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MEMORANDUM

TO: AID/PPC/CDIE/DI, room 209 SA-18

FROM: AID/SCI, Victoria Ose

SUBJECT: Transmittal of AID/SCI Progress Report(s)

Attached for permanent retention/proper disposition is the following:

AID/SCI Progress Report No. C5-147
June 88

Attachment

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

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SAISUNEE RUNGSIPIYAKUL

THAI - ISRAEL SESAME CO-OPERATION PROJECT

FIELD CROPS RESEARCH INSTITUTE

DEPARTMENT OF AGRICULTURE

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

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ABSTRACT

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 were determinate mutants to the adapted high yielding types; non-shattering with Early maturing character; high yielding with large seed size were the main cbjectives of the project. The selection was made from segregating populations by plant to row method. F_3 progenies were grown now at Ubon Field Crops Research Center in 1988 for further selection and evaluation. Cultivars with high yield, determinate, non-shattering and large seed size were desirable characteristics

BACKGROUND/INTRODUCTION

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

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Sesame seed is rich for oil content (50%) of excellent quality and protein (25%) of sulfur containing amino acid. Sesame meal has been used for animal feed and defatted flour can be used for human consumption.

Sesame has important agriculture advantages: it can set seeds and yield under relatively high temperature, on stored soil moisture without rain or irrigation. It can be grown in rotation with other main crops 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 sesame are very low although potentially they could be much higher. Various factors are responsible for the low yield such as, erratic rainfall, low input levels, uneven ripening of the capsules, dehiscence and seed shattering, diseases and insects and of course the adapted and high yielding cultivar.

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

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- Height
- Days to first flowering
- Days to 50% flowering
- Number of branches per plant
- Length of branches bearing capsules
- Number of capsules per nodes
- Number of capsules per branches and per plants
- Number of seed per capsules
- Seed size or seed weight (1,000 seed wt.)
- Seed weight or seed yield per plants
- Number of plants per unit area

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 been increased during the last ten years. Thai sesame farmers are small holder who do farming under rainfed and drough-prone land with soil low in fertility. Annual planted area is about 35,000

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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 in the North,North-east and the Central Region.

OBJECTIVES:

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 nonshattering types. 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 METHODS

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 unavoidable. Determinate genotype,discovered by Ashri by mutation will reduce seed losses and together with non-shattering or semi-shattering it will minimize seed losses to acceptable level.

Most effort in this project is to breed determinate cultivars adapted to various growing conditions in Thailand and Israel using the determine 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 local varieties and introduced cultivars and lines from foreign countries including those determinate mutants and non-shattering lines.

2. Early generation crosses made from hybridization of early and high yielding genotypes 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 yielding with non-shattering.

3. Early generation crosses made from diallele and reciprocal crosses of 7 selected large seed and high yielding cultivars, (Roi-et 1, MKS-I-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 and high yielding cultivars.

4. 57 of second generation of segregation lines from crosses of high yielding cultivar and determinate mutants in Israel. Single seed descent in used in F_3 and plant to row selection is employed in F_4.

5. 362 of F_3-F_4 progeny from crosses of high yielding cultivars and determinate mutants in Israel. Plant-to-row selection is used in F_4 and row-to-row selection is employed in F_5-F_6. Subsequent progeny evaluation is done at Ubon Field Crops Research Center.

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

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Thai conditions and needs, training and also enable us to advance the program faster by shifting and sharing the breeding materials between the two countries.

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

RESULT AND DISCUSSION

Project in Israel started later than planned because Dr.Ashri the principle investigator was on one year sabbatical leave. However, the materials he developed earlier were available to start the project in Thailand without delay.

1. Sesame Collection and Evaluation

243 lines collected locally and from foreign sources were planted in September 1985 and harvested in December 1985 Days to first flowering, days to 50% flowering, days to harvest, seed yield and seed weight were recordes, 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 yield was extremely low.

