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Some Data on the Polygenic Control of Two Quantitative Traits in a Vegetatively Propagated Flower Plant, the Carnation

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Summary. In two populations of selfed commercial varieties 4800 and 5774 of *Dianthus cariophyllus* as well as in the parents of 5774 two quantitative traits were examined: petal number and durability of blossoms after cutting. Both populations showed an increase in the number of petals, No. 4800 also in its durability. The estimated hereditary component was high for petals (0.47 and 0.35), lower but significant for lasting quality. The importance of an investigation on the selection for quantitative traits in cut flowers is discussed.

Selection work on commercial flower plants has been successfully conducted by many workers and has led to important accomplishments in such qualitative characters as flower color, disease resistance etc. On the other hand, very little research has been carried out on quantitative characters possibly controlled by polygenic systems. This is partially due to the fact that many flower plants are vegetatively propagated and hence, it would be difficult to execute extensive selection work with the normal methods of statistical analysis. On the other hand, vegetative propagation offers the clear advantage of an easier fixation of genetic variability.

In the present paper, an analysis is reported of two quantitative traits of commercial value (petal number and vase-life) in two segregating populations of the carnation (*Dianthus cariophyllus*). This in view of assessing any feasibility of selection in the two populations; in the case of sufficient genetic variability selection would be carried on, through vegetative propagation.

Material and Methods

Two segregating populations were analyzed deriving from two commercial varieties, considered as F_1s (4800 pink and 5774 red) both produced by Dr. G. NOBBIO, Sanremo, Italy. The two varieties were self pollinated by Dr. NOBBIO; the seeds were sown and the plants, considered as F_2, were grown under normal greenhouse conditions. Together with the F_2s, F_1s (4800 pink and 5774 red) and the parents of one of the varieties (4872 pink and 5217 red) were grown under the same conditions. Plants were labeled, flowers collected, scored for color (data regarding color segregation and other qualitative characters will be reported elsewhere) stored for vase-life determination and petals counted at the end of the vase-life analysis.

