Alaska Agricultural and Forestry Experiment Station

Number 48 Research Progress Report January 2015

Post-Harvest Handling Methods for Enhanced Competitiveness of Fresh Cut Peonies

Part 1.

AFES Research Progress Report 48: Vase Life Studies

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See also Part 2: AFES Research Progress Report 49: Effect of Boron and Calcium Sprays on Stem Strength of Peonies. Mingchu Zhang, PhD, and Robert Van Veldhuizen, Research Associate. January 2015.

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RESEARCH REPORT
to:
Alaska Department of Natural Resources
Division of Agriculture
Alaska Specialty Crops Research Initiative

Alaskan 'Sarah Bernhardt' peony blooming in 2013.

Post-Harvest Handling Methods for Enhanced Competitiveness of Fresh Cut Peonies

University of Alaska Fairbanks

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Joint Summary. The University of Alaska Fairbanks in cooperation with Alaska peony growers conducted a series of experiments to establish standards for best quality fresh cut flowers to meet or exceed rigorous international industry requirements. Preliminary research at UAF found that chilling at 34°F for 1 week doubled the vase life of peonies and data from 2013 season corroborates those findings.

Ruth Osborne and Makenzie Stamey in the post-harvest lab, 2014.

However, vase life for cut flowers in 2014 decreased significantly and did not improve with chilling. Vase life for 'Sarah Bernhardt' and 'Duchess de Nemours' peonies averaged 6.1 days and 5.9 days, respectively, for the entire treatment period and did not differ from the unchilled control. Because of the unexpected results from 2014, this research did not clearly identify minimum chilling requirements for Alaska peonies. In contrast, cut stems in 2013 showed a linear increase in vase life with chilling (8.2 to 14.2 days for 'Sarah Bernhardt' and 6.9 to 13 days for 'Duchess de Nemours.' Vase life and bud diameter did not differ among early-, mid-, and late-season cutting dates for both cultivars. Cut stems from two commercial farms showed the same short vase life, and there was no statistical difference in vase life among farms. These studies do not corroborate the statement that vase life of Alaska peonies is double the national standard. Environmental factors during spring growth or post-harvest handling differences play a more significant role in defining vase life than simply hours of chilling (deliverables b,c,e).

Vase life for 68 cultivars in 2014 ranged from 4 days to 9 days (mean 6.0 + 1.0 days). In 2013, vase life averaged nearly three days longer, 8.6 + 2.7 days (range 4–14 days). Vase life for 2014 was significantly lower for most cultivars than 2013. In 2013, more than 70 percent of the cultivars showed an average vase life of 7 days or more, while in 2014, only 24 percent reached that standard. The four main classifications of peonies grown at the botanical garden (semi-double, Japanese, bomb and full double) had an average vase life ranging from 5 days to 17 days. One classification had a vase life of less than 7 days for both 2013 and 2014, the Intersectional hybrids (deliverable 1d).

Plants sprayed with Boron (B), calcium (Ca), and potassium (K) showed foliar absorption of B, but not Ca and K. No spray solution improved stem strength or increased stem diameter in 2014. The machine invented to determine bending distance prior to breaking fell short of our goal. Additional work on methods of securing the peony stems in the machine is needed to reduce errors (deliverable 1a)

Part 1. Vase Life Studies

Patricia S. Holloway

2014 Student interns: Ruth Osborne and Makenzie Stamey

2013 Student interns: Melissa Pietila and Kathryn Mihalczo

Introduction

World cut flower sales are a highly competitive, volatile and multi-billion dollar industry (Highbeam Business, 2012; Sarkar, 2012; USDA, 2013). Sales are subject to fashion whims of consumers as well as industry demands for quality blooms that meet bud size standards and ship well; a product that has the requisite stem length/strength; and one with a long vase life. Since the product is a senescing (dying) stem, the industry has the daunting task of delivering a product whose consumer life is as long and colorful as possible (the reported consumer life for peonies is 7 days [Dole and Wilkin 2005]). Cut flowers must meet rigorous standards or they will be replaced by a myriad of other available specialty cuts from around the world (H.R. Kennicott of Kennicott Kutts, Ltd., Chicago, Illinois, pers. comm., 2012). The Alaska peony industry must meet these standards yet fit with the cultural conditions, climate, and distribution system of Alaska. Every stage of plant production, from cultivation, harvest, post-harvest handling, to shipping, affects product quality.

UAF researchers began studying production chain management in 2001 (Auer, 2008; Auer and Greenberg 2009; Auer and Holloway, 2008; Holloway and Buchholz, 2013; Holloway and Hanscom, 2007; Holloway et al., 2003, 2004, 2005, 2010; Klingman, 2002).

The Alaska peony industry reached a milestone in 2012. More than 25,000 fresh cut peonies entered domestic and international markets (Holloway and Buchholz, 2013), and production increased to 32,000 stems in 2013 (American Flower Farmer LLC, 2014). Alaska growers must know and understand product quality, and a policy of exporting only top grade peonies must be established. Growers need to define what a quality brand is and work toward world recognition.

Preliminary research at UAF found that chilling at 34°F for 1 week doubled the vase life of peonies, but 12 hours was not sufficient. We want to determine the minimum time necessary for chilling prior to shipping for maximum consumer vase life. Some growers actually ship the day of harvest, which may not lead to the best product. One of our experiments hinted that vase life of Alaska peonies is double that of the Lower 48. We will repeat this experiment to verify those data so growers can demonstrate one more unique feature for marketing Alaska peonies. The Georgeson Botanical Garden at UAF's Fairbanks Experiment Farm has a collection of 110 peony cultivars (Holloway, 2013). We will determine the maximum vase life for all these cultivars so growers can rank them for quality. We will also conduct an experiment to identify differences in vase life with 'Sarah Bernhardt' peonies from Alaska farms to identify quality variations within the industry.

