

Field Studies of *Achilles* as a Cut Flower: Longevity, Spacing, and Cultivar Response

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Abstract. Various species and selections of *Achillea* L. were grown for 2 to 5 years, depending on taxon, and evaluated for cut flower yield and quality. 'Coronation Gold' yarrow (*A. x 'Coronation Gold'*) was productive for 5 years. Flower yield, average stem diameter, and stem length were smallest the first year, but no differences occurred between years 2 and 5. The highest percentage of stems > 50 cm long occurred on plants at the densest spacing. Yields were higher and stems longer for *A. millefolium* L. cultivars and *A. ptarmica* L. 'The Pearl' in the second than the first year. *A. millefolium* 'Kelwayi' and 'Lilac Beauty' produced the highest yield while 'Heidi' and 'Sawa Sawa' produced the longest stems. Yields of all cultivars of Galaxy hybrids (*A. taygetea* Boiss. & Heldr. \times *A. millefolium*) increased over 4 years of harvest. Stems were longer and flower diameters were larger after the 2nd year for all cultivars but 'The Beacon'. 'Salmon Beauty' had the highest yield, but yield of 'Appleblossom' did not increase after year 2.

The genus *Achilles* (yarrow) consists of >100 species (Liberty Hyde Bailey Hortorium, 1976) of perennial herbs distributed throughout Europe, North and West Asia, and North America. Only four or five species are commonly produced in the United States, but breeding and selection in American and European nurseries have resulted in numerous cultivars. Some species such as *A. filipendulina* Lam., *A. millefolium* L. and *A. ptarmica* L. are used not only as garden plants but also as cut flowers in world floral markets. Yarrow is one of the many specialty cut flower crops that is undergoing significant production and market growth. Nationally, wholesale value of standard cut flower crops such as roses, carnations, chrysanthemums, and gladioli remained level or declined from 1987 to 1990, other cuts (i.e., specialty cuts) increased 56% during the same time (U.S. Dept. of Agriculture, 1989, 1991). Few studies have reported data on yarrow. Armitage (1987) indicated that *A. x 'Coronation Gold'* produced 150 stems/m² at 90 cm spacing, but as spacing became more dense, fewer flowers per plant but more flowers per square meter were produced. Perry (1989) tested various yarrow species in Vermont and obtained yields of 54 stems per plant and 185 stems/m² for 'Coronation Gold' at similar spacing. He also recorded yields of 450 stems/m² for *A. millefolium* 'Cerise Queen', the highest for any species tested. Although most species are perennial, I found no long-term studies on the effect of plant maturity and spacing on flower yield and stem quality of yarrow species and cultivars. The objective of this research was to determine the effects of plant age (2 to 5 years, depending on taxon) and spacing on flower yield and stem quality of various selections of yarrow. Taxa studied were *A. x 'Coronation Gold'*, ('Coronation Gold' yarrow), cultivars or closely related hybrids of *A. millefolium*, (common yarrow), selections from *A. taygetea* \times *A. millefolium*, known as the Galaxy hybrids and *A. ptarmica*, 'The Pearl' (sneezewort).

Materials and Methods

General. All plants were received as propagules and planted when sufficiently large to handle. They were placed in raised

beds in the outdoor cut flower research facility at the Univ. of Georgia (33° N), located in climate zone 7b (U.S. Dept. of Agriculture, 1990). Composted horse manure was incorporated into the natural cecil clay loam soils and the beds were filled 0.6 to 0.8 m deep with the compost clay mixture. Medium was added to the beds as needed to replace losses to oxidation over time. Water was applied as needed by subirrigation, and plants were side-dressed in the spring and when flower buds were visible with granular 10N-8.6P-6.6K. Plants were set in the early spring or fall, depending on taxon, and spaced appropriately. Three replications of 20 plants each were used for all taxa. Flowers were harvested at the base of the plant when pollen was visible. After flowers were harvested, plants were cut back to remove necrotic foliage and promote new growth as winter approached. The plants were arranged in a completely randomized design with repeated measures over years and were grown under ambient light and temperature. Upon harvest, yield (stems per plant, stems per square meter), stem length (from base of stem to top of flower), stem diameter, and inflorescence diameter were recorded. Stems within cultivars were analyzed

Table 1. Longevity of *Achilles x 'Coronation Gold'* in Athens, Ga. Spacing = 30 cm.