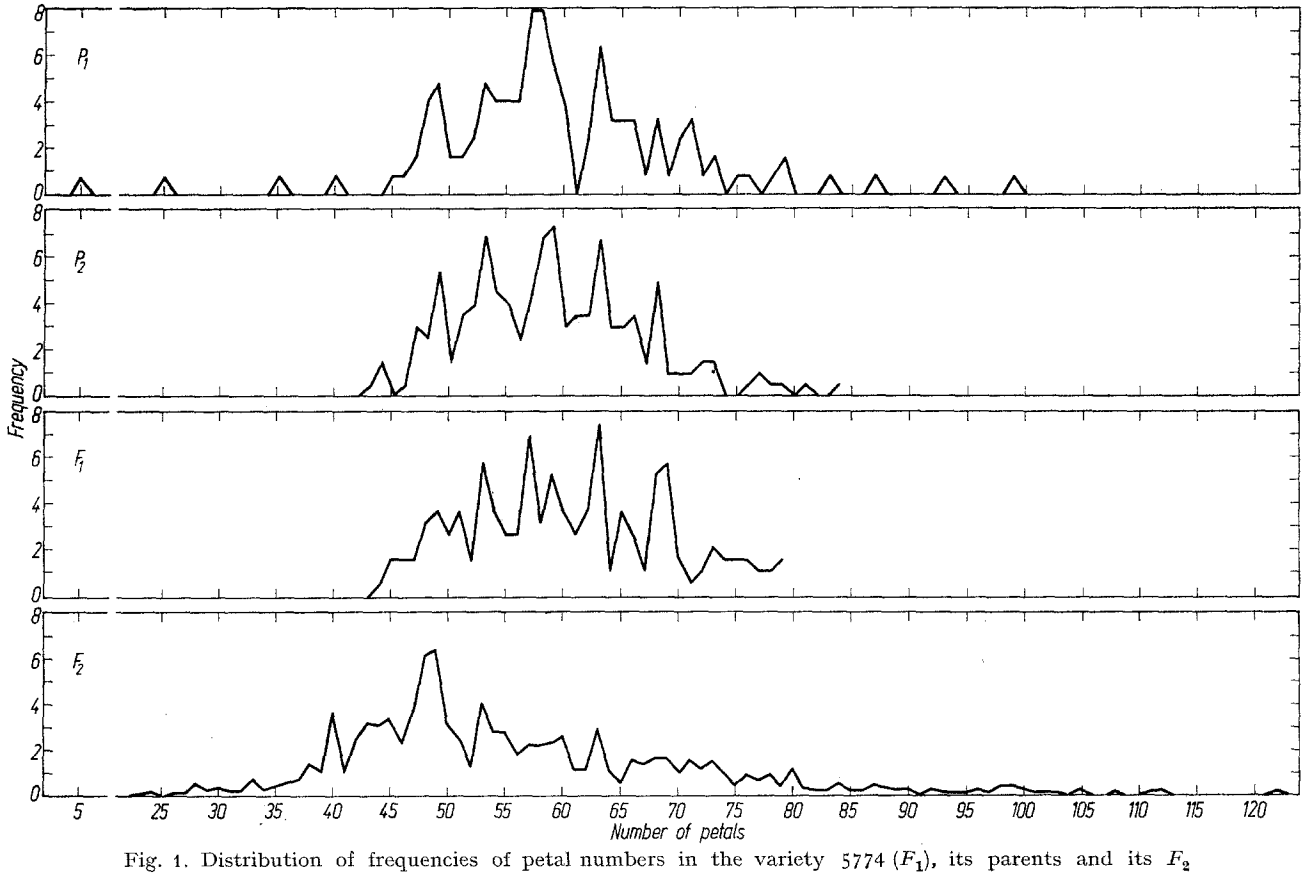

Fig. 1. Distribution of frequencies of petal numbers in the variety 5774 (F_1), its parents and its F_2

Analysis for vase-life were always conducted by the same person and flowers were considered withered when the borders of external petals started turning brownish. From each plant, cuttings were taken for successive selection work.

On the segregating progenies, F_1s and parents a statistical analysis was conducted to estimate total variance for all populations and heritability (portion of genetic variance) in the F_2s. For the latter analysis, the method of SCOSSIROLI, FERRARI and HAUSMAN 1960 was adapted to our situation. The variability between flowers within plants was taken as a parameter for estimates of environmental (physiological) variability.

Estimates of the environmental (e^2) and genetic (h^2) portions of variability were obtained from the following formulas:

$$e^2 = \frac{Q}{Q + G}$$

$$h^2 = \frac{G}{Q + G}$$

where $Q = \sigma_E^2$ = variance between flowers within plants

$$G = \frac{(\sigma_E^2 + \gamma\,\sigma_G^2) - \sigma_E^2}{\gamma}$$

$$= \frac{\textit{variance between plants} - \textit{variance within plants}}{\text{mean number of flowers per plant}}.$$

