# Double-Flowered Column Stocks

## genetic crossover responsible for breakdown in percentage of doubles produced by succeeding generations of parent variety

B. Lennart Johnson and David Barnhart

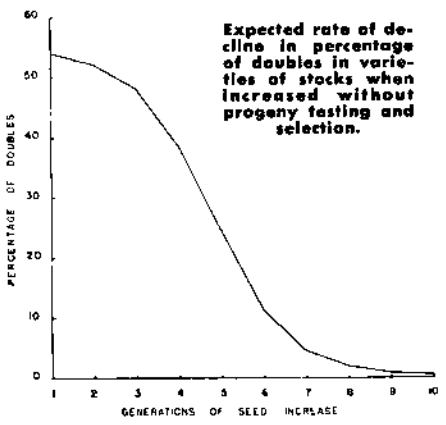
**About 20% of the cost** of field production of column stocks—*Matthiola incana*—as cut flowers is for seed because of the techniques required to obtain seed that will produce a satisfactory percentage of double flowers.

Double-flowered plants are completely sterile, so they must be obtained from eversporting single-flowered plants, so-called because their seed yields about 54% of doubles and 46% of eversporting singles. However, occasional noneversporting singles—plants which produce less than 54% of doubles—occur in eversporting varieties. When seed is increased from varieties containing such singles, the percentage of doubles will drop each year. Therefore, the percentage of doubles in a commercial variety can be depended on only if the variety is continually renewed from singles which have been progeny tested to ensure that they are of the eversporting type.

Eversporting plants will produce about 54% of doubles because—in these plants—one chromosome of a specific pair carries the gene for double flowers—*s*—while the other member of the pair carries the dominant gene for single flowers—*S*—and closely linked with it, a pollen lethal factor—*l*. When gametes are formed, only one chromosome from each pair enters a pollen grain or egg. Half of the eggs receive the single flower gene and the pollen lethal factor—*Sl*—and half receive the double flower gene—*s*. The same is true for the pollen. However, *Sl* pollen does not function owing to the effect of *l*. When the functional *s* pollen fertilizes the eggs, two types of plants are produced in about equal numbers: eversporting singles—*Sl/s*—and doubles—*s/s*. Some of the eggs carrying *l* do not function and, as a result, the proportion of doubles is about 54% rather than the expected 50%.

The real reason for the occurrence of noneversporting plants in eversporting lines has only recently been demonstrated. Basically it is because members of a chromosome pair may exchange segments by a process known as crossing-over. Clear evidence has been obtained to show that *l* occasionally becomes separated from *S* by such a process. When a gamete bearing the new *S*-chromosome fertilizes normal *Sl* and *s* gametes, exceptional single-flowered plants—*S/Sl* and *S/s*—are produced. These noneversporting plants are similar in appearance to eversporting plants, but *S/Sl* will produce only singles and *S/s* 25% of doubles while eversporting plants will produce 54% of doubles.

The infrequent noneversporting plants are the reason for the costly process of progeny testing required in the production of stock seed acceptable to the flower grower. When individual plants are progeny tested, the exceptional pure-single and 25%-double progenies can be discarded and only the 54%-double progenies used for seed increase. The pure-single progenies are easily recognized. The 25%-double progenies present a much greater problem because they necessitate actual counts of the plants in every progeny. If overlooked, such progenies will produce increasing proportions of pure singles in succeeding years.




**Expected rate of decline in percentage of doubles in varieties of stocks when increased without progeny testing and selection.**

## Increase of Crossover Types

The noneversporting types produced by exceptional crossovers have a remarkable reproductive advantage over the desired eversporting plants. All or most of the plants that they produce are singles which are capable of setting seed while less than half of the plants produced by an eversporting individual are singles. Furthermore, successive generations from the noneversporting types—*Sl/S* and *S/s*—rapidly lose the lethal factor—*l*—and the doubleness gene—*s*—to consist predominantly of pure-single—*S/S*—plants. When the lethal is lost, the seed productivity of the plant increases about 50%. Since all eversporting plants carry the lethal, they are at a disadvantage in this respect also.

**Singles and doubles from an eversporting commercial variety of stocks.**

As a consequence, when seed of an eversporting variety is increased without progeny testing and selection, the occasional noneversporting plants produced by crossing-over are expected to increase rapidly at the expense of eversporting singles. As the proportion of eversporting singles declines, the proportion of doubles also declines. The expected rate of decline in percentage of doubles is approximately as shown in the accompanying graph when the frequency of crossing-over is 1% and when the increased productivity of plants without the lethal is 50%.

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**Seed Yields of Eversporting Plants—*Sl/s*—Which Carry a Pollen Lethal Factor Compared with Yields of Closely Related Plants without the Lethal—*S/s* or *S/S***

| Individual plant progenies from: | No. of plants per progeny | Mean seed yield (grams) | | |
|---|---|---|---|---|
| | | Plants with the lethal *Sl/s* | Plants without the lethal *S/s* or *S/S* | % increase with loss of lethal |
| Four pairs of sister plants from controlled crosses | 72 | .65 | .97 | 49.2 |
| Two pairs of sister plants from a commercial variety | 20 | 1.88 | 2.89 | 53.7 |
| Two plants of the same commercial variety | 5 | 1.20 | 1.84 | 53.3 |

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## COLUMN STOCK

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In that case, seed from an eversporting plant is expected to yield 54% of doubles in the first generation, 53% in the second, and 40% in the third generation of seed increase. Percentages based on commercial plantings tend to run higher than these because all of the single seedlings do not survive to the flowering stage. In the fourth generation the percentage of doubles is expected to drop to about 38%.

### Production Limitations

Because the first generation of seed from a selected plant is required for the progeny test to determine whether that plant is an eversporting one, a seed producer has only one year available for seed increase after the progeny test. A flower grower can then expect to obtain about 48%—actually more than this from field counts—of doubles in the third year. Seed harvested from the third-year crop is expected to yield less than 40% of doubles the following year.

Frequencies of crossing-over, higher than 1%, probably do not occur in commercial varieties. Frequencies lower than 1% are expected to delay the drop in percentage of doubles, but even minute frequencies of crossing-over in a variety will eventually doom that variety when the seed is increased without progeny testing.

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*The above progress report is based on Research Project No. 1251.*

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