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PROGRESS REPORT 1985-1987

ENHANCING GENETIC VARIABILITY AND BREEDING IMPROVED SESAME (*S. indicum*) CULTIVARS

US-ISRAEL CDR PROGRAM

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Prepared by:

Prof. Amram Ashri, Israel
Dr. Vichitr Benjasil, Thailand

Submitted by:

Prof. Amram Ashri
The Hebrew University of Jerusalem
Faculty of Agriculture
Rehovot, Israel

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PROJECT PROFILE

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Coprincipal Investigators:

Prof. Amram Ashri
The Hebrew University
Faculty of Agriculture
P.O. Box 12
Rehovot 76100, Israel

Dr. Vichitr Benjasil
Department of Agriculture
Field Crops Research
Institute, Bangkhen
Bangkok 10900, Thailand

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ABSTRACT

The research in Israel and Thailand during the period 1985 to 1987 is reviewed by locations and seasons. The findings are discussed as well as some of the international interchanges.

In anticipation of the project, F_1 hybrids were grown in Israel in the winter of 1984/85 so that the F_2 plants could be grown immediately in the summer of 1985. Thus F_3 seeds were sent to Thailand in 1986 for further selection there. Seeds of selections in more advanced generations were sent there in 1987. Promising selections are now available in Israel and in Thailand in F_5 and earlier generations, from biparental crosses, three-way and four-way crosses and from backcrosses. The selections are both determinate and indeterminate, some are also non-shattering. The selections will be progeny tested in Israel and Thailand and seeds will be shared also with other investigators.

The monogenic, recessive nature of the determinate habit was ascertained and the extent of its hybridization with diverse cultivars is described.

I. OPENING REMARKS

This project was among the first to be approved and activated in the USAID-ISRAEL CDR program. The principal investigators met twice during the last 3 years at international meetings, Miss Veerana Sinsawat from Thailand worked on the project in Israel for one month in the summer of 1986 and Prof. A. Ashri worked on the project with Dr. V. Benjasil and staff in Thailand for 10 days in 1987. Communication and exchange of information and materials between the cooperating teams was good. Also, the USAID office in Bangkok was informed of progress.

On the other hand the procedures of full reporting were not clear, hence the delay in this report. As advised by USAID Bangkok the report covers the activities to the end of the 1987 season in Israel and in Thailand, in separate sections, showing the full scope of the project.

II. RESEARCH IN ISRAEL

1. INTRODUCTION

The research was and is aimed at obtaining adapted, high yielding, good quality cultivars of sesame with the determinate habit (and also indeterminate) and non-shattering if possible. F_1 hybrids of crosses made in 1984 were grown in the greenhouse in winter-spring 1985 so that the F_2 seeds would be ready for planting in summer 1985. Thus, from the project's first season, the research encompassed much genetic variability and many hybrid combinations.

The research since then will be described year by year in the following sections and the results will then be discussed.

2. RESEARCH IN 1985

As noted above, much genetic material was already available at the initiation of the project. Actually, in anticipation of the project the nursery planted in spring 19[illegible] contained:

A. F_1 hybrids and their parents (rows 201-734).
B. F_2 plants (rows 1001-1114, 10 m. long) from F_1 plants grown in the greenhouse in winter 1984/85.
C. F_2 from natural outcrosses of the determinate line (as female).
D. Newly introduced cultivars

In the F_2 the main emphasis was placed on those with the determinate habit. There were 109 F_2 rows of Determinate x 58 other cultivars (including 7 rows from crosses with non-shattering lines) and 5 F_2 rows of intercrosses between 4 indeterminate cultivars. The F_2 populations served as a source of desirable single plant selections and to verify the mode of inheritance of the determinate mutant. Earlier studies of F_2 segregations of crosses between the determinate mutant and the source cultivar, "No. 45" from Israel, showed that it was monogenic and recessive. In view of the drastic effect of the det mutant on the plants' architecture and growth habit it was important to find if and to what extent the penetrance and expressivity of the det allele are modified by various genetic backgrounds, if at all. The F_2 segregations of 33 cross combinations for standard (indeterminate) vs. determinate habits are shown in Table II.2.1. The findings confirm the monogenic, recessive, control of the determinate habit. They show that the activity of this allele is not affected by the various genetic backgrounds tested, namely of UCR selections, and cultivars from Mexico, USA, Venezuela, Sudan, Ethiopia, India, Bulgaria, S. Korea and others whose

origin was not certain. The behavior of the reciprocals with "No. 45" will be investigated further.

The F_1 hybrids and the cultivars grown were used to make many four-way crosses (F_1 x F_1), backcrosses and some three-way crosses (F_1 x cultivar) and new cross combinations of determinate x various cultivars and also to intercross indeterminate cultivars.

The F_1 and parents nursery was attacked at an early stage (before flowering) by the insect pest, Antigastra catalaunalis. Local cultivars were more tolerant than most introduced ones, and their F_1 hybrids were intermediate in their reaction, showing that the reaction to the insect pest has a large genetic component.

3. RESEARCH IN 1986

The research in 1986 encompassed several generations and locations.

In the winter of 1985/86, the F_1 seeds produced in the 1985 summer, were planted in the greenhouse to produce F_1 plants and F_2 seeds.

In the summer of 1986 the following were grown:
F_2 (rows 700-757) in Bet Dagan Experimental Farm (ca. 20 km from Rehovot). These were mostly from indeterminate intercrosses namely, Zhult Sadovski (from Bulgaria) x 18 cultivars, Pungnyeonggae (S. Korea) x 22 cultivars, and Maporal (Venezuela) x 18 cultivars.
F_2 (rows 800-977) in Rehovot included replications of many of the above and some other hybrid combinations.
F_3 (rows 1-622) in Bet Dagan, progeny rows from the F_2 plants selected in 1985, summarized in Table II.3.1.

Additional cultivars were grown in both locations so that backcrosses, new biparental crosses and other hybridizations could be made.

The emphasis in this season was again on the selection of promising F_2 and F_3 plants, determinate and some indeterminate. All id/id non-shattering plants, whether determinate or indeterminate were harvested for further testing, except those that were unproductive or very late. It should be noted that some plants that showed earlier in the season some of the secondary manifestations of id/id (i.e. convex foliage, enations on the undersides of the leaves) but not in an extreme degree, proved to be shattering at the end of the season. Thus, selection for non-shattering can be done with certainty only at the end of the growing season.

Table II.2.1. F_2 segregations for indeterminate vs. determinate in 33 hybrid combinations of indeterminate parents x determinate plants and goodness of fit to 3:1 ratio.

