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CORRELATION AND PATH ANALYSIS IN SUNFLOWER

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SUMMARY

Fifty-one inbreds and three checks of sunflower were laid in a randomized complete block design following recommended package of practices. Correlation studies revealed that seed yield was positively and significantly associated with seed volume weight, hull percentage, percent autogamy, days to 50 percent flowering and oil yield. Oil content was positively associated with plant height, number of leaves per plant, seed volume weight, hull percentage, head diameter, percent autogamy, days to 50 percent flowering, 100-seed weight, seed yield and oil yield. Path coefficient analysis for seed yield at phenotypic level showed that the direct effect was maximum for oil yield followed by 100-seed weight. The maximum indirect effect for seed yield was minimum through oil yield, while it was through yield per plant for oil.

Key words: character association, path analysis, sunflower

INTRODUCTION

The objectives of any plant breeder include selection from a natural population or from one developed by him for one or several characters. Yield is a complex character and is a function of several component characters and their interaction with environment. It would be more meaningful if the structure of yield were probed through breeding. It is necessary to measure the mutual relationship between various plant characters and determine the component characters on which selection can be based for genetic improvement in yield. Genotypic and phenotypic association reveal the degree of association between different characters. Thus it helps to base selection procedure to a required balance where two opposite desirable characters affecting the principal characters are being selected. It also helps to improve different characters simultaneously. Desai (1989), Patil *et al.* (1996b) and Abdelgawad *et al.* (1987) have reported positive associations of seed yield with various yield components. Ibrahim (1985) and Srinivasa (1982) have reported positive associations of various yield components with oil content.

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The path analysis gives the cause and effect relationship. It splits the association coefficient into measures of direct and indirect effects and determines the direct and indirect contribution of various characters towards yield. It critically breaks up different direct and indirect effects which finally make up association coefficient. Hussain *et al.* (1995) and Sheriff *et al.* (1987) have reported direct effects of different characters on seed yield.

MATERIAL AND METHODS

The experiment consisted of 51 inbreds and three checks (GAUSUF-7, TNAUSUF-15 and KBSH-1) of sunflower which were of diverse nature with respect to geographic distribution(Table 1).

Table 1: Sunflower inbreds and their country of origin

No	Inbreds	Country	No	Inbreds	Country
1	RHA-348	USA	29	ARM-250B	France
2	CMS-234B	USA	30	CMS-852B	USA
3	RHA-801	USA	31	7-1-B	India
4	CMS-336B	USA	32	CMS-302	USA
5	RHA-356	USA	33	RHA-180	USA
6	CMS-343B	USA	34	CMS-597B	Canada
7	RHA-274-1	USA	35	HAM-69	India
8	ARM-242B	India	36	RHA-R-R-I	USA
9	CMS-207B	USA	37	CMS-234B-I	USA
10	HAM-174	India	38	CMS-89B	USA
11	ARM-244B	India	39	RHA-MR-I	USA
12	CMS-850B	USA	40	86 B_3	France
13	ARM-246B	India	41	CMS-851B	USA
14	CMS-353B	USA	42	RHA-272-I	USA
15	ARM-243	India	43	RHA-587-II	USA
16	MR-1	India	44	CMS-335B	USA
17	ARM-245B	India	45	RHA-272-II	USA
18	CMS-351B	USA	46	RR-I	USSR
19	HAM-9R	India	47	CMS-349B	USA
20	ARM-247B	India	48	CMS-339B	USA
21	CMS-300B	USA	49	CMS-62B	France
22	HAM-196	India	50	338(C)-B	USSR
23	ARM-248B	India	51	ARM-248B	India
24	CMS-350B	USA			
25	RHA-274-II	Australia		Checks	
26	ARM-249B	India	1	GAUSUF-15	India
27	CMS-843B	USA	2	TNAUSUF-7	India
28	RHA-278	France	3	KBSH-1	India

Table 2: Phenotypic correlation coefficients for 15 quantitative characters in sunflower