Methods

Experiment 1. Impact of cold storage time on vase life of 'Sarah Bernhardt' and 'Duchess de Nemours' peonies. **Goal:** to establish the minimum time necessary for chilling prior to shipping for maximum consumer vase life of fresh cut peonies. An experiment (4 replicates, 5 stems per rep) was performed that exposed fresh cut stems of two cultivars, 'Sarah Bernhardt' and 'Duchess de Nemours', to a series of cold treatments (24, 48, 72, 96, 120, 144, 168 hours in 2013 and 0, 48, 96, 144, 192, 240, 288 and 336 hours in 2014) at a target 34°F degrees.

All stems were harvested from the peony fields at the UAF Georgeson Botanical Garden, Fairbanks, Alaska. Cut stems were harvested beginning 1 July in both 2013 and 2014, cut to uniform stem length (24 inches), and wrapped in newspaper. In 2013, bundles were moved immediately after processing to a laboratory cooler. In 2014, the refrigeration unit was changed to a Conex cooler with an air conditioner/CoolBot® refrigeration unit/controller. Both environments were equipped with Hobo® data loggers (Onset Computer Corp.) for hourly records of air temperature and relative humidity. In addition, field air and soil temperature and relative humidity were recorded at the Fairbanks Experiment Farm using the same data loggers with sensors at a 30-inch height for air and 6-inch depth for soil.

In 2013, flowers were held in newspaper sleeves, in the dark and unhydrated for 8 chilling treatments that included a control (no chilling) followed by chilling up to 7 days (24, 48, 72, 96, 120, 144, 168 hours). In 2014, the experiment was extended to 14 days at 2-day intervals (0,48, 96, 144, 192, 240, 288, and 336 hours). Following treatment, the chilled stems were removed from refrigeration and placed in jars of tap water in a laboratory with 24-hr fluorescent lights (25 µM.m2.s-1 measured 4 ft beneath the fixtures) supplemented with natural lighting from laboratory windows, and ambient room temperature. Flowers were observed daily and stems were gently tapped to release petals if an abscission layer had formed. The date of petal wilt or petal fall on chilled and unchilled cut stems was recorded. Air temperature and relative humidity were recorded hourly in cold storage and in the laboratory. Data were analyzed using regression analysis for total vase life and hours of chilling during two cutting seasons, 2013 and 2014.

Experiment 2. Vase life of early, mid-, and late-season buds of 'Sarah Bernhardt' and 'Duchess de Nemours' cultivars. **Goal:** to establish that Alaska peonies have a vase life that is equal to or significantly longer than the 7 days reported for peonies in world markets and to determine if there are any differences among cutting dates. Peonies of two cultivars, 'Sarah Bernhardt' and 'Duchess de Nemours,' were harvested on three dates: 1, 10, and 20 July 2014 (6 stems per cultivar, 3 replicates on each date). Half were placed immediately into jars of tap water and the remainder were refrigerated for 7 days in a Conex/CoolBot® cooler. Handling in the cooler and subsequent vase life studies were the same as in Experiment 1. Data were analyzed using analysis of variance for chilled and unchilled flowers for three harvest dates.

Experiment 3. Cultivar vase life at the Georgeson Botanical Garden. Vase studies were conducted in 2013 and 2014 on 110 peony cultivars growing at the UAF Georgeson Botanical Garden. **Goal:** show variability among cultivars, identify cultivars with the longest vase life, and show vase life differences among peony classes (single, double, Japanese, semi-double, bomb, Intersectional) by determining optimum vase life compared to national average (7 days). Six cut stems of each cultivar were harvested as they reached Stage 3 bud maturity index (Holloway and Pietila, 2012). They were chilled for 7 days, then evaluated for vase life as described in Experiment 1. Cultivars were categorized according to flower classification to learn the range, mean, and median vase life for each category. Only cultivars harvested both in 2013 and 2014 were subject to analysis of variance (6 stems per replicate, 3 replicates) for differences among cultivars and years.

Experiment 4. Vase life trials among commercial Alaska growers. **Goal:** to identify possible variations in product vase life due to diverse growing, handling, and shipping conditions of individual growers. Ten growers in Alaska's Interior were asked to submit 12 randomly cut stems of 'Sarah Bernhardt' peonies to a local pack house. These pack houses recorded methods of handling (cooler temperatures, relative humidity) for 7 days after which they were transferred to UAF, placed in jars of tap water, and evaluated for vase life.

Results and Discussion

After the 2014 season, growers were convinced that the 2013 and 2014 seasons were complete opposites in relation to temperatures and rainfall, but seasonal average air temperatures were very similar (Table 1). The 2013 season was warmer in June and July than 2014, and thaw degree-days differed by only 138 units. The most significant difference was rainfall, which was 8.61 inches greater in 2014 than 2013. In 2013, Interior residents had few complaints about the weather; it was hot and dry early in the season, then moderated in August and September. All horticultural and agronomic crops that were not irrigated suffered severe losses due to water deficits in 2013. In 2014, temperatures were much cooler during the peak peony harvest season, and beginning about the third week of June, rainfall was nearly constant. Rainfall in 2014 eclipsed the highest seasonal rainfall recorded in the past 25 years by 2.71 inches.