Cross No. 1984	F_1 # 84/85	Female parent	Male parent	F_2 1985	In-det	Det	x^2 (3:1)	P (1 df)
x212	0-1	Det.	No. 45	1001	67	23	0.151	.70-.50
	0-3	Det.	No. 45	1002	65	24		
x218	75-1	No. 45	Det.	1107	106	23	7.440	.01-.001
	75-3	No. 45	Det.	1108	152	35		
x332	2-3	UCR82-2,NS	Det.	1003	71	24	0.003	.98-.95
x339	3-1	UCR82-5,NS	Det.	1004	70	29	1.070	.50-.30
	3-5	UCR82-5,NS	Det.	1005	81	30		
x345	4-2	UCR82-8,NS	Det.	1006	149	38	0.616	.90-.80
	4-3	UCR82-8,NS	Det.	1007	176	61		
x116	5-1	UCR82-202,NS	Det.	1008	105	38	0.830	.50-.30
	5-2	UCR82-202,NS	Det.	1009	91	36		
x123	6-2	UCR82-205,Shat	Det.	1010	155	37	0.187	.70-.50
	6-4	UCR82-205,Shat	Det.	1011	148	59		
x26	7-3	UCR82-208,Shat	Det.	1012	111	45	1.230	.30-.20
x611	8-4	Cola de Borrego	Det.	1014	253	78	0.378	.70-.50
x197	16-2	Maporal	Det.	1017	95	30	0.066	.80-.70
x630	17-1	A-1-10	Det.	1019	113	55	5.360	.05-.02
x387	18-1	A-5-13	Det.	1020	98	30	0.160	.70-.50
x328	19-2	Sesamum 55	Det.	1022	70	41	8.430	.01-.001
x191	20-5	Aceitera	Det.	1025	53	11	2.080	.20-.10
x256	21-1	Caripucha	Det.	1026	111	49	2.700	.20-.10
x477	22-2	Exute	Det.	1029	104	30	0.480	.50-.30
x635	23-2	Extuvan	Det.	1031	160	53	0.0015	P>.99
x481	24-1	Dalamite	Det.	1032	78	26	0.00	1.00

Table II.2.1. Continued

x483	25-3	Glauca	Det.	1035	169	60	0.176	.70-.50
x638	26-3	Inamar	Det.	1037	88	23	1.080	.30-.20
x642	27-2	Jasbrouk	Det.	1039	74	29	0.550	.50-.30
x488	28-4	Kefalo Mixed	Det.	1041	74	22	0.220	.70-.50
x259	29-1	Mofaza Light	Det.	1042	110	36	0.009	.95-.90
x562	30-3	Margo Short	Det.	1045	122	36	0.410	.70-.50
x495	32-1	Morada	Det.	1046	203	51	3.200	.10-.05
x203	41-4	Venezuela 51	Det.	1049	133	43	0.030	.90-.80
x502	34-4	Morada Elite Sel.	Det.	1051	129	35	1.150	.30-.20
x145	50-3	Jori	Det.	1077	138	38	2.400	.20-.10
	50-5	Jori	Det.	1078	114	30		
x4	54-3	Zhult Sadovski	Det.	1085	139	50	1.430	.30-.20
x586	55-1	Bjal Sadovski	Det.	1086	118	25	4.310	.05-.02
x593	58-1	Suveon 21	Det.	1090	260	72	1.940	.20-.10
x597	61-3	Danbackggae	Det.	1091	169	51	0.380	.70-.50
x383	62-1	76, BON	Det.	1092	193	67	0.080	.80-.70
x532	63-2	Pachequeno	Det.	1093	239	110	7.900	.01-.001

Table II.3.1. Biparental F_3 rows grown in 1986 from selected F_2 plants rows (1-622).

Combination		No. of rows*			
			From which selections were made		
Type	No. of Varieties	Total	B	S	B+S
Det. x Non-shat.	5	178	4	21	2
Det. x Cola de Borrego	1	11	0	2	1
Det. x Others	45	385	14	55	37
Indet. x Non-shat.	1	7	0	1	0
Indet. x Others	1	11	4	0	1
TOTAL	-	592	22	79	41

*In addition there were 30 F_3 rows from outcrosses of determinate x unknown (male) parents, selections were taken from 7 rows.

4. RESEARCH IN 1987

4.1 Greenhouse (Rehovot)

As in previous winters, the greenhouse was used in order to advance the generations. Hybrids from crosses made in the summer of 1986 were planted on Feb. 19, 1987 and harvested in late June. There were 110 short rows (9 hills) as follows:
94 rows - 30 backcross combinations where desirable selected F_3 plants of crosses of determinate x other varieties, were backcrossed to the other parent variety.
8 rows - 3 backcross combinations where desirable F_3 plants of crosses of Zhult Sadovski x other varieties were backcrossed to Zhult Sadovski or to the other parent variety.
8 rows - 6 three-way crosses in which the determinate line was involved.

The tops were harvested, dried and threshed immediately. The seeds obtained were planted in the field four weeks after the harvest (Field II, see below).

4.2 Field I (Rehovot)

Field I was planted during the last week of May and harvested in August and September. In the last seedbed preparation operation, 3 weeks before planting, the field was treated with the herbicide Treflan at the rate of 2000 cc. in 200 liters of water per hectare. The herbicide gave good results and only light weeding was required during the first 3 weeks until the sesame plants shaded the weeds.

The rows were 10 meters long and planted in pairs with alternate spacing of 50 cm and 80 cm, i.e. /50/80/50/ etc. The field was trickle-irrigated according to need with the hoses placed in the 50 cm. spaces. Following thinning by hand, spacing within the rows was ca. 5 cm. between the plants.

The breeding materials planted in this field and the extent of selection from them are presented in Tables II.4.1 - II.4.4. They included F_2 plants from backcrosses and three-way crosses, F_2 from biparental crosses, F_3 rows from four-way and biparental crosses and F_4 rows.

In addition this nursery included parent varieties, some newly introduced materials including Sesamum radiatum and a bulk population plot. The bulk was formed with F_4 seeds harvested from many F_3 four-way hybrid combinations grown in 1986. The plot consisted of 12 rows 12 m. long (ca. 100 m^2).

4.3 Field II (Rehovot)

Field II was planted during the last week of July and harvested in October. The rows were 8 meters long, spacings

were as above. The field was trickle-irrigated according to need. Treflan was used as earlier and again was very helpful in minimizing the weed problem.

The types of breeding materials planted in this field are summarized in Table II.4.5.

