PROGRESS REPORT FOR THE FIRST HALF / 1989

Grantee : Dr.R.Pathirana

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Title of Project:

"Collection and Evaluation of Sesame Germplasm for Breeding Adapted, High Yielding Cultivars"

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INTRODUCTION

The present report covers the work carried out during the Yala (South West Monsoon) 1989 season. Data of the Maha (North East Monsoon 1988/89) season could not be collected properly due to the occupation of the campus by the army. The research plots could not be weeded in time and the segregating populations had to compete with weeds. This opportunity was taken to select a large number of genotypes that seem to have a good competitive ability. Competitive ability with weeds is also important as neither chemical nor mechanical weeding is practiced presently in farmers' fields where sesame is broadcast sown.

The field trials of the subsequent Yala 89 season were carried out at the Agricultural Research Station, Girandurukotte in Mahaweli System C where high potential for expansion of oilseeds including sesame exists.

I.FIELD STUDIES

1.1.SELECTION IN SEGREGATING POPULATIONS AND EVALUATION OF SELECTIONS

In the last report it was mentioned that the F 2 generation of 89 crosses were raised for breeding purposes. Each of these populations was handled in three different ways, viz.:

a) Pedigree selection
b) Bulk population breeding and
c) Modified single seed descent method

The details of the three methods have been described in previous report. The F 3 generation was grown and evaluated in part of the samples prepared according to these three methods. According to the available literature, research on the breeding methods for sesame have not been carried out. The breeders usually use either pedigree or bulk method to improve this crop. Therefore the results of the comparison of the three methods will be useful in sesame breeding.

1.1.1. Pedigree Breeding

At Girandurukotte two separate experiments were carried out to evaluate the selections in their F 3 generation. The design of both experiments was Randomized Complete Block with 120 treatments. One experiment involved white and cream seeded selections and the other - brown and black seeded selections. Control for white seeded selections was MI 3 and for black seeded selections - MI 2. The control was planted at every 20 plot intervals for comparison as the experiments were large. Both experiments were replicated twice.

1.1.2. Bulk Population and Single Seed Descent Breeding

Twenty five populations of each of these F 3 materials were grown and F 4 seeds harvested.

1.2. GROWING OF A COMPLETE DIALLEL CROSS

The parents, F1 and F2 of all possible crosses in a 6 x 6 diallel cross were grown and harvested. Due to large number of entries and the low seed number in M 1 generation the experiment was grown in two replications in a RCB. Eleven characters were recorded in seven plants per plot. The cultivars included in the diallel cross were D-7-1-11, MI 2, MI 3, Determinate, Jori and Australian Introduction.

1.3. EVALUATION AND CONFIRMATION OF MUTANTS

1.3.1. Evaluation of Advanced Mutants

Two experiments with M4 and M5 generations of mutants selected in gamma ray irradiated MI 2 variety were conducted. Both experiments had MI 2 variety as control. M 5 generation experiment involved 17 treatments (including control) and the M 4 generation experiment - 13 treatments. Both experiments were laid out in Randomized Complete Block design with three replications.

1.3.2. Confirmation of Mutants in M3 Generation

The varients ('putative mutants') selected in chemical mutagen and gamma ray treated MI 2 variety were tested in the M 3 generation for confirmation of mutant characters. M 2 generation of gamma irradiated(TMV 3 XT 65) selection line and of UCR-82-103 NS variety (this variety was treated with DES and EMS as well) was also grown for selecting mutants.

1.4. WORK CARRIED OUT AT MAPALANA (MAHA 1988/89 SEASON)

In April several field trials were laid out at the Faculty Farm. The experimental plots could not be properly weeded and cared for due to work stoppages, occupation of the campus by the army etc. However the more competitive genotypes survived and were harvested. Selections in the segregating populations were also carried out, mainly for competitive ability. Thirty bulk populations, their respective single seed descent populations and 165 selections (of pedigree breeding) from previous season were planted. Out of these, thirteen populations, and selections carried out from each of them were planted in two replicates as thirteen different experiments with the objective of comparing the three breeding methods in the F 3 generation. Due to poor management of the trials as a result of unavoidable

circumstances, data of only four of these experiments will be suitable for statistical analysis and interpretations.