	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
X_1	0.504**	0.103	-0.155	-0.088	0.042	0.659**	-0.124	0.459**	0.289*	0.454**	0.199	0.546**	0.210	0.540**
X_2		-0.194	-0.236	-0.238	0.193	0.466**	-0.008	0.476**	0.014	0.330*	0.184	0.356**	0.097	0.331*
X_3			-0.118	-0.098	0.034	-0.009	0.301*	0.114	0.087	-0.238	0.247	0.090	0.291*	0.176
X_4				0.166	-0.193	-0.293*	0.133	-0.124	0.021	-0.178	-0.203	-0.331*	-0.148	-0.351**
X_5					-0.868**	-0.071	0.079	-0.186	0.020	0.193	-0.110	0.085	0.133	0.097
X_6						0.095	-0.039	0.120	-0.029	-0.255	0.113	-0.115	-0.134	-0.119
X_7							-0.170	0.324*	0.037	0.583**	0.141	0.523**	0.124	0.511**
X_8								0.123	-0.093	-0.327*	-0.228	-0.325*	0.100	-0.210
X_9									0.011	0.171	0.316*	0.352**	0.172	0.355**
X_{10}										0.105	0.033	0.076	0.179	0.125
X_{11}											0.059	0.677**	0.131	0.624**
X_{l2}												0.417**	0.208	0.383**
X_{13}													0.339*	0.948**
X_{14}														0.534**

X_1=Plant height; X_2=Number of leaves per plant; X_3=Seed volume weight; X_4=Seed density; X_5=Hull percentage; X_6=Husk percentage; X_7=Head diameter; X_8=Percent autogamy; X_9=Stem girth; X_{10}=Days to 50% flowering; X_{11}=100-seed weight; X_{12}=Percent seed set; X_{13}=Yield per plant; X_{14}=Oil content; X_{15}=Oil yield

It was laid out in a random complete block design during summer 2000 under irrigated conditions with a spacing of 60 x 30 cm and two replications were adopted. The observations were recorded on five randomly selected plants. Phenotypic and genotypic associations were computed as per Weber and Moorthy (1952). Path coefficient analysis was carried out as suggested by Wright (1921) and illustrated by Dewey and Lu (1959). The characters which exhibited significant associations with seed yield and oil yield were considered for path analysis viz., plant height, number of leaves per plant, seed volume weight, hull percentage, head diameter, stem girth, days to 50 percent flowering, 100-seed weight, percent seed set, oil content and oil yield.

RESULTS AND DISCUSSION

Phenotypic association

It is evident from the results (Table 2) that seed yield was positively and significantly associated with plant height (Narayana, 1998), number of leaves per plant (Satisha *et al.,* 1995), head diameter (Singh *et al.,* 1998), stem girth, (Punia *et al.,* 1994), 100-seed weight (Singh *et al.,* 1990), percent seed set (Singh *et al.,* 1998; Narayana *et al.,* 1998) and oil content (Jhagirdhar, 1986). In general, seed yield was positively associated with all other characters except with seed density, husk percentage and percent autogamy (Figure 1).

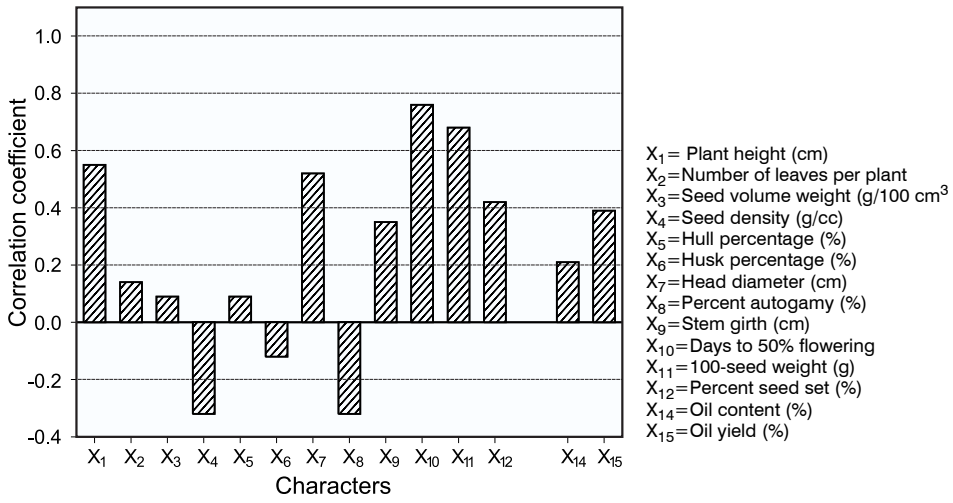

Figure 1: Phenotypic correlation coefficient of 14 quantitative characters with seed yield in sunflower

Since most of the associations are in the desirable direction, these aid in easy selection of inbreds with desirable characters. On the other hand, oil content was positively associated with plant height (Jhagirdhar, 1986; Abdelgawad, 1987) number of leaves per plant (Ibrahim, 1985; Abdelgawad *et al.,* 1987), seed volume

weight (Lakshmanaih, 1980; Shivaraju, 1984), hull percentage, head diameter (Lakshmanaiah, 1980) days to 50 percent flowering (Ibrahim, 1985), 100-seed weight (Abdelgawad *et al.,* 1987), seed yield and oil yield. Among these positive associations, the associations with seed volume weight, percent seed set, yield per plant and oil yield, while oil content were negatively and non-significantly associated with seed density and husk percentage (Figure 2).

