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EGYPT-ISRAEL-U.S. AGRICULTURAL RESEARCH PROJECT ON

TRINATIONAL AGRICULTURAL TECHNOLOGY EXCHANGE AND COOPERATION IN A SIMILAR ECOSYSTEM ("T.A.T.E.C.")

Semi-Annual Progress Report
Reporting Period - October 1, 1985 thru March 31, 1986

a. Summary Description of Technical and Scientific Progress (by Sub-project)

a.1. Intensification of Farm System Production: Cropping Systems and Water Use

Principal Investigators: A. Marani and M. J. Pinthus (Israel)
A.M. Abdel-Shafy and A.S. Badawi (Egypt)

In the 1985-86 winter growing season, the Egyptian team commenced its studie of the following topics at Gemeiza Research Station/Experimental Farm in the N.e Delta:

- the effect of different combinations of tillage treatments (no-till, chiseling, disc, and leveling) and planting techniques (broad cast, drilled) on yields of wheat under sprinkler irrigation
- timing of nitrogen application for wheat under sprinkler, surface, and drip-trickle irrigation methods
- the efficiency of drip-trickle irrigation on wheat yield under different depletion levels of available soil moisture
- identification of wheat genotypes adaptable to low soil-moisture conditions

No preliminary data trends were reported. Statistical analyses and conclusions will be discussed, along with the presentation of final data after harvesting, in the 2nd Annual Report.

Data reported by the Israeli team is based on maize studies conducted during the summer of 1985. Following a commercial wheat crop, 3 maize hybrids were planted on 2 dates (May 30 and June 13), to examine the effects of planting date, planting density, and irrigation regime on the selected hybrids. The Israeli team concluded that:

- late planting produced a statistically significant smaller yield, on the average, for all 3 hybrids
- one hybrid variety (Hazera-224) produced the lowest grain yields in both planting dates. It also had a shorter plant height and smaller average ear weight than the other two varieties. Asgrow-909 gave somewhat higher yields and had a higher grain weight per ear than JX-180, but these differences were not statistically significant.

- Plant density (spacing within the row) had no significant effect on most of the characteristics studied. (Plants had been spaced variously at 6, 8, or 10 plants per meter.) When there were more plants per meter of row, the result tended to be more ears per area. However, the average weight of grain per ear was lower. Spacing variations produced no significant effect on grain yield, but the spacing of 6 plants/m produced somewhat higher yields.

- Researchers found a distinct advantage for one drip line for every two plant rows, as compared to a line for each row. A late termination of irrigation (Sept. 26) also gave significantly higher grain yields, as compared to an earlier termination (Sept. 2).

a.2. Intensification of Farm System Production.
Economic Evaluation of Cropping System and Water Use

Principal Investigators: D. Yaron, S. Pohoryles (Israel)
Y. Mohieldin (Egypt)

The Egyptian team has been working on the following aspects of the cropping systems experiments carried out in the past year at Gemeiza:

- estimation of production functions of fertilizers used on maize, to estimate the economically optimum level of fertilizer application under both surface and sprinkler irrigation regimes.

- similar analyses on wheat experiments, focusing on the optimum amount and timing of fertilizer application under different irrigation systems, and on the use of drip irrigation under various conditions of soil moisture depletion

In addition, a questionnaire has been developed for a study of economic and other factors involved in the adoption of various irrigation systems in southern Tahrir governorate, particularly sprinkler systems.

In Israel, researchers have pursued 4 lines of effort, with specific progress in each as indicated:

1. Analysis of Factors Promoting/Inhibiting Adoption of Modern Irrigation Technology.

   A. Adoption of Drip Irrigation: Case Study of Kibbutz Cotton Growers

      An econometric estimation procedure has been developed, to estimate quantitatively the economic importance of several variables. The estimates will illuminate the major incentives which affect adoption of drip irrigation, also enabling predictions on the expected rate of adoption.

B. Adoption of New Irrigation Technologies in Citrus: Influence of Inputs Quality and Other Variables

Work on this topic began in October 1985. Thus far researchers have completed a literature survey, developed a preliminary model, and selected a sample of 180 large citrus farms in 6 regions of Israel. Questionnaire data have been collected and are undergoing analysis.