In 1986,318 lines from the whole collection of sesame were planted in early season and late season, 33 characters according to IBPGR descripter for both seasons were recorded. In early rainy season of 1986, some results were as following.

- maturity date 83-124 days

83-90 days-113 lines

- Seed Yield 10.0 - 1,581.2 kg/ha.

  631.2- 875 kg/ha -19 lines

  more than 881.2 kg/ha -2 lines

- Seed weight 1.360-4.763 gm/1,000 seeds

  3.5 gm/1,000 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 significantly lower than the early crops. All lines in both season were indeterminated and shattering. They were non branched, basal branched and top branched.

In early season 1987, collections had been postponed to late season due to late coming of rain in early season. A collection of 190 lines was grown in the field.

Again 33 characters according to IBPGR descripter were recorded, path-coefficient analysis had been done in order to study in details of the yield components. The following formular were used to determine Standard partial regression (b') and direct effect of the yield component on yield per plant.

$$b'1 = \frac{b_1 (S_1)}{S8} \qquad b'2 = \frac{b_2 (S_2)}{S8} \ldots \qquad b'7 = \frac{b_7 (S_7)}{S8}$$

b = Regression coefficient

s = square root of variance-covariance matrix

The variable X1 = 1,000 seed weight (gm)

X2 = days to 50% flowering (days)

X3 = days to physiology maturity (days)

X4 = plant Height (cm)

X5 = Number of branch per plant

X6 = the first branch baring capsule

X7 = Number of capsules per plant

X8 = Seed yield/plant (gm)

The results were as following:

		Total effect
Direct effect of number of capsule/plant on yield/plant	= 0.2571	(0.4094)
Direct effect of 1,000 seed weight on yield/plant	= 0.2141	(0.2962)
Direct effect of days to physiology maturity on yield/plant	= -0.1870	(-0.0698
Direct effect of plant Height on yield/plant	= 0.1784	(0.3435)
Direct effect of number of branch per plant on yield/plant	= -0.1357	(0.2953)
Direct effect of days to 50% flowering on yield/plant	= -0.0424	(-0.0495
Direct effect of length of branches bearing capsules on yield/plant	= 0.0337	(0.0596)

Indirect effect of plant height no. of branch/plant via no. of capsules/plant on yield/plant were 0.1222 and 0.1100 respectively. The Residual effect was 80.25%

From the experiment, some conclusions could be drawn as following :

1. Both direct and indirect effect of capsule number per plant on yield (per plant) were significantly high.
2. 1,000 Seed weight shown positive direct effect on yield.

3. Days to physiology maturity had reversible effect on yield i.e. early maturing line gave higher yield than late maturing line because of erratic rainfall, disease and insect problems.
4. Direct and indirect effects of plant Height on yield were high . It was indicated that the taller plant they were, the more capsule were set and more seed yield were achieved.
5. Direct effect of number of branch/plant on yield was as high as direct effect of plant height on yield.

In addition the criterior for plant selection for high yield could be made as following:

1. Good capsules formation.
2. Large seed size
3. Early maturing. The plant could be harvested within 85 days
4. Plant height about 100 cm. Although plant Height has direct effect on yield, but taller plant could cause plant lodging.
5. the plant has 2-3 branches per plant

Seed color 1,000 seed weight (gm), days to maturity and seed yield (kg/ha) of some sesame lines in Collection in late rainy season 1987 was shown in Table 2. There were 18 lines of white seeded sesame and 4 lines of black seeded sesame had weight more than 3.00 gm. per 1,000 seeds. Maturity date range from 79-88 days. Seed yield were 10-1,196 kg/ha. Line MKS-I-81254 gave the highest yield of 1,196 kg/ha.