In addition, this field contained parents and some new introductions for preliminary observation.

4.4 Bet-Dagan

A preliminary observation nursery with 52 newly introduced landraces and cultivars and 41 cultivars that were already known was planted on June 23 at the Bet Dagan Experimental Farm.

The sources of the materials and the numbers of accessions from each were as follows:

South Korea	21	
China (P.R.)	3	
Taiwan	2	
Thailand	9	
Burma	3	
Nepal	1	
Israel	1	
Egypt	1	
Kenya	1	
Cyprus	1	
Greece	4	
Bulgaria	2	
USA	7	(6 Non-shattering)
Venezuela	7	
FAO collection	33	(varieties from many origins including India and some African countries).

4.5 Results

4.5.1. Segregating materials and selections.

In the 1987 summer season it was possible to study and evaluate simultaneously plants in F_2, F_3 and F_4. Naturally, with promising F_4 lines available, screening for new selections in F_2 and F_3 was more critical. The numbers of rows from which selections were made are shown in Tables II.4.1-5. Selections were made mostly from crosses with the determinate mutant, but also from crosses involving indeterminate parents.

In the F_4 and F_3 there were many promising determinate lines, but they differed markedly. They differed in branching - some had no branches at all (uniculm), some had very few branches and some had many branches. Some

plants were very short while others were medium or tall, from about 50 cm. to 180 cm. and more. They varied in maturity from early to late. In some lines the determinate habit was combined with non-shattering. There was also variation for capsule size and shape and in seed size, shape and color. All the determinate plants, regardless of the variation for other traits, had the characteristic clustering of the capsules at the branches' tips, pointing upwards. There was however variation in the number of capsules per branch. In some cases 2, 3 and 4 nodes below the apex also bore capsules, thus the yield was increased. The mean number of capsules per plant varied from 10 in some determinate small uniculm plants to as high as 194 capsules (small ones) in tall, much branched plants. It would appear that the type to be preferred is a determinate plant with few branches, with 2-3 capsule bearing nodes per branch (and the main stem) plus the apical cluster of capsules. Such plants that have 25-50 large capsules/plant were selected, some with 1 capsule per leaf axil and some with 3 capsules/axil. This point will be verified, by progeny testing in 1988.

All plants that were non-shattering (indehiscent) and determinate and had reasonable yields were selected (see Tables II.4.3 and II.4.4) and will be progeny tested. Similarly, in crosses not involving the determinate line in which non-shattering progenies were obtained, all plants that were non-shattering and had reasonable yields were selected (see Table II.4.3 and II.4.4) for further evaluation in 1988.

As evident from Table II.4.4, quite a few promising F_4 lines were sufficiently uniform to be harvested in bulk. All the F_4 selections will undergo preliminary yield trials in the coming summer (1988) and will be sent for testing also to Thailand.

Promising plants were selected in the F_2 and in the F_3 of the various combinations (see Tables II.4.1-3, II.4.5), more so from some combinations than from others.

The performance of the hybrids derived from crosses of Determinate x Cola de Borrego was very disappointing (see Tables II.4.3-4). The plants had much biomass but low yields; they were tall, late and with few capsules. Thus out of 168 F_3 rows, selections were made in two only. In F_4 there were six rows, which were discarded.

Table II.4.1. Biparental F_2 rows grown in Field I, Rehovot, 1987 (rows 896-987).

Combination*		No. of rows			
			From which selections were made**		
Type	No. of varieties	Total	B	S	B+S
Det. x others	8	27	0	1	0
Indet. x "	21	65	0	0	1
TOTAL	-	92	0	1	1

* A non-shattering cultivar was not included among these varieties.

** B=Harvested in bulk; S=Selected plants harvested singly.

Table II.4.2. F_3 rows from four-way crosses grown in Field I, Rehovot, 1987 (rows 561-788, 798)

Combination		No. of rows			
			From which selections were made		
Type	No. of varieties	Total	B	S	B+S
Det. one of parents	32	226	0	37	10
All parents indet.	4	1	0	0	0
TOTAL	-	227	0	37	10

Table II.4.3. Biparental F_3 rows grown in Field I, Rehovot, 1987 (rows 221-560, 801-895)

Combination		No. of rows			
			From which selections were made		
Type	No. of varieties	Total	B	S	B+S
Det. x Non-shat.	10	32	0	8	0
Det. x Cola de Borrego	1	168	0	1	1
Det. x Others	46	114	0	9	2
Indet.x Non-shat.	7	17	0	6	2
Indet. x Others	39	104	0	10	3
TOTAL	-	435	0	34	8

Table II.4.4. Biparental F_4 rows grown in Field I, Rehovot, 1987 (rows 1-220)

Combination		No. of rows			
			From which selections were made		
Type	No. of Varieties	Total	B	S	B+S
Det. x Non-shat.	4	33	8	6	0
Det. x Cola de Borrego	1	6	0	0	0
Det. x others	37	146	23	4	5
Indet. x Non-shat.	1	1	1	0	0
Indet. x Others	6	34	2	0	0
TOTAL	-	220	34	10	5

Table II.4.5. F_2 rows from backcrosses (BC) and three-way crosses grown in Field II Rehovot, 1987 (rows 2001-2603).

Combinations		No. of rows			
			From which selections were made		
Type	No. of Varieties	Total	B	S	B+S
(Det. x other)x same other (BC)	33	514	0	186	0
(Det. x other)x third var.	7	34	0	2	1
(Indet. x other) x same other (BC)	5	55	0	10	0
(Indet. x other)x third var.	0	-	-	-	-
TOTAL	-	603	0	198	1

On the other hand, certain crosses of the determinate line contributed in the F_3 and F_4 an appreciable number of selections. They were those with non-shattering lines and with Margo, Oro Short, Oro Tall, Terras, Bjal Sadovski, Anna, Suwon 5, Pungnyeonggae, Zhult Sadovski, Egyptian. In addition some indeterminate selections were made among the progenies of crosses of Zhult Sadovski and of Pungnyeonggae by various cultivars. These selections will be tested in Israel and Thailand in 1988.

In the BC_1F_2 populations and the F_2 of some three-way crosses the following combinations gave appreciably (mainly determinate) more selections: Determinate x Anna, Eva, Terras, UCR 3, Zhult Sadovski, Bjal Sadovski, Suwon 5, Phule Til No. 9, Sesamum 55, Aceitera and Margo. Also, BC F_2 populations of Zhult Sadovsky by non-shattering lines, and by Suweon 5 contributed relatively more selections (indeterminate).