Year	Stems/plant	Stems/m ²	Avg stem length (cm)
1984	7.0 b ^a	75 b	58.7 b
1985	46.5 a	500 a	64.5 a
1986	41.0 a	441 a	70.6 a
1987	44.6 a	480 a	72.4 a
1988	44.9 a	483 a	63.0 b

^aMeans within columns followed by the same letter are not significantly different using Duncan's multiple range test, *P* = 0.05.

Table 2. Stem length distribution of *Achilles x 'Coronation Gold'* over time. Spacing = 30 cm.

Year	Stem length (%)		
	<25 cm	25-50 cm	>50 cm
1984	3 b ^a	96 a	1 d
1985	9 a	53 b	38 c
1986	3 b	36 c	61 b
1987	0 b	13 d	87 a
1988	0 b	15 d	85 a

^aMeans within columns followed by the same letter are not significantly different using Duncan's multiple range test, *P* = 0.05.

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Table 3. The effect of spacing on *Achillea* × 'Coronation Gold'. Data from 1987.

Spacing (cm)	Stems/plant	Stems/m ²	Stems > 50 cm (%)
30	45	500	87
60	79	200	60
90	110	142	46
120	148	106	40
Trend analysis			
L	*	*	*
Q	NS	NS	*

Table 4. Effect of longevity on yield and stem quality of *Achilles millefolium* hybrids. Spacing = 30 cm.

Cultivar	Year	Stems/plant	Stem length (cm)	Stem diam (mm)	Inflorescence diam (cm)
Heidi	1	10	27.8	3.0	5.8
	2	45 b ^y	57.5 a	4.0 ab	7.0 ab
Significance ^z		*	*	*	*
Kelwayi	1	15	29.1	2.7	4.5
	2	56 a	44.3 b	2.7 c	6.6 b
Significance		*	*	NS	*
Lilac Beauty	1	6	36.7	4.4	5.9
	2	51 ab	44.9 b	4.2 a	7.7 a
Significance		*	*	NS	*
Paprika	1	14	36.0	3.8	6.3
	2	46 b	46.8 b	3.7 b	7.5 a
Significance		*	*	NS	*
Sawa Sawa	1	9	29.9	2.7	5.0
	2	34 c	49.6 ab	3.6 b	6.1 b
Significance		*	*	*	*
White Beauty	1	10	35.7	3.1	5.3
	2	28 d	47.1 b	3.8 b	6.5 b
Significance		*	*	*	*

^yMeans within cultivars are significant (*) or nonsignificant (NS) using ANOVA, $P = 0.05$.

^zMeans for year 2 within columns followed by the same letter are not significant using Duncan's multiple range test, $P = 0.05$.

Table 5. Longevity of *Achilles* × Galaxy series. Spacing = 30 cm.

Criterion	Year			
	1987	1988	1989	1990
<i>Appleblossom</i>				
Stems/plant	13 b ^z	53 a	42 ab	54 a
Stem length (cm)	19.6 b	36.1 a	31.8 a	31.0 a
Inflorescence diam (cm)	5.5 c	7.1 b	9.3 a	6.5 bc
<i>The Beacon</i>				
Stems/plant	18 d	49 c	127 b	263 a
Stem length (cm)	30.0 b	44.7 a	52.6 a	50.8 a
Inflorescence diam (cm)	5.7 b	7.3 ab	8.6 b	7.7 ab
<i>Great Expectations</i>				
Stems/plant	25 d	63 c	151 b	203 a
Stem length (cm)	30.2 b	52.3 a	51.6 a	45.2 a
Inflorescence diam (cm)	7.8 b	12.2 a	9.1 ab	8.6 ab
<i>Salmon Beauty</i>				
Stems/plant	10 d	89 c	157 b	171 a
Stem length (cm)	22.6 b	53.8 a	55.6 a	59.7 a
Inflorescence diam (cm)	3.5 c	8.1 a	7.2 b	9.2 a

^zMeans within cultivars and rows with the same letter are not significantly different using Duncan's multiple range test, $P = 0.05$.

Table 6. Two-year cut flower production of *Achillea ptarmica* 'The Pearl'. Spacing = 30 cm.

Year	Stems/plant	Stem length (cm)
1	19	33.5
2	107	41.9
Significance	*	*

*Difference significant at $P = 0.05$.

by analysis of variance (ANOVA) and mean differences were analyzed by Duncan's multiple range test or trend analysis. Differences among cultivars within a species planted at the same time were analyzed, but data among taxa planted at different dates were not.

