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Development of a Labor-Efficient Hand Pollination Procedure for Flowering Dogwood[1]

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Abstract

The effect of frequency and timing of hand pollinations on seed set in flowering dogwood (*Cornus florida* L.) was studied. Six hand pollination treatments and an open-pollinated control were included in this study. The hand pollination treatments, which utilized non-emasculated flowers, were performed over a 12-day period beginning with the opening of the first flowers. All open flowers within five inflorescences of an individual plant were pollinated daily, every other day, every third day, every sixth day, on day 6 only, or on day 12 only. The experiment was repeated 10 times. There were significant differences among treatments for both percentage of inflorescences setting seed and mean number of seed produced per inflorescence pollinated. Daily or every other day pollinations produced significantly more seed and had more inflorescences setting seed than did the two treatments that involved a single pollination. Labor efficiency, which was measured as number of seed set divided by number of days on which pollinations were made, was greatest for the treatment that utilized two pollinations over the course of the study. Assuming that flower numbers are not limited, pollinating the same inflorescence twice is recommended for producing the most seed from controlled crosses of flowering dogwood.

Index words: breeding, seed set.

Species used in this study: flowering dogwood (*Cornus florida* L.).

Significance to the Nursery Industry

Development of pest-resistant flowering dogwood cultivars would benefit the nursery industry by reducing the costs associated with pest control. Developing new cultivars through plant breeding requires making controlled pollinations between selected individual plants. Since dogwood inflorescences contain 20–30 flowers that open over a 2- to 3-week period, it is important to determine when to pollinate so as to achieve maximum seed set with minimum labor expenditure. This study investigated the effect of single and multiple hand-pollinations on seed set in flowering dogwood. It was found that daily or every other day pollinations of all open flowers within individual inflorescences produced the greatest number of seeds. Pollinating each inflorescence on the 6th and 12th day of flowering, however, was the most labor-efficient treatment. If the number of inflorescences available for pollination is not a limiting factor, the total number of seeds produced during a breeding season can be increased by applying pollen twice to each inflorescence. Conversely, if inflorescence number is limiting, applying pollen to each inflorescence every other day during the breeding season can increase seed set. Use of the information obtained in this study in dogwood breeding projects will reduce the time needed to develop genetically improved flowering dogwood cultivars.

Introduction

Flowering dogwood (*Cornus florida*) is subject to several disease and insect problems (5) that could best be controlled by the development of pest-resistant cultivars. Development of improved cultivars through breeding requires making controlled pollinations. While bee-mediated controlled pollinations have been reported for flowering dogwood (1), they require special enclosure facilities for each pair of parental cultivars or selections. Hand-pollinations, while labor intensive, require no special enclosures and may be more practical when dealing with large numbers of genotypes.

The evaluation of large numbers of progeny is required if the chances of recovering plants with a desirable combination of characteristics are to be maximized. Since flowering dogwood has a short flowering period, hand-pollination techniques are needed that will generate the greatest number of seeds from the smallest time and labor expenditures. Studies have indicated that *C. florida* is highly self-sterile (4); therefore, emasculation of flowers to prevent self-pollination when conducting hand-pollinations is probably not necessary. It is not known when or how long stigmas are receptive, although it has been reported that each of the 15–35 flowers of a flowering dogwood inflorescence remain open for six to eight days (3). Approximately 40% of the flowers of an inflorescence were observed to open during each of the first two weeks of flowering, but no spatial pattern of flower opening could be discerned (Reed, unpublished data).

The purpose of this study was to develop a labor-efficient hand-pollination technique for flowering dogwood. The effect of multiple applications and the timing of single applications of pollen on seed set were investigated.

Materials and Methods

The effects of timing and frequency of pollination were tested using field- and container-grown plants of *Cornus florida* 'Cherokee Chief', 'Cherokee Brave', 'Cherokee Princess', and 'Barton'. Six hand-pollination treatments and an open-pollinated control were included in this study. Each hand-pollination treatment consisted of five inflorescences on an individual plant, all of which were pollinated with fresh pollen from one of the three other cultivars in the experiment. To apply pollen, newly dehisced anthers were held with fine-tipped forceps and touched directly to all exposed stigmas within an inflorescence. All open flowers within an inflorescence were pollinated during each pollination event, regardless of whether they had been previously pollinated. To eliminate contaminant pollinations, inflorescences were covered with breathable plastic bags both prior to flower

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opening and following pollination. Flowers were not emasculated. The open-pollinated control consisted of five inflorescences that were marked with tags prior to flower opening, but were neither bagged nor subjected to hand-pollinations. The experiment was repeated 10 times.

