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GH Naik
Department of Genetics and
Plant Breeding, College of
Agriculture, Latur, Maharashtra,
India

MK Ghodke
Oilseeds Research Station, Latur
VNMKV Parbhani,
Maharashtra, India

Correlation and path analysis studies in multihead inbred lines of sunflower (*Helianthus annuus* L.)

GH Naik and MK Ghodke

Abstract
The experimental material comprised of 60 multihead inbred lines of sunflower (*Helianthus annuus* L.) and one check SS-2038 had evaluated at oilseeds research station, Latur during the *kharif* 2017 in a randomized block design with two replications. Observations were recorded for twelve characters *viz.*, days to 50% flowering, days to maturity, plant height, head diameter, no of branches per plant, seed filling percentage, hull content percentage, Seed yield per plant, 100 seed weight, oil content, pollen production per plant and volume weight per plant etc. Correlation studies indicated that head diameter, seed filling per cent 100 seed weight and pollen production per plant had significant positive association with seed yield. Path coefficient analysis revealed that high positive direct effect of days to 50% flowering, plant height, head diameter, no of branches per plant, seed filling (%), hull content (%), 100 seed weight (g), volume weight (g) with yield. Therefore simultaneous selection for these traits is suggested for improvement of seed yield in sunflower.

Keywords: Sunflower, yield, correlation, path analysis etc.

Introduction
Sunflower (*Helianthus annuus* L.) is one of the most important oilseed crop in India. It was taken up in view of its various advantages *viz.*, photo and thermo insensitivity, short duration, high yield and better quality of oil. The correlation coefficient is a most important statistical constant used as a measure of the degree of association between two characters. The path coefficient analysis of cause and effect relationship provides the knowledge of relative importance of each of component characters the present investigation is carried out to study the character association and path analysis for pollen production, seed yield and yield contributing characters.

Material and Methods
The experimental material consisted of 61 sunflower inbred lines including one check (SS-2038) obtained from Oilseeds Research station, Latur. The experiment is conducted during *kharif* 2017. The experimental material was sown in randomized block design with two replications with Plot size 1.20 m X 3.0 m., Spacing Row to row 60cm and Plant to plant 30cm. Observations were recorded for twelve characters *viz.*, days to 50% flowering, days to maturity, plant height, head diameter, no of branches per plant, seed filling percentage, hull content percentage, Seed yield per plant, 100 seed weight, oil content, pollen production per plant and volume weight per plant etc. The mean over replication of each character was subjected to statistical analysis. Genotypic, phenotypic and environmental correlation coefficients, between pairs of characters were computed by the procedure given by Falconer (1964) [3] and Path coefficient analysis was carried out according to Dewey and Lu (1959) [1].

Result and Discussion
When a particular character is influenced by number of factors, it becomes necessary to evaluate and to know what extent they are associated. The correlation studies of twelve quantitative characters were worked out at genotypic and phenotypic levels in order to know the absolute association among the characters. In the present study the genotypic correlation coefficients were slightly higher than their respective phenotypic correlation coefficient (Table 1) for most of the character. Seed yield per plant was highly significant and positively correlated with seed filling percentage, 100 seed weight, head diameter, pollen production per plant at genotypic and phenotypic level. While, negative and non-significant correlation with days to maturity, plant height, oil content at genotypic level with low magnitude. In support of these findings seed yield per plant highly significant and positively correlated with 100 seed weight, head diameter and number of filled seeds were reported by Teklewold *et al.*, (2000)

Corresponding Author:
GH Naik
Department of Genetics and
Plant Breeding, College of
Agriculture, Latur, Maharashtra,
India

[12], Gouri et al., (2006) [4], Sowmya et al., (2010) [11], Neelima et al., (2012) [7], Prabhakaran et al., (2013) [8], Deengra et al., (2013) [2] and Venkanna et al., (2014) [15] Among the yield component seed filling percentage, 100 seed weight, head diameter and pollen production were positively and significantly correlated between each other indicating that simultaneous selection for these characters might bring an improvement in seed yield.

Path coefficient analysis was performed for seed yield per plant taking it as a dependent variable and remaining 11 characters are independent variables. Both phenotypic and genotypic paths were worked out, since the phenotypic path will have a greater influence of environmental factors, the genotypic path was considered with a greater weightage (table 2).

