement through the canopy reduces fungal attack. However, lighter seeding increases risk of competition with weeds for available nutrients and soil moisture, so proper weed control during the summer fallow rotation is important. Planting as early as possible to avoid loss of important soil moisture and utilize as much of the short growing season as possible is recommended. Certified seed is strongly recommended; it often comes pretreated with a seed protectant of fungicides and insecticides to help ensure uniform seed germination and seedling survival.

Weed control in canola is extremely important. Canola needs warm soil to germinate and when young does not compete well with weeds. The best weed control is a combination of mechanical and chemical summer fallow to reduce the number and species of weeds for the following season. In the spring, wait for weeds to germinate, then perform seedbed tillage using proper fertilization and seeding rates. There are no herbicides registered for use on canola in Alaska. Many of the Canadian fall-seeded varieties have been bred to be herbicide resistant. Without a spring tillage treatment to reduce weeds for these varieties, herbicide spraying is required. To eliminate both grassy and broadleaved weeds, a broad spectrum post-emergence herbicide such as glyphosphate (Roundup) is used. Varieties with resistance to Roundup are termed "Roundup Ready" or "RR". Testing of experimental lines of fall-seeded canola in Alaska have not been successful. All varieties developed with this trait have been Argentine types, which are more susceptible to late spring frosts than Polish types. Also, soil temperature and moisture conditions in early spring are often too cold or wet for uniform germination. Seedling vigor is reduced, often leading to total crop failure before formation of the first true leaves. Fall-seeded Argentine varieties are not recommended for Alaska.

Several fungal diseases attack canola seed and seedlings, causing damping-off and root rot. They cause seed decay and seedling blight with delayed emergence and eventual uneven stands. Cool, wet soil conditions in the spring favor development of seed-born fungal attacks. Using treated seed with any one of a number of seed protectants and fungicides helps prevent loss from seed-borne fungal attacks. Blackleg *(Leptosphaeria maculans)* is a serious fungal disease in western Canada that is caused by infected seed or crop residues. It can affect all plants at any time during any growth stage, reducing plant vigor and yield. Using clean certified seed or resistant varieties can prevent its appearance before it becomes a serious problem in Alaska. Alternaria black spot *(Alternaria brassicae)* is a serious fungal disease that has been found on canola in Alaska. Small, dark lesions that occur on leaves and seed pods throughout the growing season cause a reduced photosynthetic ability of the leaves, premature pod drying, and seed shatter. Control using a registered fungicide such as carboxin (Vitavax) applied to the seed and using certified seed. Sclerotinia or white mold fungus *(Sclerotina sclerotiorum)* infects the base of the plant, causing wilt. This fast-acting disease often takes only four to seven days from the first appearance of symptoms to complete wilting. Cool, wet soil conditions in the spring and infected plant residue from the previous year favor development of this fungal disease. It can spread from plant contact and through airborne spores. Control using crop rotation and certified seed. Sunflowers are also susceptible to this disease and should not be used in the crop rotation.

Canola is susceptible to many different kinds of insect pests, many of which can cause serious yield losses, and thus require control measures. Flea beetles (*Phyllotreta cruciferae* Goeze) are small, shiny black insects that jump quickly when disturbed. They can seriously damage the newly emerging crop by eating small holes in the leaves. Control using a registered insecticide seed treatment such as lindane (Vitavax RS) that also contains the fungicide carboxin. The cabbage root maggot or cutworm (*Hylemya brassicae* Bouche) is the larval stage of a fly. It infests the base and roots of canola in the flowering to mature growth stages. Infestations of only three or more per plant can eventually girdle the plant. Also, their feeding creates wounds that can later serve as entry sites for fungal diseases. Polish canola is more susceptible than the Argentine varieties. Diazinon insecticide sprays help control heavy infestations. Heavier seeding rates may also help by reducing the size of the main stem, because smaller stems are less attractive to egg-laying females. Another control measure that works well is to increase the number of years between growing canola in the same fields. The red turnip beetle (*Entomoscelis americana* Brown) has recently become a serious pest in Alaska. The adult beetle is bright red with three black stripes down the back and a black patch behind the head. The adults feed on canola leaves in late June to early July, often causing total defoliation in heavy infestation years. After feeding for several weeks, the beetle borrows into the soil and becomes inactive for a two-week summer hibernation period. The beetles re-emerge in August and continue feeding until killed by early frosts. Diazinon sprays help control heavy infestations when sprayed at the first outbreak. Cultural practices such as weed control (tansy mustard [*Descurainia sophioides* Fisch.] is an alternate host) and volunteer control are also recommended to reduce red turnip beetle populations. Remember to always read the pesticide label and follow the directions on mixing, application, and disposal.

Canola ripens from the bottom of the plant to the top. When 40–50% of the seeds near the bottom have turned brown or black, harvest can begin. There are still green seeds in the pods near the tips of the side branches and at the top of the plant. Average seed moisture content at this stage is 35–45%. Use seed color change and not pod color change as an indicator of maturity, because some varieties can have ripe seeds in green pods. Canola is usually swathed before combining, because seed continues to mature in the windrow and can change color by 5% per day with enough heat and low humidity. Swathing also helps dry both the canola plants and any green weeds before harvest, making combining easier and reducing shatter loss. After a heavy precipitation event, standing canola dries better than swathed canola in windrows. Swathing too early reduces overall yields and oil content, while swathing too late increases shatter loss. Combining either the swathed or standing canola can begin when the seed is around 10% moisture content. Reduce cylinder speeds to one-half or two-thirds of that used for small grains. Concave clearance should be about 1 inch at the front and ½ inch at the back. Reduce these settings to reduce the chance of over threshing and causing cracked seeds and excess plant material in the hopper. Reduce the fan speed to about three-quarters of that used for small grains to avoid blowing the seed out with the chaff. The cleaning action for canola relies more on shaking action than on air flow. Top screens should be between ¼ and ⅓ inch and the bottom screens between ⅛ and ¼ inch, depending on seed size. Care must be taken to seal up all small holes and cracks in the combine, augers, trucks, and bins as canola seed is small and round in shape, and thus leaks out easily. Equip the combine with a straw chopper and spreader to evenly distribute the plant material. Canola straw is not a good animal feed because it contains high levels of glucosinolates that can cause goiters. These glucosinolates can also have an allelochemical effect that can cause reduced seed germination of the following year's crop.

Canola should be recleaned, dried to about 8–9% moisture and cooled to between 60° and 40° F before storage. Any green or moist material can cause molds to form, reducing the quality of the oil and the germination ability of the seed. Aeration from the bottom up through the bin with supplemental heat to drive off excess moisture is the usual first step. Do not heat the seed above 110° F because this reduces germination ability. The canola seed should be cooled immediately after drying to between 60° and 40° F. Temperatures and moisture content of the seed in the bin should be checked every day for a week after harvest, then every week after that. Repeat the aeration and drying if needed, because canola seed can spoil quickly in storage. The limit for green seed in the edible canola market is only 2%. Green seed and clean-outs can be used on-farm as an animal feed. When the crop is used as a supplement for animal diets, there is no limit to the amount of green seed, whole seed, or canola meal.

Recommended Variety Descriptions for Polish Canola

Note: See Appendix 1 for the addresses of seed suppliers.

'Tobin' is an early maturing, short, high-yielding, spring Polish canola developed by the Agriculture and Agri-Food Canada Research Station in Saskatoon, Saskatchewan and licensed in 1980. This was the standard variety against which all other canola varieties were compared in this report. This variety has been deregistered and is now in the public domain. As 'Tobin' is an older variety, seed sources may be difficult to find. Direct inquiries about seed sources to the Agriculture and Agri-Food Canada Research Station in Saskatoon.

'Colt' is an early maturing mid-tall, high-yielding, spring Polish canola developed by the Svalof Weibull AB of Sweden in 1988. It yields better than 'Tobin' and has higher oil and crude protein concentrations. Lodging resistance is similar to 'Tobin'. Direct inquiries about seed sources to Bonis and Company, Ltd.

'Eldorado' is an early maturing, mid-tall, high-yielding, spring Polish canola developed at the University of Alberta in 1991. It is slightly higher yielding than 'Tobin' and matures about

three days earlier. Lodging resistance is similar to 'Tobin' and shatter resistance is fair. This variety has been deregistered and is now in the public domain. Direct inquiries about seed sources to the University of Alberta.

'Horizon' is an early maturing mid-tall, high-yielding, spring Polish canola developed by the Svalof Weibull AB of Sweden in 1988. It has a better yield than 'Tobin' with higher oil and crude protein content. 'Horizon' has a slightly better lodging resistance than 'Tobin'. Direct inquiries about seed sources to Bonis and Company, Ltd.

'Reward' is an early maturing mid-tall, high-yielding, spring Polish canola developed at the University of Manitoba in 1991. It is similar in yields to 'Tobin' but has a higher oil content and higher crude protein content. Lodging resistance is slightly less than 'Tobin'. Direct inquiries about seed sources to the SeCan Association.

Canola is still considered a marginal crop for Alaska. In good years with adequate soil moisture and GDD, the Polish varieties listed previously produce close to 2% green seed, but even in good years there can be uneven ripening resulting in green seed at harvest. This is due to the immature seed that was killed by fall frost. Any seed killed by frost does not continue to ripen and remains green. Preliminary irrigation studies on canola in the Delta Junction area show a promising increase in average yields and a decrease in average percent green seed. However, it is still not consistently lower than 2% green seed for any given year. Hopefully, further irrigation studies can help solve this problem. Any seed grown for the edible oil or lubricating oil markets should be grown on contract with a processing facility, because a high-quality seed lot is required. Unfortunately, there is currently no facility in Alaska to process oil from canola seed for either the edible oil or lubricating oil markets. Also, there are no elevators in Alaska currently set up to take canola seed. All canola presently grown in Alaska is for on-farm use as a feed supplement in livestock diets.

All Argentine canola varieties are later maturing than the Polish varieties. As a result, there are no varieties that have been tested in Alaska that produce 2% green seed or less, even when grown under irrigation. For this reason, no Argentine canola varieties are recommended.

Yields by Location for Polish and Argentine Canola

Canola (Polish and Argentine) is bought and sold by weight. Similar to small grains, there is a standard test weight for canola that is used as the legal unit for purchase or sale of the crop. This standard test weight for clean, dry, and undamaged canola is 50 pounds per bushel. Other than test weights, additional samples should be taken on-farm to determine quality. Any seed lots not meeting high quality standards should be used as lower feed grades. It is important then for the producer to clean and size all seed lots before delivery to a niche market. Test weights are used here as a measure of seed quality to determine maturity. Yields are expressed here in pounds per acre. Bushels per acre can be determined by dividing the yield of any specific cultivar by the standard test weight.

Tables 42–48 list yields and quality measurements for canola varieties for three test locations: Fairbanks, Eielson, and Delta Junction. All sites in the Delta Junction area have been combined into either the Delta dryland site (Table 46), or, if grown under irrigation, the Delta irrigated site (Table 48). Each table also contains information on seed type (Polish or Argentine) and the years it was tested at each location. Erucic acid contents for all varieties are listed as low (less than 5%), normal (20–40%), and high (greater than 50%). Glucosinolate contents are listed as either low or high. Varieties with low levels of both erucic acid and glucosinolates (low E & low G) can be used for the edible oil market. Varieties that are low in erucic acid but high in glucosinolates (low E & high G) can be used sparingly in animal feeds but not for edible oil. Most of the varieties in this category are older varieties that have since been removed from production and are no longer recommended in Canada. Varieties that are normal or high in erucic acid and high in glucosinolates (normal E & high G) and (high E & high G) can be used only in the lubricating oil markets. Most of the newer varieties in this category are all high in both erucic acid and glucosinolates for higher quality lubrication oils. Older varieties have been discontinued and are no longer recommended for production. Maturity in this study was considered to be when 50% of the seed for each plot was a brown or black color. Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued growth of the crop. The low temperature point for all canola in this report is the freezing point of water, 32° F. The GDD calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. All varieties were compared with 'Tobin' as the standard variety. Yield as a percent of 'Tobin' was determined by dividing the average yield of each variety by the average yield of 'Tobin'. Maturity vs. 'Tobin' is the number of days each variety reached 50% maturity either before or after the number of days that 'Tobin' reached 50% maturity. Seed quality data (percent oil, percent crude protein, perecent green seed, and other nutrients) for Fairbanks (Table 43), Eielson (Table 45), and Delta dryland (Table 47) are presented without statistical differences and solely for the reader's benefit. In the tables, N/D (No Data) indicates that the variety was grown, but not analyzed. Methods for determining seed quality are standard laboratory methods used for feed and forage by the UAF Soil and Plant Analysis Laboratory in Palmer, Alaska (see Appendix 1 for addresses).

Table 42. Average yields and quality measurements from canola test plots in the Fairbanks area, 1978 – 2002.

Canola Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Tobin)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Maturity vs. Tobin (days)	Average Maturity (GDD)*
Polish									
low E and low G									
Candle	(Canada)	6	2499	115	52	25	1-Sep	12	2980
Colt	(Sweden)	3	2039	94	49	38	20-Aug	0	2748
Eldorado	(Alberta)	4	1945	89	49	53	16-Aug	-4	2662
Goldrush	(Sweden)	1	N/D	N/D	N/D	25	21-Aug	1	2769
Horizon	(Sweden)	3	2156	99	50	60	20-Aug	0	2748
Maverick	(Sweden)	1	N/D	N/D	N/D	25	21-Aug	1	2769
Reward	(Manitoba)	4	1762	81	49	52	20-Aug	0	2748
Sunshine	(Alberta)	3	1817	84	49	0	20-Aug	0	2748
Tobin	(Saskatchewan)	5	2175	100	49	68	20-Aug	0	2748
low E & high G									
Span	(Canada)	1	1910	88	N/D	25	30-Aug	10	2944
Torch	(Canada)	3	1570	72	N/D	25	30-Aug	10	2944
normal E & high G									
Echo	(Canada)	1	2155	99	N/D	25	30-Aug	10	2944
high E & high G									
R-500	(Saskatchewan)	2	2094	96	51	25	1-Sep	12	2980
Argentine									
low E & low G									
Altex	(Canada)	4	1815	84	45	25	1-Sep	12	2980
Alto	(Canada)	3	1873	97	45	12	28-Aug	8	2908
Andor	(Canada)	1	1366	63	47	25	1-Sep	12	2980
Delta	(Canada)	3	1876	95	49	23	28-Aug	8	2908
Legend	(US)	3	1481	77	44	3	29-Aug	9	2926
Regent	(Canada)	3	2234	103	43	25	1-Sep	12	2980
Reston	(Canada)	1	943	43	41	25	1-Sep	12	2980
Sprite	(Canada)	1	N/D	N/D	N/D	25	4-Sep	15	3013
Tower	(Canada)	4	1883	87	45	25	1-Sep	12	2980
Trident^	(Ontario)	1	1454	93	44	25	30-Aug	10	2944
Triton^	(Ontario)	1	894	41	40	25	1-Sep	12	2980
Westar	(Saskatchewan)	3	1877	97	46	23	26-Aug	6	2869
low E & high G									
Midas	(Canada)	1	2050	94	N/D	25	1-Sep	12	2980
Oro	(Canada)	1	2065	95	N/D	25	1-Sep	12	2980
Zephyr	(Canada)	1	1645	76	N/D	25	1-Sep	12	2980
normal E & high G									
Target	(Canada)	1	1945	89	N/D	25	1-Sep	12	2980
Turret	(Canada)	1	1900	97	N/D	25	1-Sep	12	2980

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
N/D = No Data. E = Erucic acid. G = Glucosinolates. ^ = resistant to triazine or atrazine herbicides.

