COMBINING ABILITY ANALYSIS FOR YIELD COMPONENTS AND MATURITY TRAITS IN SUNFLOWER (HELIANTHUS ANNUUS L.)

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SUMMARY

Sunflower (Helianthus annuus L.) is one of the most important oil seed crops in Kenya. So far only long duration high yielding hybrid sunflower varieties are being grown and their cultivation is limited to high potential areas but due to increasing population pressure and land utilization for cereal crops in these areas, it was felt that varieties suitable for medium and low potential areas should be developed. The present investigation was therefore undertaken to assess the combining ability and gene action in some of the locally available sunflower cultivars so as to utilize the information in breeding early maturing and high yielding varieties suitable for marginal areas of Kenya. For this purpose thirteen varieties (lines) maintained at National Plant Breeding Station, Njoro were obtained. Ten of the these varieties which were being maintained through sib mating and could be considered pure, selected as females (lines) while the other three (open pollinated) were taken as males (testers). The crosses were made in isolation at three different sites at Field Station, Kabete, Faculty of Agriculture experimental area. Thirty crosses thus obtained were sown along with their thirteen parents (43 genotypes) during long rain season of 1986 in a randomized block design in single row plots replicated three times. Data were recorded on five randomly chosen plants in each replication for (i) seed yield per plant (g), (ii) 100 seed weight (g), (iii) head diameter (cm), (iv) number of filled seeds per head, (v) kernel percentage, (vi) plant height (cm), (vii) number of days to flowering and (viii) number of days to maturity. Combining ability analysis showed that gene action for seed yield per plant was predominantly nonadditive while it was additive for 100 seed weight, head diameter, number of filled seeds per head and kernel percentage. The nature of gene action for days to flowering and days to maturity was mainly additive. For plant height additive and nonadditive gene effects were found equally important. The study has also shown that certain lines were better combiners than others with respect to yield components and maturity traits. It is therefore possible to breed an early maturing, high yielding synthetic variety of sunflower suitable for marginal areas of Kenya. Parents with high specific combining ability as indicated by their performance in specific combinations could also be utilized in developing early maturing hybrids suitable for medium potential areas of Kenya.

INTRODUCTION

Sunflower is one of the most important oil seed crops in Kenya. High yielding hybrid sunflower varieties available for cultivation are meant for high potential areas only and cannot do well in marginal areas of this country because of their long maturation period. Due to high population pressure and land utilization for food crops in high potential areas, it was considered necessary to develop early maturing and high yielding varieties suitable for medium and low potential areas of Kenya. To achieve this objective a knowledge of the relative magnitude of general and specific combining abilities and type of genetic effects in parental lines would be helpful. However, this information may not be sufficient for a crop like sunflower where yield and maturity are negatively correlated (Tyagi, 1987). It is therefore imperative to determine the relative values of different genetic effects in parental material before starting an extensive breeding programme to develop varieties suitable for marginal areas. The present study was therefore undertaken to assess the general and specific combining abilities and gene action of some of the locally available sunflower lines so as to utilize the information to breed early maturing and high yielding varieties of sunflower.

MATERIALS AND METHODS

The parental material for this study included ten sunflower cultivars namely; 004, 026, 036, 067, 090, 103, Gro-21, Samena and Amiato obtained from National Plant Breeding Station, Njoro. These were maintained through sibmating and could be considered pure were selected as females (lines) and crossed with three open pollinated varieties viz; Issanka, Fedha and Shaba as males (testers). Resulting 30 hybrids and 13 parents (43 genotypes) were grown in a single row plots replicated three times in a randomized block design during long rain season of 1986 at Faculty of Agriculture experimental area in Kabete. Plots were of 3.60 meter length having twelve plants spaced 30 cm apart. Interplot distance was kept to 75 cm. Data were recorded on randomly selected five competitive plants from each plot in each replication for (i) seed yield per plant (g) (ii) 100 seed weight (g) (iii) head diameter (cm), (iv) number of filled seeds per head, (v) kernel percentage, (vi) plant height at maturity (cm), (vii) number of days to flowering and (viii) number of days to maturity. The combining ability analysis was carried out in accordance with procedures developed by Kempthorne (1957).

RESULTS AND DISCUSSION

Combining ability analysis of variance (Table 1) shows that the variances due to general combining ability (gca) of the males were highly significant (P = 0.01) for yield, its components and maturity traits while that of females were highly significant for 100 seed weight, head diameter, filled seeds per head, kernel percentage, days to flowering and days to maturity and significant (P = 0.05) for seed yield per plant and plant height. The variance due to specific combining ability (sca) was highly significant (P = 0.01) for seed yield per plant and significant (0.05) for plant height, days to flowering and days to maturity. This indicated that seed yield per plant was predominantly governed by nonadditive gene action while gene action for 100 seed weight, head diameter, number of filled seeds per head and kernel percentage was additive. The nature of gene action for days to flowering, and days to maturity was mainly additive with small effect of nonadditive gene action while for plant height both additive and nonadditive gene actions were almost equally important. Sindagi et al. (1979) however, reported higher gca variances than sca for most of the yield components and maturity characters.

