SUNFLOWER BREEDING AND AGRONOMIC RESEARCH IN KENYA

By

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Kenya, a newly independent country of East Africa, is aiming to improve its own agriculture to attain a self-sufficient internal economy In the sector of edible oils and protein the consumption per capita is very low, and yet heavy imports are required.

Several kinds of oil crops can be grown in this country, but most of them have a limited cultivable area or do not show encouraging prospects of rapid improvement. Sunflower, introduced to the Rift Valley during the 1920s, has spread throughout East Africa from sea level up to 8,000 feet (2,400 m.) and, owing to its greater drought resistance than maize or wheat, is quite often cultivated in the drier soils as green manure or fodder. If, as at present, the total estimated acreage of sunflower in Kenya is ranging from only 15,000 to 20,000 acres, it is because the local varieties are low oil yielding, not uniform in several agronomic traits (as time of maturing, tallness, etc.) and little is known of proper cultivation practices.

The purpose of the research on sunflower carried out since 1967 at the National Agricultural Research Station, Kitale, is to increase the total oil yield per acre by improving local varieties, introducing superior entries from other regions, or releasing synthetics and hybrids with better seed and oil yields. At the same time, through experiments in agronomy, growers are advised how better methods of husbandry can improve their sunflower crop.

Breeding Research:

A preliminary variety trial of several entries imported from different parts of the world together with local varieties was grown in Trans Nzoia in 1968 to obtain some comparative information on these varieties. As shown in Table 1, the majority of the local varieties, although exhibiting low oil content, are far better on seed yield than varieties from temperate areas. Even the total oil production per ha. is generally higher than that of imported varieties. Therefore, at present, there is no prospect of releasing a foreign variety good enough to compete with local varieties in this climatic environment. On the other hand, the quite large genotypic variance of local varieties suggests a selection towards more uniform and superior yielding ability types more suitable for domestic and export markets. A comprehensive breeding system used for improving maize yields in East Africa and its successful results indicates that this system might well be used on other similar outcrossing crops such as sunflower. Half-sib family selection with recombination of remnant seed, ear-to-row selection (head-to-row in sunflower), are breeding methods which are now applied on sunflower at Kitale. But although there is evidence at this early

stage in our trials that the additive genetic variance gives a substantial improvement in seed yield in some varieties, selection for increasing the oil content would require a long term project with expensive techniques, and this is difficult to implement in a developing country.

In order to gather more information on general combining ability for seed yield together with the percentage of oil, some line x variety and variety x variety crosses were made in 1968 at Kitale. The female parents of some of these crosses are inbred lines partial male steriles imported from Manitoba, Canada (CM 30 and CM 90). All have been crossed with three local varieties. Other varieties of different origin and normally fertile were crossed with local varieties.

In 1969 during the rainy season, a variety trial was carried out in eight locations of the Rift Valley Province, in particular in Trans Nzoia district, the altitude ranging between 1,500 and 2,100 metres s.l. Thirty-six entries in two replicates were tested. The plots consisted of five rows, 3 m. long and 76 cm. apart. Only the data from the three central rows were recorded. A randomized block design was used. After harvesting, all the data collected were analyzed by electronic computer. The analysis of the crude fat percentage was made in the National Agricultural Laboratories, Nairobi and in Kitale. Table 2 gives the average of each entry in all locations for ten recorded characters. Cols. 1 and 2 show the seed yield and the oil percentage in dry matter. The improvement obtained in the F_1 of some crosses (as CM 90 x KWc_2), both in seed and oil yield, is significantly superior to the local varieties. The kernel percentage in col. 4 indicates that there is some degree of correlation between these data and the oil content. Again the improvement in lodging resistance, percentage of monomhead, and rust (Puccinia helianthi), is quite satisfactory in the same F_1 (see cols. 5, 9, 10). Most of these crosses show a reduction in height (col.6) and a slightly shorter period of growing (col. 7).

