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Flowering Crab Apples as Potential Pollinizers for Commercial Apple Cultivars¹

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Additional index words. *Malus* sp., pollination, bloom date, flower color

Abstract. Fifty-nine flowering crab apple cultivars (*Malus* spp.) were evaluated in 1977 and 1978 to determine time and pattern of bloom period relative to that of 5 commercial cultivars. The crab apple cultivars 'David', 'Simpson 10-35', and 'Ellen Gerhart' had similar bloom patterns with the commercial cultivars, 'Delicious', 'Jonathan', 'Golden Delicious' and 'Gallia Beauty'. Bloom patterns of 'Donald Wyman' and 'Indian Magic' were similar to the bloom patterns of 'Jonathan', 'Golden Delicious', and 'Delicious'. 'E.H. Wilson', *M. robusta* 'Erecta', 'Ormiston Roy', 'Sentinel', and 'Turesi' had bloom patterns that were similar with 'McIntosh'. Hand pollination with pollen from 10 crab apple cultivars resulted in fruit set on 'Delicious' equal to open pollination or hand pollination with 'Jonathan' pollen.

Recent investigations in England (1, 2) and the United States (8, 10) have shown that flowering crab apples are effective pollinizers for commercial apple cultivars. The use of flowering crab apples would allow growers to plant solid blocks of one commercial cultivar, eliminating less profitable cultivars used solely for pollination purposes. Flowering crabs on dwarfing rootstocks may be interplanted between the trees of the apple cultivars and pruned so that they minimize the use of productive orchard space. Our study was initiated in 1977 to determine which flowering crab apples might be suitable pollinizers for commercial apple cultivars.

Materials and Methods

The study was conducted over a 2-year period using the crab apples available in the Secrest Arboretum at the Ohio Agricultural Research and Development Center. The study was concentrated in 3 phases: (a) evaluation of fruit setting capabilities of crab apple pollen on 'Delicious'; (b) evaluation of flower morphology and disease susceptibility; (c) evaluation of flower bud development and bloom patterns on both crab apples and commercial apple cultivars.

In fruit set studies, limbs bearing about 20 flower clusters on 23-year-old trees of an unknown red strain (Double Red) of 'Delicious' were covered with cheesecloth bags without emasculating prior to anthesis. At full bloom the bags were briefly removed and the flowers thinned to 2 per cluster to

minimize effects of nutritional competition. Pollen from each of 10 flowering crab apples was applied with the tip of the finger to stigmas on 10 replicate limbs. The limbs were recovered until fruit set counts were taken just prior to the "June drop" (June 6, 1978).

Samples of the pollen were tested for their germination on an agar medium enriched with 10% sucrose and 30 ppm boron. Percent germination was determined after 24 hr by microscopic examination.

Evaluation of disease susceptibility was based on data compiled yearly over the past 15 years at various locations throughout the Midwest (7). The trees were evaluated in the field for the presence of apple scab, cedar apple rust, powdery mildew, and fireblight.

Flower bud development and bloom patterns were evaluated daily on all the crab apples and selected apple cultivars. Evaluations began when the earliest crab apple reached full pink and ceased when the last of the 5 commercial cultivars reached full bloom. The ratings were based on the percentage of open flowers in a 5-flower cluster, with counts made on 10-15 clusters selected at random over the entire tree. The average percentage value for each data was rounded to the nearest 10% and then correlated with flowering stage of the apple cultivar over the bloom period (1977, 16 days of evaluation; 1978, 21 days of evaluation). A significant correlation coefficient indicated that the development of crab apple bloom pattern was similar with that of the commercial cultivar. Overlapping bloom periods did not necessarily have significant correlations of bloom patterns. Crab apple flowering may have commenced prior to, or extended beyond flowering of the commercial cultivars; as in the relationship of 'Indian Summer' and 'McIntosh' in 1977. Free (5) has pointed out the necessity of overlapping and coinciding bloom patterns to ensure cross-pollination by bees.

¹Received for publication April 9, 1979. Approved for publication as Journal Article No. 51-79 of the Ohio Agricultural Research and Development Center, Wooster, Ohio 44691.

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Table 1. Bloom periods of selected *Malus* spp. and cultivars in 1977 and 1978 at Wooster, Ohio.

Clone	Open flowers (%)															Open flowers (%)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
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²20% petal fall.Table 2. Correlation coefficients² between dates of bloom in 1977 and 1978 of commercial apple cultivars and those of selected crab apple cultivars at Wooster, Ohio.

