SHORT COMMUNICATION

Correlation and Path Coefficient Analysis of the Components of Yield in Sunflower Cultivars (*Helianthus annuus* L.)

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Genetic variability, character association and path analysis between seed yield and its contributing traits were studied in 22 genotypes of sunflower. Highly significant differences between genotypes were recorded for all the characters studied. A slight increase of genotypic correlation coefficients over phenotypic correlation coefficient was noticed for all the character combinations. All the examined characteristics except days to 50% flowering, % filled seeds, 100-seed weight and oil content were significantly and positively associated with seed yield. Since, plant height, head diameter, head weight and number of seeds/head are intercorrelated among themselves, selection for these traits will result in increased seed yield. Path coefficient analysis revealed that among all the traits studied, stem diameter at mid height and head weight contributed most directly to seed yield. All other yield contributing traits had sizeable influence on seed yield indirectly only through stem diameter at mid height and total head weight.

Key Words: Correlation, Path analysis, Sunflower

High seed yield and oil content are definitely the major criteria in sunflower breeding. However, breeders often encounter problems with these characteristics because of their low heritability and high responsiveness to genotype/environment interaction. Seed yield and oil content are complex characteristics which are affected by different factors which may act individually or collectively. More information are needed to clarify the relations between these characteristics and plant and seed characteristics. The experiments discussed in this paper were undertaken in order to obtain information about correlation, direct and indirect effects of bio-morphological characteristics on seed yield and oil content in sunflower.

The material comprised of 22 genotypes of sunflower were collected from the Division of Genetics, Indian Agriculture Research Institute (IARI), New Delhi and were evaluated in a randomized block design experiments with three replications at Research Farm of Kisan (PG) College, Simbhaoli, Ghaziabad, during rainy season 2007. Each genotype was assigned to two row plots of 3 m length with inter- and intra-row spacing of 75 cm and 30 cm, respectively. Recommended agronomic practices were followed to raise a good crop. Data were collected on five randomly selected competitive plants from each plot on growth, yield and oil content. Oil content was estimated by the Pulsed Nuclear Magnetic Resonance Spectrometer (NMR) technique (Tiwari *et al.*, 1974). Phenotypic and genotypic correlation coefficients for all characters combinations were computed following Al-Jibouri *et al.* (1958). Path coefficient analysis was carried out according to Dewey and Lu (1959) by partitioning the genotypic correlation coefficients into direct and indirect effects.

The analysis of variance for different characters is presented in Table 1. The critical perusal of the table revealed that highly significant genotypic differences were observed for all the characters under study. A slight increase of genotypic correlation coefficients over phenotypic correlation coefficients was noticed for all the character combinations indicating that though there is a strong inherent association between many traits studied, the phenotypic expression of the association is reduced under the influence of environment (Sivaram, 1986). Singh and Labana (1990) reported such higher genotypic correlation coefficients over phenotypic correlation coefficients in sunflower. The relative magnitude of genotypic and phenotypic correlations suggests that phenotypic selection can be reliable as the underlying cause of association has a genetic basis.

Seed yield/plant was significantly and positively correlated with number of leaves/plant, plant height, stem diameter at top height, stem diameter at mid height, head diameter, head diameter of sterile area, weight of

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Table 1. Estimates of genetic constraints (for variability) for sixteen characters in 22 genotype of sunflower

Characters	Range	Heritability (bs)	Genetic advance	Genetic advance over mean	Coefficienct variability	Difference PCV-GCV GCV	PCV
D.F. 50%	50.83-64.67	0.76	6.55	11.90	6.65	7.65	1.00
NL/P	13.67-23.83	0.49	3.22	17.12	11.82	16.84	5.02
PH	69.70-131.90	0.55	21.76	22.64	14.81	19.97	5.16
SDTH	1.93-3.40	0.35	0.35	12.86	10.46	17.62	7.16
SDMH	2.53-4.30	0.42	0.60	17.91	13.58	21.08	7.50
HD	5.60-10.47	0.39	1.44	18.34	14.31	22.95	8.64
HDSA	1.10-3.87	0.51	0.90	35.43	23.99	33.45	9.46
TWH	32.67-192.50	0.59	62.21	63.54	40.01	51.91	11.90
NS/H	82.33-213.33	0.61	58.30	43.81	27.17	34.71	7.54
PFS	62.10-80.73	0.24	3.74	5.15	5.07	10.28	5.21
100SW	8.17-16.33	0.62	3.58	28.66	17.65	22.38	4.73
SY/P	4.00-22.90	0.72	9.45	86.06	49.83	59.46	9.63
OC%	43.37-54.43	0.68	4.86	10.26	6.06	7.38	1.32
LL	10.53-22.63	0.60	3.95	27.39	17.13	22.06	4.93
LB	6.43-16.17	0.59	3.34	35.34	22.37	29.12	6.75
LA	50.73-257.57	0.61	68.83	68.29	42.59	54.72	12.13

