T1974GEN04

YIELD COMPONENTS IN SUNFLOWER

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Sunflower has become the World's most important oil seed crop. It is valued for its superior quality edible oil and, more recently, for its seed-protein as a source of food. Until the USSR developed its high oil content varieties in the last decade, which have received so much attention in recent years, most of the World's sunflower varieties stayed close to their region of origin. Once the high-yielding types from the USSR became available, the distribution pattern became much more varied. Owing to their wide adaptability most USSR varieties are doing well in other countries, especially in Eastern Europe.

At present, sunflower cultivation in Kenya is limited to about 20,000 acres (8,000 ha). Owing to its drought resistance it is often grown on marginal land, for green manure and fodder. The local varieties produce large seeds with low oil content and a high husk percentage, which are exported as bird seed. With proper agronomy, they produce good seed yields per acre. However, these local varieties show considerable variation in several agronomic characters ; time to maturity, head size, height, yield per plant. With the new and urgent demand for edible oil to replace imports, there is a need to increase local sunflower production and, in this connection a need for varieties with improved seed yield and oil content.

In principle, this could be achieved in either of three ways : (1) by introducing superior varieties from other countries ; or (b) by improving the oil content of locally adapted varieties ; or (c) by producing hybrids or synthetics with higher seed yield and oil content.

In a preliminary study, Ravagnan (1970) indicated that at present no foreign variety appears to be good enough under Kenya conditions to compete with local varieties. Most local varieties, though poor in oil content, greatly outyield the varieties introduced from temperate regions, not only in respect of yield of seed but also of yield of oil per acre. This, if confirmed, suggests that the most practical approach for the near future would be to try and improve the oil content of local varieties or, alternatively, to develop suitable hybrids or synthetics.

Any breeding programme for seed yield and oil content involves selection and the question is whether one should select for these characters as such, or whether any morphological traits are sufficiently closely correlated with seed yield and/or oil content to permit selection on the basis of these morphological characters.

The aim of the present experiment was twofold : (a) to analyse the performance of a large number of introduced and local varieties, and (b) to identify characters closely correlated with seed yield and possibly suitable as selection criteria.

METRIALS AND METHODS

Seventy one sunflower varieties were included in this study. The seed was obtained from the National Agricultural Research Station in Kitale, Kenya. They were grown during the long rainy season of 1973 at the Faculty of Agriculture, Field Station, Kabete, Kenya, in a randomized block design with three replications. Each plot consisted of one row, 3 meters long, with 30 cm spacing within the row and 90 cm between rows. The experiment received a homogenous application of 60 kg/ha P_2O_5 as Single Super Phosphate and 40 kg/ha N as Calcium Ammonium Nitrate. Routine operations included 2 weedings and hoeings. No irrigation was given.

Five plants were selected at random from each plot (i.e. 15 plants per variety) for detailed observations and were left to be open-pollinated. Immediately after flowering the heads were covered with Kraft Paper bags to protect them from birds. The following 11 characters were recorded : (1) seed yield per plant (g) ; (2) total dry matter of the plant (all above ground parts except the seeds but including the receptacles) (g) ; (3) plant height (cm) ; (4) stem diameter at 2 cm above the ground (cm) ; (5) head diameter (cm) ; (6) diameter of the sterile centre of the head cm) ; (7) number of days to opening of outer florets ; (8) weight of 100 seeds (g) ; (9) weight of husks from 100 seeds (g) ; (10) weight of 100 kernels (g) ; and (11) kernel percentage = weight of 100 kernels/weight of 100 seeds. Statistical analysis was done on the mean values over the five plants from each plot. Following the analysis of variance and covariance, estimates of between-character correlations and of heritability was obtained using the method given by Hayes, Immer and Smith (1958).

