COLORADO FLOWER GROWERS ASSOCIATION, INC.

IN COOPERATION WITH COLORADO STATE UNIVERSITY
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Some Effects of Pollination on Carnation Seed Production

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Extremely large numbers of seed are needed in the CSU carnation breeding program. Up to 75 percent of the seedlings are discarded either at transplanting (2-3 weeks) or at 8 to 10 weeks of age. These discards include the cripples, the slow growers, and the sparse branchers. In this way only the strongest and best branching seedlings are grown on to flowering. Very little has been published on carnation seed production. This experiment is the first of a series that should help us to maximize the production of carnation seed for breeding work.

All pollination studies reported here were done on unnamed seedlings that are currently being used at CSU for parent material. The origin of these parents is complex and hybrid. Parentage can be traced to most of the better named cultivars introduced during the past 20 to 30 years, and to one Italian Riviera cultivar.

Methods

Flowers that were to be used as seed parents were disbudded normally. The center petals and stamens were removed from the flowers as soon as flowers started opening. The pistil and the outer whorl of petals were left untouched. As the pistils matured they were pollinated. For the purposes of the study, three different stages of development were chosen for pollinating.

Some flowers were pollinated as soon as the styles first showed a very slight curling of the tips. There was almost no pubescence of the stigmatic surface at that stage (early). Other flowers were allowed to develop until the ends of the styles were curled and the stigmatic surfaces were clearly pubescent. This stage was usually about three days after the early stage. The stage was termed "normal" since this is the stage most commonly used by carnation breeders.

Pistils of flowers pollinated in the last stage (late) were much more developed than either of the other two stages. There was extreme curling of the styles (sometimes several curls) and the stigmatic surfaces were quite pubescent and extended. This stage of development was about three to seven days later than the normal stage. The time between stages of pistil development varied considerably with different seed parents and weather conditions. There was less time between stages during periods of sunny, clear weather.

The pollen parents were not disbudded so that a maximum amount of pollen could be produced. The prepared flowers were pollinated by brushing a mature stamen across the stigmatic surfaces of the pistils. A pair of tweezers was used for this. The tweezers were dipped in alcohol and dried thoroughly before a new pollen parent was used. This was done to help insure that crosses would not be contaminated by foreign pollen. Flowers were not covered since this leads to rotting of the seed capsules.

As the pollinations were made, each pollinated flower was identified with a colored tag, one color for each stage of pistil development. The seed parent and pollen parent were written on one side of the tag and the date on the other. As the seed capsules matured, they were harvested and the seeds counted.

Results and Discussion

Table 1 shows that pollination at any of the three stages of development should yield some seed. The data show that most seed per capsule was produced by crosses made at the normal stage. There was not a great difference between pollinating at the early and the normal stages of development. Pollinating early seems to be of no benefit and sometimes produces

slightly less seed than if the styles are more mature. However, it would be better to pollinate too early than too late.

Table 1. Effect of pollinating carnation at 3 stages of pistil development on average number of seed per capsule.

Stage of pollination	Number of pollinations	Blank capsules	Total no. of seed	Seed per pollination	Seed per capsule
Early	84	41	1190	14	29
Normal	106	35	2273	21	32
Late	79	37	637	8	15

Seed Set by Time of Year

It has been expected that as pollinations were made later in the winter the number of seeds per capsule would decrease. However, this may not be the case. It may be that short periods of unfavorable weather may have more effect than the seasons. Or, the supply of pollen may be the critical factor. Maximum seed set was for pollinations made the first part of December (Table 2). Also, there seemed to be a period of low production from crosses made in late December and an upward trend in those made in January. Light was as good during this period as for some others when seed set was much better. Day and night temperatures were the lowest for the winter from around December 25 to January 9 and probably affected plant temperatures in the greenhouse through excessive radiation outward. This is the only explanation we have at present for the poorer results of pollinations after December 21 (Table 2).

Table 2. Effect of time of pollination on carnation seed yield.

Week of pollination	Number of pollinations	Blank capsules	Percent take	No. of seed	Seed per pollination
Nov. 16	12	5	58	214	18
Nov. 23	17	6	65	322	19
Nov. 30	43	13	70	681	16
Dec. 7	36	9	75	735	20
Dec. 14	29	10	66	650	22
Dec. 21	32	23	28	181	6
Dec. 28	36	19	47	392	11
Jan. 4	31	10	68	417	13
Jan. 11	35	19	46	457	13

Relationship of Capsule Size to Seed Count

When the seed capsules were harvested and the seeds counted, the size of the capsules was arbitrarily rated as normal or small. The small capsules lacked the swollen appearance and were generally more pointed as well as being smaller in size. Small capsules seldom had seeds inside. Of more than one hundred small capsules, only a few had seeds and those had a small number. It should be possible to detect seed capsules like these well in advance of the normal harvest and remove them from the plants at that time. The chances of discarding a small capsule that might have seed are remote.

Length of Time for Seed Maturity

Ten to twelve weeks were required to ripen capsules from pollinations made in November and the first half of December whereas 8 or 9 weeks were sufficient for ripening capsules from January pollinations. This is probably a matter of incident solar energy following pollination.

Capsules pollinated at the early stage of development took longer to mature than did the ones pollinated at the other two stages (Table 3). The ones pollinated at the normal and late stages took about the same time to ripen. Cross 2 required the least time to ripen capsules and Cross 5 took the longest.

Table 3. Average number of weeks from pollination to maturing of seed capsules containing seeds.

Number of cross	Stage of pistil development at time of pollination		
	Early	Normal	Late
1	10.0	9.8	9.7
2	8.6	7.9	7.8
3	10.0	9.7	9.0
4	9.7	8.8	8.7
5	11.7	10.5	10.3

The petals left around the ovary wilted in 1 to 3 days after pollination at the late stage of development, 2 to 5 days for the normal stage and up to 2 weeks for the early stage. The wilting of the petals was slower in darker weather later in the season. It is believed that these outer petals have a hormonal effect on seed production.

CONCLUSIONS

The maximum seed set was obtained when the pollinations were made on pistils at the "normal" stage of development. Pollination at an earlier stage produced slightly fewer seeds and crosses made later produced considerably less than this.

Pollinations made in the fall generally produced slightly more seeds than those made in winter. The biggest limiting factors seem to be the production of flowers to be used as seed parents and the lack of pollen later in the period. Periods of cold weather may make substantial differences in seed production.

It was found that small capsules having no seeds could be easily detected prior to their ripening. It would probably benefit the plant if these were removed at that time. Some parents producing large seed capsules had few seeds. Many times these were filled with multiple pistils and no seeds. This seemed to be a varietal difference.

Time required from pollination to maturity of the seed capsule varied from 8 to 12 weeks depending on the seed parent, time of year, and development of the pistil. The flowers pollinated when the pistils were at the early stage of development took the longest and the

ones pollinated at the late stage of development took the least amount of time.

By not disbudding some flowers, a plant breeder may be able to produce more seeds in less space. This might be especially important for seed production when there are few seed parents.

Differences between parents are considerable. Some are good as both seed and pollen parents while some are only good for one or the other. Some pollen parents stop producing early in the season while others produce even in winter. Differences in seed capsules can be important since some are susceptible to invasion by rot organisms.