2. Comparative Analysis of the Integrated Cropping and Water Use Systems

The major parameters involved in this quantitative evaluation of alternative water use systems are: irrigation efficiency, soil moisture regime, required water pressure, water cost, flexibility of a system's operation (especially as regards timing of applications), investment and operation costs (including labor), and relative yields and income per acre.

Researchers are continuing to collect data on these factors, covering several sets of crops, climatic conditions, farm types, and irrigation technologies.

3. Case Study: Transition from a Traditional to a Modern Irrigation System

Scientists have completed most of this study, which focuses on 24 farms in an arid area served by a regional irrigation system. Various cost-benefit analyses have been performed, in addition to those previously reported, including analyses of certain segments of the modernized system (e.g. storage reservoirs only, canal cementing only).

Results have highlighted the high capital intensity of modern irrigation systems. Thus the Israeli team is considering alternative, less capital-intensive systems for further investigation.

4. Evaluation of Irrigation Systems, with Emphasis on Uniformity of Water Application

This line of effort has emerged from previous work done under item 2 above. The study's working hypothesis is that the major difference among the various existing irrigation methods in their impact on yield results from their different performances in uniformity of water application. For example, drip irrigation exhibits higher uniformity of application than sprinkler, which is in turn more uniform than any surface irrigation system.

An analytical model which includes these and other relevant parameters has been developed. Data collection and computer programming of the model are underway, so that the model can be applied empirically to several crops and irrigation systems. This will allow an economic evaluation of various irrigation systems, based on differences among them with respect to nonuniformity of water application, as well as varying investment and operation costs for certain crops.

a.3. Intensification of Farm System Production: Dairy Production

Principal Investigators: A. Berman (Israel)
M. Hathout (Egypt)

As reported previously, the Egyptian team's work has focused on artificial rearing, early weaning, roughage treatment and complete rations.

Two calf rearing trials (one each at Sakha and Karada stations, involving Friesians) have been completed, to examine the influence on 8- and 15-week-old calves of using milk replacer in an early weaning system. (Data is presented in the current report, Annex A.)

A computerized record-keeping system for several livestock research stations has been initiated, to record several new kinds of information on reproductive efficiency, milk yield, and bodyweight gain for dams and sires. This information will be very useful in breeding stations' selection programs, when used in conjunction with progeny tests for male and female offspring.

Researchers have studied the use of chemically treated rice straw, clover, corn stover, molasses, and concentrate supplement as a complete ration system for weaned calves. A feeding experiment was conducted to assess the effect of these rations on growth performance. This trial's data is being analyzed.

The main line of the Israeli team's effort has been to develop an efficient cooling system for dairy cattle, regardless of ambient humidity, which is cost effective and simple to use. High dairy cattle productivity is closely related to high metabolic heat production, which cannot be sustained unless heat is dissipated from the animal's body to the environment.

Researchers assumed that water evaporation is the most efficient means of dissipating this heat. However, continuous wetting of the animal increases the local air humidity, reducing evaporation. Thus maintaining a fast flow of air around the animal would prevent the rise in ambient humidity, increase the rate of water evaporation from the animal's body, and enhance non-evaporative heat loss from the animal.

Experiments have centered on a sprinkler system in cowsheds, involving repeated water sprays lasting only a few seconds, followed by forced ven-

tiliation for periods of minutes. Variables studied include the duration of both wetting and cooling periods, the effect of cow density in holding areas, and the daily frequency of cooling treatment. Body temperature changes were used as the best marker of effectiveness for various combinations of these variables.

An optimal combination of wetting/cooling durations, animal density, and frequency was tested for its success in preventing high ambient temperatures from affecting the body temperature of high producing animals. Results indicate that cooling such cattle 5 times a day for half an hour can prevent overheating in hot weather. In the next report period, the Israeli team will examine the effects of this cooling method on milk production.

a.4. Medicinal Uses of Desert Flora

Principal Investigators: D. Palevitch, Z. Yaniv (Israel)
K. Awaad (Egypt)

In Egypt, a limited number of Bedouin herbalists were interviewed concerning the medicinal uses of locally available plants. Thirty-four plants were collected during survey visits to the Western Desert, and a preliminary study on their active constituents has begun.