Table 43. Average quality measurements for canola seed from variety test plots in the Fairbanks area, 1978 – 2002.

Canola Variety Name	Source	Years Tested	Crude Portein (%)	Total P (%)	Total K (%)	Dry Matter (%)	Oil Content (%)	Green Seed (%)
Polish								
low E & low G								
Candle	(Canada)	6	N/D	N/D	N/D	N/D	N/D	N/D
Colt	(Sweden)	3	26.30	0.6	0.66	97.57	35.15	6
Eldorado	(Alberta)	4	26.23	0.6	0.71	97.82	35.20	2
Horizon	(Sweden)	3	26.19	0.6	0.64	97.69	34.91	4
Reward	(Manitoba)	4	26.17	0.7	0.80	98.62	34.49	3
Sunshine	(Alberta)	3	26.67	0.7	0.71	97.06	34.36	5
Tobin	(Saskatchewan)	5	26.36	0.7	0.72	97.57	33.36	3
low E & high G								
Span	(Canada)	1	N/D	N/D	N/D	N/D	37.00	N/D
Torch	(Canada)	3	N/D	N/D	N/D	N/D	36.00	N/D
high E & high G								
R-500	(Saskatchewan)	2	N/D	N/D	N/D	N/D	41.80	N/D
Argentine								
low E & low G								
Alto	(Canada)	3	26.83	0.6	0.68	97.17	34.53	23
Delta	(Canada)	3	27.23	0.6	0.68	96.87	33.99	30
Legend	(US)	3	27.51	0.7	0.72	97.39	35.64	25
Regent	(Canada)	3	N/D	N/D	N/D	N/D	37.10	N/D
Tower	(Canada)	4	N/D	N/D	N/D	N/D	33.50	N/D
Trident^	(Ontario)	1	28.38	0.7	0.70	97.80	31.02	N/D
Westar	(Saskatchewan)	3	27.17	0.6	0.73	97.39	34.21	21
low E & high G								
Midas	(Canada)	1	N/D	N/D	N/D	N/D	N/D	N/D

N/D = No Data. E = Erucic acid. G = Glucosinolates. ^ = resistant to triazine or atrazine herbicides.

Table 44. Average yields and quality measurements from canola test plots in the Eielson area, 1993 – 2001.

Canola Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Tobin)	Test Wt. (lbs/bu)	Lodging (%)	Averate Maturity Date	Maturity vs. Tobin (days)	Average Maturity (GDD)*
Polish									
low E & low G									
Colt	(Sweden)	4	1821	102	49	25	21-Aug	3	2778
Eldorado	(Alberta)	4	1758	98	49	33	18-Aug	0	2716
Goldrush	(Sweden)	1	2947	165	51	30	30-Aug	12	2955
Horizon	(Sweden)	4	1723	96	49	25	21-Aug	3	2778
Maverick	(Sweden)	2	2406	134	50	30	27-Aug	9	2899
Reward	(Manitoba)	6	1751	98	49	20	19-Aug	1	2737
Sunshine	(Alberta)	4	1757	98	49	25	21-Aug	3	2778
Tobin	(Saskatchewan)	4	1790	100	50	32	18-Aug	0	2716
Argentine									
low E & low G									
Alto	(Canada)	3	1427	80	46	25	28-Aug	10	2918
Delta	(Canada)	3	1664	93	47	22	29-Aug	11	2936
Legend	(US)	3	1225	69	44	17	29-Aug	11	2936
Sprite	(Canada)	1	2037	114	47	30	1-Sep	14	2990
Trident^	(Ontario)	1	481	27	42	85	30-Aug	12	2955
Westar	(Saskatchewan)	3	1399	78	46	25	27-Aug	9	2899

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity. E = Erucic acid. G = Glucosinolates. ^ = resistant to triazine or atrazine herbicides.

Table 45. Average quality measurements for canola seed from variety test plots in the Eielson area, 1993 – 2001.

Canola Variety Name	Source	Years Tested	Crude Portein (%)	Total P (%)	Total K (%)	Dry Matter (%)	Oil Content (%)	Green Seed (%)
Polish								
low E & low G								
Colt	(Sweden)	2	17.71	0.74	0.67	97.65	41.95	7
Eldorado	(Alberta)	3	17.64	0.73	0.64	97.85	41.65	3
Horizon	(Sweden)	2	18.03	0.72	0.67	98.08	42.67	5
Reward	(Manitoba)	3	18.02	0.74	0.65	97.80	43.01	5
Sunshine	(Alberta)	2	20.20	0.72	0.70	97.38	39.87	6
Tobin	(Saskatchewan)	3	19.71	0.77	0.65	97.96	39.68	4
Argentine								
low E & low G								
Alto	(Canada)	3	17.48	0.67	0.66	97.43	43.06	26
Delta	(Canada)	3	17.41	0.69	0.65	97.79	41.67	29
Legend	(US)	3	18.22	0.67	0.66	97.89	40.42	28
Trident^	(Ontario)	1	20.94	0.73	0.90	97.81	37.52	N/D
Westar	(Saskatchewan)	3	17.91	0.63	0.71	97.51	35.49	31

E = Erucic acid. G = Glucosinolates. ^ = resistant to triazine or atrazine herbicides.

Table 46. Average yields and quality measurements from canola test plots in the Delta Junction area, 1978 – 2002, dryland site.

Canola Variety Name	Source	Years Tested	Yield (lbs/acre)	Yield (% of Tobin)	Test Wt. (lbs/bu)	Lodging (%)	Averate Maturity Date	Maturity vs. Tobin (days)	Average Maturity (GDD)*
Polish									
low E & low G									
Candle	(Canada)	6	1726	165	49	5	3-Sep	16	2775
Colt	(Sweden)	7	1129	108	49	2	18-Aug	0	2489
Eldorado	(Alberta)	5	652	62	49	0	18-Aug	0	2489
Goldrush	(Sweden)	2	1178	112	48	0	27-Aug	9	2660
Horizon	(Sweden)	7	1267	121	50	2	17-Aug	-1	2469
Maverick	(Sweden)	4	1405	134	50	5	10-Aug	-8	2313
Reward	(Manitoba)	8	1112	106	50	2	16-Aug	-2	2446
Sunshine	(Alberta)	7	1623	155	49	2	18-Aug	0	2489
Tobin	(Saskatchewan)	6	1048	100	50	0	18-Aug	0	2489
low E & high G									
Span	(Canada)	1	1500	143	N/D	5	3-Sep	16	2775
Torch	(Canada)	3	1825	174	N/D	5	3-Sep	16	2775
normal E & high G									
Echo	(Canada)	1	1600	153	N/D	5	3-Sep	16	2775
high E & high G									
R-500	(Saskatchewan)	2	1145	109	N/D	5	3-Sep	16	2775
Argentine									
low E & low G									
AC Excel	(Saskatchewan)	1	1742	166	43	10	7-Sep	20	2241
Altex	(Canada)	4	1196	114	45	5	3-Sep	16	2138
Alto	(Canada)	3	249	50	48	0	22-Aug	4	2566
Andor	(Canada)	1	1366	130	47	5	3-Sep	16	2775
Delta	(Canada)	3	291	58	50	0	22-Aug	4	2566
Legend	(US)	3	342	81	48	0	23-Aug	5	2585
Regent	(Canada)	4	1018	97	46	5	3-Sep	16	2775
Reston	(Canada)	1	1204	115	49	5	3-Sep	16	2775
Tower	(Canada)	4	1060	101	46	5	3-Sep	16	2775
Trident^	(Ontario)	1	143	45	46	0	21-Aug	3	2548
Triton^	(Ontario)	1	894	85	40	5	3-Sep	16	2775
Westar	(Saskatchewan)	3	238	44	49	0	21-Aug	3	2548
low E & high G									
Midas	(Canada)	1	1485	142	N/D	5	3-Sep	16	2775
Oro	(Canada)	1	1255	120	N/D	5	3-Sep	16	2775
Zephyr	(Canada)	1	1105	106	N/D	5	3-Sep	16	2775
normal E & high G									
Target	(Canada)	1	1300	124	N/D	5	3-Sep	16	2775
Turret	(Canada)	1	1065	102	N/D	5	3-Sep	16	2775

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity. N/D = No Data. E = Erucic acid. G = Glucosinolates. ^ = resistant to triazine or atrazine herbicides.

Table 47. Average quality measurements for canola seed from variety test plots in the Delta Junction area, 1978 – 2002, dryland site.

Canola Variety Name	Source	Years Tested	Crude Portein (%)	Total P (%)	Total K (%)	Dry Matter (%)	Oil Content (%)	Green Seed (%)
Polish								
low E & low G								
Candle	(Canada)	1	N/D	N/D	N/D	N/D	42.60	N/D
Colt	(Sweden)	4	21.58	0.73	0.80	98.28	40.96	9
Eldorado	(Alberta)	3	22.37	0.73	0.77	98.12	41.58	2
Goldrush	(Sweden)	2	20.50	0.81	0.81	N/D	42.74	3
Horizon	(Sweden)	4	21.35	0.75	0.79	98.78	41.02	6
Maverick	(Sweden)	4	20.52	0.79	0.80	N/D	42.97	4
Reward	(Manitoba)	3	22.52	0.71	0.77	97.73	39.64	8
Sunshine	(Alberta)	4	22.95	0.77	0.76	97.79	38.53	7
Tobin	(Saskatchewan)	4	22.29	0.73	0.76	98.31	39.49	5
low E & high G								
Span	(Canada)	1	N/D	N/D	N/D	N/D	41.50	N/D
Torch	(Canada)	3	N/D	N/D	N/D	N/D	40.90	N/D
high E & high G								
R-500	(Saskatchewan)	2	N/D	N/D	N/D	N/D	42.10	N/D
Argentine								
low E & low G								
AC Excel	(Saskatchewan)	1	N/D	N/D	N/D	N/D	N/D	31
Alto	(Canada)	2	22.57	0.64	0.92	98.02	37.38	27
Delta	(Canada)	2	22.25	0.64	0.95	98.24	33.04	32
Legend	(US)	2	26.63	0.62	0.85	98.29	35.27	31
Regent	(Canada)	1	N/D	N/D	N/D	N/D	44.60	N/D
Tower	(Canada)	1	N/D	N/D	N/D	N/D	43.40	N/D
Trident^	(Ontario)	1	26.19	0.70	0.94	97.66	35.14	N/A
Westar	(Saskatchewan)	2	23.22	0.68	0.94	98.10	38.06	28
low E & high G								
Midas	(Canada)	1	N/D	N/D	N/D	N/D	41.60	N/D

N/D = No Data. E = Erucic acid. G = Glucosinolates.

Combining canola in a field near Delta Junction. AFES file photo.

Table 48. Average yields and quality measurements from canola test plots in the Delta Junction area, 1978 – 2000, irrigated site.

Canola Variety Name	Source	Years Tested	Yield (lbs/acre)	Yield (% of Tobin)	Test Wt. (lbs/bu)	Lodging (%)	Averate Maturity Date	Maturity vs. Tobin (days)	Average Maturity (GDD)*	Green Seed (%)
Polish										
low E & low G										
Colt	(Sweden)	3	2280	119	50	10	14-Aug	0	2404	3
Horizon	(Sweden)	3	2326	121	50	10	14-Aug	0	2404	4
Maverick	(Sweden)	3	2339	122	50	10	14-Aug	0	2404	3
Reward	(Manitoba)	3	2012	105	50	10	14-Aug	0	2404	3
Sunshine	(Alberta)	3	1942	101	49	10	14-Aug	0	2404	3
Tobin	(Saskatchewan)	1	1916	100	51	10	14-Aug	0	2404	4
Argentine										
low E & low G										
AC Excel	(Saskatchewan)	1	1396	73	42	25	7-Sep	24	2835	24
44A89	(Ontario)	1	1773	93	43	25	7-Sep	24	2835	85

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
E = Erucic acid. G = glucosinolates.

Flax Performance Trials

Oilseed and Fiber Flax

Flax (*Linum usitatissimum* L.) is an annual broadleaved plant that grows 12 to 48 inches tall. There may be two or more basal branches on the main stem that in turn have secondary and tertiary branches. Flax stems consist of the inner pith, middle wood, and outer bark. The bark contains the long bast or flax fiber cells that make up the linen fibers. The blue flowers on the outer ends of the branches turn into seed bolls at maturity. These bolls contain eight or less small, smooth and shiny seeds that are yellow, light brown, or black. The seed shape and appearance is similar to that of canarygrass. The seed bolls retain the seed at maturity, so seed shatter is minimal. Flax is an indeterminate plant and continues to flower until growth is stopped by a killing frost.

There are two main types of flax, one grown for oilseed content and one grown for fiber content. Oilseed flax is shorter, 15 to 30 inches tall, and is multiple branched. The seed is generally larger and higher in oil content, 32–44% oil, than that of fiber flax. Linseed oil is obtained by a combination of expressing and solvent extraction and yields about two and one-half gallons for each bushel of clean flax seed. It is a high-quality industrial drying oil used in the production of paints, varnishes, linoleum, oilcloth, inks, soaps, and other products. The short, harsh fiber of oilseed flax is used for producing upholstery and insulation materials and high-grade paper products. Fiber flax is taller, 37 to 48 inches tall and usually single stemmed. Heavier planting rates promote single-stemmed plant growth. The seed is smaller and slightly lower in oil content than oilseed flax.

Fiber flax is pulled or dug at harvest to retain as much of the long bast fibers as possible. It is allowed to dry and cure in the fields before the seed is threshed. The stems are then retted (partially rotted) in large tanks of continuously replenished and cleaned water that is kept at 80° F for six to eight days. This retting process breaks down the binding gums and thin-walled tissues that surround the fibers. The retted fibers are then dried and run between fluted rollers to break and loosen the woody portions into shives. The shives are then removed from the long fibers by a cylinder wheel in a process called scutching. Good long fibers, about 20 inches in length, are strong enough to resist breaking down

Flax in bloom. Photo by Flavio Gassen.

during the breaking and scutching processes. Flax fiber is spun into linen yards that are used for producing fine textiles and high-grade paper products.

Flax straw can be fed to livestock and has a feeding value of about equal to that of wheat or oat straw. The oilseed cake remaining after the oil extraction process contains about 1–6% oil and is about 35% protein. This linseed meal can also be fed to livestock. Flax seed that has been frozen can develop high levels of prussic acid or hydrocyanic acid (HCN). This is caused by a breakdown of a glucoside called dhurrin into toxic levels of prussic acid. Freezing causes the acid to be released quickly from the glucoside form. Any feed that has been frozen should be tested for prussic acid before feeding. Any feed lot testing over 200 ppm is considered toxic. Sheep are less susceptible than cattle, while horses and swine are apparently not injured. Flax seed is considered primarily an industrial oil and thus is not part of the edible oil market. However, there are varieties that have been developed in Canada with less than 5% linolenic acid that produce food-quality edible oil. Varieties with this trait are marketed under the term Solin.