2. RESULTS AND DISCUSSION

2.1. SELECTION IN SEGREGATING POPULATIONS

Single plants selected for testing in progeny rows were in their M 2 at the time of selection. Therefore some progeny rows continued to show segregation for many characters. In the segregating progeny rows another round of single plant selections was carried out in F 3 generation. The number of selections per cross could be reduced because the heterogenity was less than in F 2. The total number of selections was sixty at Girandurakotte and 356 at Mapalana. The selections at Girandurukotte were carried out mainly for high yielding bushy plants. The origin of cultivars involved in the crosses from which selections were carried out in F 3 generation and their characteristics are presented in table 1.

The characters that were considered when selecting single plants include high number of capsules and branches, early flowering, disease resistance, white seed coat, plant architecture (branching habit, branch angle, phyllotaxy and leaf shape), even maturity, low shattering losses (plants with upright capsules which open partially at maturity) etc. These crosses and the characters for which selections were carried out are presented in table 2.

Selections for improved plants having determinate growth habit from populations of crosses of the determinate mutant from Israel were also carried out.

2.2.PERFORMANCE OF F 3 LINES

Out of the 120 white seeded F 3 progeny rows (single plants selected in the F 2 generation) tested in the replicated experiment at Girandurukotte, 28 lines were selected for further yield testing and agronomic evaluation. When the plot yield of these progenies are compared with the mean yield of the white seeded control variety MI 3, eight lines recorded 10% higher yield. MI 3 is the only recommended white seeded sesame cultivar in Sri Lanka. The statistical analysis of yield data did not give a significant F test. Therefore the plot yields were not extrapolated to kg per ha but are presented as yield per plot.

Some of the characteristics of the more promising white seeded lines grown at Girandurukotte are presented in table 3. The results show that the cross involving Sudu Thala (a local white seeded cultivar collected in the southern dry zone) and a line

Table 1.
Parent cultivars used in crosses from which selections were carried out

Catalogue No	Name	Origin	Features
18	UCR-82-11,NS	USA	Non Shattering CApsule
31	Morada Elite	Venezuela	Late, Tall, Branching
32	Oro Short	USA	Dense capsule set, 3 capsules per axil
39	D-7-11-1	India	Yield,plant type
48	Bjal Sadovski	Bulgaria	Early, Vigorous growth
50	Suweon 21	S.Korea	Early, Disease resistance
51	Suweon 9	S.Korea	Early, Vigorous growth
67	Determinate	Israel	Determinate growth
73	Hnani 25/160	Burma	Branching, Yield
78	Zhu-Zhi-2	China	
84	Egypt 301	Egypt	Tall, productive plant
99	Mobile Home	USA	Long fruit, short internode
100	Long pod Sel.	USA	--- do ---
146	Instituto 81	Mexico	Yield,Plant type
176	Nakansawan	Thailand	Disease resistance
171	ST 70	Thailand	Yield, disease res.
161	180/52	Sri Lanka	Phytophthora resistance, Yield.
149	Rubio de la Huacana	Mexico	Tall, profuse branching
141	Improved Baco	Texas	Non shattering, long capsule, 3 fruits/axil
138	Chai Badan	Thailand	Tall, non branching, white seeds
155	TMV 3 x T 65	Sri Lanka	Yield,adaptability
157	Suduthala 102	Sri Lanka	Yield,adaptability, high seed oil %
150	San Juan de Lima	Colima Mexico	Yield, tall, profuse branching
177	Local black	Thailand	Yield, plant type
154	MI 1	Sri Lanka	Yield, adaptability
162	Aust. Introduction	Australia	Low reaction to photo-period
145	Instituto 71	Mexico	Height,3 fruits/axil
163	182/3	Sri Lanka	Selection for phytoph-thora resistance
160	MI3 x Aus. Intr.	Sri Lanka	Low reaction to photo-period, adapted
152	MI 2	Sri Lanka	High yield,adapted
166	125 BON	Japan	plant type
133	24-MKS-II-82190	Thailand	Plump white seed,Mildew resistance
159	T 40x Paloma(sel)	Sri Lanka	Yield, adaptability

Table 1 (Contd.)

153	MI 3	Sri Lanka	Released cultivar, white seeds
136	27 MKS II 82202	Thailand	Yield, Tallness, Competitive, white seed
164	MI 3 x Aus. Intr(tall)	Sri Lanka	Yield,adaptability
156	Tainan White	-- ? --	Yield,plant type
175	SI - 53	Thailand	-- do --
151	Vera Cruz	Mexico	Tall, early, branching, yield
133	24 MKS II 82190	Thailand	Tall,dense capsule set
169	GP 113	Sri Lanka	Adaptability fruits/axil

