XA0100286

YIELD IMPROVEMENT OF KENYAN SESAME VARIETIES

P.O. AYIECHO, J.O NYABUNDI
Department of Crop Science,
University of Nairobi,
Nairobi, Kenya

Abstract

In an effort to improve the yield of Kenyan sesame cultivars the seeds of three cultivars, SPS SIK6, SIK 096 and SPS SIK 50/1 were subjected to 300Gy, 400Gy and 600Gy of gamma rays. A first batch of seeds were subjected to these treatments in March 1994 (Experiment I) while the second batch was treated in March 1995 (Experiment II). The M_1, M_2, M_3 and M_4 generations of experiment I and M_1 generation of Experiment II were raised at the University of Nairobi Dryland Research Field Station, Kibwezi from 1994 to 1996. The M_6 and M_7 generations of Experiment I and M_2 of Experiment II were raised at Siaya Farmer's Training Centre in 1997. The effects of radiation in M_1 generation were expressed in reduced and delayed seedling emergence, reduced plant height, sectorial deformed plants, delayed flowering and extremely low yield. There was increased variation in M_2 for most evaluated traits. Plants in M_2 and subsequent generations were scored for a number of yield related morphological traits and days to flowering. Selection was done in the early generations for increased capsule number and earliness. As a result of selection, a total of 88 lines from M_4 generation were used to derive M_5 generation. Further selection in M_6 generation lead to 35 lines being retained for preliminary yield trials in M_7 generations.

1. INTRODUCTION

Use of artificial mutagenesis in breeding programmes leads to increased variation. This is a phenomenon that has been observed in many crop plants. For example increased variation in soybean oil and protein contents has been reported [1]. The study reported by IAEA [1] also revealed a disruption of negative correlation between these two traits. Increase in variability has also been reported in mung bean phenology and yield related traits following treatment by EMS and gamma rays [2].

In sesame increased variation has been reported following artificial mutagenesis [3,4]. In these studies substantial variation was reported for yield related traits and other agronomic traits. Rahman and Das [4] observed the occurrence of mutants with long capsules, three capsules per axil, short internodes and increased seed number per capsule as compared to the parental cultivars. In a study by Li [5] mutants were obtained that had longer capsules, taller and higher yielding than the parental cultivars. Maneekao et al. [6] reported improvement in sesame seed yield and 1000 seed weight as a result of induced mutations, and in a mutation breeding programme Hoballah [7] obtained sesame mutants that were shorter, earlier, higher yielding, had more capsules per plant, reduced first capsules height and reduced internode length.

The study presented here summarises a sesame mutation breeding work initiated in 1994 with the aim of improving yield of Kenyan sesame cultivars.

2. MATERIALS AND METHODS

2.1. Experiment I

2.1.1. M_1 to M_4 generations

Three Kenyan sesame cultivars SPS SIK 6, SIK 096 and SPS SIK 50/1 were subjected to gamma rays treatment at IAEA/FAO Agriculture and Biotechnology Laboratory in Seibersdorf, Austria, in March 1994. The seeds of the three cultivars were treated with 300, 400 and 600 Gy of gamma rays, giving a total of nine treatments. The M_1 generation was raised at the University of Nairobi Dryland Research Field Station, Kibwezi and used to obtain M_2 and subsequent generations which were also planted at Kibwezi as follows:

Generation	Season	Planted as
M_2	November '94 to March '95	Plots of progenies of individual M_1 plants
M_3	May to September '95	Plots of progenies of individual M_2 plants
M_4	November '95 to March '96	Plots of progenies of individual M_3 plants or M_3 families

Selection of individual plants and families was conducted for increased capsule number and earliness. The product of this selection was 88 lines used to raise M_5 generations as described below.

2.1.2. M_5 generation

Eighty eight lines selected in M_4 generation were planted as M_5 lines in the field at Kibwezi during May–September 1996. These lines which comprised of six lines derived from SPS SIK 6, twenty from SIK 096 and sixty two from SPS SIK 50/1 had been selected for earliness, capsule number per plant and absence of disease infestation. The lines were planted in a two-replicate randomised complete block design. Each plot had two rows spaced 50 cm apart. Spacing within the rows was 20 cm. The experiment was rainfed with supplemental irrigation. No data were taken and, therefore, no selection was done due to a serious nematode attack. However, seed was harvested from each for use in the next generation.