RESULTS

The mean values of yield and all other characters are presented in table 1. The highest seed yield of 141 g/plant was recorded from the local variety Kenya White, followed by another local variety Comet which gave a seed yield of 98.91 g/plant. Most foreign varieties were found to be poor yielders, except Bianco (Canada) and 1653 (USA) which yielded over 84 g/plant. Generally high yields were recorded with tall growing varieties. However, certain varieties like Modern 6754 (Canada) yielded well above the average even though they were compa-

Table 1

Plot means of Sunflower Varieties grown in replicated trial at Kabete, 1973

Introduced Varieties	Seed yield/ plant (gm)	Total dry matter (g)	Plant height (cm)	Stem dia-meter (cm)	Head diameter (cm)	Sterile centre diameter (cm)	Days to first flowering (no.)	100-seed weight (g)	100 husk weight (g)	100-kernel weight	Kernel %
	1	2	3	4	5	6	7	8	9	10	11
1 Ala (Italy)	46.29	161.47	161.90	2.40	19.64	5.20	94.66	6.65	2.57	4.08	61.35
2 Albina (Italy)	58.36	255.83	176.83	2.55	20.23	4.52	85.00	7.44	2.40	5.04	67.74
3 Amiata (Italy)	45.61	152.58	146.42	2.28	15.62	4.23	88.66	5.01	1.41	3.60	71.85
4 Argentario (Italy)	39.44	190.71	172.67	2.73	17.21	4.55	89.00	9.08	4.62	4.46	49.12
5 Argentine (Argentine)	35.21	69.38	98.67	1.62	13.33	3.77	82.00	4.86	1.85	3.01	61.93
6 050 A (SCM) (Argentine)	67.00	115.10	143.66	2.23	16.71	4 03	88.00	5 36	1.65	3.72	69.40
7 B_1 (Italy)	40.13	138.80	115.40	2.23	15.54	7.41	81.33	5.86	1.80	4.06	69.28
8 Bianco (Canada)	84.92	371.74	249.73	2.47	19.93	2.71	112.66	7.33	4.33	3.00	40.93
9 Black Strip (Australia)	29.49	88.54	124.93	1.97	14.04	5.48	79.33	6.49	2.20	4.29	66.10
10 CM 1968 (Canada)	4.76	74.65	129.00	1.64	11.83	5.15	92.00	3.31	1.21	2.10	63.44
11 CM 30 (Canada)	11.88	39.38	68.50	1.35	11.46	3.60	87.66	3.27	0.85	2.42	74.00
12 CM 90 (Canada)	12.52	61 64	84.00	1.11	10.78	3.20	47.66	3.30	2.16	1.14	34.54
13 Cern Ca2 (USA)	50.86	160.87	123.43	2.33	19.16	2.99	75.66	7.27	2.44	4.83	66.43
14 Col, 265499 B (Canada)	51.33	381.10	195.83	2.67	22.78	5.83	110.00	8.55	4.73	3.82	44.68
15 Chile 287181	40.81	106.42	141.17	2.27	16.08	5.41	80.66	6.41	1.96	4.45	71.66
16 GOR 101 (S, Africa)	21.29	72.98	110.46	2.09	13.76	3.61	77.33	6.10	2.51	3.59	58.85
17 GOR 104 (S, Africa)	39.79	161.71	149.30	2.55	15.13	3.66	93.33	6.90	2.04	4.86	41.97
18 Gunkelman (S. Africa)	26.82	102.30	111.33	2.03	15.33	3.12	80.66	6.08	2.76	3.32	54.60
19 Heliant tuberos (USA)	33.22	126.97	170.36	2.03	12.97	4.45	99.33	4.19	1.99	2.20	52.50
20 Iregicsikos (Hungary)	47.67	28330	179.00	2.76	15.44	2.33	89.00	5.85	2.53	3.32	56.75
21 Israel 262516	17.82	237.06	167.33	2.62	18.00	2.25	86.00	8.64	5.18	4.46	40.04
22 Krasnodarets C1 (USSR)	40.30	157.48	132.33	2.20	7.58	5.17	81.66	5.22	2.62	2.60	49.81
23 Krasnodarets C2 (USSR)	34.38	111.04	125.63	200	13.47	3 66	81.60	6.63	1.95	4.68	70.59
24 Mennonite (Canada)	29.00	113 95	116.67	3.17	14.50	4.50	80.66	6.65	3.71	2.84	43.36
25 Modern 6754 (Canada)	60.94	126.07	136.00	2 64	22.41	3.57	93.33	8.28	2.58	5.70	68.84