The F_3 of (UCR82-10, NS x Det)X (Caripucha x Pungnyeonggae) segregated for several capsule characters: one vs. three/axil; capsule length; capsules narrow at the base and wide at the distal end vs. the usual uniform width; suture structure flared vs. regular. These traits will be followed in the progenies of all the plants of this row (No. 563) which were harvested singly.

Non-shattering progenies in the F_2, F_3 and F_4 varied from very poor to fairly promising. So far though high yielding non-shattering segregants were not identified.

In some progeny rows, mainly in crosses of Determinate x Cola de Borrego, a certain unusual phenotype was recovered. The plants were short; had thick fleshy leaf petiols and stems; had very large, droopy, thick, leathery, somewhat wavy leaf blades which developed progressively more necrotic spots and had few or no capsules. In some cases the axils which normally have capsules had no flower buds (blind), some plants had no capsules at all and some had only a few.

4.5.2 <u>Bulk populations</u>

Bulk populations served in the past in sesame and other crops as sources of new desirable genetic variability for varietal improvement. In view of the large crossing program in this project, it was decided to form a bulk population as a long term undertaking. The bulk plot will be grown annually, checked for markers' frequencies and harvested. Certain single plant selections will perhaps be made, depending on the availability of promising plants.

In Sept. 1987, the first year of the bulk plot, it contained an estimated population of 1750 F_4 plants. Homozygous recessive plants were counted as follows:

Non-shattering	5, 0.286%
Fasciated	8, 0.457%
Determinate	44, 2.514%
Quadricarpellate	16, 0.914%
Red stems & capsules	43, 2.457%

Seeds of the bulk are available for distribution. They will be sent to the cooperating scientists in Thailand and to scientists elsewhere who will request seeds.

A second bulk seed lot was formed during the harvest of Field I. Two capsules were picked in one plant from every F_2, F_3 and F_4 row (ca. 950 rows). The seeds of this bulk will also be shared with other scientists as above.

4.5.3 New crosses

In order to combine traits of additional materials and to generate further genetic variability additional crosses were made in the summer of 1987. There were 558 crosses of which 48 were of *Sesamum radiatum* x cultivated (determinate and various introduced lines) and reciprocals. The remaining 510 were intercrosses of newly obtained accessions, new crosses with the determinate mutant and backcrosses and three-way and four-way crosses of selected F_3 and F_4 plants. Indehiscent (non-shattering) plants with desirable attributes were backcrossed whenever possible even if their yields were fairly low. The rate of success in the cultivated x cultivated crosses was 64% (328) and in crosses with *S. radiatum* it was 35%.

5 INTERNATIONAL COOPERATION AND INTERCHANGE

5.1 International Board of Plant Genetic Resources (IBPGR), Rome.

The IBPGR granted Prof. A. Ashri a two year project, titled: "*Sesamum* Genetic Resources: Collection and Evaluation". The first year of the project was devoted to assembling various accessions (improved cultivars, land varieties, promising breeding lines, wild species) from diverse origins. At this writing there are ca. 1500 seed samples and it is hoped that more will be obtained by April-May 1988. At that time the collection will be sown in a uniform nursery, evaluated for the various descriptors and states and increased.

5.2 Food and Agriculture Organization of the UN (FAO), Rome.

At the request of the FAO, Prof. A. Ashri developed in 1986 a proposal for a concerted, coordinated, international

effort in several countries to breed improved high-yielding sesame cultivars adapted to different environments and resistant to diseases. After evaluation, the FAO concluded that the project is promising and necessary, since sesame is basically a crop of developing countries (99%). Accordingly, an Expert Consultation was convened by the FAO in Vienna, Austria in September 1987 to prepare the final version of the proposal for the FAO and the UNDP and other possible donors. Prof. A. Ashri served as a consultant to the FAO at this meeting, prepared the report and the final copy of the research proposal. The co-principal investigator, Dr. Vichitr Benjasil from Thailand, was one of the internationally recognized experts invited to participate in the meeting.

5.3 Republic of Korea

The International Atomic Energy Agency (IAEA) (Vienna) sent Prof. A. Ashri to South Korea (Suweon) for 1 month in the summer of 1986 to serve as a consultant on sesame and peanut breeding including the use of induced mutations. Subsequently, in the summer of 1987 Dr. C.W. Kang, a sesame breeder came from Suweon to work on the project in Rehovot for 2 months on an IAEA fellowship. These missions led to close cooperation and exchange of information and breeding materials.

5.4 Venezuela

While in Venezuela in Nov. 1987 for a conference on "Science, Research and Development" Prof. A. Ashri was asked by the IAEA to visit research centers in Maracaibo and Maracay to advise on utilization of induced mutations in breeding improved crops, among them sesame. Several sesame investigators were visited including Dr. Bruno Mazzani, a veteran and leading sesame specialist. The visit led to closer contacts and exchange of materials and information.

5.5 Seed Shipments

Two large lots of seeds were sent to Thailand to the cooperating scientist, Dr. V. Benjasil. The first lot, of F_2 seeds of 57 combinations from the 1985 yield was sent early in 1986. The second lot of seeds, of more advanced selections and materials from the 1986 nursery, was brought by Prof. A. Ashri to Thailand during his visit in July-August 1987. This shipment included 296 F_4 selections (46 bulks and 250 single plant selections). Of these, 173 were derived from crosses of various varieties with the determinate line, 31 from crosses of diverse varieties with Zhult Sadovsky (from Bulgaria), 54 from crosses with Pungnyeonggae (from S. Korea) and 38 from crosses with Cola de Borrego (from Mexico).

This shipment included also 42 F_3 seed samples. They were obtained from selected F_2 plants derived from four-way crosses, where the determinate was one of the four parents.

Seeds of segregating materials and/or of various cultivars were sent to interested researchers in Venezuela, Mexico, Sri Lanka and R. of Korea.

Seeds of the determinate mutant were supplied directly or via FAO to interested researchers in Venezuela, Mexico, USA, Nigeria, Burkhina Faso, Sudan, Ethiopia, Egypt, Spain, Greece, Pakistan, India, Thailand, P R. China and R. of Korea.

Seeds of Thai cultivars of sesame were obtained from the coprincipal investigator and from Mr. Prasit Jaisil, Khon Kaen University.

6. VISIT OF PROF. ASHRI IN THAILAND

The visit of Prof. Ashri to the Thai part of the project was undertaken in the 2nd year of the project (instead of the third) in view of the needs of the research and with the encouragement of the Science and Technology Division, USAID, Bangkok. The planned itinerary of the visit (Table II.6.1) was maintained except for some minor modifications.