Fertilization, tillage practices, and seeding depths are similar to those for canarygrass. However, flax is generally seeded on soils with lower levels of available nutrients. Soils with low to moderate levels of available nutrients should receive a complete fertilizer blend of nitrogen, phosphorus, potassium, sulfur, and boron. Actual percentages of each nutrient and the application rate varies according to specific soil test results. For fiber production, a ratio of 1:4:2 of N, P_2O_5, and K_2O produces the best results. Oilseed production requires higher levels of nitrogen, or a ratio of about 1:2:1 of N, P_2O_5, and K_2O. The fertilizer can be broadcast before spring tillage or portions can be banded at planting. Higher levels of phosphorus increase the fiber percentage. Avoid excess nitrogen fertilizer because it can reduce the percentage of fiber, induce lodging, and delay maturity.

To conserve soil moisture, minimum tillage is recommended for incorporating fertilizer material and plant residue and preparing the seedbed. Pulling a packer behind the tillage implement and using a seed drill equipped with press wheels ensures that the seed is in contact with moist soil during the time needed for germination. Flax does best on well-drained silt loam soils, but requires a fair amount of soil moisture to produce high yields. It is a shallow-rooting plant and obtains most of the soil moisture from the top two feet of soil. Seeding depth is shallow at 1 to 1½ inches, or to moisture. The seeding rate is 28 to 42 pounds of pure live seed per acre for oilseed production and 75 to 85 pounds per acre for fiber production. The higher rate should be used to reduce branching in fiber flax varieties. Early planting dates are recommended to utilize as much of the short growing season as possible and get the straw as mature as possible before harvest. In the seedling stage and in the flowering to green boll stages, flax can be damaged or killed by light frosts. Otherwise, it requires moderate to cool temperatures during the growing season. Certified seed is strongly recommended.

Flax competes poorly with weeds, so weed control is important. J.H. Martin and others (1976) reported that heavy weed infestations can reduce yields by as much as 70%. Best weed control is a combination of mechanical and chemical summer fallow to reduce the number and species of weeds for the following season and an application of a postemergence herbicide. Best weed control has been with Bromoxynil and MCPA tank mixes applied when the flax was two to eight inches tall, but before the bud stage. Pennsylvania smartweed (*Polygonum pensylvanicum* L.) and volunteer canarygrass both have seed similar in size, shape, and weight, making them difficult to clean out. Seed lots containing these weed seeds are rejected by purchasers. Planting in clean ground helps to control these weeds. To eliminate grassy weeds with chemical fallow, a broad spectrum postemergence herbicide such as glyphosphate (Roundup) was used. Although no serious diseases have yet been found on flax in Alaska, in other locations a Fusarium wilt caused by the fungus *Fusarium lini* causes infected plants to wilt and die. This fungus has been found in Alaska, where it can infect small grains and survive in the soil for many years. Control by planting resistant varieties. The same insect pests that affect small grains also affect flax. The most serious pests are grasshoppers, including the lesser migratory grasshopper (*Melanoplus sanguinipes* Fabricias), the northern grasshopper (*Melanoplus borealis* Fieber), and the clear-winged grasshopper (*Camnula pellucida* Scudder). They chew off the pedicels below the base of the seed bolls, causing the bolls to fall to the ground. Diazinon or carbaryl (Sevin) sprays or baits help control heavy infestations. Remember to always read the pesticide label and follow the directions on mixing, application, and disposal.

Flax seed is harvested when a majority of the seed bolls have reached a dark brown color. Since flax is indeterminate, there are still green seed and green stems at this point. The crop can be direct combined only if stems are thoroughly dry and weed free. Otherwise, cut with a swather and allow to dry in windrows. Green or wet flax stems are quite tough and wiry and can wrap around cylinders inside combines, impeding the combining process. Use the same combine settings used to harvest canarygrass. For proper threshing, slow the feeding rate by reducing cylinder speeds. The small seed size requires reducing air flow settings similar to those for canarygrass. Control seed cracking by running augers at full capacity or slowing them down. Continual checking for cracked seeds and adjusting combining methods is important. Because of the small seed size, all cracks and holes in the combine, augers, trucks, and bins should be sealed to prevent seed loss during handling. Flax does not head shatter, so combine operations can wait for the seed to field dry to around 13% moisture. This also allows the straw to reach full maturity for easier harvesting. Flax seed must be around 9 to 11% moisture for safe, long-term storage. Higher moisture contents can cause the stored seed to germinate or mold, and lower moisture content can damage the embryo, reducing germination ability. Both situations reduce the quality of stored seed. The highest quality seed is achieved when swathing or combining at the lowest moisture content. On-farm drying may be necessary to get the seed to safe storage moisture levels. On-farm cleaning and sizing of the seed lot to oilseed standards before drying results in easier drying conditions and eventual higher prices paid to the producer. Clean-outs can be used on-farm or sold as lower grade seed.

Harvesting fiber flax is done when only one-third to one-half of the seed bolls are a dark brown color and the stems have turned yellow. The leaves should have fallen off the main stems about two-thirds of the way up the plant. Flax harvested too early has long, silky fibers that lack strength. Flax harvested too late has coarse and brittle fibers. The plants are pulled from the ground with special pulling machines or by hand and allowed to dry and cure in the field before processing. Yields of 3500 pounds per acre are considered good for unprocessed fiber flax.

Recommended Variety Descriptions for Oilseed Flax

Note: See Appendix 1 for the addresses of seed suppliers.

'Norlin' is an early maturing, mid tall, high-yielding oilseed flax developed at the Agri-Food Research Centre at Morden, Alberta in 1982. 'Norlin' has good lodging resistance, small seed size, medium oil content and a moderate resistance to Fusarium wilt. It has a lower capability of producing secondary basal branches than most other varieties. This was the standard variety against which all other flax varieties were compared. Direct inquiries about seed sources to the SeCan Association.

Flax is still considered a marginal crop for Alaska. In years with plenty of soil moisture and GDD, 'Norlin' produced acceptable yields. However, uneven ripening resulted in green seed at harvest, which was immature seed killed by fall frost. Any seed grown for the edible oil or industrial oil markets should be grown on contract with a processing facility because a high-quality seed lot is required. At the present time, there is no facility in Alaska to process oil from flax seed for either the edible oil or industrial oil markets. Also, there are no elevators presently set up to accept flax seed in Alaska. All fiber flax varieties are later maturing than the oilseed varieties. As a result, there are no varieties that have been tested in Alaska that consistently produce acceptable fiber yields. For this reason, no fiber flax varieties are recommended.

Yields and Test Weights by Location for Oilseed and Fiber Flax

Seed from both oilseed and fiber flax are bought and sold by weight. Similar to small grains, there is a standard test weight for all flax seed that is used as the legal unit for purchase or sale of the crop. This standard test weight for clean, dry, and undamaged flax seed is 56 pounds per bushel. Other than test weights, additional samples should be taken on-farm to determine quality. Any seed lots not meeting high oilseed quality standards should be used as lower seed grades. It is important then for the producer to clean and size all seed lots before delivery to a niche market. Test weights are used here as a measure of seed quality to determine maturity. Yields are expressed here in pounds per acre. Bushels per acre can be determined by dividing the yield of any specific cultivar by the standard test weight.

Tables 49–54 list yields and quality measurements for oilseed and fiber flax varieties for three test locations: Fairbanks, Eielson, and Delta Junction. All sites in the Delta Junction area have been combined into Delta dryland site (Table 53). There were no irrigation trials done for either oilseed or fiber flax. Each table also contains information on seed type (oilseed or fiber), biomass yield, the source or the location where it was bred, and the years it was tested at each location. Maturity in this study was when 50% of the bolls for each plot were a dark brown in color and the stems were a yellow in color. Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued growth of the crop. The low temperature point for both oilseed and fiber flax in this report is the freezing point of water, 32° F. The GDD calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. All varieties were compared with 'Norlin' as the standard variety. Yield as a percent of 'Norlin' was determined by dividing the average yield of each variety by the average yield of 'Norlin'. Maturity vs. 'Norlin' is the number of days each variety reached 50% maturity either before or after the number of days that 'Norlin' reached 50% maturity. Seed and forage quality data (percent oil, percent crude protein and other nutrients, and the nutritive composition from the biomass) for Fairbanks (Table 50), Eielson (Table 52), and Delta dryland (Table 54) are presented without statistical differences and solely for the reader's benefit. In the tables, N/D (No Data) indicates that the variety was grown, but not analyzed. Methods for determing seed and forage quality are standard laboratory methods used for feed and forage by the UAF Soil and Plant Analysis Laboratory in Palmer, Alaska. See Appendix 1 for addresses.

Table 49. Average yields and quality measurements from flax test plots in the Fairbanks area,1978 – 2002.

Flax Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Norlin)	Test Wt. (lbs/bu)	Biomass (lb/ acre)	Lodging (%)	Average Maturity Date	Maturity vs. Norlin (days)	Average Maturity (GDD)*
oilseed										
Dufferin	(Manitoba)	1	1188	110	N/D	N/D	0	5-Sep	2	3046
Linott	(Ontario)	1	512	48	N/D	N/D	0	4-Sep	1	3029
McGregor	(Manitoba)	1	400	37	N/D	N/D	0	5-Sep	2	3046
Noralta	(Manitoba)	2	1097	102	N/D	N/D	0	4-Sep	1	3029
Norlin	(Manitoba)	3	1077	100	51	2476	0	3-Sep	0	3013
Raja	(Canada)	1	504	47	N/D	N/D	0	5-Sep	2	3046
fiber										
Arianne	(Oregon)	2	806	75	N/D	3984	0	5-Sep	2	3046
Cascade	(Oregon)	1	737	68	N/D	N/D	25	4-Sep	1	3029
Viking	(Oregon)	2	680	63	N/D	3150	0	4-Sep	1	3029

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
N/D = No Data.

Table 50. Average quality measurements for flax from variety test plots in the Fairbanks area, 1978 – 2002.

Flax Variety Name	Seed Crude Protein (%)	Seed Total P (%)	Seed Total K (%)	Seed Dry Matter (%)	Seed Oil Content (%)	Biomass Crude Protein (%)	Biomass Total P (%)	Biomass Total K (%)	Biomass Dry Matter (%)	Biomass Oil Content (%)
oilseed										
Dufferin	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Linott	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
McGregor	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Noralta	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Norlin	26.50	0.65	0.70	98.1	37.58	26.10	0.58	0.73	99.10	39.76
Raja	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
fiber										
Arianne	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Cascade	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Viking	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D

N/D = No Data.

Table 51. Average yields and quality measurements from flax test plots in the Eielson area, 1993 – 2001.

Flax Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Norlin)	Test Wt. (lbs/bu)	Biomass (lb/acre)	Lodging (%)	Average Maturity Date	Maturity vs. Norlin (days)	Average Maturity (GDD)*
oilseed										
Norlin	(Manitoba)	2	484	100	45	2233	0	5-Sep	0	2388
fiber										
Arianne	(Oregon)	2	552	114	N/D	905	0	5-Sep	0	2388
Cascade	(Oregon)	1	585	121	N/D	N/D	20	5-Sep	0	2388
Viking	(Oregon)	2	477	99	N/D	3124	0	5-Sep	0	2388

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
N/D = No Data.

Table 52. Average quality measurements for flax from variety test plots in the Eielson area, 1993 – 2001.

Flax Variety Name	Seed Crude Protein (%)	Seed Total P (%)	Seed Total K (%)	Seed Dry Matter (%)	Seed Oil Content (%)	Biomass Crude Protein (%)	Biomass Total P (%)	Biomass Total K (%)	Biomass Dry Matter (%)	Biomass Oil Content (%)
oilseed										
Norlin	23.29	3.78	1.25	97.88	39.65	11.25	0.30	1.80	N/D	N/D
fiber										
Arianne	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Cascade	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Viking	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D

N/D = No Data.

Table 53. Average yields and quality measurements from flax test plots in the Delta Junction area, 1978 – 2002, dryland site.

Flax Variety Name	Source	Years Tested	Yield (lbs/ acre)	Yield (% of Norlin)	Test Wt. (lbs/ bu)	Biomass (lb/ acre)	Lodging (%)	Average Maturity Date	Maturity vs. Norlin (days)	Average Maturity (GDD)*
oilseed										
Linott	(Ontario)	1	771	290	N/D	N/D	0	4-Sep	0	2789
Noralta	(Manitoba)	1	486	183	N/D	N/D	0	4-Sep	0	2789
Norlin	(Manitoba)	2	266	100	53	473	0	4-Sep	0	2789
Raja	(Canada)	1	879	331	N/D	N/D	0	5-Sep	1	2805
fiber										
Arianne	(Oregon)	2	0	N/D	N/D	4865	0	9-Sep	5	2865
Cascade	(Oregon)	1	0	N/D	N/D	N/D	10	7-Sep	3	2835
Viking	(Oregon)	2	0	N/D	N/D	5074	0	11-Sep	7	2890

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
N/D = No Data.

Table 54. Average quality measurements for flax from variety test plots in the Delta Junction area, 1978 – 2002, dryland site.

Flax Variety Name	Seed Crude Protein (%)	Seed Total P (%)	Seed Total K (%)	Seed Dry Matter (%)	Seed Oil Content (%)	Biomass Crude Protein (%)	Biomass Total P (%)	Biomass Total K (%)	Biomass Dry Matter (%)	Biomass Oil Content (%)
oilseed										
Linott	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Noralta	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Norlin	26.35	0.52	0.90	98.03	38.35	14.06	0.15	1.50	N/D	N/D
Raja	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
fiber										
Arianne	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Cascade	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
Viking	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D

N/D = No Data.

Safflower Performance Trials

Safflower (*Carthamus tinctorius* L.) is an annual broadleaved plant that grows 12 to 48 inches tall. It has multiple branches on smooth white or yellowish stems. Globular flower heads (½ to 1½ inch diameteer) occur at the top of each branch. The leaves and floral bracts bear short ½ similar to those on thistles. The flowers may be white, yellow, orange, or red and produce smooth, white seed similar in shape to sunflower seed but smaller. Whole safflower seed contains 32–40% oil; dehulled seed contains 50–55% oil. Safflower oil is both an edible oil and an industrial drying oil. It contains 75% linoleic acid, an unsaturated fatty acid. It contains no linolenic glycerides, which make it a superior drying oil for producing interior white paints; unlike linseed oil, it does not yellow when exposed to sunlight. It is also used in varnishes, enamels, and soap. The oil is obtained by a combination of expressing and solvent extraction similar to that used for linseed and sunflower oils. The resulting meal contains 20–50% protein, depending on the amount of hulls left on during processing. This meal is used as a livestock feed. The flowers contain a commercial dye called carthamin that is either yellow, orange, or red.

Fertilization, tillage practices, and seeding depths are identical to those for small grain production. Safflower requires well-drained soils and long growing seasons. Yields are increased when moderate levels of nitrogen and phosphorus are available, especially when plenty of soil moisture also is available. Safflowers are usually seeded into soils with lower available nutrients, but irrigation is recommended for complete nutrient use. Without irrigation, soils with low to moderate levels of available nutrients should receive a complete fertilizer blend of nitrogen, phosphorus, potassium, sulfur, and boron. Actual percentages of each nutrient and application rates vary according to specific soil test results. The fertilizer can be broadcast before spring tillage, or portions can be banded at planting. Avoid excess nitrogen because it can delay maturity.