In Israel, researchers concentrated on plants with hypoglycaemic action for their literature, field, and laboratory studies.

The ethno-botanical and -pharmacological survey aimed to update the list of plants still in active use by folk-medicine healers in Israel. Of about 150 plants reported by over 100 folk-medicinal practicioners to have medicinal applications, 16 species were claimed to have hypoglycaemic properties. Half of the plants are unique to this survey and were not mentioned in previous literature on folk medicine in the Middle East. (Data and discussion are found in the full report, Annex A.)

In field and laboratory studies on promising hypoglycaemic plants, 6 species of Atriplex were planted at two experimental plots (Sede Boqer and Ein Yahav) and will be tested for pharmacological potency. Extracts of 6 different genera [plants of different species], including 1 of genus Atriplex, were examined in the laboratory for their effect on glucose uptake and metabolism. This information is crucial in determining the suitability of a plant extract as a potential source for an orally-administered substitute for insulin.

The most striking effects were found with extracts of Atriplex halimus and Phaseolus vulgaris. Both seem to stimulate glucose uptake and glucose metabolism. However, the active components and their site of action have not yet been identified. Likewise, the cultivars, stage of development of the plant part used, and possible effects of cultural practices on the activity of the extracts need further investigation.

a.5. Solar Heating of Soils for Pathogen, Weed, and Insect Control

Principal Investigators: Y. Katan (Israel)
M.F. Abdel-Reheim, M. Satour (Egypt)

Research cooperation between the Egyptian and Israeli solar heating teams has been in progress since 1981. In Egypt, 6 experiments were underway during the reporting period.

The Ismailiya/El-Manayef experiment found that solarization significantly controls root knot and corky root diseases in tomatoes, almost doubling the yield per plant. The weight-yield per hectare was more than tripled, since the solarized field allowed twice as many plants to live and to bear an average of 50% heavier fruits.

The Ismailiya/Fayed experiment's results (on onion, broadbean, and rapeseed) will be included in the next report. Researchers expect that the analyzed data will show good results.

In El Fayoum governorate at Tamiya, researchers have tried to determine the optimum time and duration of mulching (applying plastic tarping) and its effect on white and pink rot (soilborne diseases of onions). Initial impressions (April 1986) indicate clear differences in plant growth, with treatments performed the previous June and July excelling. Information on the actual incidence/control of disease will be available in the next report.

Two studies at Tamiya are in progress: effect of solarization on onion seed production, and effect of mulching on broomrape (Orobanche spp.) in broadbean. Data will be presented in the next report.

Another study in progress focuses on solarization's usefulness in controlling soilborne diseases in plastic houses. Specifically, the effect on disease development and ultimate crop yield in cucumbers grown in plastic houses will be detailed in the next report.

The Egyptian and Israeli solar heating teams have produced the first joint publication to result from the TATEC project. The co-authors have submitted it to refereed scientific journals, where it is presently under review. Included in Annex A as the Israeli progress report for this period, "Effectiveness of Soil Solarization in Furrow-Irrigated Egyptian Soils" outlines the most significant results to date from the collaboration of the two nation's solar heating teams:

Soil solarization is effective in controlling soilborne pest and improving plant growth and yield in a variety of Egyptian soils and crops under furrow irrigation. Control of broomrape and the corky root disease, as well as yield increase, lasted for 2 or 3 successive seasons. The long term effect found in this study takes place despite unavoidable levels of recontamination that are attributable to furrow irrigation and the continuous cultivation of successive crops.

Improved plant growth, frequently noted in disinfested soils in the absence of known pathogens, has been attributed to a variety of chemical, physical and biological factors. An additional chemical mechanism by solarization was demonstrated for the first time in the binational work performed in Egypt: a decrease in salt concentrations in the upper layers of soils which maintain shallow ground water. This change in the distribution of salts in the soil profile probably results from the plastic mulch preventing evaporation, thereby slowing the upward movement of salts from relatively shallow and possibly salty groundwater. Excess salinity can cause great damage to crops in certain soils.

The prolonged effect of solarization observed under Egyptian (and other nations') conditions might possibly be improved by various means, such as solarizing larger plots, using filtered water, or applying sanitation measures.