The temperature and relative humidity levels in the laboratory remained fairly constant in 2013 and 2014 (Table 2). Because of lack of space, we changed cold storage

Table 1. Temperature and rainfall records for the UAF Fairbanks Experiment Farm during 2013 and 2014 growing seasons.

Growing season weather statistics*	Year	
	2013	2014
Average seasonal air temp (˚F)*	53.9	55.9
Air temp (˚F) (max – min)	92.0 (27 Jun) – 16.9 (6 May)	84.2 (7 Jul) - 29.3 (30 Aug)
May (mean) (˚F)	42.2	48.9
June	64.5	56.4
July	62.8	58.3
Aug	58.2	57.5
Sept	41.9	42.6
Date of last spring frost	22 May	21 May
Date of first autumn frost	25 Aug	30 Aug
Previous Winter Min (˚F)	-45.3 (27 Jan 2013)	-41.6 (13 Jan 2014)
Rainfall (inches)**	5.42	14.03
Thaw degree-days (base temperature 32˚F	3360	3222

**1 May – 30 Sept, from the Agricultural and Forestry Experiment Station weather station.*

Table 2. Data logger averages for the post-harvest laboratory and two cold storage facilities at UAF.

	Refrigeration (Lab) 2013	Refrigeration Conex 2014	Post harvest lab 2013	Post harvest lab 2014
Air temperature (mean ± SD) (°F)	34.8 ± 2.2	33.8 ± 3.6	69.4 ± 1.6	70.5 ± 1.5
Average relative humidity	84.9 ± 6.0	95.7 ± 2.1	55.4 ± 1.9	56.1 + 1.8
Light (uM·m^2·s^{-1})	None	None	Natural daylight + fluorescent 1.5 m beneath fixtures, 25 µM·m^2·s^{-1}	

** 28 June through 31 July 2014*

facilities between years. Temperatures were similar between refrigeration units, but relative humidity was lower in the laboratory unit.

Experiment 1. In 2013, both 'Sarah Bernhardt' and 'Duchess de Nemours' responded positively to chilling temperatures (Figs 1a, c, next page). 'Sarah Bernhardt's vase life increased linearly from an average of 8.4 days (no chilling) to 14.2 days with one week of chilling. This linear trend did not occur in 2014. In fact, for both cultivars, vase life was the same at all treatments including the control and for up to 14 days of chilling (Fig 1b, d, next page).

The results for 2014 were puzzling because trials in previous years showed a positive effect of chilling on vase life. Additionally, total vase life, especially for 'Sarah Bernhardt,' showed vase life durations up to two times the national minimum of 7 days. (Holloway and Pietila, 2014).

Three factors might explain these results:

- **Environmental differences.** The 2013 season was significantly hotter and drier early in the season during maximum peony growth than 2014 which was cold and wet beginning the third week of June with record rainfall in July (Table 1).
- **Refrigeration**. The refrigeration units where cut stems were held was a large laboratory cooler in 2013, and a cold storage Conex equipped with CoolBot® controls in 2014. (Table 2). Although temperatures were similar, relative humidity levels varied. This factor is unlikely because of results in Experiment 4.
- **Measurement error.** Different student interns were employed during these two years. Despite receiving the same training, post-harvest handling differences might have occurred.

Figs. 1a–d. Vase life of 'Sarah Bernhardt' and 'Duchess de Nemours' peonies in 2013 (a, c) and 2014 (b, d) following different hours of post-harvest chilling.