2.1.3. M_6 generation

The eighty eight lines in M_5 (as described above) were harvested and the seed used to derive M_6 at Siaya Farmers Training Centre (FTC) in western Kenya during April to August 1997. The experiment was moved to Siaya FTC because of the serious nematode infestation of the fields at Kibwezi. The M_6 planted at Siaya was planted in a two replicate randomised complete block design with between row spacing of 50cm and within row spacing of 20cm. Each row was 4m long. The M_6 lines were scored for days to flowering. At maturity data were taken for plant height, height to first capsule, stem length from first capsules on the main stem per plant, mean length and mean width of lowest three capsules on the main stem and seed yield per plant.

2.1.4. M_7 generation

The 35 M_7 generation lines were planted at Siaya FTC for preliminary yield tests in October 1997. They were planted in a three replicate randomized complete block design. Each line had a plot of two rows and each plot was 4m long. The spacing was 50 cm by 20 cm. The excessive rains during the season spoilt the first planting. A second planting was done in December 1997 and will be harvested in late April 1998.

2.2. Experiment II

2.2.1. M_1 generation

Seeds of the same varieties as above were subjected to 300, 400 and 600 Gy of gamma rays at the IAEA/FAO Agriculture and Biotechnology Laboratory in Seibersdorf, Austria, in March 1995. The seeds obtained from the nine treatments were planted at Kibwezi in June 1995 to obtain M_2 seed as described in our report of 1995 [8].

2.2.2. M_2 generation

The seed previously harvested from M_1 at Kibwezi was planted out at Siaya FTC during April–August 1997 to give the M_2 generation. The M_2 for each treatment was planted as bulk in a plot with 20 rows measuring 15m long. Between row spacing was 50 cm while within row spacing was 2 cm. The aim of such close spacing was to maximise plant population within the plots. Bulking approach was adopted for M_2 due to limited resources.

3. RESULTS AND DISCUSSION

3.1. M_1 to M_4 generation

The effects of radiation were manifested in the M_1 generation in the form of low and delayed emergence, delayed flowering and maturity, reduced height to first capsule and to first branch, diminutive plants, various forms of sectorial deformation and highly reduced seed production. However, there was substantial recovery in M_2. A number of variant plants were observed in M_2 as compared to the parental cultivars. These were mainly related to morphological traits; such observations were made in M_3 and M_4 as well. As compared to the parental cultivars there were variants which were branched with three capsules/axil, lower first capsule height, more capsules/plant, early and late flowering, reduced plant height and changed locule number. The details of our observations are summarised in our previous reports [8,9,10]. Selection was conducted as from M_2 generation and by M_4 generation there were 88 lines selected to give M_5 generation.

3.2. M_5 generation

The M_5 generation at Kibwezi performed so poorly that no data were taken on the crop. The crop was seriously attacked by nematodes and only a little seed was harvested from each plant. The stand was poor because of limited rainfall which led to poor emergence. The seed harvested from M_5 was merely used to derive M_6 generation at Siaya FTC. It was the nematode infestation of the fields at Kibwezi that made it necessary to move the research site from Kibwezi to Siaya FTC.

3.3. M_6 Generation

The M_6 generation at Siaya FTC had an average of 43 days to flowering with earliest lines being 128/1, 119/2/1, and 108 which were derived from cultivar SPS SIK 50/1 (Table I). Plant height had a small negative correlation to days to flowering (Table II), an observation similarly reported by Khan *et al.* [11]. Mean plant height at flowering was 83.8 cm. Apart from lines obtained from SIK 096 the lines evaluated were slightly taller than the control (Table I).

TABLE I. OVERALL MEAN PERFORMANCE OF M_6 LINES AND CONTROL PARENTAL CULTIVARS TESTED AT SIAYA (APRIL–AUGUST, 1997)

Parent cultivars	No. of lines	Days to flowering	Plant height (cm)	Stem length from first capsule to tip (cm)	No. of branches bearing capsules	Height to first capsule on main stem	Total No of capsules on main stem	Total No. of capsules per plant	Length of 3 lowest capsules on main stem (cm)	Width of 3 lowest capsules on main stem (cm)	Mean seed yield per plant (g)
SPS SIK 006	6	41	82.3	45.3	2	34.9	10	17	2.90	0.94	1.95
	Control	42	81.1	23.8	2	57.3	11	12	2.82	0.91	1.80
SIK 096	20	43	83.0	42.1	2	36.5	10	16	2.70	0.92	2.35
	Control	50	94.9	41.2	3	5.7	11	19	2.90	0.99	2.00
SPS SIK 50/1	62	44	86.0	47.8	2	40.0	12	19	2.92	0.95	2.28
	Control	49	80.4	27.9	0	52.7	16	20	2.91	0.94	2.10

The tallest line was derived from SPS SIK 50/1 and was 52/1. On the other hand the shortest line tested, 95/2/1, was also derived from SPS SIK 50/1 and had a height of 61.8 cm. Most of the lines were branched with at least two branches. Even some lines with three capsules per axil namely 291/2/3 which was derived from SIK 096, 25/1 and 148 which were derived from SPS SIK 50/1, and 353/6/1 from SPS SIK 6 had at least 1 branch bearing capsules. Branching habit was positively related to days to flowering and plant height (Table II). Usually the sesame cultivars with three capsules/axil tend to be unbranched.