Table 1 (Continued)

	Introduced Varieties	1	2	3	4	5	6	7	8	9	10	11
26	Modern 6762 (Canada)	19.89	71.37	113.01	1.52	18.83	4.47	95.33	4.26	2.21	2.05	48.12
27	Peredovik (063) (USSR)	16.10	68.44	110.37	2.06	14.60	5.66	65.66	4.53	1.66	2.87	63.35
28	Peredovik (067) (USSR)	26.50	102.59	134.33	2.08	16.48	6.28	86.33	7.04	3.64	3.40	48.29
29	Peredovik (039) (USSR)	27.47	117.56	147.39	2.28	17.14	6.12	78.66	5.96	2.36	3.60	60.43
30	Peredovik (070) (USSR)	24.37	147.76	142.17	2.40	18.17	5.65	85.33	6.16	1.71	4.45	72.24
31	Peredovik (USSR)	32.72	121.43	140.69	2.02	14.84	4.93	95.00	5.57	2.44	3.13	56.19
32	Peredovik (077) (USSR)	47.14	158.12	156.83	2.23	18.83	4.73	70.00	6.67	3.02	3.65	54.72
33	PM 22 (Italy)	44.50	205.49	174.16	2.55	20.09	4.86	94.00	6.64	2.53	4.11	61.69
34	Romsun Record (Romania)	60.75	201.13	148.20	2.50	19.23	4.54	91.00	6.81	2.76	4.05	59.47
35	Smena (USSR)	58.13	314.48	162.50	3.12	21.83	5.78	84.33	6.86	2.51	4.35	57.70
36	Uniflor—70 (Italy)	64.13	357.01	162.67	2.43	19.73	5.72	95.00	4.93	1.19	3.74	75.86
37	VNIIMK 1660 (USSR)	28.79	177.40	158.33	2.32	19.66	5.75	91.00	5.41	2.24	3.17	58.59
38	VNIIMK 8931 (USSR)	63.22	183.48	130.50	2.52	19.33	5.17	80.66	7.66	2.72	4.94	64.49
39	VNIIMK 8931—Apollo (USSR)	37.07	228.57	151.82	2.63	18.00	6.28	89.33	6.86	3.36	3.50	51.02
40	VonBoguslawski (E, German)	33.02	113.80	124.25	1.92	13.42	4.38	92.33	4.31	1.25	3.06	70.99
41	Jdanov 6432 (USSR)	25.58	90.23	133.17	1.98	16.85	4.69	83.66	6.68	2.99	3.64	54.45
42	008 Mark (USA)	4.96	27.02	57.67	2.06	9.66	2.77	80.33	3.57	1.67	1.90	53.22
43	009 Mark (USA)	9.32	37.09	94.50	1.33	8.30	3.79	102.00	2.86	1.13	1.73	60.49
44	097 (Romania)	25.79	129.24	137.50	2.40	16.20	6.08	81.66	5.24	2.14	3.10	59.16
45	99 (USA)	37,92	129,44	162,83	1,96	14.71	3.36	96.66	6.65	2.66	3.99	60.00
46	110 (USA)	48.05	210.62	166.96	2.64	24.02	6.19	94.33	6.62	1.33	5.29	79.91
47	1653 (USA)	84.03	334.90	184.17	3.25	23.03	5.32	82.33	7.76	3.32	4.44	57.21
48	1968 (USA)	50.84	198.38	182.16	2.37	17.16	3.73	108.33	4.81	2.48	2.33	48.44
49	1968—1 (USA)	36.65	180.97	177.23	2.26	17.83	4.62	98.66	5.50	2.04	3.46	62.91
50	2380 (USA)	53.64	252.05	161.50	2.90	24.53	5.43	95.66	6.81	2.21	4.60	67.54
51	287620 (USA)	18.30	53.38	105.17	1.63	13.36	4,69	76.00	3.85	1.56	2.29	59.48
52	287228 (USA)	46.98	222.72	170.44	2.40	16.71	4.90	83.66	3.44	1.50	1.94	56.39