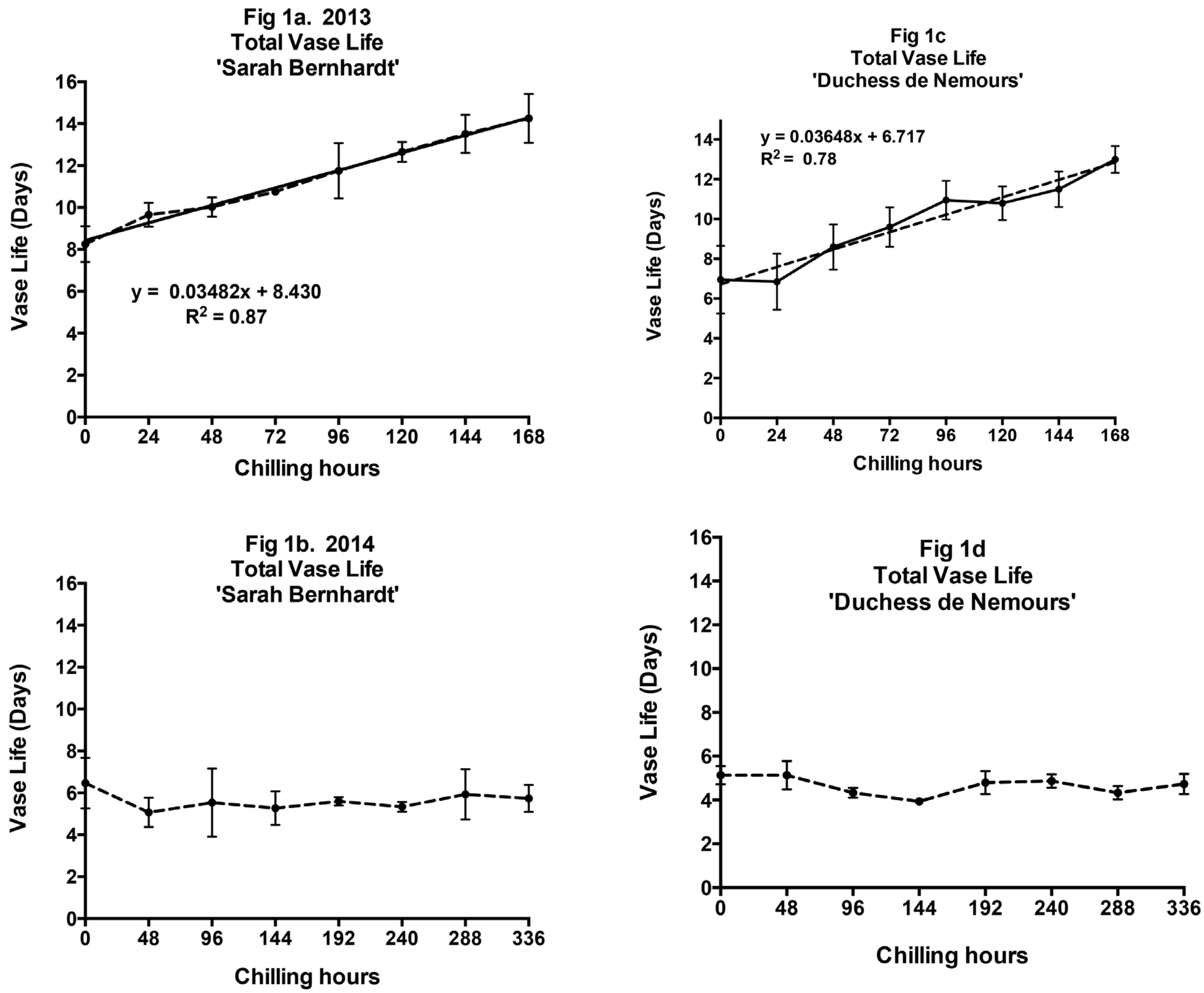
Experiment 2. Vase life and bud diameter did not differ significantly among early-, mid-, and late-season harvests within each cultivar (Table 3). However, cultivars differed in total vase life (P <.05) and bud diameter (P <.001). We expected the bud diameter to decrease over the season, but the selection was not random. We chose the largest buds for harvest on each date, and the size did not differ. The bud diameter was very consistent for each harvest date for 'Sarah Bernhardt' (very narrow standard deviations). Bud

Table 3. Vase life of 'Sarah Bernhardt' and 'Duchess de Nemours' peonies harvest at three different dates during the 2014 growing season.

Vase Life (Days ± SD)*				Bud diameter (mm ± SD)***		
Cultivar	Early (1 July)	Mid (8 July)	Late (15 July)	Early (1 July)	Mid (8 July)	Late (15 July)
Sarah Bernhardt**	6.4 ± 1.2	5.5 ± 1.6	6.1 ± 1.0	44.6 ± 0.5	43.7 ± 1.9	44.3 ± 1.3
Duchess de Nemours	5.1 ± 0.4	5.0 ± 0.4	4.7 ± 0.4	35.0 ± 4.0	37.2 ± 3.0	33.6 ± 3.5

**Followed 7 days of chilling at 34˚F, 3 replicates of 6 peony stems each.*
***Cultivars differed significantly for total vase life (P <.05), no difference in harvest dates.*
****Cultivars were highly significantly different for bud diameter (P<.001) but not for harvest date.*

Figure 1. Chilling hours vs. vase life.



diameter for 'Duchess de Nemours' showed a much wider deviation from the mean indicating that bud size varies widely on all harvest dates even among the largest buds harvested.

Experiment 3. Of the 110 cultivars at the UAF Georgeson Botanical Garden, 68 cultivars produced sufficient flowers for vase life analysis in 2013 and 2014. Vase life for all cultivars in 2014 ranged from 4 days to 9 days (mean 6.0 ± 1.0 days). In 2013, vase life averaged 8.6 ± 2.7 days (range 4–14 days) (Figs. 2a–f). Not only was the average vase life more than 2 days longer for flowers in 2013, the variation among cultivars as reflected in the standard deviation was greater. Both cultivar and year effects were highly significant ($P < .001$), and there was a significant interaction between years and cultivars. These variables are not independent. We expected cultivars to differ significantly in vase life, but the difference between years was unexpected.

Vase life for 2014 was significantly lower for most cultivars than 2013. In 2013, more than 70 percent of the cultivars showed an average vase life of 7 days or more. However, in 2014, only 24 percent of the cultivars had a similar average vase life (Table 4). In 2013, the four main classifications of peonies grown at the botanical garden (semi-double, Japanese, bomb, and full double) showed similar average vase life ranging from 5 days to 17 days. The bomb classification showed a slightly lower vase life, but only three cultivars were tested as compared to 41 cultivars for full doubles. The major classification that showed a vase life consistently less than 7 days was the Intersectional hybrids. Because different cold storage units were used, the methods were not exactly equal for both testing years.

Experiment 4. Vase life trials among commercial Alaska growers. We worked with two pack houses, North Pole Peonies and Polar Peonies to obtain samples of 'Sarah Bernhardt' peonies for the commercial grower trials. North Pole Peonies pack house did not submit any samples from growers because of high levels of bud blast throughout the Interior. Polar peonies submitted samples from three farms: Springerhill Farm, Nenana, Little Plum Farm, Fairbanks, and Georgeson Botanical Garden. The farms did not differ significantly in vase life for the samples submitted. The average vase life for all farms was 4.8 + 1.2 total days. The number of farms completing this project was too small to show regional differences. Many farms had significant issues with bud blast (attributed to winterkill and *Lygus* bugs), and could not submit samples.