In addition, integrating solarization with other means of control or crop management should be investigated. Examples: combining solarization with Rhizobium inoculation of seeds, to counteract the adverse effect of solar heating on this bacterium; using solarization in conjunction with appropriate herbicides (perhaps at reduced dosages) to control weeds which escape solarization.

Solarization could also be a useful tool in analyzing the causes of yield declines. In the present studies, yields were frequently increased to high levels by solarization. This might be attributed, among other factors, to the long history of cropping these Egyptian soils, resulting in an accumulation of mineral, chemical, and biological detrimental factors, including unidentified pests.

Detailed field and laboratory studies on solarization's role in pathogen and weed control, plant growth, and decreased salinity are underway and will be fully detailed in the next report.

a.6. Evaluation of the Methods for Technology Exchange in Agriculture

Principal Investigators: S. Pohoryles, D. Yaron (Israel)
A.M. Basheer (Egypt)

Based on the methodology developed in Year 1, and profiting from fruitful discussions with the Israeli team (reported in detail, Annex A), the Egyptian team undertook an economic analysis of soil solarization. They studied solarization experiments performed over the past 5 years, focusing on two crops: broadbeans (grown in solarized plots at Giza Research Station, 1981-82 and 1983/84) and tomatoes (solarization experiments at 4 research stations in Ismailiya governorate, 1983-84 and 1985-86).

The Giza experiments on broadbeans resulted in heavy economic losses to the grower. The average income after variable costs was found to be a loss of LE 984 per hectare for the solarized crop, versus a profit of LE 472/ha for the control, despite yield increases of 25% and 66% in each of the two years. Since broadbeans are not a high value crop, the increased yield from solarization was nowhere near enough to cover the technology's higher costs.

Analysis of the four tomato experiments revealed much more encouraging economic returns from solarization, since tomatoes are a high value crop, giving high receipts and high net income per hectare. Only one of the four Ismailiya solarization experiments showed a lower net return to the grower from solarized than from non-solarized fields. This was due to the limited increase in yield experienced in this one field (39%), which was much lower than yield increases in the other three experiments (180%, 381%, 242%). The latter demonstrated that for tomato growers, solarization can be highly profitable: yield increases more than covered increased costs, leaving a high profit.

The Israeli team's work falls into 4 categories: economic evaluation of technologies for exchange, supporting systems for agriculture, analysis of factors promoting or inhibiting the diffusion of agricultural innovations, and agricultural development on Arab farms in Israel.

1. Economic Evaluation of Technologies for Exchange.

Studies on double cropping, dairy production, and soil solarization are now underway. Different double cropping technologies were identified and cost benefit evaluation analyses performed. Several farm types will be included, to test the feasibility of each technology and combinations of technology under differing farm conditions. Results from the field experiments on a new double cropping technology involving wheat and corn are under analysis.

The Israeli dairy team's results from field experiments on a cooling system were discussed and a framework for an economic analysis was set up.

Data from new field experiments in solarization were added to the analysis detailed in the first Annual Report. The present focus is on solarization's feasibility under different farm types, crop rotations, climatic conditions, market structure, and input constraints (including capital).

2. Supporting Systems for Agriculture.

The review of credit facilities for agricultural production, discussed in detail in the first Annual Report, was continued. Its main topics focus on long-term investment capital and working capital.

A farm infrastructure survey is about ready to begin, now that a questionnaire has been elaborated in final form. In addition, a detailed plan has been prepared and is being implemented, to analyze aspects of agricultural infrastructure systems, including inputs supply, marketing, credit facilities, research and extension, institutional framework, etc.

3. Analysis of Factors Promoting or Inhibiting the Diffusion of Agricultural Innovations.

An introductory analysis of Israeli census data at the farm level, reported previously, has been further elaborated. Researchers are looking for a functional relationship between adoption of innovations and demographic and economic variables. New variables added (capital value and income) were found to be significant in explaining innovativeness, as were labor, farm area, and schooling. However, the single most important variable found was belonging to an innovative village. Researchers hope to expand this study to a wider sample of farming communities in the near future.

