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Research Paper

DETECTION AND ESTIMATION OF COMPONENTS OF GENETIC VARIATION FOR YIELD AND CONTRIBUTING TRAITS IN SAFFLOWER, *Carthamus tinctorius* L.

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Abstract

The results of gene action and mean analysis revealed that all the three types of gene actions i.e., additive, dominance and epistasis were responsible in varying proportions for all the crosses for seven characters in safflower. Among the epistatic interactions, dominance x dominance interaction was more important than additive x additive in all the crosses and such a genetic situation suggested that reciprocal recurrent selection might be most efficient for utilization of all three types of gene effects for improving the characters under study.
Key words: Safflower, gene effects.

INTRODUCTION

Yield is one of the most important economic characters and is the product of multiplicative interaction of contributing characters. Safflower is generally grown under residual soil moisture conditions both under rainfed and irrigated conditions. A sizable area is under rainfed conditions during rabi where the crop is grown under poor nutrient and water management situations in black soils where realization of maximum yield potential of the crop is challenging. For such situations, identification of promising crosses and subsequent handling of segregating material, through appropriate breeding procedures is urgently required. The developments in statistical genetics have made possible to study the various facts of operation of quantitative genes and to use this information in formulating appropriate breeding strategy to effect genetic improvement of traits under specific situations. The estimation of gene effects involved in the inheritance of yield contributing or quantitative characters are helpful in planning breeding programmes. Hence, in the present investigation, an effort has been made to study the inheritance of yield and its components for further utilization in the breeding programme.

MATERIAL AND METHODS

The experimental materials for the present investigation comprised of a set of six generations *viz.,* P_1, P_2, F_1, F_2, BC_1 and BC_2 of each of the three crosses planted in compact family block design with three replications under normal sown conditions during rabi 2010-11. Each non- segregating generation (P_1, P_2 and F_1) was sown in one row. Among the segregating generations, back crosses were sown six rows and F_1s were sown in eight rows. Rows were 4m long with spacing of 45 cm between rows and 20 cm between plants. Five randomly selected plants each of P_1, P_2 and F_1, 20 plants of F_2 and 15 plants each of BC_1 and BC_2 generations per replication were utilized for recording observations on days to 50% flowering, days to maturity, plant height, number of capitula per plant, number of seeds per capitulum, test weight(g) and seed yield (kg/ha). The data were subjected to scaling tests (Mather, 1949) to detect the presence of epistasis. In case of significance of scaling tests, data were then subjected to the estimation of various genetic components (Hayman, 1958). More precise estimates of theses parameters were then obtained by using weighted joint scaling tests. In the event of the scaling test being non-significant (i.e., absence of non- allelic interactions), the three parameter model, which is based on least square estimates (joint scaling test) were used to estimate main effects (m), (d) and (h). The significance of the parameters was tested against their corresponding standard errors.

RESULTS AND DISCUSSION

The hybrids performed better than the respective parents for all the traits in all the cross combinations except for the crosses Manjira x GMU 1946 with regard to plant height and Sagarmuthyalu x GMU 1946 with regard to days to 50% flowering, days to maturity and plant height, registered earliness in flowering than their respective P_1 generation. In general, however, the trait mean values for the F_1 generation were higher than the corresponding values of the BC_1 and BC_2 generation. However, the F2 value was higher than the corresponding BC_1 and BC_2 generation in respect of days to 50% flowering in the cross Manjira x ASD 07-10, for number of capitula per plant, seeds per capitula and test weight in cross Manjira x GMU 1946 and for seeds per capitulum and test weight in respect of the cross Sagarmuthyalu x GMU 1946. The mean performance of BC2 generation was lower than that of the BC1 generation for most of the traits in all the crosses except for plant height for the cross Manjira x ASD-07-10 and for plant height and number of capitula per plant in the cross Sagarmuthyalu x GMU 1946. The expected mean (M) was positive and significant for all the traits in all the three cross combinations.

Simple additive-dominance model was inadequate for days to 50% flowering, days to maturity and number of capitula per plant in the cross Manjira x GMU 1946, days to maturity, number of capitula per plant, test weight and seed yield in the cross Manjira x ASD-07-10 and for plant height, number of seeds per capitulum and test weight in the cross Sagarmuthyalu x GMU 1946.

Simple additive-dominance model was inadequate for days to 50% flowering in the crosses Manjira x ASD-07-10 and Sagarmuthyalu x GMU 1946 (Table 2). In the cross Manjira x ASD-07-10, dominance x dominance gene effects were important where as in respect of Sagarmuthyalu x GMU 1946 dominance, additive x additive and dominance x dominance gene effects were important. Duplicate epistasis was indicated by opposite sign of dominance and dominance type of gene effects influencing the inheritance of this trait in the crosses Manjira x ASD-07-10 and Sagarmuthyalu x GMU 1946, respectively.

