hour, and they properly prune 50 trees per hour, he will break even if he only needs to prune once per season.

However, if a grower's employees work slowly or if his stock needs to be pruned more than once during growing season, or if he could use his workers more profitably elsewhere in the nursery, the numbers change dramatically in favor of the NAA spray. We estimate that nurserymen in Zone 8 spend 25¢ or more to prune a 2-year-old field-grown river birch, whereas it would only cost them 13¢ to spray one tree with NAA. (And remember, our calculations assumed a 1 percent solution, though we believe a 0.5 percent solution is adequate and would further cut costs.)

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Mulches for Landscape Plantings in Interior Alaska

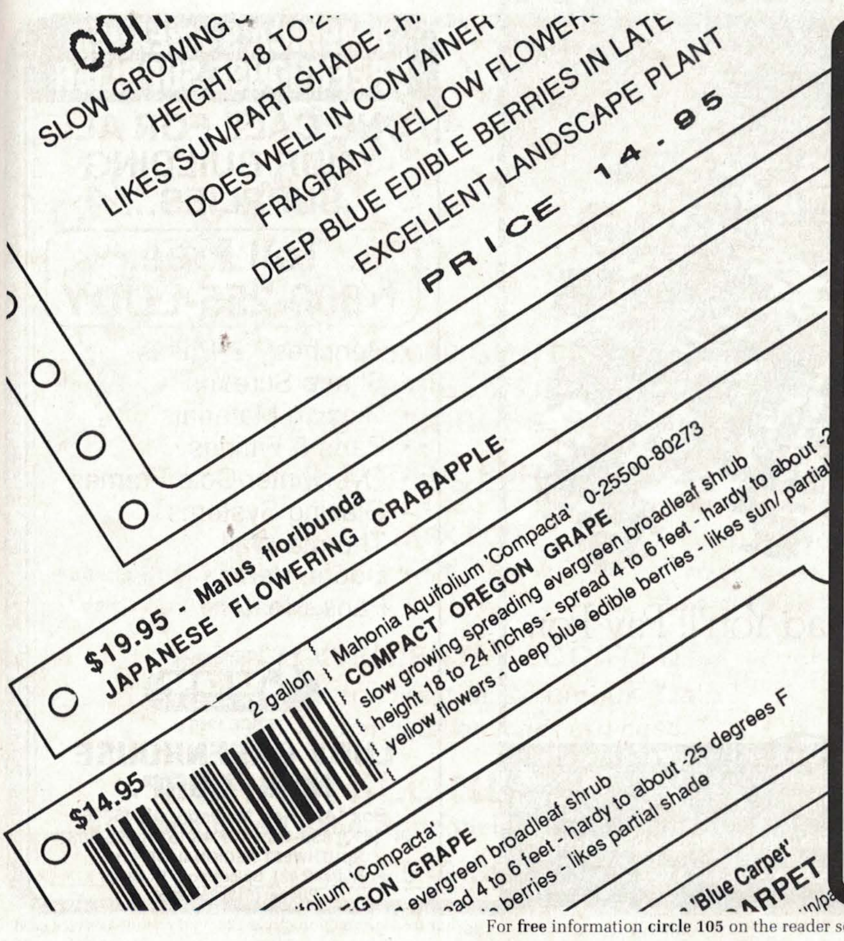
By Dr. Patricia S. Holloway

Nurserymen in subarctic Alaska (Zone 2) must contend with cold soils during the growing season that significantly limit plant growth, delay plant maturity and reduce yields. In fact, many warm-season vegetable crops and strawberry cultivars do not mature without the soil-warming benefits of clear poly mulch.

While many nurserymen in other parts of the country prefer organic mulches to plastic, Alaska growers have found that organic mulches further reduce soil temperatures, making them unsuitable. Similar recommendations have not been made for landscape ornamentals, however. Consequently, landscapers continue to specify bark and wood-chip mulches in subarctic landscape plantings.