The parental cultivars used in this study were branched with 1 capsule per axil except for SPS SIK 50/1 which was unbranched with 3 capsules per axil. The appearance of a few branched lines with 3 capsules per axil suggests a novel characteristic which may be capitalised on through selection. A combination of 3 capsules per axil and moderate branching were observed on 36/1, 128/3, 55/1/1, 63/1, 109/2/2 which were derived from SPS SIK 50/1, 287/1 which was derived form SIK 096 and 353 which was derived from SPS SIK 006. The lines with this characteristic tended to have high capsule number per plant. However, the degree of branching in such lines was moderate with branches bearing capsules rarely exceeding three. Most of them had only two capsule bearing branches. Height to the first capsule ranged from 60.1 to 23.0 cm. The lines with the lowest first capsule height were derived from SIK 096, namely lines 291/2/3, 303/1, and 303/2/4 which had first capsule heights of 23.0 cm, 23.4 cm, 28.8 cm respectively. This trait was positively correlated to days to flowering and plant height (Table II). Such a relationship was reported by Reddy *et al.* [12] and Padmarathi [13].

On the average, half of the stem length in the lines tested had capsules as reflected by mean lengths from first capsule to stem tip (Table I). The lines with the longest stretches were 218/1 and 108 derived from SPS SIK 50/1. There were strong relationships between this trait and other traits except branch number, capsule length, capsule width and seed yield (Table II).

TABLE II. PHENOTYPIC CORRELATIONS AMONG THE TRAITS STUDIED IN M_6

	Days to flower-ing	Plant height (cm)	Height to first capsule (cm)	Stem length from 1st capsule to tip (cm)	No. of branches bearing capsule	Total No. capsules on main stem	Total No. capsules/ plant	Mean seed yield/ plant (g)	Length of 3 lowest capsules on main stem (cm)	Width of 3 lowest capsules on main stem (cm)
Days to flowering	1	−0.53	0.33 ***	−0.31 ***	0.15 *	−0.31 ***	−0.17 ***	0.07	−0.01	−0.15 *
Plant height (cm)		1	0.53 ***	0.56 ***	0.22 ***	0.43 ***	0.49 ***	0.02	0.02	0.05
Height to 1st capsule (cm)			1	−0.32 ***	0.25 ***	−0.26 ***	−0.08	−0.35	−0.05	0.05
Stem height from 1st capsule to tip (cm)				1	−0.02	0.73 ***	0.65 ***	0.06	0.10	0.06
Branches bearing capsules					1	0.12	0.48 ***	0.05	0.01	0.01
Capsules on main stem						1	0.81	−0.08	0.12	0.06
Capsules per plant							1	−0.03	0.11	0.05
Mean seed yield/plant (g)								1	−0.19	−0.02
Length of 3 lowest capsules on main stem (cm)									1	0.16
Width of 3 lowest capsules on main stem (cm)										1

* Indicates level of significance at P = 0.05.

