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EFFECT OF ENVIRONMENT IN THE VARIABILITY OF CHARACTERS IN SAFFLOWER *(Carthamus tinctorius* L.*)*

B. SUBBALAKSHMI[1] and V. SIVASUBRAMANIAN[2]

Twenty-eight genotypes of Safflower *(Carthamus tinctorius* L.*)* were evaluated under rainfed and irrigated systems of cropping. The D^2 analysis has revealed that twenty eight genotypes formed into as many as nine and thirteen clusters under rainfed and irrigated cropping systems. There is some amount of parallelism in the genotypes, PI 248849 and PI 209291, not only in the clustering but also the distance between the clusters. The path analysis indicated that number of branches and number of heads per plant are the important contributing factors for yield both directly and indirectly. The genotypes K-1, PI 199901 and PI 248827 are the desirable types for these traits.

Investigations on the genetic diversity in crop plants have revealed that genotypes drawn from different geographic areas do not differ much in their genetic architecture, and these belonging to one eco-geographic origin disclosed recognisable differences in their genotypic contribution. In this context, imminent necessity for an assessment of the twenty-eight safflower varieties was felt. Path analysis and D^2 analysis were done to study the impact of various characters on yield and to bring out the enviromental influence (rainfed and irrigated) on the expression of yield and its association on the expression of yield and its associated attributes and their interrelationship.

MATERIALS AND METHODS

The test materials involved in this investigations are twenty-eight genotypes of Safflower (*Carthamus tinctorius* L.) from different geographical sources maintained at the School of Genetics, Tamil Nadu Agricultural University, Coimbatore. Out of twenty-eight genotypes, twelve had Indian origin and the rest represented eight different countries. These materials were also classified as spiny and non-spiny. Based on the height of plant, the genotypes were also grouped as dwarf, medium and tall and their ralative performance evaluated.

Path coefficient analysis suggested by Dewey and Lu (1959) was utilised to partition the genotypic correlation coefficient into direct and indirect effects and Mahalanobis D^2 statistics was used for estimating the genetic divergence.

RESULTS AND DISCUSSION

In the present study by the application of D^2 analysis, the twenty eight genotypes were clustered into nine groups under rainfed and thirteen groups under irrigated conditions

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1. Assistant Professor, School of Geneties, Tamil Nadu Agricultural University, Coimbatore
2. Professor (Rice), Tamil Nadu Rice Research Institute Aduthurai

The composition of D² clusters rainfed and composition of D² clusters under irrigated and intra and inter-cluster, average D² and D values are furnished in Table 1, 2, 3, and 4.

Under rainfed conditions cluster I composed of seven genotypes followed by cluster II with six genotypes. Each of this group consisted of entries derived from different sources. The cluster V, VI and VIII consisted of two, three and two genotypes respectively and all of which two, two and one are of Indian origin. In the grouping of genotypes grown under irrigation, ten out of the 28 could be classed under Cluster I. Eight entries out of the ten are Indian origin. Similarly, the cluster II, III, IV and V also had the entries derived from similar geographic origin. This indicated the existence of parellelism between genotic divergence and geographic origin present in the safflower materials. Similar types of relationship was also reported by Singh and Singh (1976) in Chillies.

Many earlier studies which reported the lack of parallelism between-geographic and genetic diversities were available in crops like maize (Moll *et al.*, 1962) Timothy, 1963), linseed (Singh and Joshi, 1966). green gram (Gupta and Singh, 1970), rice (Jawahar Ram *et al*; 1970 and Nagesha, 1976). Sorghum (Govil and Murthy, 1973), soybean (Verma *et al.*, 1973). However and such a relationship was not discernible in the case of clustering of these genotypes when cropped under rainfed condition. This points to the fact that other factors may also disturb the grouping of genetic divergence. This might probably be due to the susceptibility of the genotype to the varying ecological conditions under which those types were grown.

Claussen and Haisey (1958) felt that even a single component of environment such as temperature could cause differences between and within races of crop plants.

According to singh *et al.*, (1971) environmental factors such as rainfed pattern in a particular season could influence the traits like boll number and ginning percentage in cotton. In the present study, irrigation itself could have contributed to the deviation in grouping.