Questionnaire formulation and pilot testing have launched a new study: diffusion of agricultural innovations based on farm level survey data. The study focuses on 50 family farms in 2 regions where the process of agricultural innovation has been visible recently. Data collection and processing are now underway.

4. Agricultural Development on Arab Farms in Israel.

Egyptian colleagues' comments on the draft report, detailed in the first Annual Report, were considered and revisions made.

b. Description of Regional Cooperation Activities
(visits, meetings, exchanges of papers or data, etc.)

b.1. Cropping System and Water Use Subproject Meetings:

January 7-10, 1986, Egypt (1 senior Israeli: Dr. Pinthus)

For the first time, the two Principal Investigators met in person. Detailed review of each team's progress to date and near-term plans was facilitated by field site visits in the Delta. The Egyptian P.I., Dr. Abdel Shafy, made plans for a visit to Israel in early April 1986, which unfortunately did not come to pass. Subsequent visits were tentatively planned in June and August, without success. At this writing, Dr. Abdel Shefy hopes to visit his Israeli colleagues in September 1986.

b.2. Economic Evaluation of Integrated Cropping and Water Use Systems Meetings:

December 1985, Egypt (1 senior Israeli: Prof. Pohoryles)
January 1986, Egypt (4 senior Israelis: Profs. Yaron & Bresler, Drs. Feinermann and Dinar)
March 1986, Egypt (1 senior Israeli: Dr. Dinar)

During these visits the progress of various topics under study was reviewed, information was exchanged, and plans for cooperative work on mutually earmarked subjects were discussed.

b.3. Dairy Production Subproject Visits:

January 7-10, 1986, Egypt (1 senior Israeli: Prof. Berman)

Detailed review of each team's progress and plans were accomplished, aided by a field site visit to the Sakha animal research station in the Delta. Initial plans were made for a reciprocal Egyptian visit to Israel, which 3 senior researchers accomplished in July 1986. (Details to be reported in the second Annual Report.)

b.4. Medicinal Plants and Desert Flora Subproject Meeting:

January 7-10, 1986, Egypt (1 senior Israeli: Prof. Palevitch)

General discussion of progress and plans.

b.5. Solar Heating of Soils Subproject Visits:

February 1986, Egypt (3 senior Israelis: Prof. Katan, Dr. Grinstein, Dr. Dinar [economist])
2 other visits to Egypt reported, no dates specified
(3 senior Israelis: Prof. Katan, Dr. Grinstein, Prof. Chen)

Data from latest experiments was analyzed and discussed in detail with the Egyptian team. In addition, economic aspects of the several years' solarization experiments were discussed by Dr. Dinar with the Egyptian and Israeli plant pathologists, for use in the Israeli and the Egyptian subprojects on Economic Evaluation of Technology Exchange Methods.

b.6. Economic Evaluation of Technology Exchange Methods:

December 1985, Egypt (1 senior Israeli: Prof. Pohoryles)
January 1986, Egypt (3 senior Israelis: Prof. Yaron, Drs. Szeskin and Dinar)
March 1986, Egypt (1 senior Israeli: Dr. Dinar)

The two nations' teams on this subproject exchanged and discussed detailed papers that they had prepared on specific aspects of their respective work underway and in planning. Subsequent correspondence documented each team's comments on the other's paper, which both teams reported taking into account in their further research.

b.7. Third Project Coordinating Committee Meeting:

January 6-10, 1986, Egypt
(7 senior Israelis: Profs. Yaron, Berman, Bresler, Palevitch, and Pinthus; Drs. Dinar & Feinermann)
(1 American PCC member/scientific advisor: Prof. Dorfmann)
(1 American PCC member/adminstrator: Mr. Kincaid)
(3 American administrator/observers: Messrs. Marks, Resseguie, & Abbott)

This meeting was the third twice-yearly meeting of the Project Coordinating Committee (PCC), and the second to be hosted by the Egyptian project team. Seven Israeli scientists attended (4 agricultural economists, 1 economist specializing in irrigation, 1 agronomist, 1 dairy scientist, and 1 medicinal botanist). In addition, the resident Israeli advisor to Gemeiza farm attended professional discussions among the agronomists and economists in connection with site visits to view work in progress in the Delta.