Agronomic Research:

Before the initiation of agronomic research on sunflower at Kitale, full information upon the main factors which affect the yield of this crop was not available. The series of agronomic trials carried out in Trans Nzoia since 1967 aim to fill this gap. Results obtained from the trials on time of planting (see fig. 1) make it clear that yield is mainly affected in normal conditions by the amount of rainfall immediately before and during the flowering stage. The application (at different levels) of phosphate and nitrogen, together with various plant populations, were tested during three seasons and in different localities. The results reported in figs 2, 3 and 4 point out that phosphate is by far the most important fertilizer required in the majority of soils in the Trans Nzoia district.

Conclusions:

Breeding research carried out at the National Agricultural Research Station, Kitale, has indicated, up to now, that the improvement of seed yield and total oil yield per acre of sunflower in Kenya cannot be accomplished by direct introduction of outyielding varieties from temperate regions.

Within the limited resources of a developing country such as Kenya, similar methods of selection to those applied to maize can improve existing local varieties or adapt imported varieties. Partial male sterility (or full male sterility) can be utilized to produce commercial hybrids which are superior to the actual varieties cultivated in this country.

In agronomic research, results obtained by the use of proper statistical design in field experiments have given valuable practical information on how to guide growers of this crop in the areas of this country where sunflower can best be cultivated.

* * *

Table 1 - Variety trials - randomized block design, three replications, two locations. Kitale area (1,800 m. s.l.). 1968

Variety	Seed Yield 10% moist. c/ha.	Days to flowering 50%	Crude Oil* D.M. %	Oil Yield kg/ha
Dark Stripe	8.9	98	25.1	201
D/S (MI) c_2	19.6	102	27.1	478
D/S (HR) c_1	24.4	103	25.9	569
D/S E. 90	16.8	99	24.4	370
Grey Stripe	13.5	108	24.1	293
G/S (HR) c_1	9.6	108	26.8	231
G/S (MI) c_2	14.1	109	27.1	344
Kenya White	18.3	118	27.6	454
K.W. (MI) c_2	18.5	115	29.7	494
Comet	16.3	92	24.2	355
L.W.	10.5	91	26.2	248
Local Varieties Mean	15.5	104	26.2	467
Israel (262516)	8.9	85	31.9	255
Peredovik (U.S.A.)	8.9	79	38.9	312
Iregi K. Csikos (USA)	8.6	82	35.1	272
VNIIMK 1646 (USA)	8.3	78	36.1	270
NKHOI (USA)	8.1	85	30.6	223
Von Boguslawski	7.9	77	24.3	173
Columbia (265500)	7.3	89	25.1	165
Columbia (265499)	7.0	90	24.4	154
Armavirec (USA)	6.6	75	32.6	193
Armavirski (Chile)	5.7	81	32.5	167
VNIIMK 8931 (USA)	5.5	80	31.9	158
Jenisej (USA)	5.2	77	30.6	143
USSR (287231) (USA)	5.1	89	36.1	166
Imported Varieties Mean	7.2	82	31.5	204
Total Mean	10.98	92	29.1	279
L.S.D. .05	5.39			

* soxhlett method.

Table 2 - Top Crosses and Variety Trial 1969. Average of some recorded characters in 8 locations. Randomized block design.