Crab apple cultivar	McIntosh		Jonathan		Delicious		G. Delicious		Gallia Beauty	
	1977	1978	1977	1978	1977	1978	1977	1978	1977	1978
Adams	0.46	0.74	0.97	0.72	0.84	0.45	0.90	0.74	0.66	0.72
Arrow	0.81	0.74	0.14	0.72	0.28	0.65	0.02	0.74	0.23	0.72
Centennial	0.83	0.55	0.17	0.19	0.32	0.10	0.02	0.03	0.20	0.04
David	0.27	0.45	0.82	0.75	0.73	0.86	0.82	0.77	0.89	0.76
Donald Wyman	0.48	0.46	0.95	0.83	0.84	0.91	0.89	0.80	0.64	0.80
E.H. Wilson	0.72	0.99	0.53	0.64	0.70	0.37	0.41	0.45	0.15	0.43
Ellen Gerhart	0.29	0.26	0.94	0.73	0.83	0.76	0.97	0.83	0.76	0.83
Geneva	0.97	0.52	0.29	0.16	0.43	0.14	0.15	0.08	0.12	0.09
Hopa Rosea	0.79	0.57	0.12	0.20	0.26	0.07	0.04	0.01	0.25	0.02
Indian Magic	0.59	0.74	0.78	0.87	0.96	0.66	0.71	0.77	0.46	0.76
Indian Summer	0.41	0.75	0.80	0.38	0.71	0.08	0.75	0.16	0.80	0.13
<i>M. brevipes</i>	0.02	0.54	0.51	0.87	0.52	0.64	0.64	0.80	0.09	0.80
<i>M. robusta</i> 'Erecta'	0.83	0.71	0.17	0.72	0.31	0.65	0.01	0.74	0.20	0.73
Minn. 11-AB	0.83	0.72	0.17	0.77	0.33	0.53	0.03	0.66	0.20	0.65
Morden 454	0.62	0.70	0.77	0.73	0.94	0.47	0.68	0.61	0.43	0.60
Ormiston Roy	0.82	0.74	0.51	0.88	0.66	0.67	0.41	0.79	0.15	0.78
Sentinel	0.87	0.90	0.09	0.50	0.23	0.21	0.06	0.30	0.33	0.28
Simpson 10-35	0.27	0.41	0.81	0.80	0.73	0.99	0.83	0.83	0.90	0.88
Snowdrift	0.60	0.70	0.74	0.81	0.92	0.60	0.66	0.73	0.39	0.72
Turesi	0.99	0.74	0.35	0.35	0.50	0.08	0.24	0.16	0.03	0.13

²Values greater than 0.66 in 1977 and values greater than 0.59 in 1978 are significant at 1% level.

Three criteria were used to evaluate the potential of crab apple cultivars as pollinizers for commercial cultivars. These in descending order of importance were coincidence of bloom period, resistance to disease, and similar flower morphology. Flower color was deemed important because studies in England (6) had indicated that bee interchange between the different crab apple cultivars and commercial cultivars was greatest when the flowers were the same color. The incidence of fire-blight was critical because no effective means of control is currently available; spray programs are available to control the other 3 diseases considered. Previous work had eliminated other flower crab apples due to inconsistencies in blooming, disease susceptibility, and flower color and petal number (3).

Results and Discussion

Thirty years of records indicated that the average full bloom date for 'Delicious' at Wooster was May 8 (4). Full bloom occurred on April 24, 1977, 2 weeks earlier than normal and on May 24 in 1978, 2 weeks later than normal. Many of the crab apples did not flower simultaneously or have bloom patterns that correlated with the commercial cultivars in one or both years (Tables 1-3). Flowering crab apples which bloomed simultaneously with 'McIntosh', an early-blooming cultivar, generally had less bloom overlap with the other commercial cultivars.

'Arrow' and 'Hopa Rosea' had similar bloom patterns with 'McIntosh', however, these cultivars have nonwhite flowers

Table 3. Species and cultivars of flowering crab apples whose bloom pattern was not significantly correlated, 1% level, with 'McIntosh', 'Jonathan', 'Delicious', 'Golden Delicious' and 'Gallia Beauty'.