TABLE III. M_6 LINES SELECTED FOR FURTHER EVALUATIONS

Variety	Line	Days to flowering	Plant height (cm)	Stem length from 1st capsule to tip	No. of branches bearing capsules	Height to 1st capsule (cm)	No. of capsules on main stem	No. of capsules/ plant	Length 3 lowest capsules on main stem (cm)	Width of 3 lowest capsules on main stem (cm)	Mean seed yield/ plant (g)
SPS SIK 006	353/6	41	80.6	38.9	2	41.6	8	15	2.7	0.93	2.47
	335	41	80.2	36.4	3	40.8	8	15	2.7	0.92	2.47
	353/6/1	42	84.1	39.1	2	43.7	9	17	2.8	0.96	2.70
SIK 096	291/2	52	97.7	55.1	4	55.5	14	25	3.0	1.02	4.32
	303/2/1	37	76.0	36.5	1	29.3	8	12	2.5	0.89	2.61
	303/1	37	67.0	32.9	2	23.4	7	9	2.5	0.88	2.52
	303/2/4	37	75.8	35.4	1	28.8	8	12	2.5	0.87	2.58
	291/2/3	33	61.8	31.1	1	23.0	5	8	2.2	0.84	2.25
	296/2	50	88.5	43.8	3	50.1	11	19	2.9	0.98	3.08
	269	51	91.1	45.5	3	50.1	10	20	2.9	0.98	3.40
	311	48	87.3	41.5	3	46.3	11	18	2.9	0.97	2.95
	291/3	48	86.2	40.5	3	45.0	9	18	2.9	0.97	2.93
	K7/2/2	49	88.5	40.4	3	47.2	10	19	2.9	0.97	3.05
	291/1/2/2	48	85.8	43.5	3	44.7	10	18	2.9	0.97	2.90
	303/2/2	51	90.9	40.2	3	49.6	11	19	2.9	0.98	3.20
	296/1	52	93.2	45.0	3	51.1	11	22	2.9	0.99	3.72
	287/1	52	91.7	48.1	3	50.3	11	20	2.9	0.99	3.53
	286/5	51	89.8	46.7	3	49.6	11	19	2.9	0.98	3.20
	299	50	88.8	45.0	3	47.7	10	19	2.9	0.98	3.14
	303/2/3	50	88.8	44.1	3	49.2	10	19	2.9	0.98	3.20
	311	48	87.3	44.7	3	46.3	10	18	2.9	0.97	2.95
SPS SIK 50/1	55/1/1	41	82.5	45.5	2	35.6	11	17	2.9	0.95	2.90
	63/1	39	80.0	43.3	2	32.5	10	16	2.8	0.93	2.88
	165/3	40	80.5	44.1	2	32.4	10	16	2.8	0.93	2.89
	25/1	47	89.1	49.6	2	43.4	13	20	2.9	0.96	2.82
	108	48	91.6	50.9	3	46.6	14	22	2.9	0.97	2.96
	36/1	48	90.4	49.9	2	45.3	14	21	2.8	0.97	2.96
	96/3	39	78.4	43.2	2	31.8	9	15	2.9	0.92	2.82
	109/2/2	50	96.0	54.8	3	51.5	15	20	2.9	0.98	2.97
	95/2/1	47	88.6	49.0	2	43.4	13	20	2.8	0.96	2.96
	218/1	45	86.3	48.3	2	41.0	12	19	2.9	0.96	2.28
	100/2	42	84.9	46.9	2	30.0	11	17	2.9	0.95	2.14
	128/1	42	84.3	46.6	2	37.3	11	17	2.9	0.95	2.10
	119/2/1	44	85.9	48.1	2	39.4	12	18	2.9	0.96	2.21

Lines 291/2 derived from SIK 096, and 108 and 36/1 derived from SPS SIK 50/1 were among those lines that produced the highest number of capsules per plant (25, 22 and 21 respectively). Generally tall lines with high number of capsule bearing branches and high number of capsules on the main stem had the highest capsule number per plant (Table II). Similar observations for some of these traits were reported by Padmarathi *et al.* [13]. The branched lines with the highest capsule number also had three capsules per axil. Thus to maximise capsule number it would be necessary to select for these traits which were positively related to capsule number. Capsule number per axil on the main stem had significant ($P = 0.05$) correlations of 0.46 and 0.224 to capsules on the main stem and capsules per plant respectively. Unfortunately none of these traits had positive correlation to seed yield in this study. However, selecting for any of them would not have adverse effects on seed yield. The highest seed yield/plant was observed for 287/1, 269, 296/1 and 291/2 derived from SIK 096.

Capsule length as measured by length of the three lowest capsules had an overall mean value of 2.84 cm for all the lines tested. The longest capsules were obtained from lines 291/2 derived from SIK 096, 165/2, 218/3 and 108 which were derived from SPS SIK 50/1. On the other hand the shortest capsules were born on line 94 derived from SPS SIK 50/1. Another line with short capsules was line 122/2 derived from SPS SIK 50/1. This trait had no relationship to any trait except seed yield and capsule width (Table II). While Reddy *et al.* [12] reported positive relationship between capsule length and seed yield the data in this study suggested negative correlation between these two traits. Capsule width had an overall mean of 0.94 cm for the lines tested. The widest capsules were observed on SPS SIK 50/1 derived lines like 123/5, 133/2/1 and SIK 096 derived line 303/4. The values for capsule length varied form 2.26 cm to 3.03 cm while those for capsule width ranged from 0.69 cm to 1.05 cm. In this study capsule width had no strong relationship to any of the traits except days to flowering and capsule length.