Type of Sunflower	1 Average 8 loc. q/ha.	2 Crude Oil Moist Free Basis %*	3 Weight 1000 Seed grm.	4 Kernel Percent %	5 Lodged Plants %	6 Plant Height cm.	7 Days to Flower 50%	8 Head Diam. cm.	9 Multi-Heads Plants %	10 Plants with Over 25% Rust %
1. Dark Stripe orig. pop.	7.1	20.9	72.4	57.5	21.6	193	90	12	16.1	13.3
2. Grey Stripe orig. pop.	14.5	24.0	82.2	57.5	28.0	311	105	15	3.2	19.5
3. Kenya White orig. pop.	14.4	25.8	75.1	56.5	24.0	333	111	15	6.8	20.4
4. Dark Stripe (MI) c_2	12.4	23.9	87.6	55.5	21.6	271	93	14	3.3	17.8
5. Dark Stripe (HR) c_1	15.5	23.6	92.0	56.5	24.9	271	94	14	2.9	19.7
6. Dark Stripe (MI) c_3	15.7	26.0	85.9	54.5	25.5	277	94	14	4.2	14.2
7. Grey Stripe (MI) c_2	13.4	24.8	80.7	57.5	19.8	320	110	15	1.5	20.8
8. Grey Stripe (HR) c_1	14.4	25.1	76.4	56.5	22.0	319	114	15	1.6	16.0
9. Grey Stripe (HR) c_2	15.6	26.2	78.9	56.5	24.2	317	108	15	2.3	18.6
10. K. White (MI) c_2	15.3	27.4	73.8	58.3	26.6	343	108	15	15.8	11.6
11. K. Comet loc. var.	12.5	27.0	62.3	57.2	23.4	222	83	14	7.0	13.1
12. Von Boguslawski (Germany)	7.2	23.6	58.4	58.1	17.5	175	77	12	9.9	14.6
13. Peredovik (USA)	5.3	32.7	55.1	66.4	14.9	195	98	11	1.7	15.1
14. Peredovik (Hungary)	8.4	35.1	53.9	74.4	15.2	191	77	12	3.3	11.3
15. Large White (MS) c_2	17.3	26.4	94.4	58.8	20.2	279	92	15	3.7	13.7
16. CM 30 (Canada)	2.3	23.5	35.7	66.6	6.3	96	77	7	1.5	0.8

(continued)

Table 2 - continued

Type of Sunflower	1	2	3	4	5	6	7	8	9	10
17. 77 AB x D/S (MI) c_2	8.9	23.9	73.4	54.5	14.3	186	82	15	15.1	9.6
18. 77 AB x G/S (MI) c_2	10.3	23.6	67.4	57.4	17.1	218	88	15	20.1	7.9
19. 77 AB x KW (MI) c_2	11.9	23.8	66.7	56.6	20.4	226	90	15	15.8	21.0
20. CM 30 x D/S (MI) c_2	11.6	23.9	63.5	60.0	14.0	189	79	13	2.6	5.8
21. CM 30 x G/S (MI) c_2	13.5	22.5	57.7	60.0	16.1	221	85	14	0.2	5.0
22. CM 30 x KW (MI) c_2	15.2	25.4	66.6	60.5	13.3	239	88	14	2.0	8.4
23. CM 90 x D/S (HR) c_1	16.5	24.9	76.7	57.5	17.0	227	88	15	3.0	5.8
24. CM 90 x G/S (MI) c_2	16.9	27.5	71.1	61.1	11.6	261	93	15	2.9	9.6
25. CM 90 x KW (MI) c_2	19.8	31.2	72.9	61.3	17.2	292	96	15	4.1	8.9
26. Von Bog. x D/S (HR) c_1	13.2	24.1	66.1	58.3	15.1	220	81	14	11.0	11.4
27. Von Bog. x G/S (HR) c_1	14.7	24.5	67.7	58.7	17.9	265	88	14	6.5	13.5
28. Von Bog. x KW (MI) c_2	16.8	24.9	73.0	60.5	19.1	281	89	14	8.8	13.0
29. Israel x D/S (MI) c_2	12.5	26.2	79.5	61.3	23.4	228	83	14	2.1	9.1
30. Israel x G/S (MI) c_2	18.1	28.8	74.6	62.1	18.3	280	91	16	2.3	11.7
31. Israel x KW (MI) c_2	17.1	27.7	79.1	61.5	24.1	287	93	15	3.7	13.0
32. Peredovik (USA) x KW (MI) c_2	17.5	29.6	72.2	62.6	24.1	286	92	15	3.2	10.9
33. LW (MS) c_2 x D/S (HR) c_1	17.4	23.5	92.5	56.5	20.2	284	96	16	4.0	14.3

(continued)