Almey	<i>M. lancifolia</i>	Strathmore
Amisk	<i>M. purpurea</i>	Sundog
Cheal's Chrimson	<i>M. purpurea</i> 'Lemoine'	Tanner
Chesnut	<i>M. prunifolia</i> 'Rinki'	Valley City
Cowichan	<i>M. robusta</i>	Wabiskaw
Dolgo	Morden 52-12	White Angel
Dunbar	Oakes	
Elise Rathke	Prairie Rose	
Jay Darling	Niedzwetzkyana	
Makamik	Red Splendor	
<i>M. adstringens</i>	Selkirk	
<i>M. baccata</i> 'Columnaris'	Silver Moon	
<i>M. coronaria</i>	Simcoe	
<i>M. coronaria</i> 'Charlottae'	Sissipuk	
<i>M. coronaria</i> 'Klehms'	Snowcap	
<i>M. hartwigi</i>	Snowcloud	
	Spring Snow	

and may not be suitable pollinizers. 'Morden 454' has nonwhite flowers and had a tendency to be biennial flowering. 'E.H. Wilson', *M. robusta* 'Erecta', 'Ormiston Roy', 'Sentinel' and 'Turesi' all had similar bloom patterns, a bloom that coincided with 'McIntosh', had white flowers, and were either resistant or moderately resistant to fireblight.

Following 'McIntosh', the normal bloom sequence was 'Jonathan', 'Delicious', 'Golden Delicious', and 'Gallia Beauty'. Bloom periods of these 4 apple cultivars generally overlapped in whole or part. Therefore, these 4 can be considered as one group. However, 'Donald Wyman' and 'Indian Magic' did not always have a highly correlated bloom pattern with 'Gallia Beauty'.

With the exception of 'Snowdrift', the crab apples were all resistant or moderately resistant to fireblight. In areas where apple scab is a particular problem, the grower may not want to use the scab-susceptible cultivars.

A severe frost occurred 3 days after pollination in 1977, preventing evaluation of fruit set. Crab apples that bloomed with the commercial cultivars in 1977 were selected for pollination studies in 1978. However, the bloom pattern of the 'Geneva' and 'Indian Summer' was not significantly correlated with that of the commercial cultivars in 1978. The differences observed in bloom patterns between the 2 years is probably related to the fact that the bloom period in 1978 was much later than normal.

Fruit set of 'Delicious' following hand pollination with pollen of 10 flowering crab apples was not different from that following either open pollination or hand pollination with 'Jonathan' pollen (Table 4), and was sufficient to ensure a commercial crop (9). This suggests that the flowering crab apples used were as effective as the traditional pollen sources. Pollen germination on the agar medium indicated no differences among cultivars.

Before growers are encouraged to use flowering crab apples as pollinizers, their bloom periods and compatibility characteristics must be established. Our results provide a basis for selecting flowering crab apple cultivars which bloom simultaneously with commercial apple cultivars in Ohio and are effective pollinizers. However, studies must be carried out in other climatic areas, particularly further south where the bloom period is much more extended. Information is also needed as to their graft compatibility with various rootstocks.

Table 4. Susceptibility of selected crab apple cultivars to disease, flower color, and pollen germination, and effect on fruit set of 'Delicious' when used as pollinizers.

Cultivar	Susceptibility rating ^z				Pollen germ ^y (%)	Fruit set ^y (%)	Flower color ^x
	Apple scab	Cedar apple rust	Powdery mildew	Fire-blight			
Adams	0	0	0	1	76.6	25.2	L
Arrow	3	0	0	0	---	---	Pu
Centennial	1	0	0	0	---	---	W
David	0	0	0	1	78.8	23.7	W
Donald Wyman	0	0	1	0	76.7	32.0	W
E.H. Wilson	3	1	3	1	---	---	W
Ellen Gerhart	3	0	0	0	---	---	W
Geneva	3	0	1	0	70.8	21.8	Pu
Hopa Rosea	3	0	0	0	---	---	P
Indian Magic	3	0	1	0	82.6	43.6	L
Indian Summer	0	0	0	0	79.5	26.9	P
<i>M. brevipes</i>	3	0	0	1	---	---	W
<i>M. robusta</i> 'Erecta'	3	0	1	0	---	---	W
Minn. 11-AB	3	0	0	0	---	---	P
Morden 454	3	0	0	0	82.6	33.8	L
Ormiston Roy	0	1	0	1	---	---	W
Sentinel	1	0	0	1	---	---	W
Simpson 10-35	0	0	0	1	74.7	41.6	W
Snowdrift	1	0	0	3	85.2	23.5	W
Turesi	3	1	0	0	70.9	33.9	W
Jonathan					83.6	27.1	
Open pollinated						27.7	

^z0 = never observed; 1 = observed 1 year; 2 = observed 2-3 years; 3 = observed 4 or more years.

^yNo differences significant at 5% level.

^xW = white; Pu = purples; L = lavender; P = pink.

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