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ESTIMATION OF VARIABILITY PARAMETERS AND PATH COEFFICIENT ANALYSIS IN GRAM (*Cicer arietinum* L)

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Twenty one diverse varieties of gram were analysed for the estimation of variability parameters and path coefficient analysis. The estimates of genotypic coefficient of variation ranged from 1.58 for days to maturity to 40.26 per cent for grain yield per plant. High genetic advance as per cent of mean coupled with high heritabilits were recorded for grain yield, number of pods per plant and number of primary branches per plant. Correlation coefficients indicated that grain yield had significant positive association with number of pods per plant, number of primary branches and 100-seed weight at both genotypic as well as phenotypic levels. The path analysis indicated that number of pods per plant had the highest direct effect on grain yield followed by 100-grain weight and days to flower.

The progress in breeding for economic characters is dependent upon the nature, extent and magnitude of genetic variability present in the material and the extent to which it is heritable Association studies provide reliable information on nature, extent and direction of selection. Further, path analysis studies provide precise information on direct and indirect causes of association. With this view, the present study was undertaken in gram (*Cicer arietinum* L.).

MATERIALS AND METHODS

The experimental meterial consisting of 21 diverse varieties of gram was grown in randomised block design with three replications keeping single row of each entry in each replication during *rabi* 1982 - 83 at the experimental field of Rajasthan College of Agriculture, Udaipur. Row to row and plant to plant distances were maintained at 30 x 15 cm. Observations were recorded on five randomly selected plants in each entry and in each replication for days to flower, days to maturity, plant height, number of primary branches per plant, number of pods per plant, number of grains per pod, 100 - grain weight and grain yield per plant. GCV and PCV were computed following the method of Burton (1952). Heritability (broad sense) was estimated using the formula suggested by Burton and Devane (1953), Johnson *et al.*, (1955) and Hanson *et al.*, (1956). Genetic advance as per cent of mean was computed according for Johnson *et al*

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Table 1 Variability Parameters for different characters in gram

Characters	Range	Mean ± S. Em.	GCV (%)	PCV (%)	Herita-bility (%)	Genetic advance as per cent of mean
Days to flower	51.67—82 67	68.92±1.59	15 35	15.61	96.72	31.11
Days to maturity	108.33—116.00	112.14±1.79	1.58	2.51	39.33	2.03
Plant height	37.60— 55.00	46 30±1.41	8.18	8.98	82.83	15.33
(Number of primary) branches per plant	4.53—13.60	8 08±0.63	26.50	28.16	88.56	51.36
Number of pods per plant	19.67—76 93	35 14±3.06	35.75	37.31	91.82	70 55
Number of grains per pod	1.01— 1.47	1.22±0.09	9.87	13.66	52.21	14.75
100-grain weight	9.20—14.66	11.61±0.47	13.38	14.28	87.87	25 84
Grain yield per plant	2 33—11 13	4.64±0 59	40.26	43 14	87.08	77.37

(1955). Correlation coefficients were estimated using the formula suggested by Fisher (1954) and Al-jibouri *et al.* (1958) and path coefficients were calculated using the methodology described by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The range, mean, GCV, PCV, heritability and genetic advance as per cent of mean are presented in Table 1. There was a close resemblance between GCV and PCV estimates. High values of GCV were recorded for grain yield per plant followed by number of pods per plant and number of primary branches per plant suggesting that selection for these traits would be much effective. Malhotra and Singh (1973) also observed high GCV values for these characters. Minimum GCV values were recorded for days to maturity. Estimations of GCV and PCV alone do not assess the amount of heritable variation which can be studied by estimating heritability. High estimates of heritability were recorded for all the characters except days to maturity. Patil and Phadnis (1977) also noted high heritability for pod number per plant, 100-grain weight and seed weight per plant. According to Burton (1952), a character having high GCV value with high heritability would be more valuable in the selection programmes. Here high heritability values coupled with high to moderate GCV values were observed for days to flower, number of primary branches per plant, number of pods per plant,

Table 2. Genetypic and phenotypic correlation coefficients between different characters in gram

Characters	Days to maturity	Plant height	Number of primary branches per plant	Number of pods per plant	Number of grains per pod	100 grain weight	Grain yield per plant
Days to flower	0.83** (0.50*)	—0.13 (—0 10)	—0.28 (—0.25)	—0.28 (—0.27)	0.48* (0.35)	—0.56** (—0.51**)	—0.30 (—0.28)
Days to maturity	—	0.35 (0.18)	—0.12 (0.02)	0 05 (0.08)	0.60** (0.23)	—0.62** (—0.35)	—0.04 (0.05)
Plant height		—	0.35 (0.33)	—0.43* (0.38)	0.07 (0.08)	0 04 (0.03)	0.41 (0.39)
Number of primary branches per plant			—	0.77** (0.74**)	—0.62** (—0 41)	0.78** (0.68**)	0.85** (0.84**)
Number of pods per plant				—	—0.22 (0.15)	0.43* (0.36)	0.99** (0.92**)
Number of grains per pod					—	—0.73** (—0.43*)	—0.28 (—0.17)
100-grain weight						—	0.61** (0.51*)

Figures within parentheses are phenotypic correlations
*Significant at 5 per cent level
**Significant at 1 per cent level

100 grain weight and grain yield per plant, thereby indicating less environmental influence on these characters and high transmission index. Similar results were also obtained by Sandhu and Singh (1970).