Table 1 (Continued)

	Introduced Varieties	1	2	3	4	5	6	7	8	9	10	11
53	287721 (USA)	18.01	58.32	133.17	1.77	10.76	2.93	98.00	3.64	1.90	1.74	47.80
54	287722 (USA)	27.35	86.67	120.39	2.13	16.10	4.29	77.33	5.78	2.87	2.93	50.69
55	287742 (USA)	30.00	109.64	137.34	1.83	13.49	4.73	97.00	4.32	2.07	2.25	52.03
56	287756 (USA)	21.46	106.49	136.00	1.90	17.10	5.10	71.66	5.66	2.52	3.14	55.48
57	287757 (USA)	24.25	126.59	149.33	2.28	16.66	5.18	76.33	5.57	1.97	3.60	64.63
58	297762 (USA)	16.16	37.28	90.00	1.42	11.02	4.15	90.35	4.12	1.76	2.36	52.28
59	297832 (USA)	21.91	41.29	74.61	1.15	12.78	5.67	110.00	3.79	2.12	1.67	44.06
	Kenya Varieties											
60	Black C_1	60.20	214.80	175.25	2.00	18.01	2.85	79.00	6.58	3.21	3.37	51.21
61	Black C_2	53.93	149.88	157.50	2.44	17.50	5.08	86.66	7.55	3.67	3.88	51.39
62	Comet C_1	52.71	283.01	162.83	2.35	18.83	3.96	86.66	7.01	3.47	3.54	50.49
63	Comet C_2	98.91	424.74	224.64	2.78	23.66	6.19	101.00	6.71	2.87	3.84	57.23
64	Comet C_3	63.72	198.02	179.34	2.20	17.30	3.84	95.00	6.96	3.33	3.63	52.16
65	Dark Stripe	27.50	123.28	157.47	1.96	15.40	4.23	89.00	6.67	2.27	4.40	65.96
66	Grey Stripe	78.01	240.88	235.63	3.26	23.56	2.50	116.00	10.91	3.68	4.77	43.72
67	Kenya White	141.61	572.13	267.55	3.75	27.50	3.06	112.00	9.51	4.46	5.05	55.19
68	Large White C_1	67.11	227.86	185.33	3.17	18.15	3.23	94.00	9.40	4.39	5.01	53.29
69	Large White C_2	48.29	205.25	167.67	2.32	17.13	3.73	86.00	7.48	4.43	3.05	40.77
70	Local dwarf	13.03	64.47	82.36	1.86	10.86	2.97	99.00	2.99	1.31	1.68	56.18
71	77 AB × G/S	61.94	200.95	137.17	2.37	20.77	3.99	92.00	4.70	1.83	2.87	61.06
	Mean	41.20	165.74	146.40	2.25	16.79	4.49	88.61	6.02	2.52	3.47	57.51
	L.S.D. at P = .05	32.61	60.74	50.47	1.62	6.16	3.90	16.09	3.58	0.44	1.69	2.7