In June 1985, I decided to study the effect of mulches on the growth, nutrition and winter survival of native and introduced landscape plants in interior Alaska. The plants I selected were *Cotoneaster acutifolius* (Peking cotoneaster), *Malus baccata* (Siberian crabapple), *Picea glauca* (white spruce), *Pinus contorta* ssp. *latifolia* (lodgepole pine), *Populus tremuloides* (quaking aspen) and *Rosa rugosa* (rugosa rose).

I established five 108-square-foot (10 square meters) field plots on Tanana silt loam soil at the Alaska Agricultural and Forestry Experiment Station in Fair-



banks. I worked 10-20-20 fertilizer into the top 6 inches (15 centimeters) of soil at a rate of 1,000 pounds per acre (1,120 kilograms per hectare).

I then planted one of each of my selections in each plot in random order and hand watered them once.

Next, I applied the following mulch treatments on one of each of four plots:

- A 1-inch (2.5-centimeter) layer of crushed black balsaltic rock.
- A 2-inch (5-centimeter) layer of crushed black balsaltic rock.
- A 2-inch (5-centimeter) layer of *Populus tremuloides* wood chips.
- A 4-inch (10-centimeter) layer of *P. tremuloides* wood chips.

An unmulched plot served as a control.

During the next three growing seasons (1986, '87 and '88), I evaluated plant performance in all plots. (Plants were fertilized via soil injection during this period.) I took soil tests; harvested, identified, dried and weighed weeds; and dried leaves and analyzed them for nutrient content. In August 1988, I measured the plants, harvested them and dried them.

Here's what my study revealed:

Soil temperatures at 4-inch depths (10 centimeters) were consistently lower for the wood-chip treatments than for the stone or control treatments throughout the growing season. I anticipated warmer soil temperatures beneath the black stone mulches, but cumulative thaw degree days were similar to those of the control plots for all three years of the study. Air temperatures 12 inches (30 centimeters) above the soil surface were similar for all mulch treatments during each year.

Spring soil thaw (continuous above-freezing temperatures at 4-inch depths) occurred the last week of April or the first week of May, 36 to 44 days after snowmelt. During all years, spring thaw on the control and stone-mulch plots occurred within one to two days of each other; thaw on the wood-chip treatments occurred five to seven days later.

Despite this delay, both conifers and the Peking cotoneaster had very uniform budbreak across all treatments. The Siberian crabapple and rugosa rose, on the other hand, exhibited at least a four-day delay in budbreak on the wood-chip mulches. This pattern was consistent throughout the study.

Continuous soil-freezing temperatures at 4-inch-deep soil levels began during the first or second week of October for all mulched plots. There was never more than two days of difference between the mulched and control plots.

Soil tests for available nutrients and pH did not differ significantly among mulch treatments. In June and July of 1986, soil moisture was highest on plots mulched with wood chips, followed by stone mulches and the unmulched control. In August, all treatments showed similar moisture levels. Because August is typically cloudy and rainy, moisture differences were negligible late in the season.

Weed growth was curtailed by all mulch treatments but especially by the wood chips. During the first growing season, only one or two hand weedings were needed. Weeds were so prolific on the control plots, though, that continual maintenance would be required to retain an attractive ornamental landscape.

During 1987 and 1988, the control plots continued to produce the most weeds. However, the number of weeds on plots with 1-inch (2.5-centimeter) stone mulch also began to reach unacceptable levels.

Herbaceous perennials dominated the weed populations on the wood-chip and the 2-inch-deep stone mulches. Annuals accounted for the majority of weeds on the unmulched control and 1-

inch-deep (2.5-centimeter) stone plots.

White spruce and lodgepole pine grew best on the stone-mulch treatments and exhibited the greatest root, shoot and leaf dry weights when grown in these environments. I found no difference in total growth between the wood-chip and unmulched control plots.

Lodgepole pine did not show visible signs of nutrient disorders, and needle-nutrient concentration did not differ significantly among treatments. White spruce showed significant needle yellowing and lower needle-nitrogen concentrations on the wood-chip plots when compared with the stone and control plots. Needle phosphorus levels did not differ among treatments. Potassium levels, however, were significantly higher on trees grown on the wood-chip plots than on trees grown on the stone and control plots.