2. Hybridization Program

2.1 Twenty-three crosses of several high yielding large seeded varieties were made in early season 1986. F_1 seed were planted in late season at Ubon Field Crops Research Center F_2 and F_3 seed were planted in dry season with irrigation. F_4 seed harvested from F_3 were supposed to be planted at Ubon Field Crops Research Center in May. However it was postponed to late season due to lack of rain in early season 1987. Plant-to-row method of selection was used in F_4. The criterior of selection was based on good formation of capsule and large seed size. F_5 were planted at Ubon Field Crops Research Center on early season 1988. All plant are in late vegetative stage at present.

2.2 Hybridization program was made on early and high yielding varieties (Roi-et 1 and Mahasarakarm 60) with 5 lines of semi-shattering types in order to incorporate the semi-shattering characters into the standard and new varieties. F_1 seeds from 16 crosses were planted at Ubon Field Crops Research Center in late season 1986. F_2 and subsequent F_3 were planted at Supanburi Field Crops Research Center under irrigation in dry season. Single Seed Descent method was used in F_2-F_3.

Ten crosses of F_4 plants were grown at Ubon Field Crops Research Center in early season 1987 10 days after physiological maturity, the selection was made in order to get high yielding, early maturing and semi-shattering lines of sesame. Again plant-to-row

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method of selection was employed in F_4 and F_5. They were planted in early season 1988. At the present, the plants are in late vegetative stage.

3. Selection on segregation population

There were 3 sets of segregation population made from crosses of determinated, non-shattering and high yielding types in Israel were sent and planted in Thailand:

3.1 57 families of F_2 seeds were sent and planted in dry season 1986 at Supanburi with irrigation. Plant-to-row selection in F_4-F_5 were employed at Ubon Field Crops Research Center in 1987. Progeny evaluation was made in 1988 at Ubon Field Crops Research Center. High yield with determinate characters will be selected and to be put into further evaluation at various sites of the country.

3.2 337 families of F_3-F_4 seeds were sent and planted in late season 1986 at Ubon Field Crops Research Center. Row-to-row selection method will be used in F_5-F_6.

3.3 21 families of F_5 seed samples-Bulk-open pollinated seed from Israel were planted in early season 1988 at Ubon Field Crops Research Center. Row-to-row selection method will be employed.

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Table 1. Plot Yield (kg/ha),1,000 Seed Weight (gm) and Days to Maturity of Some Sesame Line in Collection in Early and Late Rainy Season 1986.

Line	Early Rainy Season 1986			Late Rainy Season 1986		
	Plot Yield (kg/ha)	1,000 Seed Weight(gm)	Days to Maturity	Plot Yield (kg/ha)	1,000 Seed Weight(gm)	Days t Maturi
1. MKS-I-81219	440	2.22	112	180	3.07	82
2. MKS-I-81299	380	2.53	108	21.9	2.25	73
3. MKS-I-81339	380	2.82	108	120	2.87	73
4. MKS-I-81328	402.5	2.97	112	200	2.99	82
5. MKS-I-81052	520	3.48	108	300	3.25	73
6. MKS-II-82254	500	3.06	93	160	3.51	83
7. MKS-II-82288	400	3.10	93	300	3.32	85
8. MKS-II-82294	420	2.74	93	360	3.24	82
9. MKS-L-82431	380	3.11	93	160	3.09	82
10. MKS-L-82199-1	760	2.64	93	200	2.43	82
11. MKS-L-82330	720	2.63	93	200	2.45	82
12. MKS-L-82405	780	3.01	93	80	2.51	82
13. MKS-L-82550	460	2.54	93	170	2.62	82
14. MKS-L-82189	760	2.65	93	240	2.98	82
15. MKS-L-82193-2	656.2	2.44	93	240	2.47	90
16. MKS-L-82214	880	2.68	93	180	2.47	82
17. MKS-L-82284	805	2.80	93	150	2.70	82
18. MKS-L-82269-2	700	2.84	93	280	2.18	82
19. MKS-II-81004-1	500	3.25	93	140	2.79	80

Table 1. (cont.)