Based on the tests conducted and reported here 35 lines were selected for preliminary trials in M_7. Among these selections 3 had SPS SIK 6 as the original parental cultivar 15 lines were of SIK 096 origin while 17 had the parental cultivar as SPS SIK 50/1. The selected lines are listed in Table III.

3.4. M_7 generation

The lines listed in Table III were planted to raise the M_7 generation for preliminary trials. This was seriously affected by excessive rains from October 1997 to February 1998. The second planting which was done in December 1997 was harvested in late April 1998. Though yield data have not been taken observations that were made on other yield related traits and freedom from disease attack in the field lead to conclusions that lines 96/3, 218/3, 55/1/1, 353/6/1, 291/2, 287/1, 269, and 296/1 would be promising lines 96/3, 218/3, 55/1/1 and 36/1 were derived from the unbranched SPS SIK 50/1 having 3 capsules per axil. A novel character that these four lines have in common is that they are branched. Line 96/3 has an additional character in that its plants develop purple pigmentation at maturity. Line 218/3 is also pubescent, a character that is absent in the parental SPS SIK 50/1. Plants from line 353/6/1 develop purplish coloration at maturity and have 3 capsules per axil. These two characteristics are absent in the parental SPS SIK 6. The lines obtained from the branched SIK 096 were 291/1, 287/1 and 303/2/3. These lines were branched and had 3 capsules/axil. The parental cultivar had only one capsule/axil. Once the yield data have been obtained from the M_7 generation about half of the lines will be advanced for a second season of preliminary yield trials.

REFERENCES

[1] AYIECHO, P.O. and NYABUNDI, J.O. Yield Improvement of Kenyan Sesame Varieties Using Induced Mutations. 1st year Report to IAEA. University of Nairobi (1994).

[2] AYIECHO, P.O. and NYABUNDI, J.O. Yield Improvement of Kenyan Sesame Varieties Using Induced Mutations, 2nd Year Report to IAEA. University of Nairobi (1995).

[3] AYIECHO, P.O. and NYABUNDI, J.O. Yield Improvement of Kenyan Sesame varieties Using Induced Mutations, 3rd Report to IAEA. University of Nairobi (1996).

[4] HOBALLAH, A.A. Developing high yielding mutants of sesame in Egypt. 2nd FAO/IAEA Research Co-ordination Meeting on Induced Mutation for Sesame Improvement. 9–13 Sept. 1996. Antalya, Turkey, IAEA. Vienna, (1996) 24–30.

[5] BHATNAGAR, P.S., S.P. TIWARI, C. SINGH. Disrupting the negative association between oil and protein content in soybean seeds through mutagenesis. Mutation Breeding Newsletter 39 (1992) 7.

[6] GUPTA, P.K. S.P. SINGH, J.R. BAHL. A new mung bean variety through induced mutations. Mutation Breeding Newsletter 42 (1996) 6–7.

[7] KHAN, W.A., ANSARI, H.A., CHOUDHRY, N.A. RAJPUT M.A. and QAYYUM, S.M. Interrelationships of growth attributes with seed yield in sesame. *Sesame indicum* L. Oilcrops Newsletter 5 (1988) 73–75.

[8] LI, Y. The induced mutation of sesame genetic male sterility and heterosis breeding. 2nd FAO/IAEA Research Co-ordination Meeting on Induced Mutations for Sesame Improvement. 9–13 September 1996. Antalya, IAEA. Vienna, (1997) 18–23.

[9] MANEEKAO, S., SIRIKUL, N., POO-SRI, B. and KUMPHAI, S. Sesame improvement through mutation induction for reduction of seed loss at harvest (Semi-shattering). 2nd FAO/IAEA Research Co-ordination Meeting on Induced Mutations for Sesame Improvement. IAEA, Vienna, (1997) 69–73.

[10] MARY, R.J. and JAYABALAN, N. EMS induced variability in sesame. Crop Improvement 22 (1995) 170–174.

[11] PADMARATHI, N. and THANGAVELU, S. Association of various yield components in sesame. Sesame and Safflower Newsletter 11 (1996) 40–45.

[12] RAHMAN, A. and DAS, M.L. Evaluation of improved varieties of sesame through induced mutations. 2nd FAO/IAEA Research Co-ordination Meeting on Induced Mutations for Sesame Improvement, 9th–13th Sept. 1996. Antalya, Turkey. IAEA, Vienna, (1997) 2–17.

[13] REDDY, K.U.O., DORAIRAJ, M.S. and PADMARATHI, N. Character association in *Sesame indicum* L. Sesame and Safflower Newsletter 8 (1993) 41–44.