To conserve soil moisture, minimum tillage is recommended for incorporating fertilizer material and plant residue and preparing the seedbed. Pulling a packer behind the tillage implement and using a seed drill equipped with press wheels ensures that the seed is in contact with moist soil during the time needed for germination. Seeding depth is the same as that for small grains, 1½ to 2 inches, or to moisture. Seeding rates are between 15 and 30 pounds of pure live seed per acre, depending on row width and soil moisture. The lower rates should be used on wide row spacing or under dryland conditions. Safflowers should be seeded in rows that are 18 to 30 inches apart. Wider row spacings are required if mechanical cultivation weed control methods are to be used. Seeding heavier allows for some establishment loss due to poor conditions. Grain drills can be used to plant safflowers by blocking off the appropriate opening in the seed box. The seed box should be kept full to account for the effect of seed weight on the flow through the drill. Early planting dates are recommended to utilize as much of the short growing season as possible. Use of certified seed is strongly recommended.

Weed control in safflowers is extremely important. Like all the other oilseed crops, safflowers need warm soils to germinate and do not compete well with weeds until about four weeks after emergence. Best weed control is a combination of mechanical and chemical summer fallow to reduce the number and species of weeds for the following season. In the spring, wait for weeds to germinate, then perform seedbed tillage and use proper fertilization and seeding rates. To eliminate all weeds with chemical fallow, a broad spectrum post-emergence herbicide such as glyphosphate (Roundup) was used. Safflower planted in wide rows can be mechanically cultivated to control weeds. There are no registered herbicides for safflowers in Alaska. Safflower is relatively free of disease in the dry climates of interior Alaska. In areas of high fall moisture it suffers attack from Botrytis head rot *(Botrytis cinerea)*, which is found mostly on late and very late maturing varieties that are still high in moisture after the first killing frost. If harvested with uninfected seed, the mold can spread during storage. The only control is planting early maturing varieties. Aphids (family Aphididae) are the most serious insect pests for safflowers, but rarely become serious enough to warrant treatment.

Safflower is ready to harvest when the bracts on the seed heads are brown and the leaves have lost most of their green color. When mature, the seeds thresh freely from the heads. This usually is 35 to 40 days after flowering. Safflower is resistant to lodging and shatter loss and can be direct combined when the stalks are dry and brittle. For best combing results, moisture content of the seed should be around 12–13% at this stage. Combine settings are similar to those used for sunflowers. Reduce cylinder speed to as slow as possible to reduce the amount of cracked and dehulled seed. Concave adjustments depends on the moisture content of the seed. If it is less than 12%, open the front 1 inch and set the back at ¾ inch. At moisture levels higher than 12%, slightly reduce concave settings to increase threshing success. Remember that closer concave settings results in more cracked and dehulled seed. Reduce air speed over the sieves to avoid blowing the light-weight seed out with the tailings. The allowable percentage of cracked and dehulled seed is 2–5%.

Safflower seed is dry and safe for long-term storage at 8–10% moisture. In Alaska, the late maturity of most varieties requires harvest before this, so supplemental drying is required. Cleaning the seed lot to remove all green foreign material and cracked and dehulled seeds facilitates drying and produce a more acceptable seed lot after drying. Clean-outs can be used on-farm or sold for animal feed. Supplemental heat in driers should not be above 120° F as higher temperatures can damage seed.

Safflowers are a marginal crop for Alaska. Even in the best years there are not enough GDD to mature seed before a killing frost. Also, seed grown for the industrial oil markets should be grown on contract with a processing facility because a high-quality seed lot is required. Currently, there is no facility in Alaska to process oil from safflower seed and no elevators are set up to accept safflower seed. No varieties that have been tested in Alaska consistently produce a viable crop. Due to the cultural problems, there are no safflower varieties recommended.

Yields and Test Weights by Location for Safflower

Safflower seed is bought and sold by weight. Similar to small grains, there is a standard test weight for safflower that is used as the legal unit for purchase or sale of the crop. This standard test weight for clean, dry, and undamaged safflower is 45 pounds per bushel. Other than test weights, additional samples should be taken on-farm to determine quality. Any seed lots not meeting high oilseed quality standards should be used as lower grade seed. It is important then for the producer to clean and size all seed lots before delivery to a niche market. Test weights are used here as a measure of seed quality to determine maturity. Yields are expressed here in pounds per acre. Bushels per acre can be determined by dividing the yield of any specific cultivar by the standard test weight.

Tables 55–56 list yields and quality measurements for safflower varieties for two test locations: Fairbanks and Delta Junction. All sites in the Delta Junction area have been combined into the Delta dryland site (Table 56). No irrigation trials were done for safflower. Each table also contains information on the source or the location of where it was bred and the years it was tested at each location. Maturity in this study was considered to be when 50% of the flower bracts for each plot were brown. Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued growth of the crop. The low temperature point for safflowers in this report is the freezing point of water, 32° F. The GDD calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. The many varieties that did not reach maturity due to seasonal frosts are represented by N/D (No Data) in each of the tables. There are no standard varieties of safflowers for Alaska, so there were no comparisons except among varieties.

Table 55. Average yields and quality measurements from safflower test plots in the Fairbanks area, 1978 – 2002.

Safflower Variety Name	Source	Years Tested	Yield (lbs/acre)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*
oilseed							
Oker	(Montana)	1	0	N/D	0	N/D	N/D
Saffire	(Alberta)	1	132	12	0	25-Sep	3308
Sidwell	(Canada)	1	0	N/D	0	N/D	N/D
S-208	(Montana)	1	0	N/D	0	N/D	N/D

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
N/D = No Data.

Table 56. Average yields and quality measurements from safflower test plots in the Delta Junction area, 1978 – 2002, dryland site.

Safflower Variety Name	Source	Years Tested	Yield (lbs/acre)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*
oilseed							
Sidwell	(Canada)	1	0	N/D	0	N/D	N/D
S-208	(Montana)	1	0	N/D	0	N/D	N/D

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
N/D = No Data.

Meadowfoam Performance Trials

Meadowfoam (*Limnanthes alba* Hartw.) is a small broad-leaved annual that grows only 4 to 12 inches tall. The leaves grow in a rosette form and are long and segmented into pairs of leaflets along the midrib. Leaflets are light green and covered with a shiny wax layer. The flowers are borne on separate stems that grow up through the middle of the rosette. They are numerous, small, white. The back of the buds are covered with many fine hairs. Meadowfoam is open pollinated and requires insects for successful pollination and seed formation. At maturity, there are three seeds or nutlets per flower bud. Seeds are small (⅛ inch diameter), round, elongated, and mottled brown. They can be smooth to wrinkled and rough with broad ridges. The seed contains 25–30% oil and about 20% protein. The unique oil is 90–95% long-chain unsaturated fatty acids, so it can be used on metal surfaces that are exposed to high variations in pressure and temperature without breaking down. The liquid wax esters are used in plastics production and as base oils in cosmetics and pharmaceuticals. The remaining meal from the extraction process contains high levels of glucosinolates and phytoecdysteroids. Like canola residues, the glucosinolates in meadowfoam have an allelochemical effect, inhibiting growth of some species of subsequent crops, weeds, nematodes, insects, and soil-borne plant diseases. Research is ongoing in the Pacific Northwest to determine the effectiveness of meadowfoam meal residues as an organic pest control for the horticultural industry.

As a winter annual, meadowfoam grows naturally along gravelly stream banks in the Sierra Nevada foothills of California. It requires well-drained soils with available soil moisture levels similar to small grains and a pH of 5.6 to 6.0. Meadowfoam germinates well at 40° F and requires cool growing season temperatures of between 50° and 65° F. High growing season temperatures and drought conditions severely reduce yields.

Fertilization and tillage practices are similar to those for other small-seeded crops. Meadowfoam is lower yielding than other oilseed crops like canola, but grows better under dryer soil conditions. It requires lower levels of available nitrogen to produce an acceptable crop, but competes better against weeds if sufficient nutrients are present. Soils with low to moderate levels of available nutrients should receive a complete fertilizer blend of nitrogen, phosphorus, potassium, sulfur, and boron. Actual percentages of each nutrient and the application rate varies according to specific soil test results. The fertilizer can be broadcast before spring tillage. Meadowfoam does not usually respond to high levels of available nutrients, especially under dryland conditions. Following summer fallow, fertilization may not be required. Avoid excess nitrogen fertilizer, greater than 45 pounds of available N per acre, because it can delay maturity.

To conserve soil moisture, minimum tillage is recommended for incorporating fertilizer material and plant residue preparing the seedbed. Seedbed preparation is extremely important as a firm seedbed is needed to ensure seed contact with moist soil. Pulling a packer behind the tillage implement and using a seed drill equipped with press wheels ensures that the seed is in contact with moist soil during the time needed for germination. Regular grain drills must have the drill speed reduced with a reducer sprocket due to the small seed size. Other options would be to use a grass seed attachment or horticultural vegetable seeder. Because of the small seed size, seeding depth is only ¼ to ½ inch. The seeding rate for meadowfoam is 25 to 30 pounds of pure live seed per acre. Higher seeding rates helps to reduce competition from weeds. Meadowfoam requires a long growing season in Alaska. An early planting date is therefore recommended to utilize as much of the growing season as possible. Certified seed is strongly recommended.

Weed control in meadowfoam is extremely important. Even though it germinates well in cool soil temperatures, when young it does not compete well with weeds. Best weed control is a combination of mechanical and chemical summer fallow to reduce the number and weed species for the following season and using proper fertilization and seeding rates. To eliminate all weeds with chemical fallow, a broad spectrum post-emergence herbicide such as glyphosphate (Roundup) was used. There are no herbicides registered for use on meadowfoam in Alaska. There are no diseases or insect pests reported for meadowfoam in Alaska.

Meadowfoam is ripe and ready to harvest when the flower buds are completely brown and the seed has turned a mottled brown. At this stage the seedheads shatter easily. Direct combining or swathing into windrows can cause 16 to 54% seed loss due to shattering. Combine ground speed should be slower than that for other oilseed crops. The leaves do not dry quickly even at maturity and can wrap around the cylinder inside combines, impeding the combining process by causing delays to clean out the plant residues. Concave clearances must be opened to accommodate the thicker plant residues. Therefore, using grass seed stripper headers is recommended. Cylinder speeds and air flow should be reduced to avoid seed loss. Canola screens should be used for maximum seed separation from dirt and chaff. Even so, combined seed contains excess chaff and other plant residues. This material attracts moisture, molds, and insects and should be removed before grain drying. On-farm seed cleaning before shipment results in higher prices paid to the producer. Because of the small seed size, all cracks and holes in the combine, augers, trucks, and bins should be sealed to prevent seed loss during handling. Optimum moisture content for safe long-term storage of meadowfoam is 9%. Typical grain dryers have perforated floor openings that are too large for the small seed size of meadowfoam. A 5-mesh nylon sheet over the floor prevents seed loss.

Meadowfoam is considered a marginal crop for Alaska. Even in the best years there were not enough GDD to produce mature seed at harvest. Seed grown for the industrial oil markets should be grown on contract with a processing facility. Currently, there is no facility in Alaska to process oil from meadowfoam seed and no elevators are set up to accept meadowfoam seed. No varieties that have been tested in Alaska have consistently produced a viable crop. Due to these cultural problems, no meadowfoam varieties are recommended.

*Meadowfoam (*Limnanthes alba *Hartw.) is a small broad-leaved annual native to northern California, southern Oregon, and Vancouver Island. It did not mature in Alaska trials due to weed competition and seasonal frosts. Photo by Brian Prechtel courtesy of the USDA Agricultural Research Service Photo Unit.*

Yields by Location for Meadowfoam

There is no established standard test weight for meadowfoam. Higher prices are paid to the producer for the oilseed grade niche crop but only if they meet the quality criteria established by the industry. Samples should be taken on-farm to determine quality. Any seed lots not meeting high oilseed quality standards should be used as lower grade seed. It is important then for the producer to clean and size all seed lots before delivery to a niche market. Yields are expressed here in pounds per acre. Typical yields for meadowfoam can range from 800 to 1500 pounds per acre.

Tables 57–58 list yields and quality measurements for one meadowfoam variety for two test locations: Fairbanks and Delta Junction. All sites in the Delta Junction area have been combined into the Delta dryland site (Table 58). There were no irrigation trials done for meadowfoam. Each table also contains information on the source or the location of where it was bred and the years it was tested at each location. Maturity in this study was considered to be when 50% of the flower bracts for each plot were brown. Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued growth of the crop. The low temperature point for meadowfoam in this report is the freezing point of water, 32° F. The GDD calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. Maturity was not reached for any variety due to severe weed competition and seasonal frosts and is represented by N/D (No Data) in each of the tables.

Table 57. Average yields and quality measurements from meadowfoam test plots in the Fairbanks area, 1978 – 2002.

Meadowfoam Variety Name	Source	Years Tested	Yield (lbs/acre)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*
oilseed							
Foamore	(Oregon)	1	300	N/D	100	N/D	N/D

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
N/D = No Data.

Table 58. Average yields and quality measurements from meadowfoam test plots in the Delta Junction area, 1978 – 2002, dryland site.

Meadowfoam Variety Name	Source	Years Tested	Yield (lbs/acre)	Test Wt. (lbs/bu)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*
oilseed							
Foamore	(Oregon)	1	1340	N/D	100	N/D	N/D

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
N/D = No Data.

Sunflower Performance Trials

Common and Sunwheat Sunflower

Sunflower (*Helianthus annus* L.) is an annual broadleaved plant that can grow five to twenty feet tall. They have stout, rough, and hairy stems (1–3 inch diameter) topped by a seed head (3–24 inch diameter). The heads have many small, cross-pollinated flowers surrounded by pointed scales and 40–80 yellow rays. Wild sunflowers or horticultural varieties may have multiple branched heads from a single stalk. Two types of sunflowers are grown as an agronomic crop: those that have black or dark brown seed grown for oil content (45–55% oil from hulled seed) and those with white stripes on the seed grown for the confectionery market. Both the heads and the leaves of sunflowers track the sun during the day and tilt upwards at midnight. This phenomenon is called nutation and continues every day until the end of the flowering stage. About half of the dried weight of sunflower heads is seed. The whole seed contains about 24–45% oil. However, only about 20–35% oil can actually be expressed from the whole seed. Sunflower oil is obtained by a combination of expressing and solvent extraction. The remaining oil cake meal, which contains about 35% protein, is used as a livestock feed. Sunflower oil is mostly polyunsaturated and is used in the edible oil market. It also is a semidrying oil used in the manufacture of soaps and paints. Whole oil seed is used as a feed for poultry and caged and wild birds. Confectionery seeds are either eaten raw or roasted. Although sunflowers have been grown as silage for livestock, they are less palatable and nutritious than either grasses or legumes. In Alaska, sunflowers have been grown on limited acreages off and on for many years, primarily as livestock forage and secondarily as oil and confectionery seed for the local birdseed market, but with limited success.

Common sunflowers are either open pollinated or hybrid varieties. They are long-season plants that are both drought and heat resistant. Because of the large amount of biomass they produce before flowering, few ever reach physiologic seed maturity in Alaska before the first killing frosts. Sunwheats, on the other hand, are a dwarf hybrid sunflower similar in head size to the common sunflower but only growing 36–50 inches tall. They are earlier maturing (about the same as for wheat) and the seed often reach physiologic maturity in Alaska. When grown in areas where both reach complete physiologic maturity, sunwheats are slightly lower yielding with lower oil content compared to common sunflowers. However, when both are grown in areas with short growing seasons, sunwheats outperform the common sunflower. Sunola is the term for the open-pollinated dwarf sunflower made from Canadian selections of the common sunflower. Sunola is as short as sunwheat, 24–36 inches high, and has a correspondingly small head size (3–5 inch diameter). It is lower yielding than the common sunflower, but has a higher oil content.