Table 2
The segregating populations used for pedigree selection

Cross	Criteria for Selection
145 x 163	Early flowering,seed colour,leaf arrangement, yield
152 x 145	Seed colour, maturity date
160 x 163	Seed colour, yield
152 x 166	Yield, flowering date,seed colour
152 x 133	Early flowering
159 x 153	Seed colour, time to flowering,yld.
136 x 166	Dense capsules, yield, carpel No.
67 x 73	Determinate, yield, flowering date
166 x 152	Flowering & maturity date, yield
39 x 136	Yield, dense capsule setting
67 x 146	Yield, determinate with increased number of branches,height
176 x 166	Earliness, yield, carpel number
171 x 155	Earliness, yield, carpel number
37 x 67	Improved determinate types,earliness
166 x 161	Profuse fruiting,yield,
149 x 67	Seed yield, tall,competitive
37 x 161	Earliness, yield,height,
51 x 152	Yield, earliness,
67 x 150	Determinate, yield, seed colour
141 x 51	Earliness, seed colour, yield
67 x 138	Plant architecture, yield
153 x 18	Seed colour,plant type
155 x 160	Dense fruiting,seed colour
67 x 84	Yield, branch number, height
161 x 146	Earliness, yield, seed colour, yield components
50 x 157	White seeds,profuse branching,height
161 x 160	Yield, height, plant type, Disease resistance
18 x 39	Plant type, yield
150 x 67	Improved determinates, seed colour
177 x 154	Plant type, yield, earliness
73 x 152	Yield, leaf arrangement
152 x 138	Yield & white seed
162 x 166	Earliness,Yield, dense fruiting
67 x 78	Earliness, yield
141 x 152	Yield, branching type
171 x 145	Yield, White seed,Non-branching tall
166 x 162	Yield, seed colour, Earliness, Highly branching & dense fruiting
158 x 153	Earliness,long branches, white seed
158 x 67	Yield,profuse branching,tall plants
149 x 133	Early maturing tall plants
67 x 164	Medium height, high yield, dense capsule set with 2 - 4 branches
164 x 153	Early, white seed
149 x 152	Quadricarpellate,white seeded,early
50 x 138	Medium compact plants
51 x 161	Early, medium sized plants

Table 2 (Contd.)

Cross	Criteria for Selection
152 x 164	Yield, tall & early
154 x 166	Tall,branching & high yield
163 x 156	Early, Tall, white seeds
175 x 150	Early, white, 2-4 branches
153 x 145	Early, tall & white seeded
99 x 48	Early, tall,high yield
175 x 157	Tall,profusely branched types with dense capsule setting
170 x 151	Yield, earliness, height, branches
153 x 51	White seeded,tall & basal branching high yielding types
150 x 31	Tall types with top branching
162 x 133	Earliness & yield
152 x 150	Pubescence, Highly productive non-branching types
51 x 153	Yield,earliness,basal branching
169 x 157	Yield,early,tricarpellate,basal branching
136 x 150	Yield, tricarpellate, white seed
39 x 152	Very tall,early, white seeded
100 x 145	High yield, white seeded, medium
159 x 136	Branching habit, increased No. of capsules with white seeds
32 x 138	Early, branching & productive
175 x 158	V. tall,non-branching & branching
73 x 153	Profuse branching high yielders
171 x 160	-- do -- white seeded
153 x 151	Profuse branching,medium height, white seeded high yielders
171 x 152	-- do --, black seed
151 x 133	High yield
48 x 100	Early, white seed, plant type
166 x 137	Yield, plnt architecture
150 x 166	Medium growth,tall basal brnch
159 x 162	Profuse branching & yield
37 x 76	Early, white seeded medium plnts
152 x 157	Plant type & V. high yield
136 x 31	Quadricarpellate,yield, plant type
151 x 67	Carpel No.,improved determinates

Table 3

Characteristics of promising white seeded lines in F 3 (G'Kotte)

Line No	Days to flowering	Days to harvest	Plant height, cm.	Yield per plot,g
83-88-9	39	90	96	157.3
83-88-10	38	92	100	135.5
83-88-14	38	91	99	126.3
91-88-1	25	75	82	114.1
29-88-10	29	80	92	109.8
83-88-8	38	92	91	107.1
84-88-1	30	85	82	106.8
83-88-5	37	92	96	105.9
83-88-15	38	93	95	101.4
40-88-9	26	81	92	97.1
22-88-10	32	84	95	95.9
96-88-13	35	80	89	95.9
83-88-7	39	93	84	92.9
MI 3 (Control)	25	77	63	95.4

derived from the cross (MI 3 x Australian Introduction) has given rise to many promising selections. These are the line numbers starting with 83 in table 3. The common feature in most of these selections is their similarity to the MI 2 (black seeded) variety i.e. tall, branching stem with single capsule per leaf axil and short internode for more dense capsule setting. Late maturity compared to the MI 3 (white seeded) check is another feature. Therefore it is expected that these selections will adapt well to the rainfed cultivation during North East monsoon season (Maha) in the Southern Dry Zone and South West monsoon season in the rest of the dry areas and also for cultivation under irrigation during 'off seasons'.