One interesting note from this study is that the cold storage of these small samples occurred at the pack house cooler, not the university cooler. The poor vase life seems to be region-wide, in which case the cause for the overwhelmingly poor vase life in 2014 appears to be environmental or post-harvest handling difference and not related to the coolers as speculated in Experiment 1.

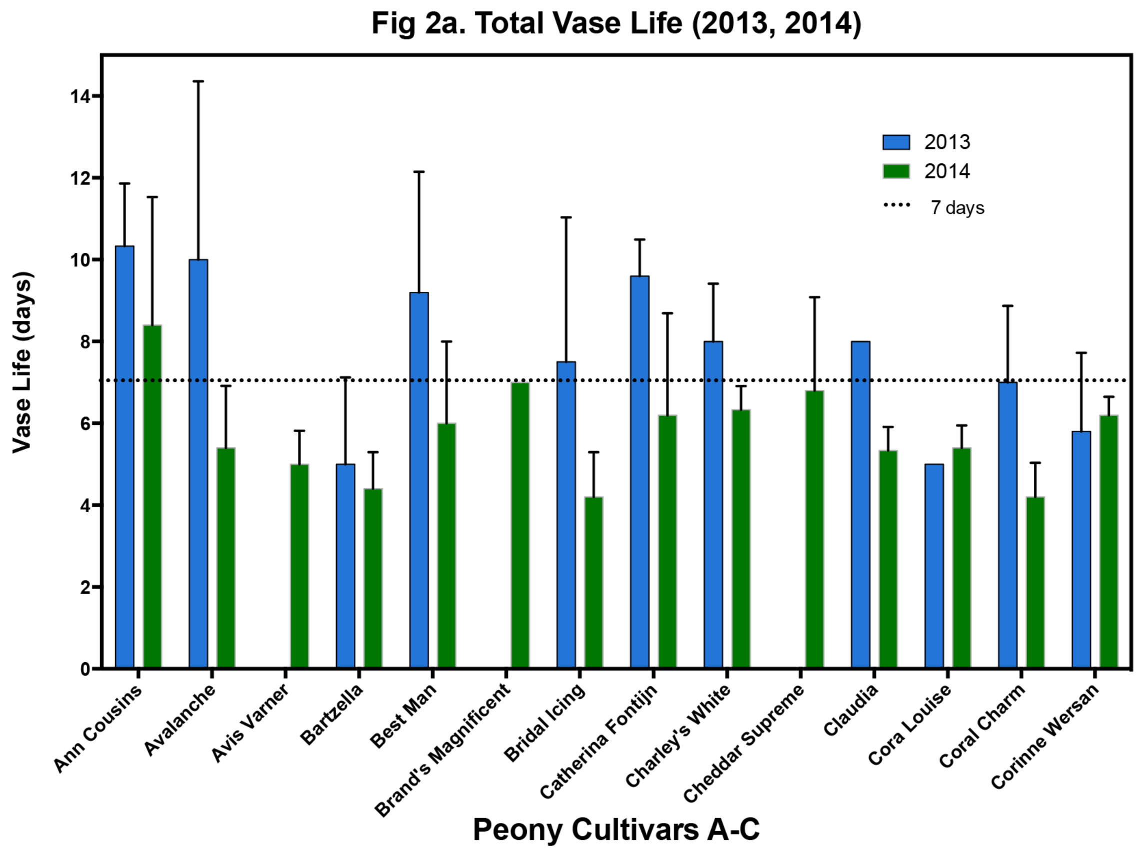
Table 4. Vase life for peony flower classes.

All cultivars	71	26
Japanese n= 10	90	30
Semi Double 6	50	33
Bomb 3	100	33
Full Double 41	90	24
Intersectional (ITOH) single 1	0	0
Intersectional semi-double 5	0	0
Intersectional double 2	0	0
Japanese n= 10	9.8 [6 - 10]	6.7 + 1.2 [5 – 9]
Semi Double 6	8.8 [6 – 15]	6.0 + 1.1 [4 – 7]
Bomb 3	8.0 ± 0.5 [7.5 – 8.5]	7.0
Full Double 41	9.4 ± 2.9 [5 – 17]	6.0 ± 1.0 [4 – 8]
Intersectional (ITOH) single 1	4.0	4.0
Intersectional semi-double 5	5.3 ± 0.2 [5 – 5.6]	4.2 ± 0.4 [4 – 5]
Intersectional double 2	5.0	4.5 ± 0.7 [4 – 5]

**Total n = 68, only included cultivars with harvestable blooms both in 2013 and 2014*

'Sarah Bernhardt' peonies tagged for vase life studies.

Figure 2a–b. Total vase life.