Fertilization, tillage practices, and seeding depths are identical to those for small grains. Sunflowers require a well-drained soil with a near neutral pH (6.5–7.5). Soils with moderate to low levels of available nutrients should receive a complete fertilizer blend of nitrogen, phosphorus, potassium, sulfur, and boron. Actual percentages of each nutrient and the application rate varies according to specific soil test results. The fertilizer can be broadcast before spring tillage, or portions can be banded at planting. Sunflower seed is quite sensitive to soluble salts from fertilizers applied with the seed. No more than 15–20 pounds per acre of phosphorus should be applied with the seed. Broadcast the remaining phosphorus with the other fertilizer materials. Avoid excess nitrogen fertilizer, which can delay maturity.

To conserve soil moisture, minimum tillage is recommended for incorporating fertilizer material and plant residue and preparing the seedbed. Pulling a packer behind the tillage implement and using a seed drill equipped with press wheels ensures that the seed is in contact with moist soil during the time needed for germination. Seeding depth is the same as that for small grains, 1½ to 2 inches, or to moisture. Seeding rate varies depending on seed size. Number two grade size contains 5,000–6,000 seed per pound, number three grade contains 6,000–7,000, number four contains 7,000–8,000, and number five contains 9,000–10,000. Generally, a population density of 30,000 to 40,000 plants per acre is recommended for sunflowers and sunwheat. Sunola should have a population density of about 60,000 plants per acre. Common sunflowers should be seeded about 12–14 inches apart on 36-inch row spacing. Sunwheat should be planted 12–14 inches apart on 12-inch row spacing. Sunola, because of the smaller head size, can be seeded 6 inches apart on 6-inch row spacing. Seeding heavier than recommended rates compensates for some establishment loss due to poor conditions. Grain drills can be used to plant sunflowers by blocking off the appropriate opening in the seed box. The seed box should be kept full to account for the effect of seed weight on the flow through the drill. Early planting dates are recommended to utilize as much of the short growing season as possible. Certified seed is strongly recommended. Hybrid seed must be purchased new every year to maintain variety purity. Seed from open-pollinated varieties can be used the following season, if no other sunflower varieties have been grown within a mile of any other variety. A mile is the distance insect pollinators such as honey bees would travel from their hive to a nectar and pollen source.

Uniform seedling germination requires a soil temperature of at least 50° F and good soil moisture. Cool soil or low soil moisture conditions delay germination and cause nonuniform stands. Young sunflower plants have a strong frost tolerance before the six-leaf stage. Also, the ripening seeds have strong frost tolerance after physiologic maturity has been reached. Light frosts after flowering do not effect seed production. For maximum seed production, sunflowers require about an inch more soil moisture than small grains or canola. Sunflowers can deplete soil moisture for the following year.

Weed control in sunflowers is extremely important. Like canola, sunflowers need warm soil temperatures to germinate and do not compete well with weeds until about four weeks after emergence. Best weed control is a combination of mechanical and chemical summer fallow to reduce the number and species of weeds for the following season. In the spring, wait for weeds to germinate, then perform seedbed tillage and use proper fertilization and seeding rates. To eliminate all weeds with chemical fallow, a broad spectrum post-emergence herbicide such as glyphosphate (Roundup) was used. There are no registered herbicides for sunflowers in Alaska.

There are several fungal diseases that attack sunflowers, but only a few are of economic importance. Sclerotinia or white mold fungus *(Sclerotina sclerotiorum)* can infect any part of the sunflower plant from the base to the head. The most important disease is wilt caused by this white mold infection at the base of the plant. This fast-acting disease often takes only four to seven days from the appearance of the first symptoms to produce complete wilting. Wilted plants are noticeable just after the flowering growth stage. Cool, wet soil conditions in the spring favor development of this fungal disease. It can also be spread from root-to-root contact and heavy planting. Controls are crop rotation and certified seed. Canola is also susceptible to this disease and should not be used in the crop rotation.

Sunflower heads bend down towards the ground and then curl back when mature. This shape acts like a cup, catching any precipitation and holding it there. This extra moisture on the back of the head provides an environment for the development of a Botrytis head rot *(Botrytis cinerea)*. This gray mold works its way through the head, infecting the seed before it is dry enough to harvest. It is found mostly on late and very late maturing varieties that are still high in moisture after the first killing frost. If it is harvested with uninfected seed, the mold can spread during storage. The only control is planting early maturing varieties.

Grasshoppers, including the lesser migratory grasshopper (*Melanoplus sanguinipes* Fabricias), the northern grasshopper (*Melanoplus borealis* Fieber), and the clear-winged grasshopper (*Camnula pellucida* Scudder) attack sunflowers later on in the year. They feed on the leaves but not on the heads and not severely enough to affect crop yields. No control is necessary at this time. The cutworm (*Hylemya brassicae* Bouche) also attacks sunflowers. It is the larval stage of a fly that infests the base and roots of sunflowers in the flowering to mature growth stages. Infestations of only one or more per square foot can cause a 25–30% stand reduction. Also, their feeding creates wounds that can later serve as entry sites for fungal diseases. There is limited chemical control of cutworms; diazinon sprays help control heavy infestations. Another control measure that works well is to increase the number of years between planting sunflowers or canola in the same field. Remember to always read the pesticide label and follow the directions on mixing, application, and disposal.

Many bird species like sunflower seeds and sunflowers are grown specifically for use as feed for both caged and wild birds. Large flocks of both pigeons and migratory waterfowl can cause large yield losses while trying to get at the seed. Using a propane scare cannon is recommended to keep birds away. For more information contact the local office of the Alaska Department of Fish and Game.

Sunflower heads are mature when the backs of the heads have turned from green to yellow and the bracts have turned brown. The seed matures from the outside of the head to the inside, and continues to ripen as the stalks dry. Average seed moisture at this time is around 40%. Sunflowers can be harvested two to three weeks after physiologic maturity when the seed has reached 20–25% moisture levels. As mentioned previously, sunflower heads bend down towards the ground and curl back when mature. This shape acts like a cup catching any precipitation and holding it there, providing an environment for the development of a gray mold. In Alaska, the harvest season is often wet. When moldy heads and wet stalks make direct combining of sunflowers extremely difficult, hand harvesting, drying, and threshing become the only option. If the weather cooperates and stalks are dry and brittle, then direct combining can be successful. Moisture content of the seed should be around 12–15% for best combining results. Conventional combines can be used with a sunflower pan attachment to the header to reduce shatter loss. Heads should be cut just below the attachment to the stalk to reduce the volume running through the combine. Forward speed depends on the moisture content of the seed. To reduce shattering losses, as moisture content decreases, speed should be decreased. Reduce cylinder speed as much as possible to minimize cracked and dehulled seed. Concave adjustments depend on seed moisture content. If less than 12%, open the front to 1 inch and set the back at ¾ inch. At moisture levels higher than 12%, slightly reduce concave settings to increase threshing success. With moisture levels of 20% or greater, reduce the concave setting and increase the cylinder speed. Remember that closer concave settings result in more cracked and dehulled seed. Reduce air speed over the sieves to avoid blowing the lightweight seed out with the tailings. Properly set combines should pass through only slightly broken heads with unfilled seed remaining. The amount of cracked and dehulled seed is limited to 2–5%.

Sunflower seed is dry and safe for long-term storage at 8–10% moisture. It is often harvested before that to prevent losses due to shattering or bird damage. Supplemental drying is then required. Cleaning the seed lot to remove all green foreign material and cracked and dehulled seeds facilitates drying and produces a more acceptable seed lot after drying. Clean-outs can be used on-farm or sold for animal feed. Supplemental heat in driers should not be above 120° F. Higher temperatures can damage seed. Also, the many fine hairs that are rubbed off the seeds during handling can easily ignite at high temperatures.

Recommended Variety Descriptions for Sunwheat Sunflower

Note: See Appendix 1 for the addresses of seed suppliers.

'Sunwheat 103' is an early maturing, dwarf, high-yielding, hybrid sunflower developed by SeedTec International and Agripro Seeds Inc. of Minnesota. It has an oil content of 38–42%, slightly less than conventional sunflowers. Maturity is two weeks earlier than common sunflowers. Direct inquiries about seed sources to Proven Seed – Agricore United of Winnipeg.

Starting in 1993, seeds were collected from the earliest maturing heads of the 'Sunwheat 103' variety in the Fairbanks area. These seeds were hand threshed, cleaned, and planted in test plots the following season. This process has been repeated every year since then. Since 'Sunwheat 103' is a hybrid, there was considerable variation in the following years' sunwheat crop. However, continued selection for early maturity has resulted in an increasingly uniform, open-pollinated sunwheat that closely resembles the Canadian Sunola varieties. To date, the plants are quite dwarf, averaging twenty-four inches tall with head diameters of close to six inches. It matures seven days earlier than 'Sunwheat 103'. Because of its smaller size, planting is similar to Sunola, with plant populations of 60,000 per acre. This results in yields approaching that of 'Sunwheat 103'. There is still considerable variability among plants and continued selection is needed to get a more uniform, early maturing, dwarf sunflower crop for Alaska.

Sunflowers are considered a marginal crop for Alaska. In good years with plenty of soil moisture and GDD, the sunwheat variety listed previously produces acceptable yields. Even in good years, there is uneven ripening that results in immature seed at harvest. Any seed grown for the edible oil markets should be grown on contract with a processing facility because a high-quality seed lot is required. At the present time there is no facility in Alaska to process oil from sunflower seed and no elevator is set up to accept sunflower seed. All common sunflower varieties are later maturing than the sunwheat varieties. As a result, no varieties that have been tested in Alaska have consistently produced a viable crop. Due to these cultural problems, no common sunflower varieties are recommended.

Yields and Test Weights by Location for Common and Sunwheat Sunflower

Both common sunflowers (oil and confectionery) and sunwheats are bought and sold by weight. Similar to small grains, a standard test weight for all sunflower seed is used as the legal unit for purchase or sale of the crop. This standard test weight for clean, dry, and undamaged sunflower seed is 25 pounds per bushel. Other than test weights, additional samples should be taken on-farm to determine quality. Because seed lots not meeting high quality oilseed standards should be used as lower feed grades, it is important for the producer to clean and size all seed lots before delivery to a niche market. Test weights are used here as a measure of seed quality to determine maturity. Yields are expressed here in pounds per acre. Bushels per acre can be determined by dividing the yield of any specific cultivar by the standard test weight.

Tables 59–65 list yields and quality measurements for sunflower varieties grown at three test locations: Fairbanks, Eielson, and Delta Junction. All sites in the Delta Junction area have been combined into either the Delta dryland site (Table 63) or, if grown under irregation, the Delta irrigated site (Table 65). Each table also contains information on seed type (common or dwarf), the source or the location of where it was bred, biomass yield, heights, and the years it was tested at each location. Maturity in this study was considered to be when 50% of the backs of the heads for each plot were a yellow color. Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued growth of the crop. The low temperature point for all sunflowers in this report is the freezing point of water, 32° F. The GDD calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. The many varieties that did not reach maturity due to seasonal frosts are represented by N/D (No Data) in each of the tables. There are no standard varieties of sunflowers for Alaska, so there were no comparisons, except among varieties. Seed and forage quality data (percent oil, percent crude protein and other nutrients, and the nutritive composition from the biomass) for Fairbanks (Table 60), Eielson (Table 62), and Delta dryland (Table 64) is presented without statistical differences and solely for the reader's benefit. In the tables, N/D (No Data) indicates that the variety was grown, but not analyzed. Methods for determing seed and forage quality are standard laboratory methods used for feed and forage by the UAF Soil and Plant Analysis Laboratory in Palmer, Alaska (see Appendix 1 for addresses).

Table 59. Average yields and quality measurements from sunflower test plots in the Fairbanks area, 1978 – 2002.

Sunflower Variety Name	Source	Years Tested	Yield (lbs/acre)	Est. Wt. (lbs/bu)	Biomass lb/acre)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*
common								
891	(US)	2	N/D	N/D	N/D	0	N/D	N/D
Black Russian	(Russia)	1	N/D	N/D	N/D	0	5-Sep	3046
CM 400	(US)	2	N/D	N/D	N/D	0	N/D	N/D
DO 164	(US)	2	N/D	N/D	N/D	0	N/D	N/D
HA 89	(Australia)	2	N/D	N/D	N/D	0	N/D	N/D
HA 124	(Australia)	1	N/D	N/D	N/D	0	N/D	N/D
HA 300	(Australia)	1	N/D	N/D	N/D	0	N/D	N/D
HA 301	(Australia)	1	N/D	N/D	N/D	0	N/D	N/D
HA 303	(Australia)	1	N/D	N/D	N/D	0	N/D	N/D
Hysun - 30	(North Dakota)	2	N/D	N/D	N/D	0	N/D	N/D
IS 241	(North Dakota)	1	2604	N/D	N/D	0	25-Sep	3308
IS 893	(North Dakota)	1	2195	N/D	N/D	0	25-Sep	3308
IS 894	(North Dakota)	2	2961	N/D	N/D	0	25-Sep	3308
IS 897	(North Dakota)	2	2732	N/D	N/D	0	25-Sep	3308
IS 903	(North Dakota)	2	2156	N/D	N/D	0	25-Sep	3308
IS 907	(North Dakota)	2	2556	N/D	N/D	0	25-Sep	3308
IS 1166	(North Dakota)	1	1296	N/D	N/D	0	25-Sep	3308
IS 1210	(North Dakota)	1	1057	N/D	N/D	0	25-Sep	3308
IS 1490	(North Dakota)	1	1199	N/D	N/D	0	25-Sep	3308
IS 1500	(North Dakota)	1	1148	N/D	N/D	0	25-Sep	3308
IS 1500X2100	(North Dakota)	2	3849	N/D	N/D	0	25-Sep	3308
IS 1500X2490	(North Dakota)	1	2704	N/D	N/D	0	25-Sep	3308
IS 3107	(North Dakota)	2	2281	N/D	N/D	0	25-Sep	3308
IS 3500	(North Dakota)	1	827	N/D	N/D	0	25-Sep	3308
IS 3600	(North Dakota)	1	291	N/D	N/D	0	25-Sep	3308
IS 3800	(North Dakota)	1	553	N/D	N/D	0	25-Sep	3308
IS 7775	(North Dakota)	2	3062	N/D	N/D	0	25-Sep	3308
IS 7785	(North Dakota)	1	2137	N/D	N/D	0	25-Sep	3308
IS 8907	(North Dakota)	2	3615	N/D	N/D	0	25-Sep	3308
IS 8943	(North Dakota)	1	2235	N/D	N/D	0	25-Sep	3308
IS 8944	(North Dakota)	2	2802	N/D	N/D	0	25-Sep	3308
Peredovik	(North Dakota)	2	2506	N/D	N/D	0	25-Sep	3308
RHA 271	(North Dakota)	2	N/D	N/D	N/D	0	N/D	N/D

Table 59 continued on next page

Table 59. Average yields and quality measurements from sunflower test plots in the Fairbanks area, 1978 – 2002.