Estimates of the gca effects of the females and males are presented in Table 2. Among females 090 was the best general combiner for almost all characters under study but relatively late maturing followed by 004. All female lines showed high gca for filled seed per head and many of them had shown negative gca for days to flowering and days to maturity indicating that these can be utilized for early maturity (Table 2). Among males the Issanka was the best general combiner for all characters except 100 seed weight and head diameter. Negative gca for plant height, days to flowering and days to maturity showed by Issanka can be utilized to develop an early maturing variety with relatively high yield. Similarly Shaba can also be used for earliness in breeding programme.

Table 3 shows the sca effects of the crosses. Out of thirty crosses analysed Thirteen crosses showed highly significant sca effects for seed yield per plant. The best among them was 090 x Shaba followed by 090 x Issanka and 090 x Fedha indicating the potentiality of the combinations for commercial exploitation for seed yield. However most of these crosses were late maturing leaving little

Table 1. Analysis of variance for combining ability in sunflower for yield components and maturity traits.

Source of variation	df	Seed yield per plant	100 seed weight	Head diameter	Filled seeds per head	Kernel percentage	Plant height	Days to flowering	Days to maturity
Males	2	731.32**	5.72**	28.34**	278,320.84**	537.62**	3,879.85**	371.60**	618.78**
Females	9	198.65**	4.08**	21.23**	14,376.39**	318.68**	1,704.23*	123.45**	201.98**
MalesxFemales	18	102.86**	3.01	7.60	5,185.71	98.09	856.65*	11.58*	23.86*
Error	29	43.76	2.76	5.29	4,270.43	65.52	448.81	4.49	10.96

*and **; Significant at P = 0.05 and 0.01 respectively.

Table 2. General combining ability effects of the parents in sunflower for yield components and maturity traits.

Parents	Seed yield per plant	100 seed weight	Head diameter	Filled seeds per head	Kernel percentage	Plant height	Days to flowering	Days to maturity
Females:								
1 004	9.59**	2.09*	2.86*	141.19**	21.23**	5.41*	1.97*	2.78*
2 026	3.06	-0.96	0.64	42.32*	5.70	-0.78	-1.24*	-1.79*
3 036	4.90*	2.13*	1.48*	83.14**	14.06*	-0.23	-0.37	-0.96
4 067	2.70	-0.95	-0.41	51.82*	5.08	-1.03*	-1.78*	-2.15*
5 090	11.12**	3.21*	2.07*	147.27**	24.38**	4.81*	2.81*	3.87*
6 095	4.60*	0.78	1.23	98.53**	11.71*	-0.45	-0.26	-0.68
7 103	3.48	-0.28	-0.04	73.95**	7.86	-0.63	-1.68*	-2.03*
8 Gro 21	4.24*	1.67	1.09	102.42**	11.68*	-0.89	-0.36	-1.19
9 Samena	3.08	0.42	0.57	68.23*	6.20	-0.21	-1.68*	-2.14*
10 Amiato	6.83*	1.79*	1.59*	107.92**	17.47*	1.09*	-0.24	-0.37
Males:								
1 Issanka	5.89*	1.65	1.32	87.34**	15.21*	-1.39*	-2.74*	-1.32*
2 Fedha	2.98	-0.59	-0.34	-21.40*	4.89	-0.97	-1.42*	-1.67*
3 Shaba	3.87	-0.18	-0.12	46.89**	8.68	-0.54	-1.67*	-2.48*

Table 3. Specific combining ability effects of the crosses in sunflower for yield components and maturity traits