One-year-old plants of *A.* × 'Coronation Gold' were placed in beds in Spring 1984 at 30, 60, 90, or 120 cm spacing and harvested for 5 years. Root cuttings of *A. millefolium* 'Heidi', 'Kelwayi', 'Lilac Beauty', 'Paprika', 'Sawa Sawa', and 'White Beauty' were planted on 30-cm centers in Spring 1989 and harvested for 2 years. Four cultivars of the Galaxy series (*A. taygetea* × *A. millefolium*), 'Appleblossom', 'The Beacon', 'Great Expectations', and 'Salmon Beauty' were planted in Spring 1987 and harvested for 4 years. Previous work with 'Coronation Gold' and common yarrow (Armitage, 1987) indicated an optimum spacing of 30 cm, and all Galaxy cultivars were spaced accordingly. Plants of *A. ptarmica* were placed 30 cm apart in Spring 1989 and harvested for 2 years.

Results and Discussion

Achilles × 'Coronation Gold'

Effect of plant age. No significant interactions occurred between spacing and plant age for the characteristics measured; therefore, only data from the 30-cm spacing are presented. Yield increased initially, then levelled off after the 2nd year and remained about the same after year 2 (Table 1). Perry (1989) also reported little change in yield over time in Vermont plantings.

Although similar trends with stem length occurred, the average stem length was significantly smaller in 1988 than in previous years, indicating a decline in productivity. Stem diameters were similar in all years (range 4.5–5.4 mm). Stem length distribution, however, changed significantly over time (Table 2). Only 1% of the total harvested stems were longer than 50 cm in 1984, but the same plants in 1987 and 1988 produced > 85% of the stems longer than 50 cm. The data suggest that 'Coronation Gold' yarrow can remain productive for at least 4 years without decline in yield and with concomitant increase in stems longer than 50 cm.

Spacing. All years showed similar trends in yield and stem length due to spacing; therefore, only data for 1987 are presented. The poorest yield per plant but the highest yield per square meter and the greatest number of long stems grew with the 30-cm spacing (Table 3). The long stem length at the 30-cm spacing was likely due to poor branching at this dense spacing. These data suggest optimum yield and stem lengths are obtained for *A.* × 'Coronation Gold', in north Georgia at least, if plants are spaced ≈ 30 cm apart and remain undisturbed for at least 4 years.

Achilles millefolium

Yield, stem length, and inflorescence diameter of all cultivars were higher the 2nd years than the first (Table 4), although stem

diameter was significantly affected for only one-half of the cultivars tested. Increase in yield the 2nd year was attributable to the spreading growth habit of this species. Although 20 plants were planted originally, they formed a continuous mat by the 2nd year. Previous data with *A. millefolium* 'Rose Beauty' (Armitage, 1987) indicated similar increases in yield over time, regardless of spacing. The cultivars tested in this work have *A. millefolium* in their parentage (although absolute parentage is not certain for some of them) and are similar in growth habit to *A. millefolium*; therefore, effects of spacing likely would be similar. Few differences in characteristics measured occurred among cultivars in the first year, but differences were obvious in year 2 (Table 4). Statistics for year 2 data only are shown. Yield (stems per plant) for 'Kelwayi' was significantly higher than for all other cultivars, except 'Lilac Beauty'. Stems were longest for 'Heidi' and 'Sawa Sawa', but were of similar length for the latter and all other cultivars. 'Kelwayi' had the smallest stem diameter, a detriment to cut flower handling. 'Heidi', 'Lilac Beauty', and 'Paprika' produced the largest inflorescences, but the inflorescence diameter for 'Heidi' did not differ from that of the other cultivars.

Galaxy hybrids

All cultivars were productive throughout the experimental period and, except for 'Appleblossom', yields rose significantly each year, particularly after the 2nd year (Table 5). Stem length and flower diameter increased after the first year for all cultivars, likely due to increased root activity and vigor of the plants. No differences in stem length or flower size were apparent after the 2nd year (Table 5). The data suggest that cultivars of the Galaxy series reach their potential stem length and flower size

during the second season of production but yield continues to increase as plants mature. 'Appleblossom' was the poorest yielding cultivar, regardless of year harvested.

Achilles ptarmica

Yield increased significantly from year 1 to year 2 (Table 6). The increase in yield was attributed to increased plant size and a longer harvest period. Harvest was completed by 15 Aug. for first year harvest, but flowers were cut until 15 Nov. during the 2nd year. Increase in yield and stem length likely was due to a more vigorous root system and better growth compared with the first year's growth.

This work has considerable practical implications to specialty cut flower growers. Yield and stem quality are basic components of profitability, and knowledge of longevity and spacing influence those components. The choice of species and cultivars will be determined by marketability, in-ground longevity, and productivity.

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