There was some amount of parallelism between rainfed and irrigated cropping in certain genotypes not only in the clustering but also in the distance between the clusters. As for example the genotype PI 248849 and PI 209291 which occurred in cluster I under Irrigated cropping also came under the same cluster under rainfed cropping. There was also less of disturbances in some of the genetypes in the clustering between rainfed and irrigated system. This may perhaps indicate that these genotypes are less susceptible to environment for the expression of various characters.

Path analysis, indicated that the number of heads and plant height had positive direct effects. The number of branches influenced markedly the plant height, number of heads, 1000 seed weight and oil content. The number of branches had very high genotypic correlation (r = 0.85) and the number of heads had r = 0.7415. The indirect effect of number of heads was

Table 1 : Composition of D² clusters

Cluster	No. of genotypes	Genotype Number	Habit of growth	Nature of Spiny	Origin
I	7	PI 248364	IM	SP	India
		PI 248849	IM	SP	India
		PI 237548	IM	SP	Sudan
		PI 209291	D	SP	India
		PI 248383	D	SP	India
		PI 253388	D	NSP	Spain
		PI 253885	D	NSP	Israel
II	6	PI 250533	IM	SP	Egypt
		PI 250076	D	SP	Egypt
		PI 250713	D	NSP	Iran
		CTS 7218	IM	NSP	India
		PI 198845	IM	NSP	France
		PI 250528	IM	NSP	Egypt
III	2	PI 251289	IM	NSP	USA
		PI 250596	IM	NSP	Egypt
IV	2	CTS 7403	T	NSP	India
		PI 250525	T	NSP	Egypt
V	2	K.1	IM	SP	India
		PI 199901	D	SP	India
VI	3	PI 253387	D	NSP	Israel
		PI 248827	D	SP	India
		PI 198209	D	SP	India
VII	3	PI 199915	IM	SP	India
		PI 251262	D	NSP	Jordan
		PI 253386	D	NSP	Israel
VIII	2	PI 250714	IM	NSP	Iran
		PI 248852	IM	SP	India
IX	1	PI 250838	T	SP	Iran

D—Drarf
IM—Medium
T—Tall

SP—Spiny
NSP—Non-spiny

Table 2 Composition of D^2 Clusters (Irrigated)

Cluster	No. of genotypes	Genotype Number	Habit of Growth	Nature of Spiny	Origin
	10	PI 248864	IM	NSP	India
		PI 251289	IM	NSP	USA
		PI 199915	IM	SP	India
		PI 248849	IM	SP	India
		PI 209291	D	SP	India
		PI 248852	IM	SP	India
		PI 198209	D	SP	India
		PI 250528	IM	NSP	Egypt
		PI CTS 7403	T	NSP	India
		PI 199901	D	SP	India
	3	PI 237548	IM	SP	Sudan
		PI 250596	IM	NSP	Egypt
		PI 253386	D	NSP	Israel
III	2	PI 250838	T	SP	Iran
		PI 250713	D	NSP	Iran
IV	3	PI 250525	T	NSP	Egypt
		PI 250533	IM	SP	Egypt
		PI 250076	D	SP	Egypt
V	2	PI 248383	IM	SP	India
		CTS 7218	IM	SP	India
VI	1	K.1	IM	SP	India
VII	1	PI 250714	IM	NSP	Iran
VIII	1	PI 198845	IM	NSP	France
IX	1	PI 253387	D	NSP	Israel
X	1	PI 253885	D	NSP	Israel
XI	1	PI 251262	D	NSP	Jordan
XII	1	PI 253388	D	NSP	Spain
XIII	1	PI 248827	D	SP	India

Table 3 Inter (Diagnonal) and Inter Cluster average D² and D values (within paranthesis) Rainfed Safflower

	I	II	III	IV	V	VI	VII	VIII	IX
I	4.7536 (2.18)	7.4540 (2.73)	6.9474 (2.64)	9.3498 (3.06)	9.3311 (3.05)	9.4228 (3.07)	8.9134 (2.99)	12.9191 (3.59)	17.2583 (4.15)
II		3.8461 (1.96)	7.8957 (2.81)	9.4304 (3.07)	12.4426 (3.53)	10.5373 (3.25)	8.4385 (2.90)	16.2365 (4.03)	14.9182 (3.86)
III			4.7570 (2.18)	10.3659 (3.22)	8.5881 (2.93)	11.2880 (3.36)	12.7057 (3.56)	11.3021 (3.36)	10.9755 (3.31)
IV				6.8903 (2.62)	15.1835 (3.90)	15.7786 (3.97)	17.3485 (4.17)	14.0686 (3.75)	13.9203 (3.73)
V					10.9909 (3.32)	14.7783 (3.84)	17.0116 (4.02)	19.4458 (4.41)	20.3444 (4.51)
VI						7.4444 (2.73)	13.6027 (3.69)	12.4795 (3.53)	19.335 (4.40)
VII							9.9769 (3.16)	14.7288 (3.84)	18.321 (4.28)
VIII								10.2358 (3.20)	16.319 (4.04
IX									—