Sunflower Variety Name	Source	Years Tested	Yield (lbs/acre)	Est. Wt. (lbs/bu)	Biomass lb/acre)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*
RHA 274	(North Dakota)	2	N/D	N/D	N/D	0	N/D	N/D
RHA 276	(North Dakota)	2	N/D	N/D	N/D	0	N/D	N/D
RHA 290	(North Dakota)	1	N/D	N/D	N/D	0	N/D	N/D
RHA 299	(North Dakota)	1	N/D	N/D	N/D	0	N/D	N/D
S 894 A	(US)	2	N/D	N/D	N/D	0	N/D	N/D
Sundak^	(North Dakota)	2	2983	N/D	N/D	0	25-Sep	3308
Sunfola 68-2	(US)	2	N/D	N/D	N/D	0	N/D	N/D
dwarf								
Sunwheat 101	(Minnesota)	3	1938	26	26955	0	4-Sep	3029
Sunwheat 103	(Minnesota)	3	2638	26	26955	0	3-Sep	3013

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
^ = confectionery type, N/D = No Data.

Table 60. Average quality measurements for sunflowers from variety test plots in the Fairbanks area, 1978 – 2002.

Sunflower Variety Name	Seed Crude Protein (%)	Seed Total P (%)	Seed Total K (%)	Seed Dry Matter (%)	Seed Oil Content (%)	Biomass Crude Protein (%)	Biomass Total P (%)	Biomass Total K (%)	Biomass Dry Matter (%)	Biomass Oil Content (%)
common										
IS 241	N/D	N/D	N/D	N/D	42.40	N/D	N/D	N/D	N/D	N/D
IS 893	N/D	N/D	N/D	N/D	40.80	N/D	N/D	N/D	N/D	N/D
IS 894	N/D	N/D	N/D	N/D	41.90	N/D	N/D	N/D	N/D	N/D
IS 897	N/D	N/D	N/D	N/D	41.00	N/D	N/D	N/D	N/D	N/D
IS 903	N/D	N/D	N/D	N/D	41.40	N/D	N/D	N/D	N/D	N/D
IS 907	N/D	N/D	N/D	N/D	43.20	N/D	N/D	N/D	N/D	N/D
IS 1166	N/D	N/D	N/D	N/D	42.40	N/D	N/D	N/D	N/D	N/D
IS 1210	N/D	N/D	N/D	N/D	43.10	N/D	N/D	N/D	N/D	N/D
IS 1490	N/D	N/D	N/D	N/D	38.30	N/D	N/D	N/D	N/D	N/D
IS 1500	N/D	N/D	N/D	N/D	41.00	N/D	N/D	N/D	N/D	N/D
IS 1500X2100	N/D	N/D	N/D	N/D	42.40	N/D	N/D	N/D	N/D	N/D
IS 1500X2490	N/D	N/D	N/D	N/D	39.10	N/D	N/D	N/D	N/D	N/D
IS 3107	N/D	N/D	N/D	N/D	39.40	N/D	N/D	N/D	N/D	N/D
IS 3500	N/D	N/D	N/D	N/D	40.30	N/D	N/D	N/D	N/D	N/D
IS 3600	N/D	N/D	N/D	N/D	42.20	N/D	N/D	N/D	N/D	N/D

Table 60 continued on next page

Table 60. Average quality measurements for sunflowers from variety test plots in the Fairbanks area, 1978 – 2002.

Sunflower Variety Name	Seed Crude Protein (%)	Seed Total P (%)	Seed Total K (%)	Seed Dry Matter (%)	Seed Oil Content (%)	Biomass Crude Protein (%)	Biomass Total P (%)	Biomass Total K (%)	Biomass Dry Matter (%)	Biomass Oil Content (%)
IS 3800	N/D	N/D	N/D	N/D	38.80	N/D	N/D	N/D	N/D	N/D
IS 7775	N/D	N/D	N/D	N/D	41.50	N/D	N/D	N/D	N/D	N/D
IS 7785	N/D	N/D	N/D	N/D	40.20	N/D	N/D	N/D	N/D	N/D
IS 8907	N/D	N/D	N/D	N/D	39.60	N/D	N/D	N/D	N/D	N/D
IS 8943	N/D	N/D	N/D	N/D	40.80	N/D	N/D	N/D	N/D	N/D
IS 8944	N/D	N/D	N/D	N/D	41.50	N/D	N/D	N/D	N/D	N/D
Peredovik	N/D	N/D	N/D	N/D	37.30	N/D	N/D	N/D	N/D	N/D
Sundak^	N/D	N/D	N/D	N/D	27.70	N/D	N/D	N/D	N/D	N/D
dwarf										
Sunwheat 101	19.13	0.66	1.08	96.3	43.92	22.57	0.50	1.10	97.63	27.01
Sunwheat 103	18.38	0.62	0.87	98.7	51.60	22.29	0.59	0.99	97.87	39.51

N/D = No Data, ^ = confectionery type.

Table 61. Average yields and quality measurements from sunflower test plots in the Eielson area, 1993 – 2001.

Sunflower Variety Name	Source	Years Tested	Yield (lbs/ acre)	Est Wt. (lbs/bu)	Biomass (lb/acre)	Lodging (%)	Average Maturity (Date)	Average Maturity (GDD)*
common								
Black Russian	(Russia)	1	N/D	N/D	N/D	0	17-Sep	3236
dwarf								
Sunwheat 101	(Minnesota)	3	978	20	23746	0	7-Sep	3092
Sunwheat 103	(Minnesota)	3	1134	23	12091	0	6-Sep	3074

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
N/D = No Data.

Table 62. Average quality measurements for sunflowers from variety test plots in the Eielson area, 1993 – 2001.

Sunflower Variety Name	Seed Crude Protein (%)	Seed Total P (%)	Seed Total K (%)	Seed Dry Matter (%)	Seed Oil Content (%)	Biomass Crude Protein (%)	Biomass Total P (%)	Biomass Total K (%)	Biomass Dry Matter (%)	Biomass Oil Content (%)
dwarf										
Sunwheat 101	16.22	0.51	1.18	98.71	43.48	23.38	0.76	2.27	N/D	N/D
Sunwheat 103	16.22	0.56	1.12	96.49	48.35	18.94	0.69	1.50	N/D	N/D

N/D = No Data.

Table 63. Average yields and quality measurements from sunflower test plots in the Delta Junction area, 1978 – 2002, dryland site.

Sunflower Variety Name	Source	Years Tested	Yield (lbs/acre)	Est. Wt. (lbs/bu)	Biomass (lb/acre)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*
common								
Black Russian	(Russia)	1	N/D	N/D	N/D	0	12-Sep	2903
IS 241	(North Dakota)	1	N/D	N/D	N/D	0	N/D	N/D
IS 893	(North Dakota)	1	N/D	N/D	N/D	0	N/D	N/D
IS 894	(North Dakota)	2	30	N/D	N/D	0	20-Sep	2997
IS 897	(North Dakota)	2	35	N/D	N/D	0	20-Sep	2997
IS 903	(North Dakota)	2	39	N/D	N/D	0	20-Sep	2997
IS 907	(North Dakota)	2	284	N/D	N/D	0	20-Sep	2997
IS 1166	(North Dakota)	1	52	N/D	N/D	0	20-Sep	2997
IS 1210	(North Dakota)	1	120	N/D	N/D	0	20-Sep	2997
IS 1490	(North Dakota)	1	N/D	N/D	N/D	0	N/D	N/D
IS 1500	(North Dakota)	1	N/D	N/D	N/D	0	N/D	N/D
IS 1500X2100	(North Dakota)	2	107	N/D	N/D	0	20-Sep	2997
IS 1500X2490	(North Dakota)	1	34	N/D	N/D	0	20-Sep	2997
IS 3107	(North Dakota)	2	N/D	N/D	N/D	0	N/D	N/D
IS 3500	(North Dakota)	1	N/D	N/D	N/D	0	N/D	N/D
IS 3600	(North Dakota)	1	N/D	N/D	N/D	0	N/D	N/D
IS 3800	(North Dakota)	1	N/D	N/D	N/D	0	N/D	N/D
IS 7775	(North Dakota)	2	48	N/D	N/D	0	20-Sep	2997
IS 7785	(North Dakota)	1	12	N/D	N/D	0	20-Sep	2997
IS 8907	(North Dakota)	2	121	N/D	N/D	0	20-Sep	2997
IS 8943	(North Dakota)	1	45	N/D	N/D	0	20-Sep	2997
IS 8944	(North Dakota)	2	208	N/D	N/D	0	20-Sep	2997
Peredovik	(North Dakota)	2	25	N/D	N/D	0	20-Sep	2997
Sundak^	(North Dakota)	2	37	N/D	N/D	0	20-Sep	2997
dwarf								
Sunwheat 101	(Minnesota)	4	146	N/D	247.3	0	12-Sep	2903
Sunwheat 103	(Minnesota)	5	150	N/D	211.1	0	10-Sep	2878

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
^ = confectionery type, N/D = No Data.

Sunflowers grown commercially in Fargo, North Dakota. Photo by Bruce Fritz courtesy of the USDA Agricultural Research Service Photo Unit.

Table 64. Average quality measurements for sunflowers from variety test plots in the Delta Junction area, 1978 – 2002, dryland site.

Sunflower Variety Name	Seed Crude Protein (%)	Seed Total P (%)	Seed Total K (%)	Seed Dry Matter (%)	Seed Oil Content (%)	Biomass Crude Protein (%)	Biomass Total P (%)	Biomass Total K (%)	Biomass Dry Matter (%)	Biomass Oil Content (%)
common										
IS 907	N/D	N/D	N/D	N/D	22.60	N/D	N/D	N/D	N/D	N/D
IS 1210	N/D	N/D	N/D	N/D	29.00	N/D	N/D	N/D	N/D	N/D
IS 8944	N/D	N/D	N/D	N/D	14.20	N/D	N/D	N/D	N/D	N/D
dwarf										
Sunwheat 101	15.69	0.39	1.20	98.14	33.92	N/D	N/D	N/D	N/D	N/D
Sunwheat 103	15.81	0.42	1.10	96.20	41.48	N/D	N/D	N/D	N/D	N/D

N/D = No Data.

Table 65. Average yields and quality measurements from sunflower test plots in the Delta Junction area, 1998 – 2000, irrigated site.

Sunflower Variety Name	Source	Years Tested	Yield (lbs/ acre)	Est. Wt. (lbs/bu)	Biomass (lb/acre)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*
dwarf								
Sunwheat 103	(Minnesota)	1	N/D	N/D	N/D	0	9-Sep	2865

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.
N/D = No Data.

Tuber and Forage Sunchoke

The Jerusalem artichoke or Sunchoke (*Helianthus tuberosus* L.) is a six-foot-tall, broadleaved plant more closely related to wild sunflowers than to the true artichoke. The artichoke name came from the taste of Sunchoke tubers, which resemble the taste of the edible bracts of the true artichoke. Sunchokes are a long-season and short-day crop. Flowers and tubers do not form until the shorter days of late August. Since the tops are killed by a frost before harvest, this does not leave much time for tuber development. The tubers are small, oval, and irregularly shaped, weighing 1–5 ounces when mature. They can be white, yellow, or red skinned and are thinner skinned than potatoes. In the ground, tubers can survive Alaska winters quite well, and because it is difficult to retrieve all the tubers at harvest, the plant can establish itself as a perennial crop or as a weed.

The primary use of the tubers is human food. They are similar to potatoes in composition, but contain no starch. The carbohydrates in Sunchokes are mostly several polysaccharides that hydrolyze into a sugar called levulose. Levulose is sweeter than cane sugar and is often prescribed for diabetics. The tubers themselves turn watery when cooked and are low in digestibility. The tops, when harvested before flowering and tuber formation, are suitable forage for livestock. After tuber harvest they become woody and unpalatable. The entire plant can also be used in the fermentation and distillation of alcohol for fuel.

Fertilization and tillage practices are similar to those for potato production. Sunchokes require low levels of available nitrogen and high levels of available phosphorus and potassium to produce an acceptable tuber crop. Sufficient soil nutrients result in improved competition against weeds and higher yields. Soils with moderate levels of available nutrients should receive a complete fertilizer blend of nitrogen, phosphorus, potassium, sulfur, and boron. Actual percentage of each nutrient and the application rate vary according to specific soil test results. The fertilizer can be broadcast before spring tillage, or portions can be banded at planting. Liming soil pH to around 6.5 increases tuber sugar content. Because sunchokes do better in areas of high available soil moisture, irrigation is recommended for complete nutrient utilization in both tuber and forage production. Avoid excess nitrogen fertilizer that can delay maturity.

To conserve soil moisture, minimum tillage is recommended for incorporating fertilizer material and plant residue and preparing the seedbed. Pulling a packer behind the tillage implement ensures that the seed tuber is in contact with moist soil during the time needed for sprouting. Seeding depth is 4 inches and the seeding rate for Sunchokes is 300 to 1300 seed tubers per acre in rows 3½ to 5 feet apart. Seed tubers should be two to three ounces, either cut or whole. Large pieces or tubers produce more stems, but not larger tubers. An early planting date is recommended to utilize as much of the growing season as possible. Certified seed tubers are strongly recommended. Unlike potatoes, sunchokes do not need to be hilled during the growing season.

Best weed control is a combination of mechanical and chemical summer fallow to reduce the number and species of weeds for the following season, along with spring through early summer cultivation between rows. To eliminate all weeds with chemical fallow, a broad spectrum postemergence herbicide such as glyphosphate (Roundup) was used. There are no herbicides registered for Sunchokes. By midsummer, the plants are large enough to shade out weeds within the rows. Control of Sunchokes as volunteer weeds involves mechanical summer fallow when the plants are about one foot high. This may take multiple seasons because the tubers can survive in the ground over several winters. Sunchokes suffer from the same diseases that attack sunflowers. The most prevalent is Sclerotinia or white mold fungus *(Sclerotina sclerotiorum)* a fungal stem rot that causes wilting, but it is not serious enough in Alaska to be of economic importance. Grasshoppers, including the lesser migratory grasshopper (*Melanoplus sanguinipes* Fabricias), the northern grasshopper (*Melanoplus borealis* Fieber), and the clear-winged grasshopper (*Camnula pellucida* Scudder), can attack the young vegetative portion of Sunchokes, and voles often eat portions or whole tubers that are close to the soil surface; neither occur severely enough to affect crop yields.

Sunchoke stems and leaves are thick and high in moisture content, even late into the season. As the plant reaches maturity, lower leaves start to turn brown and curl, while the plant's upper portion remains green. It often takes a killing fall frost followed by sufficient good weather to dry. Digging for tubers is done with a potato digger modified to keep from losing the small tubers. Since the skins are thinner than those of potatoes, extra care should be taken in handling tubers. For safe, long-term storage, they are best kept in cold storage at 41–42° F and at 90–95% relative humidity.

Producing Sunchokes for tubers in Alaska is problematic. It is a long-season crop that needs short days with a dark period to set tubers. This often does not occur before the first killing frost. Harvest is difficult due to the thick plant material and small tuber size. Although there is a small health food niche market for Sunchoke tubers that commands a high price paid to producers, no Sunchoke processing facilities presently exist in Alaska. Due to the high cost of production and the unlikelihood of consistently producing a high-quantity, high-value crop, it is not an economically viable crop for Alaska. Due to these cultural problems, no varieties of Sunchokes are recommended.