The line No 91-88-1 which recorded the fourth highest yield has acute branches and leat angle. We selected the plants with such leaf types expecting to accomodate more plants per unit area with out mutual shading of leaves and for better utilization of morning and evening sunlight.

The line No 29-88-10 is another beneficial plant type having less or no branches. The internode length is also less. It has three capsules per leaf axil. This plant type should hold more capsules per unit area of the field under good management. There should be no vacancies in the field if this plant type is to be cultivated successfully because the plant can not compensate for vacancies as in the case of much branched plants. Therefore it will be more suited to farms with improved cultural practices (land preparation, more precise planting etc.). Some of these selections are still segregating and need more purification and testing in larger plots.

Yield analysis of the experiment with black and brown seeded F 3 progeny rows and those grown at Mapalana has not been completed yet. Height to first branch, height to first capsule, plant height, number of branches, number of nodes and capsules and the varietal group according to the FAO descriptors of sesame were the characters studied at Mapalana.

2.3.BULK AND SSD POPULATIONS

Although it is too early to come to conclusions yet, some of the F 4 bulk populations are showing promise. More competitive and productive genotypes are already predominating the others. Some of these crosses are Sudu Thala x (MI 3 x Australian Introduction); Cola de Borrego x Hnani; ST 70 x MI 2 and MI 2 x 125 BON. The above mentioned populations recorded over 1250 kg/ha in plots of 50 M^2.The SSD populations show more variability than the bulk populations and the pedigree selections in F 3 stage.

BEST AVAILABLE

2.4. DIALLEL CROSS

Time taken to flowering and maturity, plant height, height to first branch and capsule, number of branches, capsules, nodes, length of capsule and seed weight per plant are the characters recorded in the diallel cross. Although the data recording has been completed, the statistical analysis is yet to be performed. The data will be analysed according to Griffing. The preliminary results indicate that heterosis is high in the combinations Jori x D-7-11-1; Australian Introduction x D7-11-1 and Determinate x Australian Introduction for characters such as yield per plant, number of capsules and plant height.

2.5.EVALUATION AND CONFIRMATION OF MUTANTS DERIVED FROM GAMMA RAY IRRADIATED MI 2 CULTIVAR

The thirty six selections carried foreward were tested in larger plots for yield and other biometrical characters. In the field experiment where twelve M 4 generation mutants were tested with the parent MI 2 variety, analysis of variance for seed yield showed that the yield differences among the treatments were significant at 5% probability level. The yield of three mutants significantly exceeded that of the parent cultivar MI 2 (table 4). Two of these mutants had the added advantage of larger seeds than the parent and another two mutants recorded increased number of capsules per plant.

The seeds of mutant line No MB 29 were found to have very brittle seed coats, which can be easily removed by rubbing between hands. This will also be an advantageous character as the seeds are dehulled before use in the confectionary industry. The line No MB 33 was found to have capsules which are less prone to shattering. Therefore this line will also be used in further investigations.

In the experiment where the M 5 material was tested, seven mutants recoerded higher yield than MI 2, but the yield differences were not significant statistically. Seven mutants were shorter than the parent variety (differences statistically significant). Four mutants recorded sigficantly larger seeds (1000 seed weight). The bold seeded varieties are preferred in the confectionary use of sesame and therefore these mutants will be followed up in the next generation.

In another experiment with M 3 material derived from gamma ray and chemical mutagen (DES and EMS) treated MI 3 cultivar several mutants with hairy capsules (one from DES, two from EMS and one from 20 kr gamma rays); 4 carpels per capsule instead of two in MI 2 (two from DES and one from 20 kr gamma rays); 3 capsules per axil instead of one in MI 2 (two from DES and one from gamma rays)

were confirmed. Two of these lines recorded higher yield than the parent variety. Another selection made for early flowering in a population derived from DES treatment was also confirmed.

The treatment of other varieties with mutagens was relatively unsuccessful than MI 2. Only three putative mutants were selected in UCR-82-203NS variety. No selections were made in treated TMV3 x T65 in M 2. The M 3 seeds will be grown for detecting any mutants showing up in that generation.