Line	Early Rainy Season 1986			Late Rainy Season 1986		
	Plot Yield (kg/ha)	1,000 Seed Weight(gm)	Days to Maturity	Plot Yield (kg/ha)	1,000 Seed Weight(gm)	Days t Maturi
20. MKS-II-81008	740	2.79	93	200	2.66	82
21. MKS-II-81012-1	760	3.20	93	320	3.06	83
22. MKS-II-81027	440	2.25	93	230	2.27	82
23. MKS-I-81162	560	3.14	93	-	-	-
24. MKS-I-81375	460	2.43	85	200	2.80	75
25. MKS-I-81028	720	2.40	85	240	2.77	82
26. MKS-I-81029	1,580	3.46	85	180	2.99	75
27. MKS-I-81040	440	3.50	85	160	2.58	75
28. MKS-I-81157	400	3.13	85	140	2.85	75
29. MKS-II-81406	560	3.26	85	-	-	-
30. MKS-II-82048-2	520	3.07	86	140	1.51	75
31. MKS-II-82087	500	2.63	86	142.5	2.78	73
32. MKS-II-82189	440	2.43	86	90	2.69	75
33. MKS-II-82239	540	2.79	86	200	2.52	75
34. MKS-II-82296	460	2.77	86	240	2.51	75
35. NW Bi 4	620	2.67	86	177.5	2.49	75
36. NW Bi 28	820	3.44	86	101.2	2.60	75
37. NW Bi 31	820	3.13	86	180	2.57	75
38. MKS-I-81250	640	2.86	86	220	2.82	75
39. NW Bi 21	780	3.04	86	220	2.65	75
40. NW Bi 24	780	3.05	87	-	-	-

Table 1. (cont.)

Line	Early Rainy Season 1986			Late Rainy Season 1986		
	Plot Yield (kg/ha)	1,000 Seed Weight(gm)	Days to Maturity	Plot Yield (kg/ha)	1,000 Seed Weight(gm)	Days t Maturi
41. NW Bi 26	440	3.34	87	180	2.89	75
42. NW 106 B	660	2.48	87	142.5	2.53	75
43. Br-268	560	2.80	87	240	2.60	75
44. PL-259	840	2.75	87	240	2.62	75
45. SI-19	620	1.87	87	400	2.74	75
46. SI-1	400	3.00	87	220	2.56	75
47. MKS-L-82390	380	3.05	87	120	2.53	86
48. MKS-II-82268	380	2.63	87	40	2.82	75
49. MKS-II-82280-1	500	2.53	87	150	2.36	75
50. MKS-II-82247	556.2	3.50	87	220	2.82	75
51. MKS-II-82264	600	3.34	87	320	2.62	75
52. MKS-II-82285	660	2.62	87	240	3.00	75
53. MKS-II-82259	380	2.86	87	220	2.65	75
54. MKS-II-82286	380	3.12	87	360	2.68	75
55. 2-BAN Br	420	2.03	87	300	2.34	75
56. 17-3 BO	440	2.73	87	142.5	2.72	75
57. 18-2-QO	460	2.76	87	142.5	2.67	75
58. 18-2 BA	420	2.63	87	120.5	2.84	75
59. 17-0	500	2.74	87	130	2.72	75
60. 10-BAN	700	3.42	87	170	2.45	75

Table 2. Seed Color, 1,000 Seed Weight (gm), Days to Maturity and Seed Yield (kg/ha) cf Some Sesame Lines in Collection in Late Rainy Season 1987.