It is observed that days to 50% flowering exhibited highest direct positive effect and indirect effect through no of branches per plant and oil content, pollen production per plant. Since this trait showing high correlation and high direct

effect on seed yield per plant, one can improve the seed yield per plant by making selection for this character during yield improvement programme. Similar finding reported by Tilak et al., (2016) [13] and Sanju et al., (2018) [10]. After days to 50% flowering, Volume weight per plant, Head diameter, Seed filling percentage, Hull content percentage, Plant height, 100 seed weight exhibited a considerable amount of direct positive effect on seed yield per plant. Similar finding reported by Neharu and Manjunath (2003) [6], Neelima et al., (2012) [7], Sanju et al., (2018) [10]. By Vidhyavathi et al., (2005) [14] etc. Days to maturity, Oil content percentage influenced seed yield per plant by negative direct effect. At both genotypic and phenotypic levels. Similar finding also reported by Gouri et al., (2006) [4], Tilak et al., (2016) [13], Pandya et al., (2015) [9], Venkanna et al., (2014) [15] and Deengra et al., (2013) [2]. These findings suggested that, simultaneous selection for these traits is important for improvement of seed yield in sunflower.

Table 1: Estimation of genotypic (G) and phenotypic (P) correlation for 12 characters in sunflower

Sr. No.	Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	Head diameter (cm)	No. of branches /plant	Seed filling (%)	Hull content (%)	100 seed weight (g)	Oil content (%)	Pollen production (mg)/plant	Volume weight (g)/plant	Seed yield (g)/plant
1.	Days to 50% flowering	G	1.000	0.7295**	-0.1515	-0.2043*	0.1465	-0.0449	-0.0032	-0.1975*	-0.0908	-0.2352**	-0.1313	0.1079
		P	1.000	0.6123**	-0.1252	-0.1822*	0.1155	-0.0119	0.0444	-0.1526	-0.0601	-0.1704	-0.1032	0.0563
2.	Days to maturity	G		1.000	0.1763	0.1348	0.2478**	-0.1120	0.1177	-0.0733	-0.2414**	-0.2370**	-0.1595	-0.0630
		P		1.000	0.1382	0.0808	0.1334	-0.0796	0.1410	-0.0675	-0.1621	-0.1453	-0.1176	-0.0253
3.	Plant height (cm)	G			1.000	0.4450**	-0.1088	0.0751	0.0503	0.4959**	0.2568**	0.3506**	-0.0766	-0.0192
		P			1.000	0.4111**	-0.1095	0.0495	0.0778	0.4479**	0.2272*	0.3350**	-0.0703	-0.0105
4.	Head Diameter (cm	G				1.000	-0.2101*	0.0947	0.0978	0.4439**	-0.1252	0.3783**	-0.0828	0.6648**
		P				1.000	-0.1870*	0.0703	0.1007	0.3778**	-0.1280	0.3276**	-0.0786	0.2192*
5.	No of branches per plant	G					1.000	-0.0214	-0.0552	0.0100	-0.0655	-0.2915**	-0.1120	0.0246
		P					1.000	-0.0108	-0.0411	0.0127	-0.0535	-0.2568**	-0.1013	0.0268
6.	Seed filling (%)	G						1.000	-0.0598	0.1379	0.1720	-0.0302	-0.0171	0.2800**
		P						1.000	-0.0870	0.0729	0.1523	-0.0094	-0.0421	0.2117*
7.	Hull content (%)	G							1.000	0.3340**	0.0533	-0.0224	-0.2994**	0.0859
		P							1.000	0.2792**	0.0611	0.0045	-0.2281*	0.0720
8.	100 seed weight (g)	G								1.000	0.1398	0.2516**	-0.0390	0.2214*
		P								1.000	0.1095	0.1965*	-0.0281	0.1827*
9.	Oil content (%)	G									1.000	0.1298	-0.0322	-0.0017
		P									1.000	0.1061	-0.0112	0.0105
10.	Pollen production (mg)/plant	G										1.000	0.1149	0.2956**
		P										1.000	0.0779	0.2447**
11.	Volume weight (g)/ plant	G											1.000	0.1590
		P											1.000	0.1375
12.	Seed yield (g) /plant	G												1.000
		P												1.000

*Indicate significant at 5% level   ** Indicate significant at 1% level

Table 2: Phenotypic (P) and genotypic (G) path coefficients among yield attributes in 61 sunflower genotypes