In Khon Kaen University, several sesame researchers described their research projects and their nursery was visited. While there I met also the Deans of Agriculture and of Technology and the Rector. In Bangkok, I visited the head office of the Population and Community Development Association (=PDA) at their request.

The main objectives of the visit were:

a. To make selections in the F_4 generation together with the investigators at the Ubon Ratchatani Field Crops Research Center.
b. Study the needs and potentials of sesame production in the NE area of Thailand.
c. Exchange knowhow and experience with the cooperating investigators.

The breeding history of the F_4 populations was the following: F_2 seeds of 57 hybrid combinations (mostly indeterminate cultivars from various origins x determinate, but also some indeterminate intercrosses) harvested in the fall of 1985 were sent to Thailand in 1986. The F_2 seeds were planted in Ubon in Aug. 1986 and handled in a modified single seed descent (SSD) approach. One capsule per plant was harvested, the seeds of each line were bulked and a sample was drawn to plant the F_3. The F_3 seeds (2 rows each line) were sown in early January 1987 in Suphan

Buri Field Crops Research Center. The F_3 was harvested by the same modified SSD approach described above. The F_4 seeds were planted in 6-row plots, 6 m. long in mid-June 1987 in Ubon. My visit was timed to coincide with the maturation of the F_4 plants.

The F_4 plots and plants were evaluated together with the Director of the Research Center, Mr. Thanom Dao-Ngarm, and with the researchers, Ms. Saisunee Rungsipiyakul, Mr. Boonguer Pooxri and Mr. Chatchawan Meerot (student trainee).

Very promising plants, both determinate and indeterminate, with and without branches were identified and tagged. These plants were to be harvested and their F_5 progeny tested in preliminary yield trials.

It was interesting to note that in the F_4 plots which had a non-shattering parent, the indehiscent (id/id) plants were rare. It is possible that this phenotype competes poorly in these conditions. The frequency of determinate F_4 plants varied in the populations that had a determinate parent. Some had a high proportion and some had a very low one. This is a clear indication of the importance of the genetic background.

It is still too early to conclude how effective the SSD method is in sesame, but it did narrow the variability and increased the proportion of more adapted plants within each population.

The problems, expectations and potentials of sesame in NE Thailand became clearer to me during my visits in the various research centers and Khon Kaen University (Table II.6.1). The discussions with the investigators in the various locations were most helpful. Some of the conclusions from this study visit helped Prof. A. Ashri and Dr. V. Benjasil to assess priorities of research objectives in the FAO Expert Consultation on sesame, in September 1987 (see publication No.5 in list below).

The seminar given by Prof. A. Ashri at the Field Crops Research Institute in Bangkok dealt with sesame breeding objectives, breeding methodologies including the use of induced mutations and the role of major gene mutations in the domestication of plants. It served as a further opportunity for exchange of ideas.

During the visit I met with Dr. Jaroon Kumnuanta and Dr. Gordon L. Hiebert of the Science and Technology Division, USAID, Bangkok. The status of the research was described, its potentials were discussed and the reporting procedures were agreed on. This visit was used also to form communication links to assist other researchers in Thailand and Israel to find cooperators for future CDR projects; at the last call for project preproposals (fall 1987) six

projects were aided in this way. One of them, submitted by the author and colleagues in Israel and Thailand proposed to apply molecular approaches and classical breeding methods in order to develop sesame cultivars resistant to the mycoplasma-like organisms causing the destructive phyllody disease.

7. PUBLICATIONS RELATED TO PROJECT

1. Ashri, A. 1985. Sesame (Sesamum indicum L.). In; Handbook on Flowering. 4:309-312. CRC Press Inc., Boca Raton, FL.

2. Ashri, A. (Ed.). 1985. Sesame and Safflower: Status and Potentials. Proc. Expert Consultation, Viterbo, Italy, 17-22 December, 1984. FAO Plant Production and Protection Paper No. 66, Rome. pp. 223.

3. Ashri, A. 1985. Sesame improvement by large-scale cultivars' intercrossing and by crosses with indehiscent and determinate lines. In: Sesame and Safflower: Status and Potentials. FAO Plant Production and Protection Paper No. 66. Rome p. 177-181.

4. Ashri, A. (Ed.). 1985. Sesame and Safflower Newsletter. No. 1. FAO, Rome. pp. 97.

5. Ashri, A. 1987. Report on FAO/IAEA Consultation on Breeding Improved Sesame Cultivars, Vienna, Austria, 14-18 September 1987. FAO, Rome, pp. 16.

6. Ashri, A. Sesame. In: Oil Plants of the World: Their Breeding and Utilization. Chapter 19. Macmillan Publ. Co., New York. (In press).

7. Ashri, A. Major gene mutations and domestication of plants. Paper presented at FAO/IAEA Advisory Group Meeting on the Possible Use of Mutation Breeding for Rapid Domestication of New Crop Plants. Vienna, Austria. November 17-21, 1986. (In press).

8. ACKNOWLEDGEMENTS

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I would like to acknowledge with thanks the warm hospitality and the effective research cooperation extended to me by all the persons I met during my visit to Thailand. I wish to thank especially Dr. Vichitr Benjasil and Dr. Jinda Jan-Orn of the Field Crops Research Institute, Bangkok; Mr. Thanom Dao-Ngarm and Miss Saisunee Rungsipiyakul of the Ubon Field Crops Research Center; Dr. Nimitr Vorasoot and Mr. Prasit Jaisil of Khon Kaen University; and Dr. Jaroon Kumnuanta of USAID, Bangkok.

III. RESEARCH IN THAILAND

1. INTRODUCTION

In Thailand, the sesame research of the Field Crops Research Institute of the Department of Agriculture is based in the Ubon Field Crops Research Center, Ubon Ratchathani, N.E. Thailand. Other centers and stations participate in it as needed. In 1987, the main sesame research projects at Ubon included breeding for improved cultivars, tests of white seeded lines, tests of early maturing lines and of late maturing lines in Ubon and in farmers' fields, collection and evaluation of germ plasm; screening for disease resistance and studies on the effects of insect pests. Thus, the cooperative project constitutes part of a larger undertaking. Progress reports on the findings of the project which were submitted in 1985 to 1987 in Thailand are reproduced below.