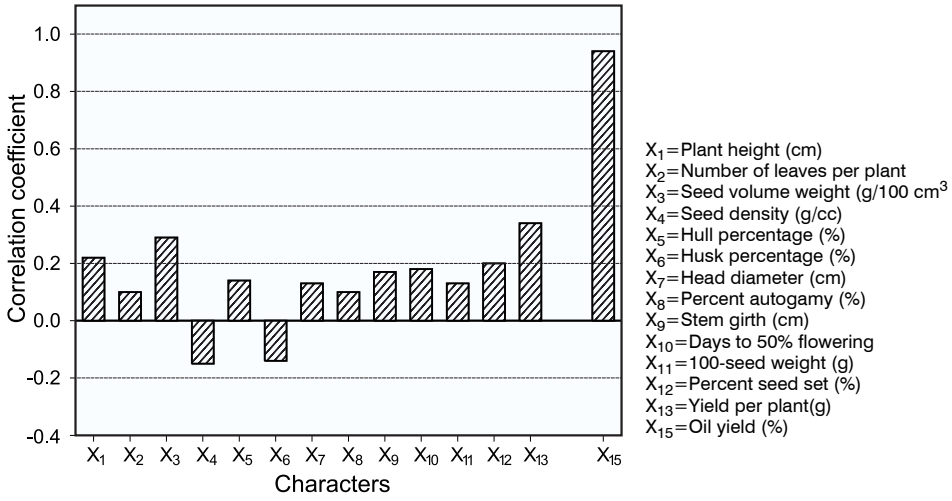

Figure 2: Phenotypic correlation coefficient of 14 quantitative characters with oil content in sunflower

Lack of strong association between seed volume weight, hull percentage, days to 50 percent flowering and seed yield gives ample scope to select desired high seed volume weight with high yielding, higher hull percentage with high yielding and early flowering with high yielding types. Fortunately, seed yield and oil content were reported to be desirably and negatively associated with husk percentage. One of the interesting features in sunflower reflected by the present study is that the associations among all yield components were positive which would be encouraging for rapid improvement of seed yield and oil content. Though seed density was negatively associated with most of the characters including seed yield and oil content, its lower magnitude would not affect much in the improvement of seed yield and oil content.

Path analysis

Path analysis was carried out in respect of seed yield and oil yield (Tables 3 and 4).

Path analysis for seed yield

The direct effect for seed yield was maximum through oil yield followed by 100-seed weight. The maximum indirect effect for any character was through oil yield which itself was the major contributor.

Table 3: Direct and indirect effects of yield components on seed yield at phenotypic level

	X_1	X_2	X_4	X_7	X_8	X_9	X_{11}	X_{12}	X_{14}	X_{15}	r(P)
X_1	0.0705	-0.0250	0.0040	-0.0209	0.0083	0.0066	0.1053	-0.0024	-0.0248	0.3884	0.5460
X_2	0.0355	-0.0498	0.0061	-0.0147	0.0005	0.0069	0.1265	-0.0023	-0.0115	0.2376	0.3560
X_4	-0.0109	0.0118	-0.0257	0.0093	-0.0089	-0.0018	-0.0413	0.0025	0.0175	-0.2903	-0.3310
X_7	0.0465	-0.0232	0.0075	-0.0032	0.0114	0.0047	0.1352	-0.0017	-0.0147	0.3501	0.5230
X_8	-0.0087	0,0004	-0.0034	0.0054	-0.0673	0.0018	-0.0759	0.0028	-0.0118	-0.1517	-0.3250
X_9	0.0323	-0.0237	0.0032	-0.0103	-0.0083	0.0145	0.0897	-0.0039	-0.0203	0.2724	0.3520
X_{11}	0.0320	-0.0164	0.0046	-0.0184	0.0220	0.0025	0.2319	-0.0007	-0.0154	0.3909	0.6770
X_{12}	0.0140	-0.0092	0.0052	-0.0045	0.0153	0.0046	0.0136	-0.0123	-0.0245	0.4098	0.4170
X_{14}	0.0148	-0.0048	0.0038	-0.0039	-0.0067	0.0025	0.0304	-0.0025	-0.1179	0.4048	0.3390
X_{15}	0.0381	-0.0165	0.0090	-0.0162	0.0141	0.0051	0.1447	-0.0047	-0.0630	0.4100	0.5340