Presence of non- allelic interaction was observed for inheritance of days to maturity in the cross combination Sagarmuthyalux GMU 1946. In addition to dominance, additive x additive and dominance x dominance gene effects were also observed for this trait. however, in the crosses Manjira x GMU 1946 and Manjira x ASD-07-10 , in addition to dominance, additive x additive and additive x dominance gene effects were also influencing the inheritance of this trait . These results are in agreement with the earlier reports of Gupta and Singh (1988).

Presence of epistasis was detected for plant height in all the three crosses. More over in addition to additive dominance gene effects, non- allelic interactions such as additive x additive, additive x dominance and dominance x dominance gene effects were important. The negative value of dominance gene effects suggest the presence of alleles decreasing the trait in the cross Manjira x ASD-07-10. In the crosses Manjira x GMU 1946 and Sagarmuthyalu X GMU 1946, dominance, additive x additive and dominance x dominance gene effects indicate duplicate epistasis. Prasad *et al*. (1993) observed dominance effect was more important for the inheritance of this trait.

In case of number of capitula per plant presence of non- allelic interactions were important. In all the cross combinations, dominance and dominance x dominance gene effects was important influencing the inheritance of the trait. Duplicate epistasis was observed in the cross Manjira x ASD-07-10 and Sagaramuthyalu x GMU 1946 due to opposite signs of dominance x dominance gene effects. The present findings are similar to earlier reports of Manjare and Jambhale (1997) who also reported duplicate type of gene action.

Simple additive dominance model was in adequate in all the crosses except for Sagaramuthyalu x GMU 1946 for number of seeds per capitulum. In the crosses Manjira x GMU 1946 and Manjira x ASD-07-10, dominance and dominance x dominance type of non-allelic interactions were significant. However, in the cross, Sagarmuthyalu x GMU 1946 dominance, additive x dominance and dominance x dominance type gene effects were significant indicating duplicate epistasis for this trait.

In case of test weight presence of non-allelic interactions were important for all the three crosses under study. In the cross Manjira x GMU 1946 simple additive model was inadequate. However, in the cross Sagaramuthyalu x GMU 1946 dominance, additive x dominance and dominance x dominance gene effects were important in the inheritance of test weight. Inadequacy of simple additive dominance model for seed yield was observed for crosses Manjira x GMU 1946. Presence of additive gene action and additive x additive, additive x dominance, dominance x dominance gene effects were observed for the cross Manjira x ASD-07-10. However for the crosses Manjira x GMU 1946 and Sagaramuthyalu x GMU 1946 presence of dominance, additive x dominance and dominance x dominance gene effects were significant for the inheritance of seed yield. Duplicate epistasis was observed for all the crosses as indicated by the opposite signs of dominance and dominance x dominance type of gene effects. Similar results were reported by Ragab (1991).

The dominance effects and gene interaction dominance x dominance (1) or other digenic duplicate type of gene interactions can be exploited effectively by selection for the improvement of the characters. Use of reciprocal recurrent selection or bi-parental mating was suggested for improving the characters, when both additive and non-additive gene effects are involved in the expression of these traits. Presence of non-additive gene effects for some characters indicates that conventional selection procedure may not be effective enough for improvement of yield. Therefore, postponement of selection in later generations or intermating among the selected segreagants followed by one or two generations of selfing could be suggested to break the undesirable linkage and allow the accumulation of favourable alleles for the improvement of this trait.

Thus the above study revealed the presence of additive and non additive gene actions in the expression of these traits. Hence, methods which exploit additive and dominance gene action such as reciprocal recurrent selection could hold promise for genetic improvement of these traits. Furthermore, as the duplicate type of epistasis was observed in most of the traits, so the selection intensity should be mild in the earlier and intense in the later generations to achieve the desirable improvement in these traits in safflower.

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Table 1 Mean of six generations in three crosses of safflower for seven traits