2. THAI-ISRAEL SESAME COOPERATION PROJECT, 1985 PROGRESS REPORT

243 lines of sesame, some collected from specific localities in Thailand and others introduced from foreign countries, were planted at Ubon FCRC from September 1985 to January 1986. Data were collected for the materials on No. of days to first flowering, No. of days to 50% flowering, No. of days to harvest, yield (kg/rai, 6.25 rai=1ha) and 1000 seed weight. The detailed descriptions were submitted by Dr. V. Benjasil, and can be obtained from him. It was found that 20 lines had desirable production characteristics (>80 kg/rai). Some lines had non-shattering characteristics but most of them gave very low yield. For the 1986 trial, the lines which have high yield (>80 kg/rai) early maturing (<85 days), and semi-shattering characteristics will be studied.

3. Progress Report (1986)

Enhancing Genetic Variability and Breeding Improved Sesame (S. indicum) Cultivars

Three hundred and eighteen lines of sesame were planted in the early and late rainy season, 1986, only 272 lines were harvested. Thirty three characters were recorded according to the IBPGR descriptors Some characters in many lines have shown seasonal differences from environmental effects including photoperiod, temperature, soil moisture and relative humidity.

In the early rainy season, the earliest lines matured at 83 days after emergence, the latest one at 124 days. 113 lines in the range of 83 - 90 days, 33 lines in the range of 91 - 100 day and remaining lines were over 100 days. Seed yield per plot was estimated in kg/rai (6.25 rai = 1 hectare). The introduced lines produced both maximum and minimum yields. The highest yield was from an introduced line in 1981 (253 kg/rai) and the lowest 1.6 kg/rai, was from a line introduced in 1984. 37 lines had yields averaging between 60 - 100 kg/rai and 19 lines between 101 - 140 kg/rai. Thirteen of those nineteen were local varieties. Only 2 lines produced over 140 kg/rai. The remaining lines had yields under 60 kg/rai. 1,000 seed weight also varied. Black seed coat color, local variety, had the highest 1,000 seed weight (4.763 gm.) The lowest weight appeared in an introduced line (1.306 gm.) 83 lines and local varieties, had a 1,000 seed weight between 3.0 - 3.5 gm. Most local varieties were in this range. 19 lines, one from local varieties, 6 from out-crossing, and 12 from introduced varieties, had a weight over 3.5 gm.

In the late rainy season, maturity period had slightly changed. The obvious differences were found in seed yield, plant height and number of capsules per plant. No line had the highest yield over 100 kg/rai. The introduced line in 1981 produced the highest yield (78.4 kg/rai). Only 6 lines had a yield averaging between60 - 100 kg/rai, the remainders were under 60 kg/rai. The highest 1,000 seed weight was 3.806 gm from an introduced line in 1984, while only 1,397 gm was from an out-crossed line. 66 lines varied from 3.0 to 3.5 gm and only 10 lines had over 3.5 gm.

Maximum number of capsules per plant in the early rainy season was 100.2 capsules while only 39.3 capsules per plant were found in the late rainy season. Shattering in the field was present in most lines in both early and late rainy season. However, period to first flowering was shorter in the late rainy season. Plant height in every line was very different from early to late rainy season.

Growth habit of all lines was indeterminate. Branching habit varied, there were non-branching, basal branching and top-branching lines. However, most lines were top-branching. Number of primary branches per plant varied from 0 to 9.6 (10 plants average). Most lines had two carpels per capsule (bi-carpel), the remaindees were quadri-carpel.

Other characters following the IBPGR descriptors have been recorded.

Hybridization

Twenty three crosses of 7 high yielding seasme varieties were made in the early rainy season, 1986. The 23 F1 from these crosses were planted in the late rainy season in Ubon. The F2 were planted in the irrigated field at Suphan Field Crops Research Centre during the dry season.

Selection

Fifty seven F2 (from Prof. A. Ashri) were planted and evaluated in the late rainy season, 1986. The F3 were planted and evaluated in the dry season at the irrigated location of the Suphan Field Crop Research Centre.

4. Addendum Progress Report January - June 1987

The subsections in this addendum cover progress from January to June, 1987. Each subsection describe progress subsequent to that reported in the corresponding section of the 1986 report.

Collection

Because of the late arrival of the rains this year, and the late - maturing characteristics of some of the varieties used, sesame collection will be done only in the late rainy season at the Ubon Field Crops Research Centre (Ubon FCRC). Materials are the same as those in 1986. Their characteristics following the IBPGR descriptors will be verified.

Hybridization

The F_3 of 23 crosses were planted in the dry season at the irrigated area of the Suphan FCRC. The F_4 were planted in the early rainy season at the Ubon FCRC. The plants are in the vegetative stage and will be harvested by single seed descent method.

Selection

The F_4 from the Suphan FCRC were planted at the Ubon FCRC. They are in the vegetative stage and will be harvested by single seed descent method.