Controlled pollinations were made every day (Treatment A), every other day (Treatment B), every third day (Treatment C), every sixth day (Treatment D), and one time only (Treatments E and F). Treatments A, B, C, and D were performed over a 12 day period, with day 1 being the first day in which open flowers were observed in half of the inflorescences in the open-pollinated control (Treatment G). For Treatment E, pollinations were made only on day 6, whereas in Treatment F they were made only on day 12. A complete set of treatments, Treatments A through G, was performed on each plant used in this study; all of the treatments on an individual plant were pollinated using the same pollen source. The following combinations served to make up the 10 replications of the study: 'Barton' x 'Cherokee Brave' (2×); 'Barton' x 'Cherokee Chief'; 'Barton' x 'Cherokee Princess'; 'Cherokee Brave' x 'Cherokee Chief'; 'Cherokee Chief' x 'Cherokee Brave'; 'Cherokee Princess' x 'Cherokee Brave' (2×); and, 'Cherokee Princess' x 'Barton' (2×).

Data were collected on the percentage of inflorescences in each treatment setting seed and on number of seed produced from each group of five inflorescences. Percentage data were arcsin transformed when necessary to correct for variance heterogeneity. A mean number of seed per inflorescence pollinated was calculated. Data were subjected to analysis of variance procedure. Treatment means were separated by least significant difference (LSD), P = 0.05.

As a check for self-pollination and contaminant pollination, 10 inflorescences on each of 10 plants were bagged, but not pollinated. These were examined for seed set, but the data was not included in the pollination data analysis.

Results and Discussion

The two hand-pollination treatments that received the most pollinations, Treatments A and B, had significantly greater percentage of inflorescences setting seed than did Treatments E and F, which received only one pollination (Table 1). There were no significant differences in percentage of inflorescences setting seed between the open-pollinated control (Treatment G) and any of the hand-pollination treatments, except for Treatment F.

Daily (Treatment A) or every other day (Treatment B) pollinations resulted in more seed per inflorescence pollinated than did single applications of pollen (Treatments E and F). However, there were no differences in numbers of seed produced between the open-pollinated control and any of the hand-pollination treatments. Only one seed was produced from the 100 bagged, unpollinated inflorescences.

Both the number of inflorescences setting seed and the number of seed produced were greater when inflorescences were pollinated daily or every other day than when they received a single application of pollen. Two or three pollinations over the 12-day period, however, were just as effective as daily or every other day pollinations. This indicates that the maximum number of seeds that could be supported by the plants was achieved from two to three pollinations, and that any additional pollinations were unnecessary. Outcrossing hermaphrodites, especially those with fleshy seeds, produce many more flowers than seeds (2, 6). Thus, it is not surprising that daily pollinations did not result in more seed than the other multiple, but less frequent, pollination treatments. Single pollinations, on the other hand, did not produce a maximum number of seeds. It is possible that only a few stigmas of the flowers that were open on the day of pollination were receptive. Delaying pollination until day 12 (Treatment F) also resulted in significant inflorescence abscission as compared to the open-pollinated control.

Since only one seed was obtained from an unpollinated check, there appears to be no need to emasculate flowers of flowering dogwood before making controlled pollinations. While no insects were found inside any of the bags of the hand-pollinated treatments, it is possible that one could have penetrated the bag of this unpollinated check; if so, this seed could have been the result of a contaminant cross- rather than a self-pollination.

To further reduce the labor requirements for flowering dogwood controlled pollinations, the labor efficiency of the treatments included in this study was evaluated. A labor efficiency value was calculated by dividing the mean number of seeds for each treatment by the number of days on which pollinations were made (Table 1). Although Treatment A produced the most seed, it had the lowest labor efficiency. Treatment D, in which inflorescences were pollinated on day 6 and day 12, was the most labor efficient. If the number of flowers available for pollinations is limited, as it may be in young plants, it may be advantageous to pollinate the inflorescences every other day to insure obtaining the maximum

Table 1. Effect of frequency and timing of hand pollinations on seed set in flowering dogwood

Treatment	Frequency of pollination	Percentage of inflorescences setting seed	Mean number of seed produced/inflorescence pollinated	Labor efficiency value[z]
A	Every day, up to day 12[y]	62a[x]	3.2a	0.3
B	Every 2 days, up to day 12	52a	3.2a	0.5
C	Every 3 days, up to day 12	45abc	2.4ab	0.6
D	Day 6 and day 12	48ab	1.9abc	1.0
E	Day 6	22bc	0.8bc	0.8
F	Day 12	18c	0.4c	0.4
G	Open-pollinated	48ab	1.8abc	—

[z]Mean number of seeds per inflorescence pollinated divided by number of days on which pollinations were made

[y]day 1 = first day in which open flowers were observed in half of the inflorescences in the open-pollinated control

[x]Means followed by the same number are not statistically different (P = 0.05).

number of seeds. In contrast, if flowers are abundant, once a flowering dogwood inflorescence has received two hand pollinations, a greater increase in seed production can be achieved by pollinating additional inflorescences rather than by making additional pollinations on the same inflorescence. Further investigations are needed for determining the best timing of the two pollinations.

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