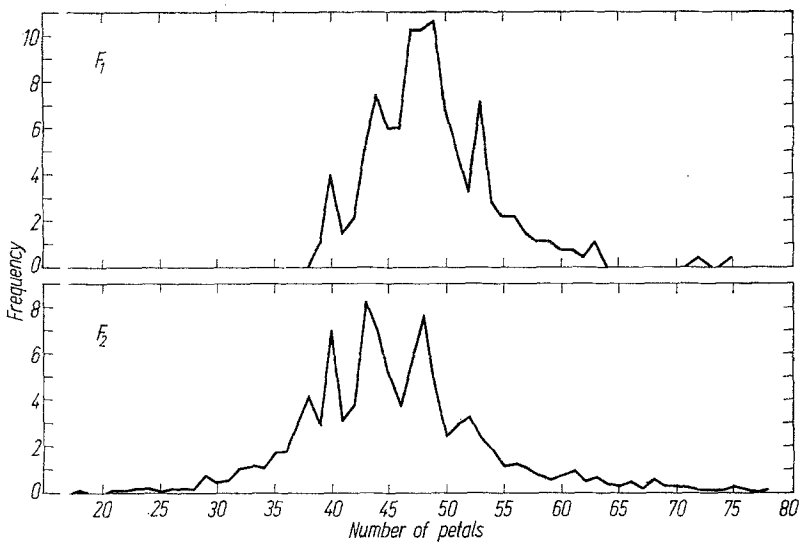

Fig. 2. Distribution of frequencies of petal numbers in the variety 4800 (F_1) and its F_2

Results

Petal Number

As shown in Fig. 1 and Fig. 2, both F_2s showed a significant release of variability for petal number when compared with F_1s and parents. This was further supported by the increase in total variance shown in table 1.

Estimates of heritability as shown in table 2 were very high for both varieties (0,35 and 0,47) thereby showing the possibility for a fruitful selection program.

Table 1. *Variance values for petal numbers in segregating populations (F_2s), F_1s and parents of the two varieties 4800 and 5774*

Varieties	P_1	P_2	F_1	F_2
4800	—	—	28.65	108.30
5774	50.09	9.20	24.90	377.62

Vase-Life

The situation of vase-life was less clear.

As shown in table 3 and Fig. 3 and Fig. 4, in 4800 there was an increase in total variance from F_1 to F_2, whilst in 5774 such a situation did not occur, though both F_1 and F_2 had higher variances than the parents. Estimates of heritability (table 4) were also lower than for petal number. Heritability was still high enough for a selection program, given the easiness of selection in a vegetatively propagated plant as the carnation.

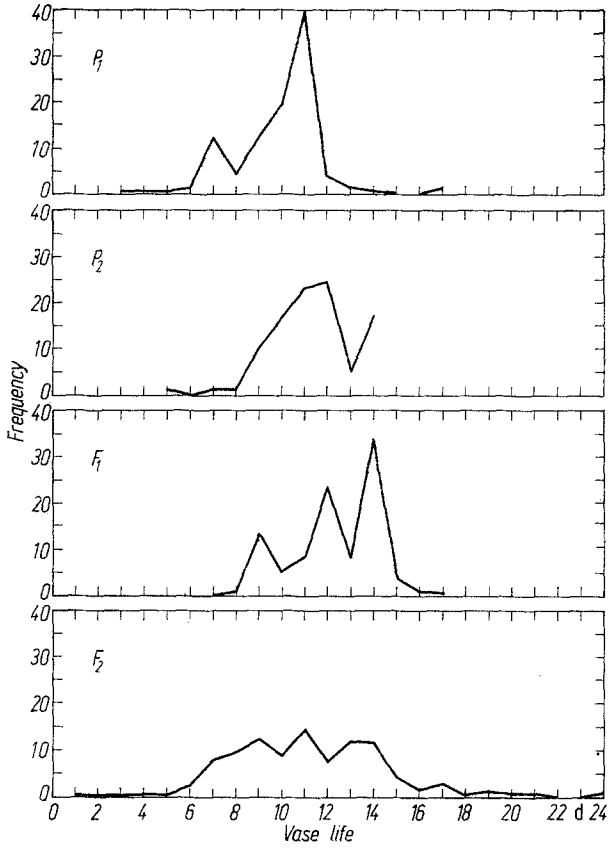

Fig. 3. Distribution of frequencies (in days) of vase-life value in variety 5774 (F_1), its parents and its F_2.