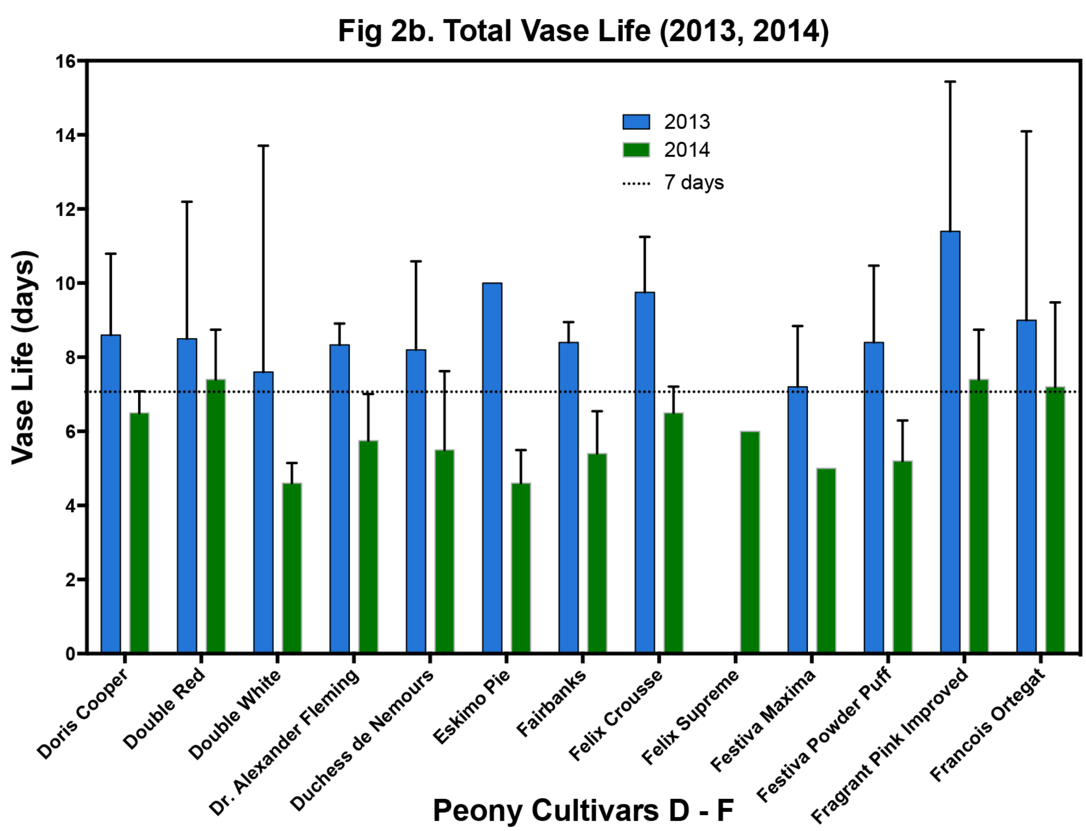
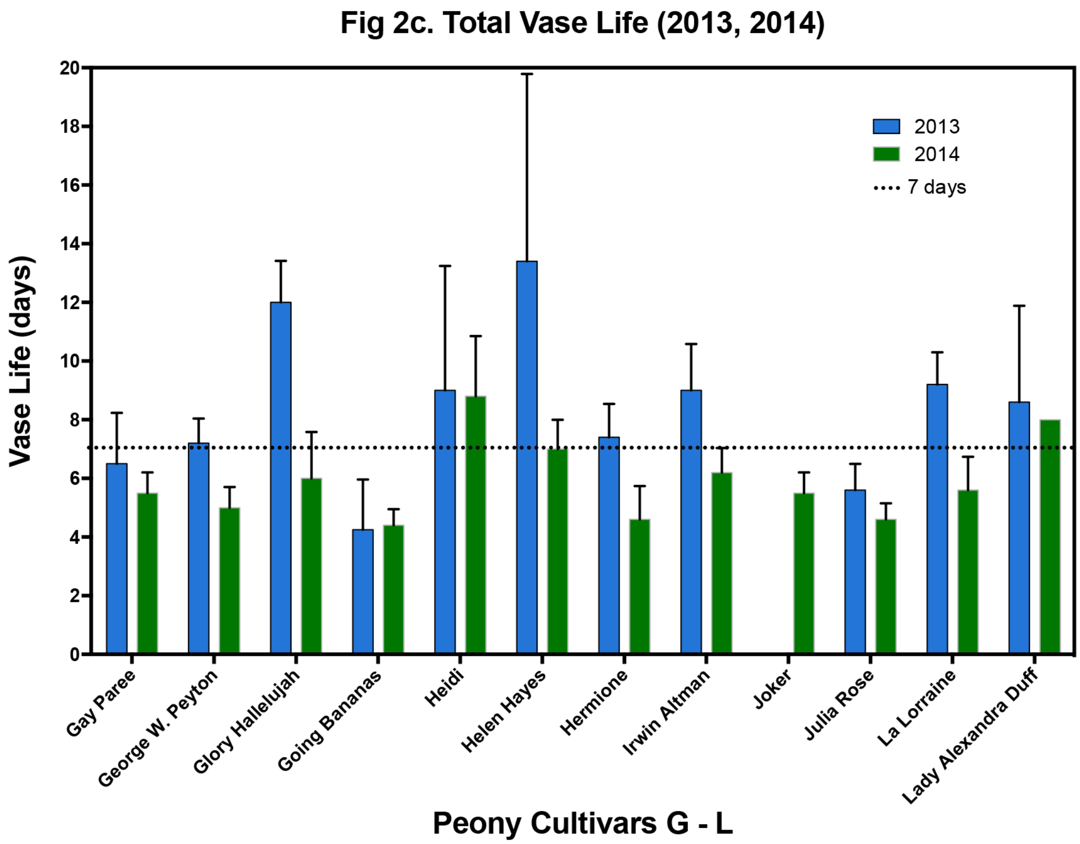


Figure 2c–d. Total vase life.