RAIN FALL 1986

UBON FIELD CROP RESEARCH CENTER

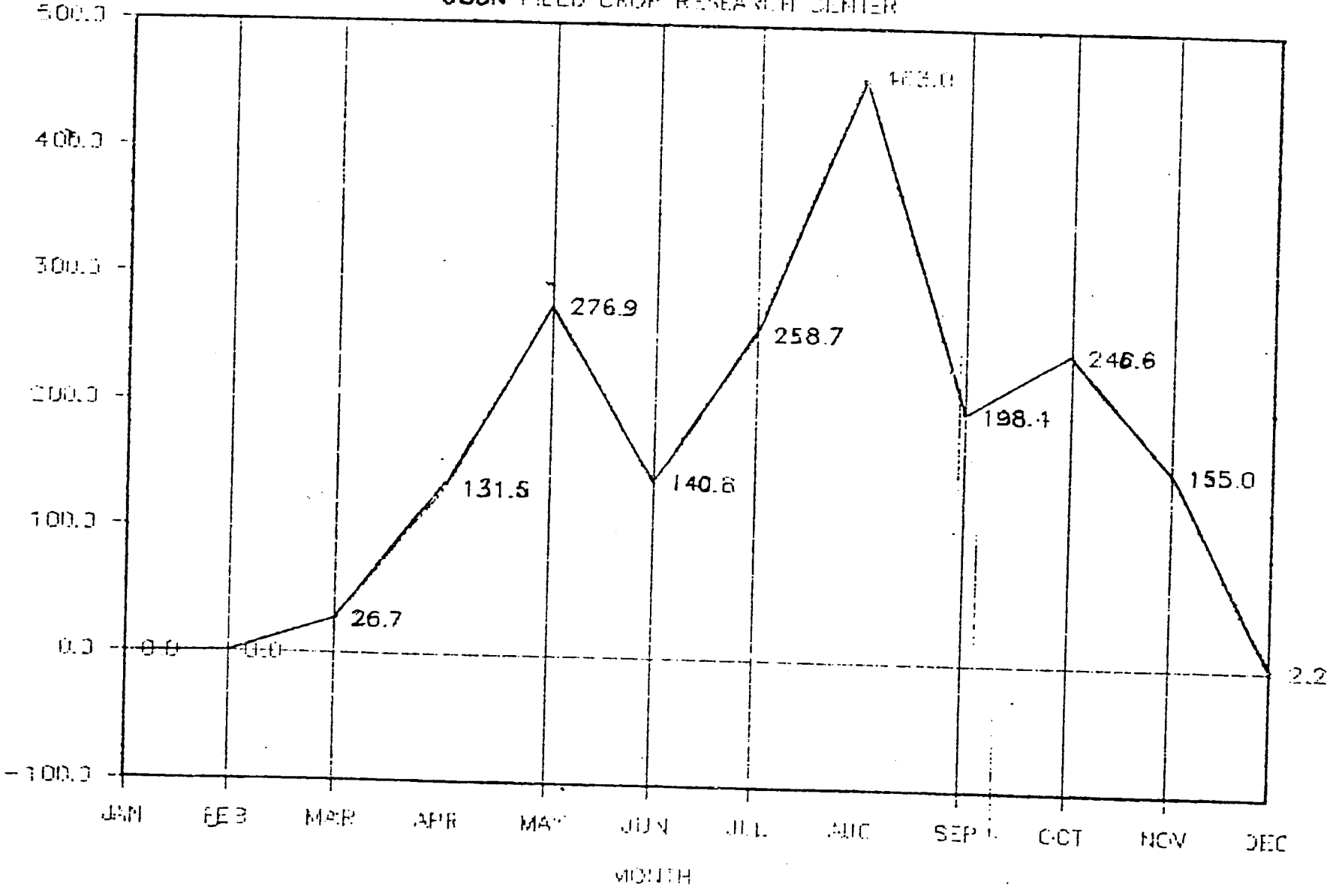

Table II.6.1. Itinerary for Dr. Amram Ashri, 1987.

Wed. 29 July	07:25	Arrive Bangkok by SK 971
	13:00	Dicussion with FCRI Director and a call on D.G. and/or Deputy D.G. of Department of Agriculture
Thur. 30 July	07:00	Leave for Ubon Ratchathani (Plane)
Thur. 30 July - Sat. 1 Aug.		Sesame selection at Ubon Ratchathani Field Crops Research Center
Sun. 2 August		Leave for Mukdahan and Sakol Nakhon Field Crops Experiment Stations by car. Stay overnight at Sakol Nakhon (Thanom)
Mon. 3 August		Leave for Kalasin and Roi-Et Field Crops Experiment Station. Stay overnight at Roi-Et (Thanom)
Tue. 4 August	Morning	Leave for Maha Sarakham Field Crops Experiment Station
	11.00	Join Khun Vilat-Population and Rural Development Association (Thanom) Stay overnight at Khon Kaen
Wed. 5 August		Visit Khon Kaen Field Crops Research Center and Khon Kaen University (Prasit Jaisil)
	Evening	Return to Bangkok
Thur. 6 August	Morning	Dr. Vichitr Benjasil, FCRI, Bangkok
	12:00	Lunch at Dairy Queen
	14:00	Seminar at Field Crops Research Institute, Room 101
Fri. 7 August	Morning	USAID
	Afternoon	PDA
Sat. 8 August	Morning	Free
	Afternoon	Dr. Jinda Jan-Orn
	Evening	Departure

5. Enhancing Genetic Variability and Breeding Improved Sesame (S. indicum) Cultivars.

Progress Report [1/]

by

Vichitr Benjasil[2/], Thanom Doa ngarm and Saisunee Rungsipiyakul [3/]

Abstracts :- Thailand - Israel cooperative research project on sesame breeding for high yield and desirable characters has been conducted since 1985. Collection of sesame lines and cultivars were studied and crosses were made from selected parents in both Thailand and Israel. Combining determinate mutants and non-shattering characteristics to the adapted high yielding types, the selection is made from segregating populations by plant to row method. F4 progenies are grown now at U-bol Field Crop Research Center in 1987 for further selection. Cultivars with high yield, determinate and non-shattering characteristics are desirable.

Introduction.

Sesame is one of the world's most important oil crops. It is grown mostly in developing countries and by small farmers. Sesame

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1/ Paper prosented at MOSTE/USAID Conference of USAID Science Research Award Grantees, Nakorn Pathom, July 24 - 26, 1987.

2/ Director, Field Crops Research Institute, Department of Agriculture, Bangkhen, Bangkok.

3/ Director and Research Agronomist U-bol Ratchthani Field Crops Research Center, U-bol Ratchthani.

seed is rich for oil content (50%) of excellent quality and protein (25%) of sulfur containing amino acid. Sesame oil is widely used for salad, cooking and margarine, and also in industrial uses e.g. paints and insecticides. Sesame oil contains sesamol which is anti-oxidant making it high resistance to rancidity and prolong shelf life. Sesame meal has been used for animal feed and defatted flour can be used for human consumption.

Sesame has important agricultural adventages: it can set seeds and yield under relatively high temperature, on stored soil moisture without rain or irrigation. It can grown in rotation with other main crop in the area and the season when other crops can not be grown and yield.

However, very little research in the past has been devoted to sesame. Limited research has been done in less developed countries where funds and scientists are scarce. No International Research Center has sesame as their mandate crop. Furthermore, sesame research in developing countries could not benefit from research done in developed countries, as has been the case in many other crops, because it is very minor crops or they has not grown sesame in their countries. Therefore mean yields of se sesame are very lows although potentially they could be much higher. Various factors are responsibles for the low yield such as, erratic rainfall, low input levels uneven fipening of the capsules, dehiscence and seed shattering, diseases and insects and of course the adapted and high yielding cultivar.