Yields by Location for Tuber and Forage Sunchoke

Table 66 list yields and quality measurements for a Sunchoke variety for the Fairbanks test location. The table also contains information on the source or the location of where it was bred, biomass yields, and the years it was tested. Maturity in this study was considered to be after the first killing frost. Average maturity GDD were calculated from the average daily temperature minus a standard low temperature at which there can be no continued growth of the crop. The low temperature point for Sunchokes in this report is the freezing point of water, 32° F. The GDD calculations for each day were then added to the preceding GDD value to determine the cumulative value to the date at which the specific variety had reached 50% maturity. True maturity was not reached for this variety due to the long growing season requirement. Tubers, however, are usually harvested after the top growth has been removed or killed by frost. Therefore, the recorded maturity date was the date of the first killing frost after which the tubers were harvested. The test was for two years. However, there were mature tubers produced each year because the plant came up as a volunteer weed for three years after the initial test. There are no standard varieties for Sunchokes in Alaska, so there were no comparisons with other varieties.

Table 66. Average tuber yields and quality measurements from Sunchoke test plots in the Fairbanks area, 1978 – 2002.

Sunchoke Variety Name	Source	Years Tested	Yield (lbs/acre)	Lodging (%)	Average Maturity Date	Average Maturity (GDD)*	Plot Biomass (lbs/acre)
tubers							
Sunchoke	(Illinois)	2	997	0	25-Sep	3308	52005

*GDD, growing degree days, are the cumulative average temperatures above 32° F to reach 50% maturity.

Left: Helianthus tuberosus *Girasole. Photo © 2004 Dr. Nick Kurzenko. This plant, a native of North America, was photographed near Kiparisovo village, Primorsky Territory, Russian Federation.*

Right: Helianthus tuberosus L., Jerusalem artichoke. Image courtesy of the USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. Illustrated flora of the northern states and Canada. *Vol. 3:486..*

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Oats, barley, and some products made from these grains. Photo by Peggy Greb courtesy of the USDA Agricultural Research Service Photo Unit.

Appendix I – Addresses of Seed Suppliers

Agricore United – Calgary
505 Second Street S.W.
Box 2700
Calgary, Alberta T2P 2P5
Canada
phone: (403) 290-4827
fax: (403) 290-4815

Agricore United – Winnipeg
T D Centre
201 Portage Ave.
Winnipeg, Manitoba R3C 3A7
Canada
phone: (204) 435-2063
fax: (204) 435-2369
e-mail: thyra@ugg.com

Alamasu, Inc.
Mile 1403 Alaska Highway
Delta Junction, Alaska 99737
phone: (907) 895-4715

Alaska Farmers Co-Op
Elevator and Fertilizer
P. O. Box 447
Delta Junction, Alaska 99737
phone: (907) 895-4645
fax: (907) 895-4263

Alaska Plant Materials Center
Dept. of Natural Resources
Division of Agriculture
Bodenburg Loop Road
HC 04 Box 7440
Palmer, Alaska 99645
phone: (907) 745-4469
fax: (907) 746-1568

Alaska Seed Growers Association
Box 895
Palmer, Alaska 99645

Bonis and Company, Ltd.
P.O. Box 217
Lindsay, Ontario K9V 5Z4
Canada
phone: (705) 324-0544
fax: (705) 324-2550
e-mail: sloffice@seed-link.ca

Brewers & Malting Barley
Research Institute
303-161 Portage Ave. East
Winnipeg, Manitoba R3B 2L6
Canada
phone: (204) 927-1407
fax: (204) 927-5960

Canadian Seed Growers Association
Stock Seed Distribution Committee
Box 8455
Ottawa, Ontario K16 3T1, Canada
phone: (613) 236-0497
fax: (613) 563-7855

Crop Diversification Centre South
SS 4
Brooks, Alberta T1R 1E6, Canada
phone: (403) 362-3391
fax: (403) 362-2554

Morden Research Centre
Agriculture and Agri-Food Canada
Route 100 @ Steven Street
Morden, Manitoba R6M 1Y5, Canada
phone: (204) 822-4471
fax: (204) 822-6841

Pennsylvania State University
College of Agricultural Sciences
Department of Crops and Soil Sciences
116 ASI building
University Park, Pennsylvania 16802-3504
phone: (814) 865-6541

Progressive Seeds Ltd.
Box 1237
Three Hills, Alberta T0M 2A0, Canada
phone: (403) 443-9661
fax: (403) 443-9664
e-mail: bcuffe@telusplanet.net

Saskatchewan Wheat Pool
2625 Victoria Ave.
Regina, Saskatchewan S4T 7T9, Canada
phone: (306) 569-4448
fax: (306) 569-4897
e-mail: monte.kesslering@swp.com

Saskatoon Research Station
Agriculture and Agri-Food Canada
107 Science Place
Regina, Saskatchewan S7N 0X2, Canada
phone: (306) 956-7200
fax: (306) 956-7247
SeCan Association
201-52 Antares Drive
Ottawa, Ontario K2E 7Z1, Canada
phone: (613) 225-6891
fax: (613) 225-6422
e-mail: seed@secan.com

University of Alaska Fairbanks
AFES Plant, Animal, and
Soil Sciences Dept.
303 O'Neill Resources Building
P.O. Box 757200
Fairbanks, Alaska 99775-7200
phone: (907) 474-7188
fax: (907) 474-6184

University of Alaska Fairbanks
Soil and Plant Anaylsis Laboratory
Palmer Research Center
533 East Fireweed
Palmer, Alaska 99645-6629
phone: (907) 746-9484
fax: (907) 746-2677

University of Alberta
Dept. of Agricultural, Food &
Nutritional Science
410 Agriculture/Forestry Centre
Edmonton, Alberta T6G 2P5,
Canada
phone: (403) 492-3239
fax: (403) 492-4265

University of Manitoba
Department of Plant Science
Winnipeg, Manitoba R3T 2N2,
Canada
phone: (204) 474-8221
fax: (204) 474-7528

University of Saskatchewan
Crop Development Centre
51 Campus Drive
Saskatoon, Saskatchewan S7N 5A8
Canada
phone: (306) 966-8195
fax: (306) 966-5015
e-mail: holm@sask.usask.ca

Appendix II – English and Metric Conversions

In international markets, small grains and oilseed are bought and sold in metric units. In U.S. markets they're bought and sold in English units. The conversion factors below will assist readers in converting from English to metric and metric to English units.

Length

1 mile = 5280 feet = 1760 yards = 1.6 kilometers

1 kilometer = 1000 meters = 0.6 miles

1 yard = 3 feet = 0.9 meters

1 meter = 100 centimeters = 3.3 feet = 1.1 yards

1 inch = 2.54 centimeters

1 centimeter = 0.4 inch

Area

1 acre = 43,560 feet^2 = 0.405 hectares

1 hectare = 10,000 meters^2 = 2.471 acres

1 yard^2 = 9 feet^2 = 0.8 meters^2

1 meter^2 = 10,000 centimeters^2 = 10.76 feet^2 = 1.2 yards^2

1 inch^2 = 6.5 centimeters^2

1 centimeter^2 = 0.16 inch^2

Volume

1 yard^3 = 27 feet3 = 0.76 meters^3

1 meter^3 = 35.5 feet^3

1 bushel = 2150.42 inches^3 = 8 gallons = 30.4 liters = 0.30 hectoliters

1 hectoliter = 100 liters = 0.1 meters^3 = 3.53 feet^3 = 26.4 gallons = 2.84 bushels

1 foot^3 = 1728 inches^3 = 0.03 meters^3

1 gallon = 128 fluid ounces = 16 cups = 8 pints = 4 quarts = 3.8 liters

1 liter = 1000 milliliters = 1000 centimeters^3 = 33.6 fluid ounces = 1.06 quarts = 0.26 gallons = 0.028 bushel

1 fluid ounce = 28.4 milliliters

1 milliliter = 1 centimeter^3 = 0.034 fluid ounces

Weight

1 ton = 2000 pounds = 20 hundred weight = 0.9 metric tons

1 metric ton = 1000 kilograms = 2204 pounds

1 pound = 16 ounces = 454 grams = 0.454 kilograms

1 kilogram = 1000 grams = 2.2 pounds

1 ounce = 28 grams

1 gram = 0.035 ounces

Standard Test Weights

Feed and Malting Barley = 48 pounds/bushel

Hulless Barley = 60 pounds/bushel

Oat = 32 pounds/bushel

Hulless Oat = 44 pounds/bushel

Wheat = 60 pounds/bushel

Rye = 56 pounds/bushel

Triticale = 56 pounds/bushel

Buckwheat = 48 pounds/bushel

Canarygrass = 50 pounds/bushel

Field Pea = 60 pounds/bushel

Canola = 50 pounds/bushel

Sunflower = 25 pounds/bushel

Flax = 56 pounds/bushel

Safflower = 45 pounds/bushel

Rates and Yields

1 pound/acre = 1.12 kilograms/hectare

1 kilogram/hectare = 0.9 pounds/acre

1 pound/bushel = 1.287 kilograms/hectoliter

1 kilogram/hectoliter = 0.8 pounds/bushel

bushels/acre = (pounds/acre) ÷ (standard test weight)

pounds/acre = (bushels/acre) x (standard test weight)

tons/acre = (pounds/acre) ÷ 2000

Appendix III
Agronomic Varieties Tested 1971 – 2002

The following is a complete list of all agronomic varieties tested by the agronomy program at the University of Alaska Fairbanks AFES from 1971 through 2002, (Eielson 1993 – 2001, Palmer 1989 – 2002). It includes varieties that were previously published in the "Performance of Cereal Crops in the Tanana River Valley of Alaska" series, 1978 – 1986, by F.J. Wooding and others, (denoted by an [*] after the name). It does not include any experimental lines that were tested, unless those varieties were eventually released as an officially named cultivar.

BARLEY

Barley Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Aappo	*	1	0	1	0
Abee (2-row)	*	2	0	2	0
Advance	*	1	0	1	0
Agneta		3	0	2	3
Albright		6	0	5	6
Amy	*	1	0	1	0
Andre (2-row)	*	2	0	2	0
Argyle (malting)	*	3	0	1	3
Arra	*	13	1	13	6
Arve		4	0	3	4
Azure		2	0	2	1
B 1215 (2-row) (malting)		2	3	4	1
B 1602 (malting)		1	3	3	0
Balder	*	3	0	2	0
Bamse		3	0	1	3
Beacon	*	1	0	1	0
Bedford	*	1	0	1	0
Belle	*	1	0	1	0
Betzes (2-row)	*	6	0	5	0
Bode	*	4	0	2	3
Bonanza (malting)	*	3	0	3	3
Bonus (2-row)	*	2	0	3	0
Bowman (2-row)	*	1	0	1	0

Barley varieties continued next page

BARLEY					
Barley Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Brier		3	0	1	3
Brock	*	2	0	0	0
Buck (hulless)		3	3	4	0
Carlsberg II	*	1	0	1	0
Cathy	*	1	0	1	0
Centennial (2-row)	*	1	0	2	0
Conquest	*	2	0	0	0
Cougbar		2	0	2	1
Cree	*	1	0	1	0
Crest		0	0	1	0
Datal	*	14	0	13	3
Diamond	*	1	0	1	0
Dickson	*	1	0	0	0
Delores	*	1	0	1	0
Dicktoo (winter)		1	0	0	0
Dolly (2-row)		1	0	1	1
Dual (malting)		1	3	3	0
Duece (2-row)		3	0	3	1
Duke		1	0	1	0
Earl		0	0	1	0
Early Carlsberg II	*	1	0	1	0
Early Freja	*	1	0	1	0
Early Hannchen	*	1	0	1	0
Edda	*	11	0	8	3
Ellice (2-row) (malting)		3	0	3	1
Elrose	*	1	0	1	0
Empress	*	2	0	2	0
Erbet (2-row)	*	1	0	1	0
Eero 80	*	20	4	19	7
Ershabet (2-row)	*	2	0	2	0
Etu	*	1	0	1	0
Falcon (hulless)		3	0	3	1
Fairfield (2-row)	*	3	0	4	0

Barley varieties continued next page

BARLEY					
Barley Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Fergus (2-row)	*	2	0	0	0
Finaska		4	0	4	7
Finnaska	*	6	0	5	0
Firlbecks III	*	2	0	1	0
Freja	*	1	0	1	0
Frontier	*	1	0	0	0
Gallatin (2-row)		2	0	2	1
Galena		0	0	1	0
Galt	*	19	0	18	1
Gateway 63	*	5	0	5	0
Hankkija 72802	*	2	0	2	0
Hankkija 673	*	1	0	2	0
Hannchen	*	1	0	1	0
Harrington (2-row) (malting)	*	7	3	7	7
HB 3443 (hulless)		2	0	2	2
Heartland	*	2	0	2	0
Herta (2-row)	*	1	0	0	0
Hiland	*	1	0	0	0
Hyproly	*	1	0	0	0
Hyproly Normal	*	1	0	0	0
Jackson	*	4	0	4	1
Johnston	*	2	0	2	0
Jokioinen 1103	*	4	0	4	0
Jokioinen 1315	*	4	0	4	0
Jokioinen 1599		4	0	3	4
Jokioinen 1632		5	0	5	5
Jubilee	*	4	0	4	0
Karin		3	0	1	3
Kasota		4	0	3	4
Karl	*	1	0	1	0
Kearney (winter)		1	0	0	0
Klages (2-row) (malting)	*	4	0	4	1
Klondike	*	1	0	2	0

Barley varieties continued next page

BARLEY					
Barley Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Lacombe		3	0	2	3
Larker	*	1	0	1	0
Lidal	*	14	0	11	3
Leduc	*	1	0	1	0
Lewis (2-row)		2	0	2	1
Loviisa		4	0	2	4
Lud (2-row)	*	2	0	2	0
M 14		0	0	1	0
Mari (2-row)	*	2	0	2	0
Massey	*	1	0	1	0
Melvin	*	4	0	5	0
Mingo	*	1	0	1	0
Moravian III	*	1	0	1	0
Morex (malting)		3	0	2	3
Nobel		2	0	2	1
Norbert (2-row)	*	1	0	1	0
Nordlys		3	0	1	3
Nova	*	1	0	1	0
Olli	*	10	0	7	3
Olsok		3	0	1	3
Onda	*	1	0	1	0
Otis	*	2	0	0	0
Otal	*	24	6	24	10
Otra	*	15	0	17	1
Paavo	*	7	0	8	0
Palliser (2-row)	*	4	0	2	0
Paragon	*	2	0	0	0
Parkland	*	2	0	0	0
Pohto		4	0	3	4
Piroline	*	3	0	2	0
Poco	*	1	0	1	0
Pokko	*	11	1	10	4
Polaris	*	4	0	4	0
Prilar	*	1	0	0	0
Primus II	*	2	0	1	0