Table 4 Yield and other characters of sesame mutants in M_4 compared with MI 2 (Girandurukitte, 1988)

Treatment	Plant height cm	#Capsules Plant $^{-1}$	# Seeds Capsule^{-1}	1000 Seed weight, g	Seed Weight Plant $^{-1}$, g
MB 10	111	44.4	69.2	3.13	8.8
MB 13	129	50.6	79.6*	3.43*	9.1
MB 15	96	47.8	65.6	3.33	7.2
MB 16	114	49.3	62.9	4.20*	12.7*
MB 17	86	31.1	37.0	3.73*	1.3
MB 25	146	61.8	73.5	2.93	7.9
MB 29	108	64.7	59.6	3.57	9.7
MB 30	129	92.9*	58.6	3.40*	13.1*
MB 32	139	80.7*	76.7	3.07	13.8*
MB 33	127	69.9*	59.8	3.33	11.1
MB 4	97	91.4*	68.7	3.30	7.2
MB 8	119	74.0*	54.9	3.20	9.1
MI 2	117	48.1	63.6	3.20	7.2
CU	9.0	16.8	13.0	3.5	25.4
Pr>F	0.0001	0.0001	0.0003	0.0001	0.0001
LSD	17.8	17.5	14.0	0.20	3.89

Table 5. yield and other characters of sesame mutants in M_5 compared with MI 2

(Girandurukotte, 1988)

Treatment	Seed yield per plant, g	Plant height, cm	# Capsules per plant	# Seeds per Capsule	1000 Seed Weight, g
MB 1	10.2	130.9	54.2	78.0	2.77
MB 10	5.7	102.6	50.0	45.3	3.20*
MB 11	4.4	105.1	27.7	75.9	2.97
MB 15	6.7	136.1	56.6	52.9	3.20*
MB 18	6.3	136.9	57.6	57.1	2.70
MB 2	10.2	122.1	54.3	76.2	2.90
MB 20	8.9	119.2	49.5	65.7	3.03
MB 21	3.8	89.6	39.7	48.8	3.43*
MB 27	5.4	113.9	30.8	73.5	2.90
MB 29	5.9	110.3	60.1	44.1	3.23*
MB 3	10.2	131.8	51.3	75.7	2.93
MB 30	8.0	124.0	47.0	69.6	2.87
MB 4	8.7	116.3	45.5	72.1	2.77
MB 5	2.7	74.1	22.0	61.3	2.17
MB 7	9.1	114.7	68.8	63.9	3.03
MB 8	6.4	100.2	41.2	81.8	3.07
MI 2	8.4	130.5	52.8	69.1	2.90
Pr>F	0.0003	0.0001	0.005	0.0001	0.0001
LsD	3.3	15.0	20.5	15.6	0.19
CV	17.9	7.8	25.9	14.4	4.1

3.PLAN OF WORK FOR THE NEXT HALF YEAR

Test more promising selections in two separate experiments for white and coloured seeded sesame.

Generation advance of 25 of the best crosses in the bulk and single seed descent populations.

Evaluation of the best progenies and mutants in one experiment in a dry zone location.

Continue selection in mutant and segregating populations.

Grow segregating populations received from Israel (Prof.A.Ashri).

Include best selections in a crossing programme.

Confirmation of selections and selected mutants.

Chemical analysis of seeds of better lines at Institute of Fundamental Studies (Kandy) for oil, protein and amino-acids.

Complete statistical analysis of data of previous trials.

Exchange of promising material with collaborators.

Visit to sesame breeding programme in Thailand.

4.ANY OTHER REMARKS

Field trials were established late during the Maha (North East Monsoon) 1988/89 season due to occupation of the campus by the Army and the violence in the South. However most of the planned field experiments were established at the Agricultural Research Station of the Department of Agriculture, at Girandurukotte in the Mahaweli System C. The approval of this arrangement by Deputy Directors (Research), Department of Agriculture (Peradeniya and Girandurukotte) gratefully acknowledged.

Only two Research Assistants were involved in trials due to difficulty in recruiting a third Research Assistant.
The Grantee attended the Fourth International Symposium of Plant Biosystematics in Kyoto, Japan in July, 1989 and presented poster "Intraspecific variation in Sesamum indicum L. with relation to it's classification". Immediately after the conference I proceeded to University of Guelph, Canada for a fellowship training in isozyme analysis techniques in genetics and plant breeding at the Department of Crop Science. A separate report on this visit has been submitted to NARESA.

Signature of Grantee