ratively short. The largest heads (27.50 cm) were produced by the local variety Kenya White followed by varietis Modern 6754 (Canada), 2380 (USA), 110 (USA), Comet (Kenya) and Grey Stripe (Kenya) whose head diameters were slightly above 22 cm. In respect of the size of the sterile centre of the heads it was observed that most high yielding varieties had very small sterile centres. This included almost all Kenyan varieties. Stem diameter showed large variation (1.11—3.75 cm) with a mean of 2.25 cm ; the greatest stem thickness was observed in the highest yielding (local) variety Kenya White, followed by another local variety Large White. Most thin stemmed varieties were poor yielders though between them were large differences (compare for instance Argentine with CM 1968). Most varieties started flowering about 88 days after sowing but some were appreciately late. The highest yielding variety Kenya White was, with 112 days, among the latest, though some much lower yielding varieties (Bianco, Col. 265499 B_I, 297832 and the local Grey Stripe) were equally late. The 100-seed weight was above the average of 6 g, in most of the high yielding varieties, the maximum being found in the local varieties Kenya White (9.51 g) and Large White (9.41 g). A reverse trend was found for the kernel percentage : all except one of the local varieties had kernel percentage well below 60% while several foreign varieties had kernel percentages close to or exceeding 70%. It was interesting to note that certain varieties combine a high kernel percentage with high seed yield, e.g., Uniflor (Italy) with a kernel percentage of 75.86% and a reasonable seed yield of 64 g/plant. Total dry weight was high in most high-yielding varieties, with Kenya White topping the list. However, there were some notable exceptions, e.g., 050 A (SMC) and Modern 6754, which did not accumulate high dry matter in their stems, leaves and receptacles produced quite high seed yields.

The coefficients of correlation between all characters studied, in all combinations are given in table 2. Seed yield per plant showed a highly significant correlation, in order of decreasing r-value, with total dry matter, head diameter, 100-seed weight, 100 kernel weight, plant height, stem diameter and 100-husk weight ; all these associations were positive. Seed yield per plant also showed a significant though small negative correlation with kernel percentage and an insignificant positive correlation with days to flowering ; both these undesirable associations are not so large that they would make selection for high kernel percentage and for early flowering incompatible with selection for high seed yield.

Table 2 shows that seed yield per plant, total dry matter, plant height, stem diameter and head diameter were all strongly correlated with each other ; all r-values were positive and the lowest was $r = .41$. Days to first flowering, as was to be expected, showed a positive correlation with both total dry matter and plant height, it also exhibited a positive correlation with head diameter and with 100-seed weight. While this would suggest some difficulty in avoiding increased lateness when selecting for large heads and large seed size as components of

Table 2

Correlations between seed yield and its components and between various components

Character	Total dry matter	Plant height	Stem dia-meter	Head dia-meter	Sterile centre dia-meter	Days to first flowe-ring	100-seed weight	100-husk weight	100-kernel weight	Kernel %
Seed yield/plant	87**	.49**	.41**	.71**	—.04	.12	.59**	.30**	.58	—.23*
Total dry matter		.71**	.50**	.59**	—.10	.39**	.46**	.32**	.28*	.52
Plant height			.48**	.51**	—.32**	.45**	.16	.32*	.05	—.41**
Stem diameter				.48**	.13	.17	.41**	.24*	.41**	.07
Head diameter					.16	.34**	.58**	.21*	.19	.07
Sterile centre diameter						—.12	—.03	—.18	.14	—.03
Days to first flowering							.28*	—.03	.08	—.11
100—seed weight								.71**	.66	—.21*
100—husk weight									.01	—.93**
100 kernel weight										.49**

* Significant at P = .05; ** Significant at P = .01

yield, the virtual absence of correlation with seed yield suggest that this problem may not arise if selection is based on this complex trait.

The size of the sterile centre of the head was negatively associated with most other characters ; this association which was insignificant in all cases except with plant height, indicates a weak tendency for greater plant vigour to be accompanied by a reduction in the sterile centre.