Sr. No.	Characters		Days to 50% flowering	Days to maturity	Plant height (cm)	Head diameter (cm)	No. of branches/ plant	Seed filling (%)	Hull content (%)	100 seed weight (g)	Oil content (%)	Pollen production (mg)/plant	Volume weight (g) /plant	Seed yield (g)/plant
1.	Days to 50% flowering	G	0.6617	0.4827	-0.1003	-0.1352	0.0969	-0.0297	-0.0021	-0.1307	-0.0601	-0.1556	-0.0869	0.1079
		P	0.1307	0.0800	-0.0164	-0.0238	0.0151	-0.0016	0.0058	-0.0199	-0.0079	-0.0223	-0.0135	0.0563
2.	Days to maturity	G	-0.4989	-0.6838	-0.120	-0.0922	-0.1694	0.0766	-0.0805	0.0501	0.1651	0.1621	0.1091	-0.0630
		P	-0.0471	-0.0769	-0.0106	-0.0062	-0.0103	0.0061	-0.0108	0.0052	0.0125	0.0112	0.0090	-0.0253
3.	Plant height (cm)	G	-0.0254	0.0295	0.1676	0.0746	-0.0182	0.0126	0.0084	0.0831	0.0430	0.0588	-0.0128	-0.0192
		P	0.0061	-0.0067	0.0484	0.0199	-0.0053	0.0024	0.0038	0.0217	0.0110	0.0162	-0.0034	-0.0105
4.	Head Diameter (cm)	G	-0.0545	0.0360	0.1188	0.2669	-0.0561	0.0253	0.0261	0.1185	-0.0334	0.1010	-0.0221	0.6648**
		P	-0.0008	0.0004	0.0019	0.0046	-0.0009	0.0003	0.0005	0.0017	-0.0006	0.0015	-0.0004	0.2192*
5.	No of branches per plant	G	0.0201	0.0340	-0.0149	-0.0289	0.1374	-0.0029	-0.0076	0.0014	-0.0090	-0.0400	-0.0154	0.0246
		P	0.0025	0.0029	-0.0024	-0.0041	0.0218	-0.0002	-0.0009	0.0003	-0.0012	-0.0056	-0.0022	0.0268
6.	Seed filling (%)	G	-0.0097	-0.0244	0.0163	0.0206	-0.0047	0.2174	-0.0130	0.0300	0.0374	-0.0066	-0.0037	0.2800**
		P	-0.0026	-0.0171	0.0106	0.0151	-0.0023	0.2146	-0.0187	0.0157	0.0327	-0.0020	-0.0090	0.2117*
7.	Hull content (%)	G	-0.0007	0.0247	0.0106	0.0205	-0.0116	-0.0126	0.2099	0.0701	0.0112	-0.0047	-0.0628	0.0859

		P	0.0039	0.0124	0.0069	0.0089	-0.0036	-0.0077	0.0881	0.0246	0.0054	-0.0201	0.0004	0.0720
8.	100 seed weight (g)	G	-0.0178	-0.0066	0.0448	0.0401	0.0009	0.0125	0.0302	0.0903	0.0126	0.0227	-0.0035	0.2214*
		P	-0.0302	-0.0133	0.0885	0.0746	0.0025	0.0144	0.0552	0.1975	0.0216	0.0388	-0.0056	0.1827*
9.	Oil content (%)	G	0.0115	0.0307	-0.0326	0.0159	0.0083	-0.0219	-0.0068	-0.0178	-0.1271	-0.0165	0.0041	-0.0017
		P	0.0020	0.0053	-0.0074	0.0042	0.0017	-0.0050	-0.0020	-0.0036	-0.0326	-0.0035	0.0004	0.0105
10.	Pollen production (mg)/plant	G	0.0586	0.0590	-0.0873	-0.0942	0.0726	0.0075	0.0056	-0.0627	-0.0323	-0.2491	-0.0286	-0.2956**
		P	0.0104	0.0089	-0.0204	-0.0200	0.0157	0.0006	-0.0003	-0.0120	-0.0065	-0.0610	-0.0048	-0.2447**
11.	Volume weight (g)/plant	G	-0.0370	-0.0449	-0.0216	-0.0233	-0.0316	-0.0048	-0.0843	-0.0110	-0.0091	0.0324	0.2818	0.1590
		P	-0.0186	-0.0212	-0.0127	-0.0142	-0.0182	-0.0076	-0.0411	-0.0051	-0.0020	0.0140	0.1802	0.1375

Genotypic residual effect = 0.8369, phenotypic residual effect = 0.1859

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