X_1=Plant height; X_2=No. of leaves per plant; X_4=Seed density; X_7=Head diameter; X_8=Percent autogamy; X_9=Stem girth; X_{11}=100-seed weight; X_{12}=Percent seed set; X_{14}=Oil content; X_{15}= Oil yield; r=0.0449; r (p)=Phenotypic correlation with seed yield

Table 4: Direct and indirect effects of yield components on oil yield at phenotypic level

	X_1	X_2	X_4	X_7	X_9	X_{11}	X_{12}	X_{13}	X_{14}	r(p)
X_1	0.0016	-0.0393	0.0239	0.0282	-0.0074	-0.0315	0.0011	0.5070	0.0480	0.5400
X_2	0.0008	-0.0780	0.0066	0.0199	-0.0077	-0.0229	0.0010	0.4030	0.0022	0.3310
X_4	-0.0003	0.0184	-0.1546	-0.0455	0.0020	0.0124	-0.0011	-0.0803	-0.0888	-0.3510
X_7	0.0011	-0.0363	0.0353	0.0428	-0.0052	-0.0405	0.0008	0.5001	0.0104	0.5110
X_9	0.0007	-0.0371	0.0192	0.0139	-0.0161	-0.0119	0.0017	0.3282	0.0394	0.3550
X_{11}	0.0007	0.0257	0.0275	0.0249	-0.0027	-0.0695	0.0003	0.5801	0.0299	0.6240
X_{12}	0.0003	-0.0143	0.0313	0.0060	-0.0051	-0.0041	0.0053	0.2992	0.0475	0.3830
X_{13}	0.0009	-0.0258	0.0912	0.0219	-0.0057	-0.0461	0.0022	0.1217	0.7562	0.9480
X_{14}	0.0003	0.0076	0.0229	0.0053	-0.0028	-0.0091	0.0011	0.4831	0.0085	0.5340

X_1=Plant height; X_2=Number of leaves per plant; X_4=Seed density; X_7=Head diameter; X_9=Stem girth; X_{11}= 100 seed weight; X_{12}=Percent seed set; X_{13}=Yield per plant; X_{14}=Oil content; r=0.0483; r (p)=Phenotypic correlation with oil yield

On the contrary, the direct effect of oil content was observed to be maximum by some workers (Lakshmanaiah, 1980; Ibrahim, 1985). The direct and indirect effects of seed density and percent autogamy were in the negative direction, while these were important characters with maximum indirect effects (Figure 3).

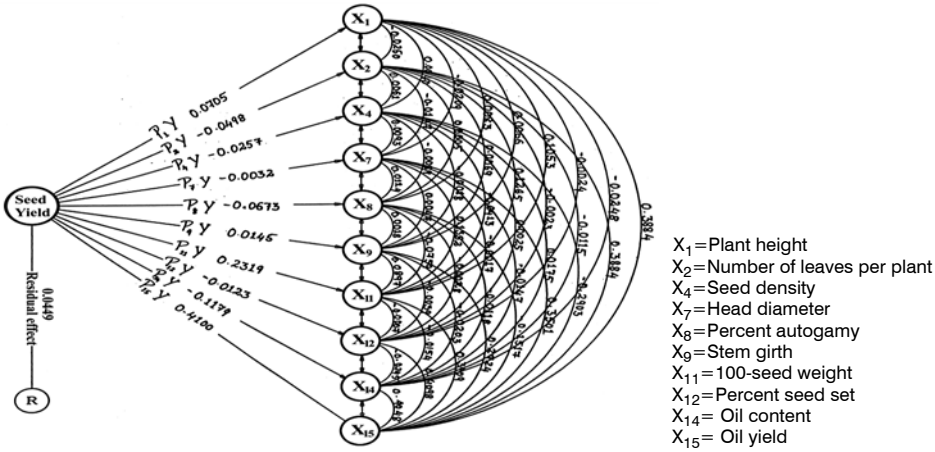

Figure 3: Path diagram showing direct and indirect effects of yield components on seed yield at phenotypic level.