Line	Seed Color	1,000 Seed Weight(gm)	Days to Maturity	Seed yiel (kg/ha)
1. MKS-II-82160	White	3.01	88	152
2. MKS-I-81085	"	3.15	79	460
3. MKS-I-81044	"	3.15	79	268
4. MKS-I-81285	"	3.17	79	260
5. MKS-I-81006	"	3.21	79	444
6. MKS-I-81375	"	3.07	79	606
7. MKS-I-83141	"	3.78	79	518
8. Mcyashiyoo Goma	"	3.55	79	464
9. MKS-I-81117	"	3.03	79	282
10. Synyadna 1	"	3.28	79	574
11. Pachequeno	"	3.20	79	436
12. No.463 Tetrahori(medium)	"	3.33	79	92
13. No.452 Aspa	"	3.15	79	154
14. 30-15	"	3.88	79	340
15. No.471 Proimo	"	3.35	79	250
16. X-30/46	"	3.15	79	796
17. Teras 77	"	3.03	79	376
18. Teras	"	3.02	79	162
19. L-73	Black	3.04	79	330
20. L-192 U	"	3.13	79	192
21. MKS-I-81335	"	3.03	79	582

Table 2. (Cont.)

Line	Seed Color	1,000 Seed Weight(gm)	Days to Maturity	Seed yie (kg/ha)
22. MKS-I-81372	Black	3.09	79	856
23. Ex MBARA	White	2.96	88	76
24. Maporal	"	2.77	88	180
25. 65-B-61	"	2.65	88	10
26. MKS-I-81256	"	2.79	79	1,118
27. MKS-I-81120	"	2.90	79	770
28. MKS-I-81121	"	2.79	79	760
29. MKS-I-81154	"	2.82	79	90
30. GUMMA-2	"	2.91	79	268
31. MKS-I-81132	"	2.58	79	152
32. MKS-I-81135	"	2.58	79	272
33. UCR 82-18, shat	"	2.75	79	344
34. Cola De Borrego	"	2.73	79	488
35. TY-13	"	2.99	79	334
36. Jori	"	2.70	79	304
37. Italy 3	"	2.77	79	262
38. MKS-I-81161	"	2.50	79	190
39. T-85	"	2.90	79	350
40. Oro 9/71	"	2.56	79	228
41. UCR 82-14,NS	"	2.95	79	98
42. Cross No.3	"	2.57	79	86
43. Oro Short	"	2.52	79	86
44. Ciano 27	"	2.68	79	238

Table 2. (Cont.)

Line	Seed Color	1,000 Seed Weight(gm)	Days to Maturity	Seed yield (kg/ha)
45. Yiyang White	White	2.51	79	276
46. Kostantsa(midium)	"	2.56	79	150
47. No.450 Katy (midium)	"	2.90	79	118
48. 38-1-7	"	2.68	79	190
49. Ciano 16	"	2.61	79	152
50. No.45 BA.Sindos	"	2.56	79	150
51. No.451 Balmi	"	2.65	79	66
52. Yori 77	"	2.69	79	256
53. Italy	"	2.79	79	100
54. Eva	"	2.67	79	158
55. MKS-I-81254	Black	2.98	79	1,196
56. L-18 U	"	2.78	79	1,236
57. L-13 U	"	2.73	79	600
58. L-23 U	"	2.81	79	176
59. L-29 U	"	2.78	79	122
60. L-30 U	"	2.58	79	240
61. L-40	"	2.63	79	234
62. L-43 U	"	2.83	79	482
63. L-47 U	"	2.87	79	180
64. L-143 U	"	2.84	79	114
65. L-147-2	"	2.68	79	106
66. L-156	"	2.78	79	266
67. L-163 U	"	2.73	79	352

Table 2. (Cont.)

Line	Seed Color	1,000 Seed Weight(gm)	Days to Maturity	Seed yield (kg/ha)
68. MKS-I-81230	Black	2.79	79	298
69. MKS-I-81141	"	2.71	79	400
70. MKS-I-81236	"	2.94	79	258
71. MKS-I-81237	"	2.97	79	672
72. MKS-I-81242	"	2.65	79	608
73. MKS-L-82025	"	2.91	79	328
74. DT-1	"	2.96	79	482
75. L-142	"	2.76	79	152
76. L-215-2	"	2.55	79	48
77. Huaypha	"	2.77	79	254
78. Ban Taew	"	2.85	79	592