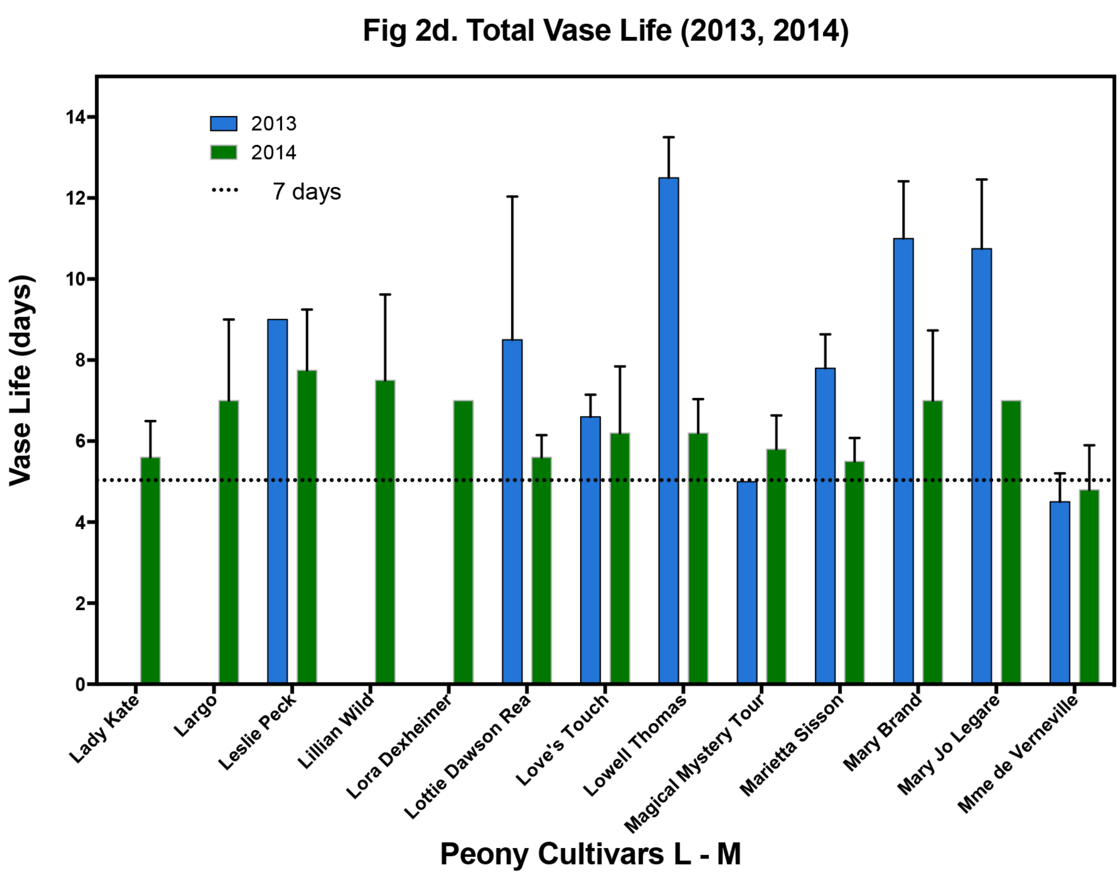
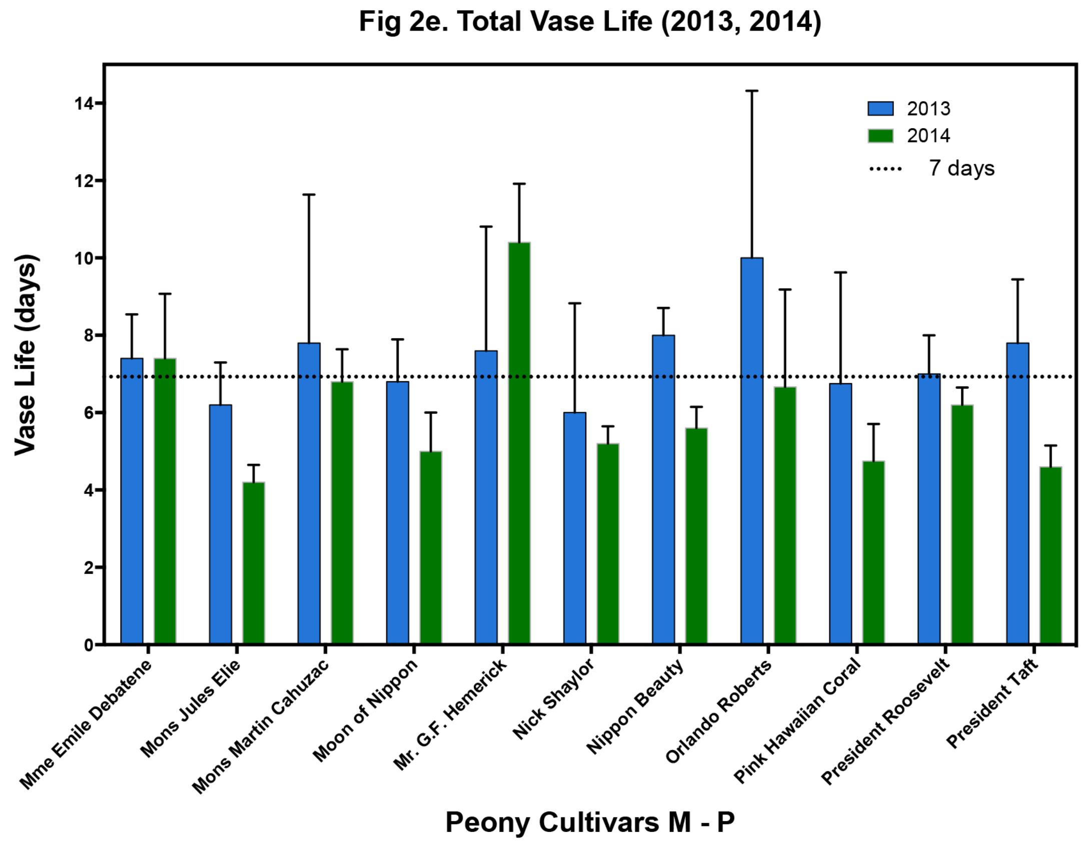
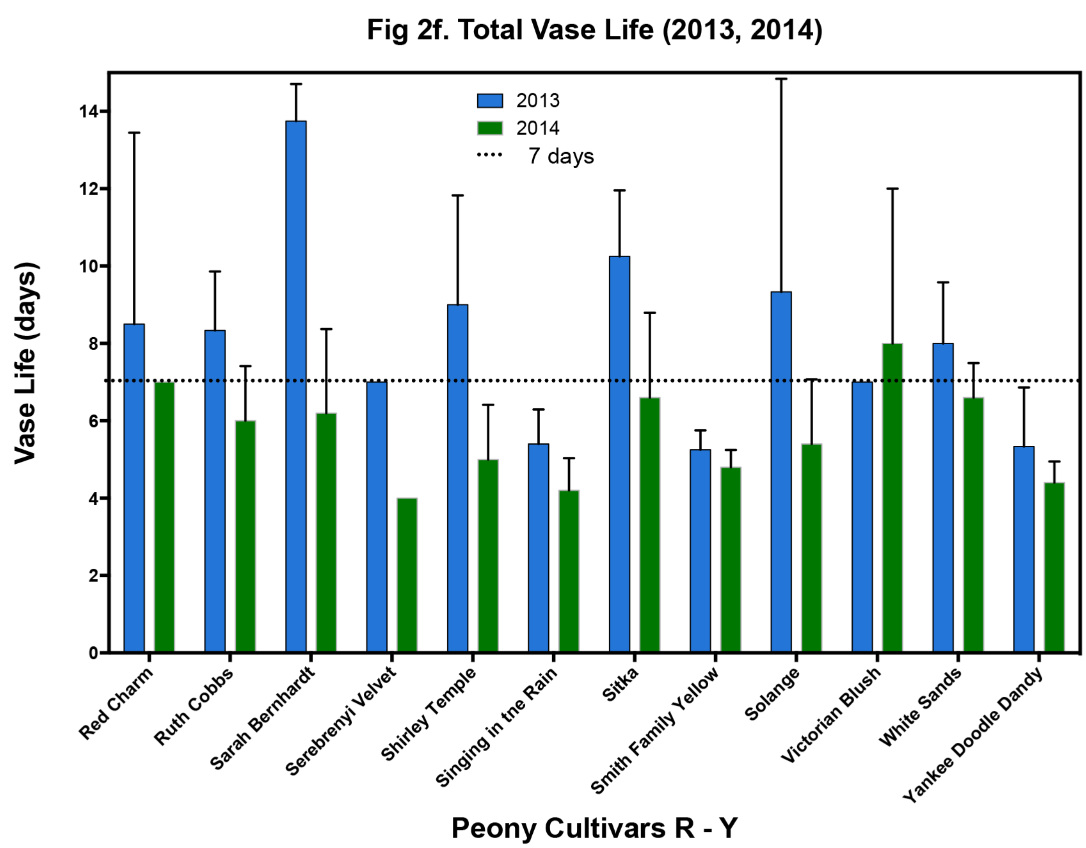