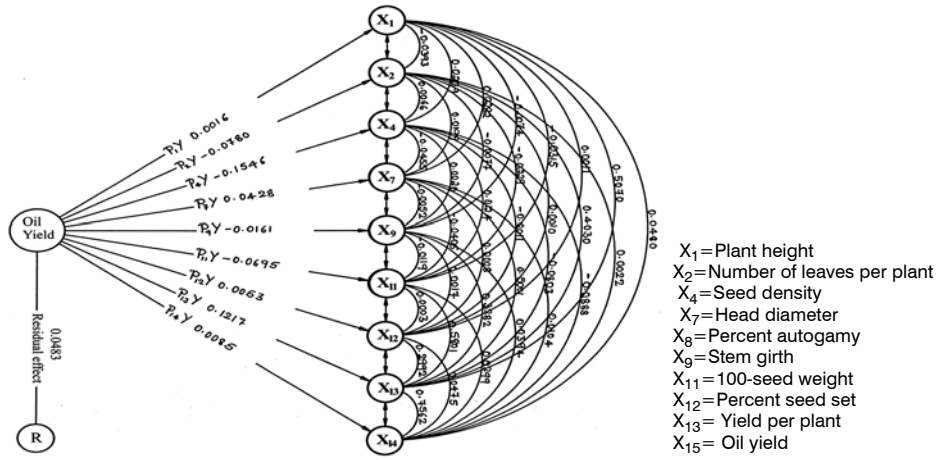

Figure 4: Path diagram showing direct and indirect effects of yield components on oil yield at phenotypic level.

Path analysis for oil yield

The path analysis carried out in respect of oil yield showed that the direct effect was maximum for yield per plant. The maximum indirect effect for any character was through yield per plant which itself was a major contributor. Patil *et al.* (1996b), Hussain *et al.* (1995) and Punia *et al.* (1994) have reported maximum direct effect through test weight. Except yield per plant and oil content the direct

and indirect effects of all other characters were non-significant. Interestingly, both direct and indirect effects of 100-seed weight was in the negative direction even though it was an important yield-contributing character (Figure 4).

CONCLUSION

From the above results it would be reasonable to suggest that a breeder engaged in the improvement of sunflower yield and oil content should pay great emphasis on the yield per plant, 100-seed weight, oil content and oil yield.

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ANÁLISIS CORRELATIVO Y EL "PATH" DE GIRASOL

RESUMEN

Se ha desarrollado el ensayo del 51 consanguíneas y tres líneas control de girasol, según el sistema bloques al azar, con aplicación de las medidas agrotécnicas recomendadas. La investigación de la correlación ha demostrado que el rendimiento de la semilla ha estado en la significante correlación positiva con el peso volumétrico de la semilla, porcentaje de la vaina, el porcentaje de autogamia, número de días hasta la floración de 50% de plantas y el rendimiento de la semilla. El contenido de aceite estaba en correlación positiva con la altura de la planta, el número de hojas por planta, el peso de volumen de la semilla, el porcentaje de vaina, diámetro de la cabeza, porcentaje de autogamia, número de días hasta la floración de 50% de plantas, el peso de 100 semillas, el rendimiento de semilla y el rendimiento de aceite. El análisis "path" del coeficiente para el rendimiento de semilla en el nivel de fenotipo, ha mostrado el mayor efecto directo en el caso de rendimiento de aceite, y luego en el peso de 100 semillas. El mayor efecto indirecto para el rendimiento de semilla, se ha logrado a través de rendimiento de aceite, mientras que en el aceite, éste fue el caso con el rendimiento por planta.

CORRÉLATION ET ANALYSE "PATH" DANS LE TOURNESOL

RÉSUMÉ

Une expérience a été faite avec cinquante et une lignes inbred et trois lignes de contrôle selon un plan de bloc aléatoire et suivant les mesures agrotechniques recommandées. L'examen de la corrélation a montré que le rendement en semences étaient en corrélation significativement positive avec le poids du volume de semence, le pourcentage d'enveloppes de semence, le pourcentage d'autogamie, le nombre de jours avant la floraison de 50% des plantes et le rendement en huile. Le contenu d'huile se trouvait en corrélation positive avec la hauteur de la plante, le nombre de feuilles par plante, le poids du volume de semence, le pourcentage d'enveloppes de semence, la circonférence de la tête, le pourcentage d'autogamie, le nombre de jours avant la floraison de 50% des plantes, le poids de 100 semences, le rendement en semences et le rendement en huile. L'analyse du coefficient "path" pour le rendement en semences au niveau phénotypique a montré l'effet direct maximal dans le cas du rendement en huile et ensuite pour la masse de 100 semences. L'effet indirect maximal sur le rendement en semences a été constaté par le rendement en huile tandis que l'effet indirect maximal pour l'huile a été constaté par le rendement par plante.