Hundred-seed weight in addition to its expected correlation with seed yield per plant, showed significant positive association with total dry matter, stem diameter, head diameter and number of days to flowering, and insignificantly with plant height. These positive correlations indicate that seed size is influenced by the vegatative vigour of the plant and, to some extent, by the length of the period till the onset of flowering. A strong positive correlation of hundredseed weight with both 100-husk weight and 100-kernel weight was to be expected. This was a low negative correlation, not significant, between 100-seed weight and the kernel percentage ; this illustrates that there is a tendency for heavy seeds to have a somewhat lower kernel percentage ; (i.e. a higher husk percentage) which might make selection for a high kernel percentage in heavy seeds somewhat difficult.

Hundred-husk weight and hundred-kernel weight showed some degree of complementarity in their correlations with seed yield and the vegatative traits. Hundred husk-weight showed slightly stronger association with total dry matter and plant height than with seed yield and stem diameter. In the case of 100-kernel weight it was the reverse. The association with head diameter was slight but, in case of 100 husk weight, just reached significances ; this implies that selection for large heads may tend to lead to larger seeds. This does not necessarily mean a lower kernel percentage although there is an insignificant negative association between kernel percentage and 100-seed weight.

There was a significant negative correlation between kernel percentage and both seed yield and plant height (but no correlation between the former and total dry matter). Finally kernel percentage exhibited a very high negative correlation with 100-husk weight which is an expression of the negative association, observed earlier, between 100 seed weight and kernel percentage.

Broadsense heritability estimates are presented in table 3. Stem thickness proved to be a higly heritable character. Also seed yield per plant showed an encouragingly high heritability estimate (0.51) followed by head diameter (0.42). Kernel percentage and 100-seed weight produced low heritability estimates.

Table 3

Heritability estimates for yield and its components in sunflower

	Seed yield per plant	Plant height	Head diameter	Stem diameter	100 seed weight	Kernel percentage
Heritability estimates	0.57	0.20	0.42	0.81	0.30	0.23

DISCUSSION

The objectives in sunflower breeding are high seed yield, improved oil content and resistance to diseases, insects and lodging. Sunflower is not an easy crop to breed : it has perfect insect-pollinated flowers, a wide range of variation in degree of natural cross pollination and variation in self-fertility and incompatibility systems. It has many economically unfavourable traits like branchiness, thick husks and great height. The seed yield and oil content show a negative association.

Under these conditions one might prefer the introduction of high oil yielding foreign varieties instead of breeding new ones. In the present experiment however, none of the foreign varieties yielded anywhere near the best local variety Kenya White. This confirms the finding of Ravagnan (1970) that at present no foreign variety could replace the locally adapted varieties in Kenya.

The second aspect of this paper was to identify characters closely related to seed yield per plant that might serve as a guide in selection. The association of some desirable agronomic traits with unfavourable ones in the same material limits the advance under selection. Low heritability reduces the effectiveness of selection even further. The finding in the present material that seed yield was strong and positively correlated with head diameter, 100-seed weight, stem diameter and plant height suggests that selection for seed yield could be based on these "component" characters. The absence of a significant correlation between 100-seed weight and plant height suggests that selection for heavy seeds might be effective without increase in tallness of the plants. On the other hand, the highly significant positive associations between 100-seed weight and stem diameter and between the latter and plant height are indicative of a relationship between vegatative vigour and 100-seed weight. Also the strong positive associations between head diameter and both plant height and stem diameter indicates that it would be somewhat difficult to select for reduced plant height without affecting the head size. Of all characters recorded total dry matter showed the highest values of the correlation coefficient with seed yield, plant height, head diameter and stem diameter.

Number of days taken to first flowering was not significantly associated with seed yield suggesting that it might be possible to select for earlier maturity without loss in yielding capacity. However, this must be stated with caution since maturation time was positively- related to 100-seed weight and head diameter, both of which are yield components.

Most results agree with findings of other workers. P u t t (1943) reported postive correlation between seed yield and several other characters: plant height, stem diameter, head diameter and number of days to first flowering. Also K o v á č i k and Š k a l o u d (1972) found that taller plants tended to flower later and give higher yields. B u r n s (1970) found a correlation coefficient between seed yield and head diameter as high as r = 0.95, much higher than in the present experiment S c h u s t e r (1964) found high positive correlations between seed yield, plant height and head diameter; but in contrast to Putt's and the present results, seed yield per plant showed a negative correlation with the length of the flowering period, though the latter character was positively correlated with head size and plant height.