Siberian crabapple grown on the wood-chip mulch plots registered a significantly lower dry weight than plants grown on control and stone mulches, especially in the weight of shoots and leaves. Dry-weight differences between plants grown on stone-mulched and control plots were insignificant.

Of all the plants studied, Siberian crabapple showed the most severe nutrient-deficiency symptoms, including leaf yellowing and early season leaf drop. Leaf-nutrient samples from the wood-chip plots revealed significantly lower levels of nitrogen than samples from the control and stone plots. Conversely, leaf potassium levels were significantly higher on the wood-chip plots.

Peking cotoneaster had the greatest dry weight accumulation on the 2-inch (5-centimeter) stone treatments, especially in shoot and leaf dry weight. In addition, plant height was significantly greater on the stone-mulch treatments than on the wood-chip and control plots.

Although no visible symptoms were evident, leaf nitrogen was significantly lower in Peking cotoneasters grown on wood-chip plots than on other mulch treatments. Leaf phosphorus did not differ among treatments, and leaf potassium was significantly higher on the wood-chip plots than on the stone-mulch and control treatments.

Rugosa roses were the only plants tested that did not show a significantly lower dry weight on the wood-chip plots. These roses grew fairly well on all mulch treatments. Visual observations, however, did not support this data.

The rose seedlings grew very differently on the wood-chip mulches. The initial year's growth was limited to small amounts of shoot growth on existing aboveground stems and no suckering. Overall, the plants were spindly, weak and tiny.

By contrast, the roses grown on the stone mulches and the unmulched plot had strong, robust suckers that quickly dwarfed the original seedling shoot. After the second year, these stiff, upright shoots exhibited significant winter dieback. Only buds located beneath the snow, close to the crown, produced new shoots in subsequent seasons.

On the other hand, plants on the wood-chip mulches did not exhibit dieback and continued to grow annually. The thinner, recumbent shoots were buried each year by snowfall, which protected them from winter injury. While plants growing on the control and stone-mulch plots eventually recovered to their previous year's size, their total growth did not exceed the visibly poorer growth of roses on the wood-chip mulches after three full growing seasons.

The leaves of rugosa roses growing on the wood-chip plots were a uniformly pale yellow-green and had significantly lower leaf-nitrogen levels than those of plants on the stone-mulch and control plots. Leaf phosphorus and potassium did not differ among treatments.

Overall, the five species grew best on the stone-mulch treatments. Considering the effectiveness of weed control, the most acceptable mulch for subarctic landscapes is 2-inch (5-centimeter) crushed black balsaltic rock.

Although plants growing on wood-chip mulches seemed similar in size and shape to those on control plots, they were unsightly because of nitrogen-deficiency symptoms that began to appear at the end of the second growing season. All plots showed similar levels of available soil nutrients.

Cooler soil temperatures could have reduced nitrogen uptake on the wood-chip plots, but the location of plant roots could also have influenced nutrient availability. When the wood-chip mulches were removed just before the plants were excavated, large quantities of roots were visible just below the mulch. A similar mat of roots was not evident beneath the stone mulches.

Researchers have noted a similar root-distribution pattern for maples grown on wood-chip mulched soil where improved water relation and temperature conditions in the upper soil strata resulted in significant root growth at the root-mulch interface. Organic mulches can also tie up nitrogen as they decompose, but the soil tests showed little difference in available nitrogen among treatments.

Some organic mulches leach toxic substances that limit plant growth. Although growth was visibly poorer on the wood-chip plots (except for Siberian crabapple), plant dry-matter accumulation did not differ significantly between wood-chip and unmulched control treatments.

Three of the five species showed higher levels of leaf potassium on the wood-chip plots, which is a common occurrence on organic mulches. This potassium could have leached from the wood chips and remained readily available to the plants because of a better, more consistent moisture regime.

The stone mulches did not increase soil temperature over control plots, but the combination of reduced weed competition and greater moisture availability probably provided a better environment than the unmulched plots.

Organic mulches provide a favorable environment for a variety of plants growing in more southern latitudes. However, in subarctic Alaska, wood-chip mulches are not recommended. Stone mulches, on the other hand, provide an acceptable mulch for perennial landscape plantings in interior Alaska.

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