Table 4: Intra (diagonal) and Inter Cluster average D^2 and D values (within paranthesis) irrigated safflower

		II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII
I	4.3231 (2.08)	7.0284 (2.65)	8.2372 (3.04)	9.7592 (3.12)	8.3643 (2.89)	9.4355 (3.07)	9.1871 (3.03)	9.7909 (3.13)	10.4054 (3.23)	9.5440 (3.99)	8.4976 (2.92)	7.5137 (2.74)	10.5166 (3.24)
II		4.7943 (2.19)	10.9785 (3.31)	14.9225 (3.86)	12.9053 (3.59)	13.3839 (3.66)	10.3081 (3.21)	12.8720 (3.59)	17.1577 (4.14)	8.6205 (2.94)	6.6072 (2.57)	10.2435 (3.20)	18.8399 (4.34)
III			2.9017 (1.70)	14.8361 (3.85)	14.2133 (2.77)	17.3766 (4.17)	10.2641 (3.20)	17.1950 (4.15)	17.3335 (4.16)	17.1170 (4.14)	10.2672 (3.20)	9.3097 (3.05)	15.3487 (3.92)
IV				5.8992 (2.43)	12.3469 (3.51)	14.4134 (3.80)	13.0415 (3.61)	14.8218 (3.85)	17.2857 (4.61)	18.3375 (4.28)	11.8731 (3.45)	17.8563 (4.23)	20.9904 (4.58)
V					6.4018 (2.53)	14.2723 (3.78)	8.5764 (2.93)	20.9217 (4.57)	13.3015 (3.65)	17.4488 (4.18)	16.1430 (4.02)	16.1313 (4.02)	8.3924 (2.90)
VI						7.2899 (2.70)	8.5989 (2.93)	15.6814 (3.96)	116.9088 (4.11)	7.2899 (2.70)	15.2131 (3.90)	20.6362 (4.54)	11.4736 (3.39)
VII							10.3243 (3.21)	16.6149 (4.08)	16.4640 (4.06)	14.5666 (3.82)	10.3242 (3.21)	21.8965 (4.68)	10.7358 (3.28)
VIII								11.3689 (3.37)	24.1208 (4.91)	15.2598 (3.91)	18.6666 (4.32)	11.3689 (3.37)	12.5432 (3.54)
IX									15.6147 (3.95)	12.0525 (3.47)	18.1365 (4.26)	18.1133 (4.26)	15.6147 (3.95)
X										14.1830 (3.77)	16.2745 (4.03)	16.2745 (4.03)	19.2425 (4.39)
XI											—	12.6337 (3.55)	15.2425 (3.94)
XII												—	16.7474 (4.09)
XIII													—

also considerable, particularly through the number of branches. This relationship was consistant both under rainfed and irrigated system. Hence these two components namely, number of heads and number of branches are important while selecting for yield improvement in safflower.

The results of the path analysis with seven components were compared with path analysis with five important traits like plant height, number of branches, number of heads, 1000 seed weight and oil content. The two methods of path analysis had negligible residual effect of 0.4 and below. This indicates the characters chosen to path analysis are adequate. The contribution of direct and Indirect effect of each of the components indicated that the contribution by diameter of the head, number of seeds per head, 1000 seed weight and oil content are negligible and plant height, number of branches, and number of heads appear to be major components of yield.

CONCLUSION

The twenty-eight genotypes formed into as many as nine and thirteen clusters respectively under rainfed and irrigated conditions by D^2 analysis. The scattering of the genotypes of Indian origin in three and four different clusters with different magnitude of distance, among them, revealed the availability of wide genotic diversity in the material from the same ecogeographical origin. Both the seven and five character path analysis brought out that plant height, number of heads and branches were the most important traits to be considered in breeding for higher yield.

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