The results show only an insignificant positive association between head diameter and size of the sterile centre, suggesting that selection for large heads with a small sterile centre is possible. S c h u s t e r (1964) found a positive correlation between the two characters. K o v á č i k and Š k a l o u d (1972) reported that head diameter was positively associated with husk percentage (i.e. negatively with kernel percentage). The present experiment also showed positive and significant correlation, though of low magnitude, between the two characters.

K h a n n a (1973) found a negative association between both head- and stem diameter and the percentage of filled seeds. The same tendency is seen in the present experiment: slight positive though insignificant correlation between head-and stem diameter on the one hand and the size of the sterile centre on the other. This was explained by postulating that a thicker stem indicates higher nutrient requirements of the vegatative parts which limits the nutrients available to the flower heads.

The kernel percentage has a direct bearing on oil yield. One of the most consistent is the strong positive relationship between oil content and percent kernel of the seed (Putt, 1943; Russell, 1953; and Diakov, 1969). The negative relationship of this character with seed yield per plant which is manifested, e.g., in the high yielding variety Kenya White, indicates problems in selecting for both traits simultaneously. It was interesting to note however, that there was no relationship between kernel percentage and head diameter which appears to be the main component of seed yield. This suggests that selection for high kernel percentage will not affect the head diameter. Unfortunately the situation becomes trivial by the positive association between husk weight and the head diameter. The selection for low husk weight will increase the kernel percentage but decrease the head diameter and hence the seed yield. However, it should be possible to raise the oil content by selecting for kernel yield (kernel weight) which showed strong positive association with kernel percentage. Thus selection for high values of some components is likely to result in a reduction in the value of other components.

Because of the low heritability estimates for plant height, 100-seed weight and kernel percentage, selection for these characters will be difficult. In contrast, the somewhat higher heritability of the complex character seed yield per plant suggests that this may well be the most effective character on which to base selection. The low heritability for plant height (0.20) is in contrast to Schuster (1964) who observed a high heritability for this character.

Differing views have been presented on the value of component characters as a basis for selection for increasing yield. Williams (1959, 1960) and Grafius (1964) suggested that yield, which is a complex trait, might be increased by selecting for yield components and the study of individual yield components ("Somatic analysis") can lead to great simplification of the genetic explanations. Hayman (1960) and Moll et al (1962) dispute this, arguing that yield is inherited as an overall character and that component analysis is unhelpful, or even confusing, in attempt to clarify its genetic control. A plausible explanation for the failure of plant breeders to more fully reutilize components has been advanced by Adams (1967). He states that selection for one of the components may fail to result in yield increases because of negative associations among components. Rasmusson and Cannell (1970) in a selection experiment in barley, concluded that selection for yield through yield component was very effective in certain situations but could not be recommended as a routine procedure as it actually resulted in a yield reduction in one of the populations. Recently Yap and Harney (1972) have reported that in barley, certain morphophysiological traits other than yield components, were highly heritable and strongly correlated with yield. Consequently selection for morphophysiological traits appears to be a promising means of establishing a high yielding plant type. Until such morpho-physiological traits are identified in sunflower, it appears that the selection criterion to increase yield should be yield itself. However, visual selection for large head size, medium tallness and early flowering in the field may be used as a preliminary selection criteria to reduce the number of plants which will be evaluated for yield and kernel percentage (i.e. oil content). Kernel weight appears to be a reliable component to raise the kernel percentage. However, results of comparative experiments would be needed to prove or disprove the validity of these conclusions.

Acknowledgement. The author is grateful to Prof. R. B. Contant for going critically through the manuscript. The author also acknowledges the Deans' Committee for providing the Research Grant for this Project.

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