Figure 2e–f. Total vase life.





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About the Agricultural and Forestry Experiment Station

The federal Hatch Act of 1887 authorized establishment of agricultural experiment stations in the U.S. and its territories to provide science-based research information to farmers. There are agricultural experiment stations in each of the 50 states, Puerto Rico, and Guam. All but one are part of the land-grant college system. The Morrill Act established the land-grant colleges in 1862. While the experiment stations perform agricultural research, the land-grant colleges provide education in the science and economics of agriculture.

The Alaska Agricultural Experiment Station was not originally part of the Alaska land-grant college system. In 1898, the station was established in Sitka, also the site of Alaska's first experiment farm. Subsequent branches were opened at Kodiak, Kenai, Rampart, Copper Center, Fairbanks, and Matanuska. The latter two remain as the Fairbanks Experiment Farm and the Matanuska Experiment Farm. The USDA established the Fairbanks experiment station in 1906 on a site that in 1915 provided land for a college. The land transfer and money to establish the Alaska Agricultural College and School of Mines was approved by the U.S. Congress in 1915. Two years later the Alaska Territorial Legislature added funding, and in 1922, when the first building was constructed, the college opened its doors to students. The first student graduated in 1923. In 1931, the experiment station was transferred from federal ownership to the college, and in 1935 the college was renamed the University of Alaska. When campuses were opened at other locations, the Fairbanks campus became the University of Alaska Fairbanks.

Early experiment station researchers developed adapted cultivars of grains, grasses, potatoes, and berries, and introduced many vegetable cultivars appropriate to Alaska. Animal and poultry management was also important. This work continues, as does research in soils and revegetation, forest ecology and management, and rural and economic development. As the state faces new challenges in agriculture and resource management, the Agricultural and Forestry Experiment Station continues to bring state-of-the-art research information to the people of Alaska.

AGRICULTURAL & FORESTRY EXPERIMENT STATION AFES

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