Table 2. *Analysis of variance and heritability estimates for petal number in F_2s of the varieties 4800 and 5774*

Variety	n° of plants	n° of flowers	total	variances		heritability
				between plants	within plants	h^2
4800	169	912	108.30	277.98	69.81	0.35
5774	138	680	377.62	1083.16	198.59	0.47

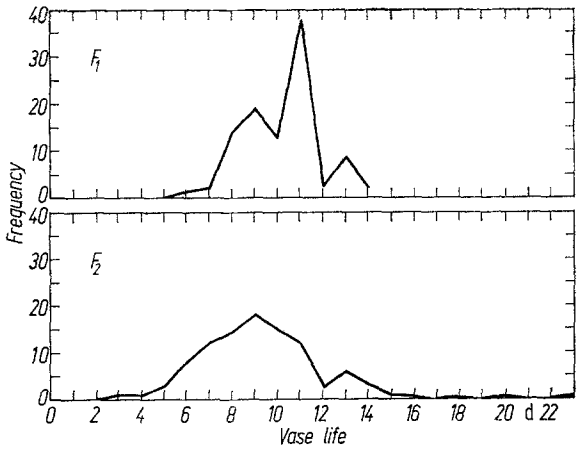

Fig. 4. Distribution of frequencies (in days) of vase-life values in the variety 4800 (F_1) and its F_2

Table 3. *Total variance values for vase-life in segregating progenies (F_2s), F_1s and parents of the two varieties 4800 and 5774*

Variety	P_1	P_2	F_1	F_2
5774	3.25	4.02	16.81	9.39
4800	—	—	2.01	13.27

BERGER and HOLLEY, 1955; HALEVY and WITTWER 1965; MASTALERZ, 1961, KLOUGART, 1967). In our case, the vase-life range was strongly increased up to peaks of 23—24 days; it remains to be ascertained whether this behaviour can be fixed through selection given the not very high estimates of heritability. This condition, however, may be due to strong environmental influences on this character, both during plant growth and the period of vase-life determinations.

Further selection work, at present on progress, will clarify this situation.

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Zusammenfassung

An Spaltungspopulationen zweier selbstbestäubter Handelssorten (4800 und 5774) von *Dianthus caryophyllus* sowie der beiden Ausgangssorten und den Eltern von 5774 wurden zwei quantitative Merkmale von wirtschaftlichem Wert, nämlich die Anzahl der Petalen und die Haltbarkeit der Blüten nach dem Schnitt, untersucht. Bei beiden Spaltungspopulationen war hinsichtlich der Anzahl der Petalen und bezüglich der Haltbarkeit — nur bei 4800 — ein Ansteigen der Gesamtvarianz zu erkennen. Die geschätzte Heritabilität war hoch für die Petalen (0,47 und 0,35), bezüglich der Haltbarkeit niedriger, aber noch signifikant für ein Selektionsprogramm. Die Bedeutung einer Untersuchung quantitativer Merkmale an Schnittblumen für die Selektionsarbeit wird diskutiert.

Table 4. *Analysis of variance and heritability estimates for vase-life in F_2s of the varieties 4800 and 5774*

Variety	n° of plants	n° of flowers	total	variances		heritability
				between plants	within plants	h^2
4800	135	662	19.27	23.85	10.58	0.20
5774	104	467	9.39	15.27	7.55	0.18

Discussion

The data presented here show the possibility of a successful selection program both for number of petals and vase-life in the carnation.

As far as petal number is concerned, the polygenic nature of the genetic control of the character is strongly supported by this experiment, which shows an increase in variability in segregating populations without any relevant changes in the means and with the maintenance of a normal distribution of frequencies. This hypothesis was put forward also by BUIATTI, RAGAZZINI and D'AMATO (1965) as an interpretation of variability increase following gamma-radiation treatments in carnation.

Our data are, however, in contrast with the earlier assumption by IMAI (1938) of a monogenic control for "double", "semidouble", and "single" flowers in carnations. Furthermore, the high heritability estimates suggest that a large proportion of the variability found is of genetic origin and hence easy to fix through selection work.

Vase-life of cut carnations is considered as a character of high economic importance. Vase-life values vary in the range from 8 to 12 days (LARSEN and SCHOLES, 1965) and a good amount of work has been carried to increase it through chemical treatments (LARSEN and SCHOLES, 1965; KNAPPER-

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