Table 2 - continued

Type of Sunflower	1	2	3	4	5	6	7	8	9	10
34. LW (MS) c_2 x G/S (MI) c_2	20.5	26.1	90.8	58.5	17.7	306	96	17	2.4	16.0
35. LW (MS) c_2 x D/S (MI) c_2	19.0	23.7	93.6	56.0	19.4	309	98	15	2.6	16.1
36. VNIIMK 8931 x D/S (HR) c_1	12.6	29.9	75.9	63.8	19.9	250	91	15	6.2	22.9
Mean	13.8		73.5		19.3	255	92	14	5.7	13.2
F.	12.1***									
L.S.D. .05	2.26	3.22**	7.67	2.55**	11.7	15.1	3.6	0.1	6.7	9.3
L.S.D. .01	2.97									

* soxhlett method
** average of 8 locations

Figure 1 - Effect of the time of planting upon the yield.

The low yield of the crop planted on 11 April is a consequence of the high proportion of seed loss due to lodging and rotting before harvest.

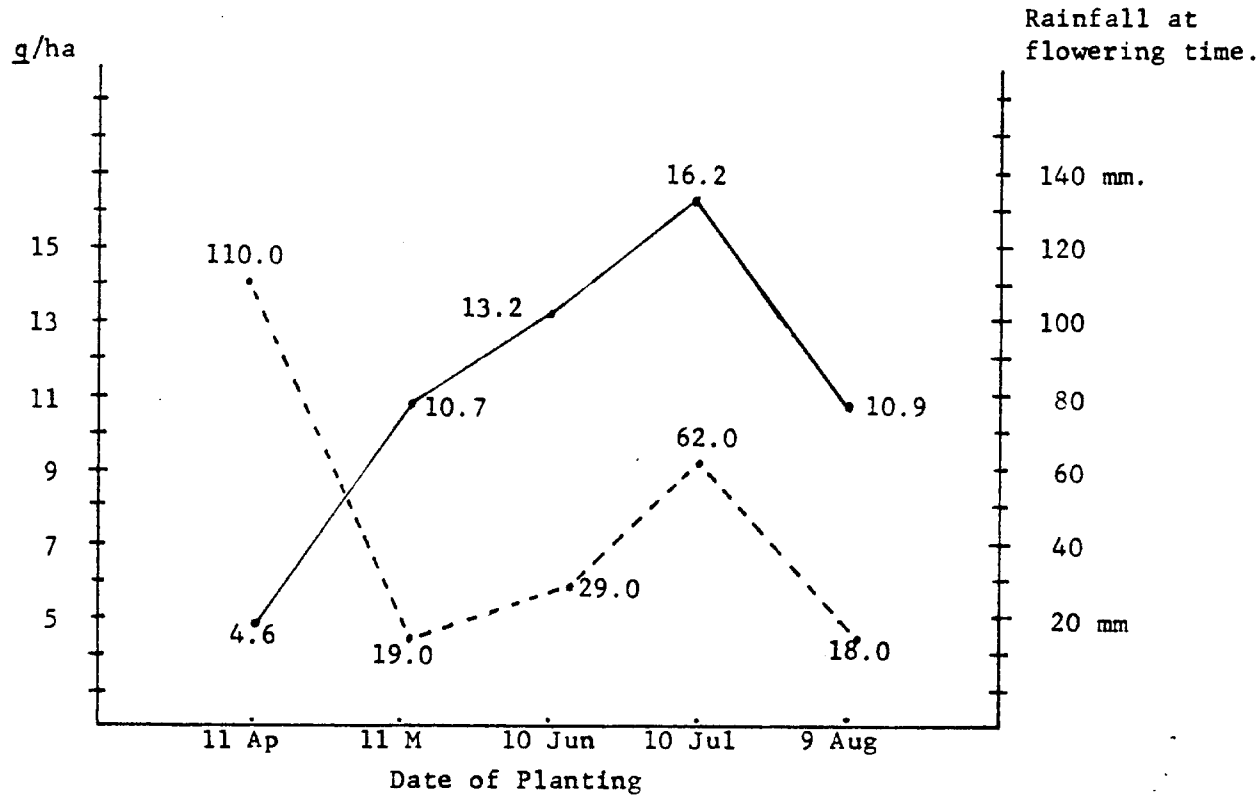
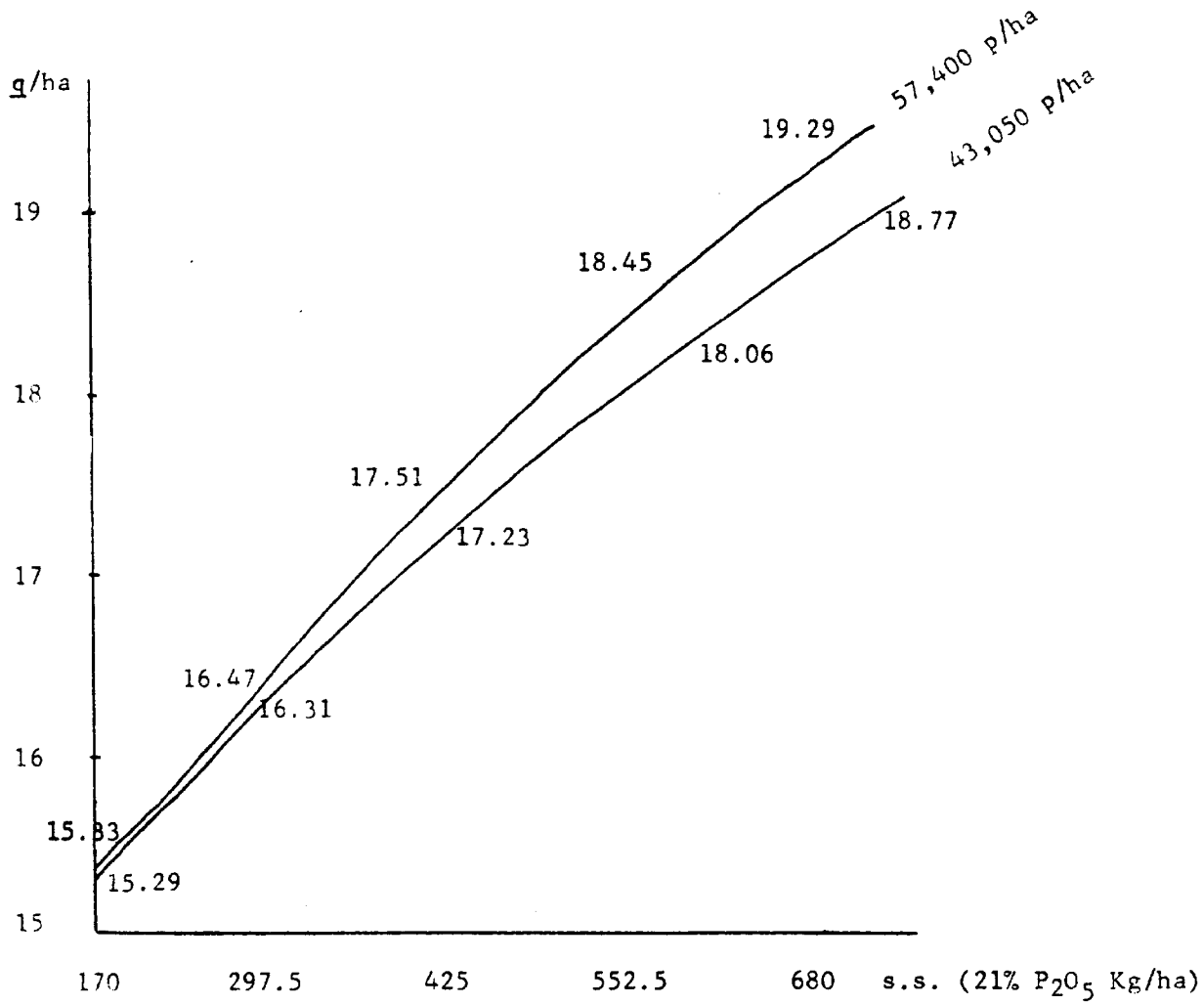
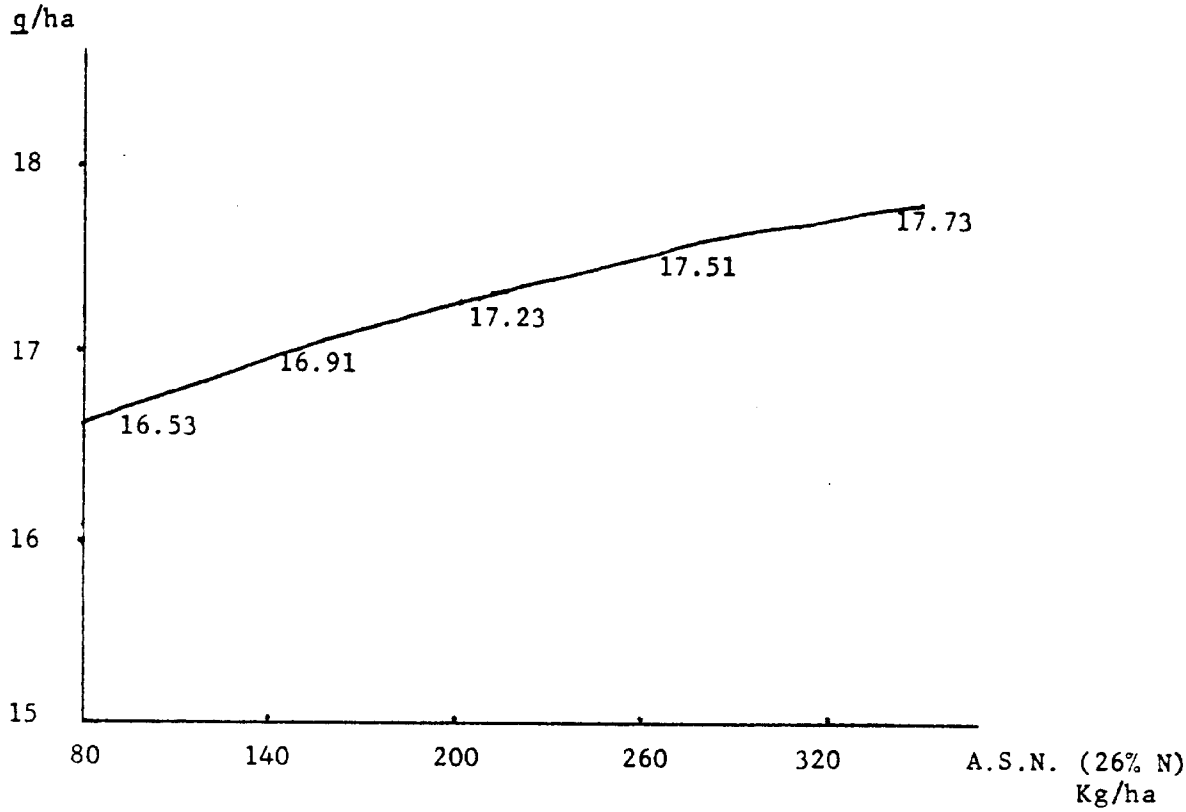


Figure 2 - Agronomic Trials. Phosphate response at planting time. Kitale area, 1969.



Variety K.W. - Kg. 200/ha of A.S.N. - Phosphate linear is highly significant at 0.01.

Figure 3 - Sunflower. Agronomic trials. Nitrogen response at planting time. Central Composite Second Order design. Two replications, three locations. Kitale area, 1969.



Variety K.W. - Kg.425/ha of Single Super. - Nitrogen linear is not significant.

Figure 4 - Isoquants for N and P responses. Three locations, two replications. Trans Nzoia district, 1969 43,050 plants/hectare.