Johnson *et al.* (1955) suggested the heritability and genetic advance when calculated together would be more useful in predicting the resultant effects of selection. High genetic advance as per cent of mean together with high heritability was noted for grain yield per plant followed by pod number and number of primary branches per plant. This indicated the preponderance of additive gene action (Panse, 1957). Therefore, these characters would be effective for the improvement in yield levels.

Table 3 Path analysis showing direct and indirect effects of seven characters on grain yield in gram

Characters	Days to flower	Days to maturity	Plant height	Number of primary branches per plant	Number of pods per plant	Number of grains per pod	100 grain weight	Genotypic Correlation with grain yield per plant
Days to flower	(0.5513)	—0.2975	—0.0293	—0.1547	—0.3521	0.0076	—0.3385	—0.3028
Days to maturity	0.4583	(—0.3579)	0.0791	0.0689	0.0690	0.0095	—0.3787	—0.0518
Plant height	—0.0708	—0.1242	(0.2279)	—0.1969	0.5425	0.0010	0.0262	0.4057
Number of primary branches per plant	0.1524	0.0440	0.0802	(—0.5597)	0.9649	—0.0010	0.4742	0.8512**
Number of pods per plant	—0.1956	—0.0198	0.0990	—0.4327	(1.2481)	—0.0035	0.2585	0.9940**
Number of grains per pod	0.2647	—0.2145	0.0151	0.3501	—0.2755	(0.0158)	—0.4454	—0.2897
100-grain Weight	—0.3082	0.2238	0.0099	—0.4382	0.5328	—0.0117	(0.6056)	0.6140**

Figures within parenthesis are direct effects
Residual effect : 0.0782
**Significant at 1 per cent level

Study of correlation coefficients (Table 2) showed that grain yield exhibited strong positive association with number of primary branches per plant, number of pods per plant and 100-grain weight at both genotypic as well as phenotypic levels, confirming the reports of Khedar *et al.* (1984). Mutual correlation study revealed that days to flower showed strong positive association with days to maturity and significant negative correlation with 100-grain weight at both the levels. Plant hight was positively correlated with number of pods per plant at genotypic level. Number of primary branches per plant showed strong positive association with number of pods per plant and 100-grain weight at both the levels. Significant positive correlation was observed between number of pods per plant and 100-grain weight at genotypic level only, while negative and significant association was recorded between number of grains per pod and 100-grain weight at both the levels.

Path coefficient analysis (Table 3) indicated that number of pods per plant had maximum direct effect on grain yield followed by 100 - grain weight and days to flower, confirming the results of Khedar *et al.*, (1984). Number of primary branches per plant exhibited marked indirect effect *via* number of pods per plant on grain yield. The positive indirect effects for days to maturity were observed *via* days to flower. Direct effect of plant height was relatively low but its maximum indirect effect was observed through number of pods per plant on grain yield. Low magnitude of direct effect was exhibited by number of grains per pod on yield. However, its maximum direct effect was observed *via* number of primary branches per plant. 100-grain weight also exhibited high indirect effect on grain yield through number of pods per plant besides having high direct effect.

Hence, from path analysis studies, it may be concluded that maximum direct effects were exhibited by number of pods per plant followed by 100-grain weight and days to flower. Of these, number of pods per plant and 100-grain weight exhibited positive and significant correlation with grain yield and were considered to be the most important yield contributing characters. Therefore, due emphasis should be placed on these characters while breeding for high grain yield in gram.

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STUDIES ON SYNCHRONISATION OF FLOWERING IN THE PARENTAL LINES OF SORGHUM HYBRIDS - II ASSOCIATION OF WEATHER ELEMENTS WITH THE DURATION TO FLOWERING

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The parental lines of sorghum hybrids CSH 5, CSH 6, CSH 9 and COH 2 were sown at fortnightly intervals to study the flowering behaviour. Correlations were worked out between the days to (i) panicle initiation, (ii) half-bloom and (iii) from panicle initiation to half-bloom on the one hand and the weather elements viz., maximum and minimum temperature, fore-noon and after-noon relative humidity, sun shine and rainfall that prevailed during the four phases of plant growth on the other. Nature and extent of association varied among the parental lines and also between growth phases.

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