Barley varieties continued next page

BARLEY					
Barley Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Richard (2-row) (hulless)		4	3	5	1
Ripa		3	0	2	3
Samson	*	3	0	3	0
Scout (2-row) (hulless)	*	2	0	2	0
Shabet (2-row)	*	5	0	6	0
Silky (hulless)		1	0	2	1
Stacey		3	0	1	3
Stander (malting)		1	0	3	0
Stanka	*	3	3	1	0
Steptoe	*	5	0	5	1
Stetson		1	3	3	0
Strom	*	1	0	1	0
Summit (2-row)	*	2	0	3	0
Svendal	*	8	3	8	1
Thual (hulless)	*	14	4	17	4
Thule		3	0	1	3
Tibet (2-row) (hulless)	*	5	0	3	0
Trebi	*	1	0	0	0
Triumph (2-row)	*	3	0	3	0
Trophy	*	1	0	0	0
Tupper (hulless)	*	2	0	2	0
Unitan	*	1	0	0	0
Vale 70	*	1	0	1	0
Valier (2-row)		1	0	1	1
Verner		3	0	2	3
Weal (hooded)	*	21	0	18	1
Weal (2-row) (hooded)	*	1	0	1	0
Windsor	*	2	0	3	0

OAT					
Oat Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Astro	*	1	0	1	0
Athabasca	*	17	4	19	4
Bates 89 (red seeded)		1	0	2	0
Belmont (hulless)		1	0	2	1
Calibre	*	10	4	11	1
Cascade	*	15	4	18	3
Cavell	*	6	0	5	0
Cayuse	*	6	0	5	0
Ceal	*	6	0	6	0
Cherokee	*	1	0	0	0
Chief	*	1	0	1	0
Clark	*	1	0	1	0
Cody II	*	1	0	0	0
Derby		1	0	1	0
Dumont	*	2	0	2	0
Eagle	*	3	0	3	0
Fidler	*	3	0	3	0
Foothill	*	2	0	2	0
Frazer	*	5	0	5	0
Freedom (hulless)		5	4	7	1
Garry	*	2	0	1	0
Gemini	*	0	0	1	0
Glen	*	5	0	4	0
Golden Rain	*	3	0	2	0
Grizzley	*	4	0	4	0
Harmon	*	6	0	5	0
Hinoat	*	0	0	1	0
Hudson	*	4	0	3	0
Jasper	*	4	0	4	1
Kanota (red seeded)		1	0	2	0
Kelsey	*	4	0	3	0

Oat varieties continued on next page

OAT					
Oat Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Larry	*	1	0	1	0
Laurent	*	2	0	2	0
Markton	*	1	0	0	0
Montezuma (red seeded)		1	0	2	0
Nip (black seeded)	*	22	1	24	3
Ogle	*	1	0	1	0
Orbit	*	2	0	2	0
Orion	*	2	0	2	0
OT 238		2	0	2	1
OT 736	*	2	0	2	0
OT 745	*	2	0	2	0
OT 755		2	0	2	1
Pendek	*	12	0	12	0
Pennuda (hulless)		4	3	4	1
Pert (red seeded)		1	0	2	0
Pol	*	8	0	8	1
Ptoat		1	0	1	0
Puhti	*	1	0	1	0
Ramdon	*	6	0	5	0
Rapida	*	1	0	0	0
Riel		3	0	3	1
Rodney	*	13	0	12	0
Russell	*	2	0	1	0
Sierra (red seeded)		1	0	2	0
Sioux	*	4	0	3	0
Spear	*	1	0	1	0
Terra (hulless)	*	1	0	2	0
Tibor (hulless)		2	0	2	1
Toral	*	25	4	23	3
Valko	*	1	0	1	0
Vicland	*	1	0	0	0
Victory	*	5	0	5	0
Vouti	*	1	0	1	0
Woodstock	*	2	0	2	0

WHEAT					
Wheat Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Anza	*	1	0	0	0
Ariabian	*	1	0	1	0
Benito	*	1	0	1	0
Blackhawk (winter)		1	0	0	0
Blue Sky		2	0	2	1
Butte	*	1	0	1	0
Canthatch	*	6	0	4	0
Canuck	*	2	0	2	0
Capa	*	1	0	0	0
Carpo	*	1	0	0	0
Chena (experimental)	*	17	0	17	1
Cheyenne (winter)		2	0	0	0
Colano	*	2	0	1	0
Columbus	*	1	0	1	0
Conway		1	0	1	0
Crim	*	2	0	0	0
Cutler		3	3	3	0
Dundas	*	2	0	2	0
ECM 316	*	1	0	0	0
Fletcher	*	1	0	0	0
Fortuna	*	2	0	1	0
Froid (winter)		7	0	0	0
Garnet	*	1	0	0	0
Gasser	*	19	0	19	1
Glenlea	*	0	0	1	0
HY 320		2	0	2	1
Idaed	*	1	0	0	0
Ingal	*	26	3	20	2
Katepwa	*	2	0	2	0
Kaharkov (winter)		1	0	0	0

Wheat varieties continued on next page

WHEAT					
Wheat Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Kaharkov (spring)	*	2	0	1	0
Kenyon		2	0	2	1
Kitt	*	1	0	0	0
Lancer (winter)		2	0	0	0
Laura		2	0	2	1
Lazer		0	0	1	0
Leader	*	1	0	1	0
Lemhi 66	*	1	0	0	0
Macoun (durum)	*	1	0	1	0
Manitou	*	4	0	2	0
Mexipak	*	2	0	1	0
MN 7083	*	1	0	0	0
MN 70113	*	1	0	0	0
Napayo	*	0	0	1	0
NB 66403 (winter)		2	0	0	0
Neepawa	*	4	0	5	0
Nogal	*	11	1	11	1
Norana	*	1	0	1	0
Norstar (winter)		2	0	0	0
Omaha (winter)		3	0	0	0
Opal	*	1	0	0	0
Oslo		2	0	2	1
Pac. Triple Dwarf	*	1	0	0	0
Park	*	19	0	19	1
Peak 72	*	0	0	1	0
Pitic 62	*	7	0	5	0
Polk	*	1	0	1	0
Roblin		4	2	5	1
Roughrider (winter)		2	0	0	0

Wheat varieties continued on next page

WHEAT					
Wheat Variety	**Trial prior to this study period**	**Number of Years Tested**			
		Fairbanks	**Eielson**	**Delta Junction**	**Palmer**
Ruso	*	8	0	6	0
Saunders	*	7	0	6	0
Sawmont (winter)		3	0	0	0
Scout 66 (winter)		2	0	0	0
Selkirk	*	2	0	1	0
Sheridan	*	2	0	0	0
Shoshoni (winter)		3	0	0	0
Siberian Bearded	*	3	0	2	0
Siberian Beardless	*	3	0	2	0
Sinton	*	2	0	2	0
Sonora 64	*	1	0	0	0
Speltz (spelt)	*	1	0	2	0
Springfield	*	0	0	1	0
Sundance (winter)		2	0	0	0
Taava	*	5	0	5	0
Tapio	*	8	0	8	1
Thatcher	*	7	0	6	0
Trader (winter)		3	0	0	0
Trapper (winter)		3	0	0	0
Ulla	*	6	0	6	0
Vernon	*	2	0	2	0
Vidal		5	2	6	1
Wakooma (durum)	*	1	0	1	0
Warrior (winter)		2	0	0	0
Wascana (durum)	*	1	0	1	0
Wildcat		2	0	2	1
Winalta (winter)		2	0	0	0

RYE					
Rye Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Gazelle	*	3	0	3	0
Jussi (winter)		1	0	0	0
Karlshulder		1	0	0	0
Norwegian		1	0	1	0
Petkusser		1	0	0	0
Prolific	*	5	0	2	0
Saskatoon (winter)		5	0	0	0

TRITICALE					
Triticale Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Craman		1	0	1	0
HN470		1	0	0	0
Rosner		1	0	0	0
6TA131 (winter)		1	0	0	0
6TA208		1	0	0	0
6TA419		1	0	0	0
6TA518		1	0	0	0
Welsh	•	2	0	2	0

WILD RICE					
Wild Rice Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Canadian K		1	0	1	0
Franklin		2	0	1	0
K2		1	0	1	0
La Ronge		0	1	0	0
M1		1	0	1	0

CANARYGRASS					
Canarygrass Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Elias		3	3	3	0

MILLET					
Millet Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Abarr		1	0	1	0
Big Red		1	0	1	0
Common White		1	0	1	0
Dawn		1	0	1	0
Golden German		1	0	1	0
Japanese		1	0	1	0
Leonard		1	0	1	0
Manta		1	0	1	0
Turhahi		1	0	1	0

BUCKWHEAT					
Buckwheat Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Botan Soba		1	0	1	0
CM – 15 (small-seeded)		4	0	4	0
Common (Minn)		1	0	1	0
Common (NY)		1	0	0	0
Japanese		1	0	1	0
Mancan		2	1	2	0
Manor		1	1	1	0
PA Composite		1	0	1	0
PA - 158		1	0	1	0
Pennquad		4	0	4	0
Tempest		1	0	1	0
Tokyo		1	0	1	0
Winsor Royal		3	3	3	0

AMARANTH					
Amaranth Variety	**Trial prior to this study period**	**Number of Years Tested**			
		Fairbanks	**Eielson**	**Delta Junction**	**Palmer**
1011		2	0	0	0
477914		2	0	0	0
K343		2	0	0	0
R158		2	0	0	0

FIELD PEA					
Field Pea Variety	**Trial prior to this study period**	**Number of Years Tested**			
		Fairbanks	**Eielson**	**Delta Junction**	**Palmer**
Anno		2	2	2	0
Ascona		2	2	3	0
Baroness		2	2	2	0
Carneval		3	3	4	0
Celeste		3	3	2	0
Century		1	1	0	0
Choque		2	2	2	0
Clipper (normal leafed)		1	1	0	0
Concorde (normal leafed)		1	1	0	0
Danto		2	2	1	0
Discovery (normal leafed)		1	1	0	0
Endeavor (normal leafed)		1	1	0	0
Express (normal leafed)		3	3	4	0
Fluo		2	2	2	0
Grande (normal leafed)		2	2	2	0
Highlight		3	3	2	0
Impala		2	2	2	0
Keoma		2	2	2	0
Majoret		3	3	2	0

Field pea varieties contined on next page

FIELD PEA					
Field Pea Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Miranda		1	1	1	0
Montana		2	2	2	0
Mustang		1	1	0	0
Orb		2	2	2	0
Patriot (normal leafed)		2	2	3	0
Phantom		1	1	0	0
Profi		2	2	0	0
Promar		2	2	2	0
Radley		1	1	1	0
Ricardo		1	1	1	0
Scorpio		2	2	2	0
Spitfire		1	1	0	0
Spring		1	1	1	0
Stehgolt		1	1	1	0
Totem		1	1	0	0
Trump		1	1	1	0
Voyageur		1	1	0	0
Yorkton		1	1	0	0

CANOLA					
Canola Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Altex		4	0	4	0
Alto		3	3	3	0
Andor		1	0	1	0
Candle		6	0	6	0
Colt		3	4	7	0
Delta		3	3	3	0
Echo		1	0	1	0
Eldorado		4	4	5	0
Excel		0	0	1	0
44A89		0	0	1	0
Goldrush		1	1	2	0
Horizon		3	4	7	0
Legend		3	3	3	0
Maverick		1	2	4	0
Midas		1	0	1	0
Oro		1	0	1	0
R - 500		2	0	2	0
Regent		1	0	4	0
Reston		1	0	1	0
Reward		4	6	8	0
Span		1	0	1	0
Sprite		1	1	0	0
Sunshine		3	4	7	0
Target		1	0	1	0
Tobin		5	4	6	0
Torch		3	0	3	0
Tower		4	0	4	0
Trident		1	1	1	0
Triton		1	0	1	0
Turret		1	0	1	0
Westar		3	3	3	0
Zephyr		1	0	1	0

FLAX					
Flax Variety	**Trial prior to this study period**	**Number of Years Tested**			
		Fairbanks	**Eielson**	**Delta Junction**	**Palmer**
Arianne (fiber)		2	2	2	0
Cascade (fiber)		1	1	1	0
Dufferin		1	0	0	0
Linott		1	0	1	0
McGregor		1	0	0	0
Noralta		2	0	1	0
Norlin		3	2	2	0
Raja		1	0	1	0
Viking (fiber)		2	2	2	0

SAFFLOWER					
Safflower Variety	**Trial prior to this study period**	**Number of Years Tested**			
		Fairbanks	**Eielson**	**Delta Junction**	**Palmer**
Oker		1	0	0	0
Saffire		1	0	0	0
Sidwell		1	0	1	0
S-208		1	0	1	0

MEADOWFOAM					
Meadowfoam Variety	**Trial prior to this study period**	**No. of Years Tested**			
		Fairbanks	**Eielson**	**Delta Junction**	**Palmer**
Foamore		1	0	1	0

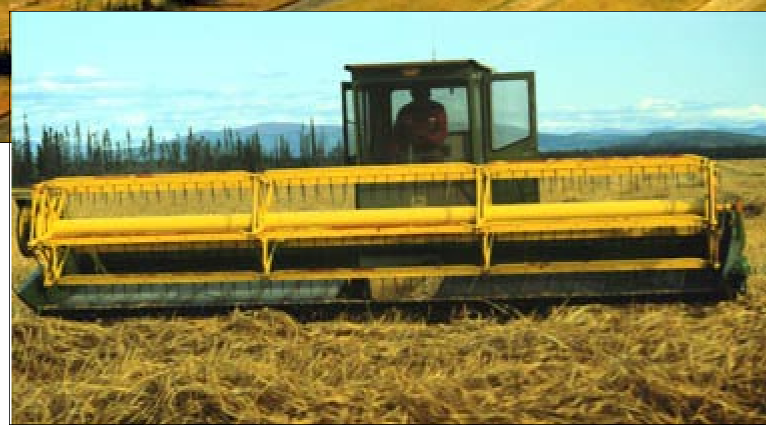
SUNFLOWER					
Sunflower Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Black Russian		1	1	1	0
CM 400		2	0	0	0
DO 164		2	0	0	0
891		2	0	0	0
HA 89		2	0	0	0
HA 124		1	0	0	0
HA 300		1	0	0	0
HA 301		1	0	0	0
HA 303		1	0	0	0
Hysun - 30		2	0	0	0
IS 241		1	0	1	0
IS 893		1	0	1	0
IS 894		2	0	2	0
IS 897		2	0	2	0
IS 903		2	0	2	0
IS 907		2	0	2	0
IS 1166		1	0	1	0
IS 1210		1	0	1	0
IS 1490		1	0	1	0
IS 1500		1	0	1	0
IS 1500X2100		2	0	2	0
IS 1500X2490		1	0	1	0
IS 3107		2	0	2	0
IS 3500		1	0	1	0
IS 3600		1	0	1	0
IS 3800		1	0	1	0
IS 7775		2	0	2	0
IS 7785		1	0	1	0
IS 8907		2	0	2	0
IS 8943		1	0	1	0
IS 8944		2	0	2	0

Sunflower varieties continued on next page

SUNFLOWER					
Sunflower Variety	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Peredovik		2	0	2	0
RHA 271		2	0	0	0
RHA 274		2	0	0	0
RHA 276		2	0	0	0
RHA 290		1	0	0	0
RHA 299		1	0	0	0
S 894 A		2	0	0	0
Sundak (confectionery)		2	0	2	0
Sunfola 68-2		2	0	0	0
Sunwheat 101		3	3	0	0
Sunwheat 103		3	3	0	0

JERUSALEM ARTICHOKE					
Jerusalem Artichoke	Trial prior to this study period	Number of Years Tested			
		Fairbanks	Eielson	Delta Junction	Palmer
Sunchoke (tuber)		2	0	0	0

A grain drying facility at a Delta Junction area farm. AFES file photo.



These AFES file photos show, from the top, Delta Junction area grain fields, swathing, and harvesting grain.