Character	Generation	Manjira x GMU 1946	Manjira x ASD-07-10	Sagaramuthyalu x GMU 1946
Days to 50% flowering				
	P1	80.0	79.6	82.3
	P2	80.3	83.0	80.7
	F1	82.0	84.0	79.6
	F2	78.0	82.0	77.7
	BC1	80.0	79.6	82.3
	BC2	78.0	81.3	78.6
Days to maturity				
	P1	110.0	110.0	112.4
	P2	112.3	115.0	112.6
	F1	112.3	115.0	110.3
	F2	108.0	112.0	107.7
	BC1	110.0	113.0	112.3
	BC2	108.0	111.3	108.6
Plant height (cm)				
	P1	87.0	87.0	90.0
	P2	92.0	92.0	95.2
	F1	81.0	93.7	87.7
	F2	80.3	86.4	84.0
	BC1	82.0	84.7	88.0
	BC2	91.3	90.6	89.3
Number of capitula per plant				
	P1	15.3	15.4	11.7
	P2	14.6	16.0	14.8
	F1	24.6	31.7	24.2
	F2	22.0	24.7	19.6
	BC1	21.0	25.6	20.1
	BC2	18.6	24.3	20.7
Number of seeds per capitulum				
	P1	23.6	23.7	19.7
	P2	20.0	20.0	20.0
	F1	25.0	25.3	28.0
	F2	20.0	20.3	23.0
	BC1	19.3	20.0	23.7
	BC2	18.3	17.4	16.6
Test weight (g)				
	P1	5.57	5.57	4.20
	P2	4.91	4.57	4.91
	F1	6.37	5.39	6.29
	F2	6.08	5.08	5.68
	BC1	5.84	5.46	5.26
	BC2	5.23	4.33	4.86
Seed yield (kg/ha)				
	P1	759.2	759.4	597.0
	P2	902.6	695.7	902.6
	F1	955.8	930.1	1062.5
	F2	865.7	791.2	857.7
	BC1	928.7	868.4	988.3
	BC2	853.5	768.6	986.0

Table 2 Scaling test, components of variance and interaction effects for seven traits in three safflower crosses

Cross	Scaling test				Interaction effects					
	A	B	C	D	M	d	h	i	j	l
Days to 50% flowering										
Manjira x GMU 1946	-2.00	-6.32	-12.36	-2.14	76.18	-0.16	1.52	4.00	2.17	4.29
Manjira x ASD-07-10	-4.26	-4.18	-2.68	3.48	87.58	-1.67	-18.25	-6.00	0.00	14.67
Sagarmuthyalu x GMU 1946	2.65	-3.12	-11.67	-5.66	70.16	0.83	20.54	11.65	2.83	-11.02
Days to maturity										
Manjira x GMU 1946	-2.35	-8.64	-15.21	-2.15	107.67	-1.16	-1.83	4.14	3.15	7.54
Manjira x ASD-07-10	1.02	-7.12	-7.00	-0.35	111.84	-2.54	-2.14	0.67	4.16	5.68
Sagarmuthyalu x GMU 1946	2.03	-5.21	-14.68	-5.69	101.15	-	17.56	11.32	3.67	-8.14
Plant height (cm)										
Manjira x GMU 1946	-4.00	9.67	-19.25	-12.68	64.18	-2.56	47.83	25.21	-6.84	-31.00
Manjira x ASD-07-10	-11.25	-5.14	-21.02	-2.35	84.83	-2.54	-2.83	4.67	-3.16	11.67
Sagarmuthyalu x GMU 1946	-1.66	-4.15	-24.33	-9.25	73.86	-2.51	26.83	18.67	1.16	-13.05
Number of capitula per plant										
Manjira x GMU 1946	2.14	-2.54	8.69	4.57	23.67	0.45	-7.54	-8.67	2.19	8.67
Manjira x ASD-07-10	4.23	1.23	4.26	-0.67	14.25	-0.33	24.13	1.32	1.68	-6.69
Sagarmuthyalu x GMU 1946	4.54	2.67	4.15	-1.36	10.52	-1.52	23.16	2.67	0.83	-9.67
Number of seeds per capitulum										
Manjira x GMU 1946	-10.44	-8.54	-13.24	2.54	26.51	1.83	-24.50	-4.65	-0.83	23.42
Manjira x ASD-07-10	-9.00	-10.65	-13.61	3.25	28.52	1.85	-29.12	-6.68	0.83	26.33
Sagarmuthyalu x GMU 1946	-0.33	-14.69	-3.67	5.68	31.16	-0.64	-29.51	-11.33	7.17	26.35
Test weight (g)										
Manjira x GMU 1946	-0.26	-0.82	1.10	1.09	7.43	0.32	-4.33	-2.18	0.28	3.27
Manjira x ASD-07-10	-0.04	-1.29	-0.59	0.37	5.81	0.49	-2.49	-0.74	0.62	2.07
Sagarmuthyalu x GMU 1946	0.03	-1.48	1.02	1.23	7.02	-0.35	-4.64	-2.46	0.75	3.91
Seed yield (kg/ha)										
Manjira x GMU 1946	142.68	-187.14	-109.68	-32.58	765.50	-71.54	210.83	65.18	164.84	-21.47
Manjira x ASD-07-10	47.23	-89.64	-151.00	-54.87	618.83	31.84	377.51	108.69	68.57	-66.29
Sagarmuthyalu x GMU 1946	317.33	7.48	-193.25	-259.47	231.67	-152.69	1673.25	518.00	155.12	-842.67