Yield components of sesame consits of many characteristic of sesame crops itself and its related functions that contribute to seed yield and all of these characteristic must be improved by plant breeder singly or in combinations. They are as following:

- Height
- days to first flowering
- days to 50% flowering
- number of branches per plant
- lenght of branches bearing capsules
- number of capsules per nodes
- number of capsules per branches and per plants
- number of seed per capsules
- seed size of seed weight (1000 seed wt.)
- seed weight or seed yield per plants
- number of plants per unitarea

Due to several components and their variations, sesame breeder will concentrate on only few characters that mainly contribute to yield and has economical value. They are as following:

- Seed size and seed color
- Non-shattering or semi-shattering
- Determinate
- Upright growth, no lodging
- Earliness
- High oil and protein
- Disease resistance
- Drought resistance

Although sesame has been grown in Thailand for very long time but planted area and production of sesame has not increased during the last ten years. Thai sesame farmer are small holder who do farming under rainfed

and drough-prone land with soil low in fertility. Annual planted area is about 35,000 to 46,000 ha while production ranges is about 21,000 to 30,000 ton. Average yield per hectare is relatively low, about 600-700 kg/ha.

Sesame is a versatile crop that can be grown in many parts of the country. Sesame production area in Thailand are from the North, Northeast and the Central Region.

Objectives of this project are to create widely based segregating population of sesame for selection and breeding of improved cultivar for Thailand and Israel, which will be determinate and non-shattering. The determinate type of sesame will mature within a short time span together with non-shattering capsules, thus facilitating harvest with minimum seed losses and shorter growing season.

Materials and method.

At the present, all sesame cultivars are indeterminate, i.e. the plants produce leaves flowers and capsules continuously as long as there is moisture available in the soil. At harvest time, the capsules will be over matured, matured and immature ones on the harvested branches. That make seed losses unavoideble. Determinated genotype, discovered by Ashri will mutant will reduce seed losses and together with non-shattering or semi-shattering will minimize it.

Most effort in this project is to breed determinate cultivars adapted to various growing conditions in Thailand and Israel using the determinate mutant induced by Ashri (1, 2) and the local sesame cultivars

of desirable types.

Materials in this project are the following.

1. Collection of cultivars from land varieties and introduced cultivars and lines from foreign countries including those determinate mutants and non-shattering lines.

2. Early generation crosses made from hybridazation of early and high yielding genotyprs with semi-shattering genotypes from collection and single seed descent and plant to row method of selection is used in order to select genotypes of early high yielding with non-shattering.

3. Early generation crosses made from diallel and reciprocal crosses of 7 selected large seed and high yielding cultivars, (Roi-et 1, MKS-1-81111, Local white Chaibadan, Local Black Nakorn Sawan, Terras 77, Shang Cai Purple Flowers, and ICB-30-P4-(M3)). Again single seed descent and plant to row method is used to select large seed high yielding cultivars.

4. 57 second generation of segregating lines from crosses of high yielding cultivar and determinate mutants in Israel. Single seed descent is used in F3 and Plant to row selection is employed in F4.

This cooperative breeding project will make possible for Thai sesame breeder to obtain seeds of cultivars, segregating populations and advance selected lines of genotypes adapted to Thai conditions and needs, training and also enable us to advance the program faster by shifting and sharing the breeding materials between the countries.

The project was planned for 3 years in both Israel and Thailand (June 1985 - June 1988)

Result and Discussion.

Project in Israel started late than planned because Dr. Ashri the principle investigator was on one year sabathical leave. However, the materials he developed earlier can be used to start the project in Thailand without delay.

Progress Report 1985.

At Ubol Field Crops Research Center, 243 lines from collection locally and foreign sources were planted in September 1985 and harvested in December 1985. Days to first flowering, dayst to 50% flowering, days to harvest, seed yield and seed weight were recorded. Twenty lines of high seed yield and other desirable characteristics were selected for further study. -Some lines in the study were non-shattering but seed yeild was extremely low.

Progress Report 1986.

1. Approximately half of the whole collections of sesame lines (318 lines) were planted in early rainy season and late rainy season in order to study in details all 33 characters according to IBPGR descripter for both seasons and their interaction to seasonal variation.

In early rainy season of 1986, some results were as folowing.

- maturity date 83 - 124 days

  83 - 90 days - 113 lines,

- Seed yield 1.6 - 253.0 kg/rai

  101 - 140 kg/rai - 19 lines

  more than 141 kg/rai - 2 lines.

- Seed weight 1.360 - 4.763 gm/1000 seeds

3.5 gm/1000 seed - 19 lines.

In late rainy season, little change was observed in maturity date. Seed yield, seed weight and number of capsules per plant were signeficently lower than the early crops. All lines in both season were indeterminated and shattering. They were non branched, basal branched and top branched.

2. Hybridization Program.

2.1 Twenty-three crosses of sever high yielding large seeded varieties were made in early season 1986. F1 seed were planted in late season at U-bol Field Crops Research Center and F3 seed were planted at Supanburi Field Crops Research Center in dry season with irrigation. F4 seeds harvested from F3 were supposed to be planted at U-bol Field Crops Research Center in June. However, it was postponed to late season due to lack of rain in early season 1987.

2.2 Hybridization program was made on early and high yielding varieties (Roi-et 1 and MKS-1-81111) with 5 lines of semi-shattering types in order to incorporate the non-shattering characters into the standard and new varieties. F1 seeds from 16 crosses were planted at U-bol Field Crops Research Center in 1986. F2 and subsequent F3 were planted at Supanburi Field Crops Research Center under irrigation in dry season and F4 was planned to plant at U-bol Field Crops Research Center in rainy season of 1987 with plant-to-row method of selection.

3. Selection in segregation population. Fifty seven families of F2 seed made from crosses of determinated, non-shattering and high yielding types in Israel were sent and planted at Supanburi Field Crops

Research Center in 1986 dry season with irrigation. Plant to row selection in F4 in rainy season at U-bol Field Crops Research Center will be employed in rainy season 1987.

Progress Report 1987.

All F4 lines were planted at U-bol Field Crops Research Center as planned in early rainy season. At the present, plants are in late vegetative stage. Early rainy season collections has to be postponed due to lack of early season rain this year.

Reference :

1. Ashri, A (1981) Sesame, Status and Improvement, FAO Plant Production and Protection Paper No. 29, Rome, pp 198.

2. Ashri, A (1981) Increase Genetic Variability for Sesame Improvement by Hybridization and Induced mutation. FAO Plant Production and Protection Paper No. 29, Rome, p 141 - 145.

3. Benjasil, V. (1984) Production, Research and Development of Sesame and Sufflower in Thailand. Proceeding of FAO Internation Export Consultation on Sesame and Sufflower. Viterbo, Italy, (in press)

4. Meerith, C. (1986) Sesame Genetics and Varietal Improvement. Proceeding on the First Sesame Research Workshop, Faculty of Agriculture, Khon Kaen University, Khon Kaen. p 75 - 78 (in Thai).

6. PUBLICATIONS (IN ENGLISH)

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