head, number of seeds/head, leaf length, leaf breadth and leaf area. Singh and Labana (1990) and Doddamani *et al.* (1997) observed similar positive significant correlations for these traits. On the other hand, Patil *et al.* (1996) reported that there was a negative correlation between seed yield and head diameter. Furthermore, some researchers could not find correlations between seed yield and certain characteristics (Natali and Saikh, 1970; Varshnay and Singh, 1977).

As a rule, the plants with a large size of heads also had a large number of seeds/head as illustrated by the highly significant positive correlation between the head diameter and the number of seeds/head (+0.441*). There were positive but non significant correlations between the head diameter and the weight of 100 seeds.

The poor association of seed yield with days to 50 per cent flowering suggests that duration of photosynthetic activity is not a limitation in sunflower. Therefore, reducing the length of growing period without affecting final seed yield is at the realm of sunflower breeding. Gowda (1994), Patil *et al.* (1996) and Doddamani *et al.* (1997) also reported poor association between seed yield and days to flowering.

The positive significant correlation observed between plant height and seed yield is justifiable and is in agreement with results reported by Patil *et al.* (1996) and Doddamani *et al.* (1997). Tall plant supporting many leaves as illustrated by highly significant positive association between plant height and number of leaves per plant could increase total biomass production through increased carbon fixation which can ultimately be partitioned to reproductive organs. Thus, the number of internodes, which are sites of leaf initiation, should remain constant during breeding for shorter plant types. From the foregoing, it may be concluded that an intensive selection for plant height, head diameter, total weight of head and number of seeds per head will automatically improve seed yield in sunflower. Again, since all these four traits are intercorrelated among themselves, selection in any one of the traits will result in improvement of other traits, thereby finally increasing the seed yield.

With regard to one important quality character, oil content, the breeder facing real challenge, since oil content is not significantly related to any of the yield components mentioned above, the selection of these traits will not influence the oil content. However, oil content is negatively correlated not only with seed yield, but also with number of leaves/plant. Hence, there is every chance of reduction in oil content if selection process is exerted on these traits in the positive side. Therefore, a compromise has to be arrived at to have an optimum oil content without sacrificing the seed yield. Among the other characters, % filled seeds and 100-seed weight showed non-significant but positive association with seed yield and thereby, suggesting the possibilities of improving these characters independent of seed yield.

Since, we could not establish the cause and effect relationships between the examined yield components and seed yield per plant on the basis of simple correlation coefficients, we processed the data by the path-coefficient analysis which enabled the partitioning of the direct and indirect effects of individual yield components and identification of yield components applicable as selection criteria in sunflower breeding. Partitioning of genotypic

correlations of other characters with yield into direct and indirect effect revealed that stem diameter at mid height (0.515) and head weight (0.471) had maximum direct effect on seed yield. The correlation coefficients recorded for these characters, being most important components of yield, should be given more weightage during selection process. Patil *et al.* (1996) also observed high positive direct effect of stem diameter at mid height and head weight on seed yield. The direct effect of stem diameter at top height, plant height, head diameter of sterile area and leaf breadth was negative on seed yield per plant, but their significant positive correlations with seed yield was due to their respectively high and moderate indirect effects through stem diameter at mid height. Similar findings were reported by Doddamani *et al.* (1997). Oil content, the only trait which showed negative association with seed yield had low positive direct effect. But its positive influence on seed yield was mainly due to high positive indirect effect through stem diameter at mid height. Even the traits which had no significant association with seed yield, *viz.*, days to 50% flowering and 100-seed weight had moderate indirect influence on seed yield through diameter at mid height.

The above findings revealed that increase in seed yield can be achieved through increase in stem diameter and mid height. All the characters exhibited their indirect effect mostly through stem diameter at mid height. Hence, it may be concluded that more seeds developed when sufficient nutrients were supplied through a thicker stem measured in terms of the stems diameter at mid height. Variations at genotypic level were also quite high for most of the traits indicating sufficient scope for selection. The magnitude of GCV and PCV were comparatively higher for seed yield/plant, leaf area, total weight of head and number of seeds/head as compared to other characters.

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