Crosses	Seed yield per plant	100 seed weight	Head diameter	Filled seeds per head	Kernel percentage	Plant height	Days to flowering	Days to maturity
1 004 x Issanka	38.59**	7.84**	16.34**	139.14**	25.46**	3.34*	2.07	3.02*
2 026 x Issanka	22.68*	-1.76	-5.14*	-21.81*	5.07	-5.97*	-3.83*	-4.96*
3 036 x Issanka	34.39**	4.20*	11.52*	87.89**	12.68**	-2.89	-2.90	-2.81
4 067 x Issanka	22.98*	-1.38	-1.34	-21.28*	7.83*	-7.43*	-5.28*	-6.65*
5 090 x Issanka	48.12**	8.53**	19.87**	171.96**	44.17**	4.90*	2.75	4.64*
6 095 x Issanka	18.60*	-1.02	1.29	39.64*	9.29*	-11.83**	-6.98*	-7.60*
7 103 x Issanka	24.31*	0.97	2.23	15.20	13.86**	-9.46**	-3.28*	-4.67*
8 Gro 21 x Issanka	30.42**	3.35*	9.94*	26.64*	7.91*	-2.89	-2.16	-2.82
9 Samena x Issanka	19.92*	1.08	7.02*	23.12*	12.18**	-6.29*	-3.88*	-4.76*
10 Amiato x Issanka	35.73	3.78*	15.95**	109.83**	19.74**	-2.73	-1.68	-2.82
11 004 x Fedha	34.68**	5.29*	14.47**	131.64**	22.67**	2.68	3.14*	4.62*
12 026 x Fedha	16.17	-0.14	-3.64	-11.81	3.87	-6.79*	-5.88*	-7.63*
13 036 x Fedha	25.82**	3.78*	9.25*	74.24**	8.52*	-3.87*	-4.74*	-6.28*
14 067 x Fedha	14.98	-0.19	-2.43	-27.66*	4.41	-8.34*	-8.27*	-11.46**
15 090 x Fedha	37.72**	5.78*	18.60**	148.95**	43.67**	2.89*	4.70*	3.68*
16 095 x Fedha	21.80*	2.92	- 2.06	87.39**	13.97**	-17.82**	-15.45**	-17.42**
17 103 x Fedha	16.12	-0.57	- 2.72	27.48*	6.21*	-13.63**	- 9.13**	-11.44**
18 Gro-21 x Fedha	19.23**	1.84	7.49*	86.28**	18.81**	- 4.98*	- 3.06*	-4.85*
19 Samena x Fedha	19.14*	2.09	5.89	38.64*	5.70	- 8.92*	- 3.81*	-5.78*
20 Amiato x Fedha	31.94**	3.65*	9.59*	81.68**	19.42**	- 3.94*	- 6.80**	-3.17*
21 004 x Shaba	47.65**	7.87**	19.43**	157.53**	29.68**	4.32*	2.16	2.98
22 026 x Shaba	19.82*	2.62	1.62	-10.15	6.07*	- 5.46*	- 2.38	-3.95*
23 036 x Shaba	27.18**	3.84*	13.54**	83.90	13.47**	-2.18	-1.64	-3.70*
24 067 x Shaba	15.65	-0.78	-1.08	-8.47	7.90*	-5.68*	-4.24*	-5.28*
25 090 x Shaba	52.79**	7.89**	24.60**	192.83**	47.36**	5.82*	2.37	3.43*
26 095 x Shaba	23.84*	3.67*	0.71	41.81*	11.07*	17.38**	-4.24*	-5.62*
27 103 x Shaba	16.42	1.81	2.76	20.52*	16.80**	14.46**	-2.74	-3.86*
28 Gro-21 x Shaba	22.91*	2.24	6.86*	37.64*	9.19*	-2.26	-1.46	-1.98
29 Samena x Shaba	14.51	-0.65	-0.54	-18.46	12.31**	-4.46	2.87	-4.01
30 Amiato x Shaba	35.60**	5.15*	16.36**	118.71**	23.15**	-2.18	-2.37	-2.18

* and **; Significant at P = 0.05 and 0.01 respectively.

scope to develop early maturing and high yielding hybrid or synthetic variety. The best combination, showing significant sca for most of the yield components and maturity traits simultaneously, was 036 x Fedha followed by 095 x Shaba and 067 x Issanka. Parents involved in these crosses also showed significant gca for yield components and negative gca for maturity traits (Table 2). Male parent Issanka was both a good general and specific combiner for yield and some of its components and maturity traits. It is therefore apparent that lines and tester possess a specific genetic architecture and capacity to transmit their characteristics to the offspring. Bains et al. (1967) in pearl millet and Sindagi et al. (1979) in sunflower also reported that high combining parent alone may not always result in a cross with a high sca. It is therefore suggested that lines 036, 067 and 095 can be used to develop an early maturing and high yielding hybrid variety. These lines and other lines including 103 and 026 together can also be used to develop a high yielding and early maturing synthetic variety for marginal areas of Kenya.

CONCLUSIONS

The investigation showed that seed yield per plant was mainly governed by non-additive gene action while all other characters mainly showed additive gene action except plant height where additive and nonadditive, both, gene actions were almost equally important. The parents which depicted high gca and sca for most of the yield components and maturity traits simultaneously can be used to develop hybrid or synthetic varieties of sunflower for medium and low potential (marginal) areas of Kenya.

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REFERENCES

Bains, K.S., Athwal, D.S. and Gupta, V.P. 1967. Combining ability of pearl millet inbreds. J. Res. Pb. Agric. Univ. 4: 192-196.

Kempthorne, O. 1957. An introduction to genetic statistics, John Willey and sons, Inc., New York.

Sindagi, S.S., Kulkarni, R.S. and Seetharam, A. 1979. Line tester analysis of the combining ability in sunflowers (Helianthus annuus). Sunflower Newsletter. 3: 11-12.

Tyagi, A.P. 1987. Correlation and path coefficient analysis among earliness and yield components in sunflower (Helianthus annuus L.) Accepted East Afri. Agric. and Forestry. J. (In press).