The Israeli visitors represented all but one of the project's subject areas. The only area unrepresented, Solar Heating of Soils, has experienced excellent cooperation between Egyptian and Israeli researchers for over 5 years, with no foreseeable diminution of intensity.

The several days' visit consisted of an intensive round of site visits and technical discussions, as well as a substantive meeting with Deputy Prime Minister / Minister of Agriculture Youssef Wally, which lasted almost 90 minutes. Researchers presented oral and written reports to the PCC, which indicated and documented significant activity in most of the project's 6 subject areas.

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SEMI ANNUAL REPORT # 3

(October 1985 - March 1986)

I- TECHNICAL AND SCIENTIFIC PROGRESS :

Soil solarization, by means of covering the soil with transparent polyethylene sheets during the hot summer months, was studied in several in Ismailia and Fayoum Governorates during 1985/86.

The following summary represents the activity accomplished during the period from October 1985 to March 1986 :

(1) ISMAILIA EXPERIMENTS

A) El-Manayef Exp. :

The aim of this experiment is to study the effect of soil solarization on root diseases, growth and yield of tomatoes. Tomato plants were examined on Feb. 10th 1986. Results could be summarized in Table 1.

Table (1): Effect of soil solarization on root diseases, growth and yield of tomatoes, El-Manayef, 1985-1986.

Soil treatment	Stand plants/ in.	Plant fresh wt.(g)	Root knot nem.%	Corky root %	No. fruits/ plant	Av. fruit wt.(g)	Yield g/plant	Yield kg/ha
Non-solarized	1.5[z]	266[b]	48[a]	6[a]	31.7[a]	26.6[b]	843.8[b]	15 832[b]
Solarized	3.0[a]	484[a]	6[b]	0[d]	37.8[a]	38.2[a]	1442.8[a]	54 142[a]

z Number in each column with the same letter are not significantly different (P = 0.05).

B) Fayed Exp. :

Onion, broad bean and rapeseed crops were harvested late May and the data will be reported in the next report (# 4). However, our observation could conclude that there are good results with solarization.

(2) TAMYIA (EL-FAYOUM) EXPERIMENTS

A) Effect of mulching time and length of covering :

The purpose of this experiment is to study the optimum time of mulching and its duration, on the control of soil borne diseases, white and pink rot, of onion. The experiment was carried out in three replicates in a complete randomized design where each plot consists of 25 rows, each plot sized 25 x 12 meters.

The following treatments were included :

1. Mulched on June for 4 weeks.
2. " " " " 6 weeks.
3. " " July " 4 weeks.
4. " " " " 6 weeks.
5. " " August for 6 weeks.
6. Control (without mulching).

Mulching was carried out on June 17, July 18 and August 7th and the polyethylene sheets were removed after desired periods according to the above schedule. Onion nursery was prepared and mulched on July 18th, 1985 for 8 weeks and seeded on Sept. 24th, 1985.

Various treatments were transplanted with onion seedlings during the first half of Dec., 1985. All treatments were sprayed periodically every 12 - 14 days against downy mildew and purple blotch with

fungicide , Ridomyl mancozeb. The first observations were on April 17th, 1986 and indicates clear differences in plant growth. June and July treatments are excellent (see Table 2). Final data will be recorded in late May and will include :

- No. of leaves / plant.
- Length and weight / plant.
- Neck and base diameter / plant.
- Yield.
- Whitr rot.
- Pink rot.

B) Effect of mulching on onion seed production :

Soil was mulched on July 18th, 1985 for 46 days and was cultivated with onion bulbs, for seed production. Each plot, solarized and nonsolarized, sized 1500 m^2. Onion bulbs used were originally from 1984/85 experiment.

C) Effect of mulching on brome rape in broad bean :

Plots, each 750 m^2 , were mulched on July 18th, 1985 and planted with broad bean on Nov., 1985.

Data will be presented in the next report.

Table (2) : Effect of mulching time and length of covering on plant growth of onion , Tamyia , 1985-86.

Treatment		No. of leaves	Plant height (cm)	Bulb diameter (cm)	Neck diameter (cm)	Plant wt. (g)
June	4 weeks	9.79	42.10	3.96	1.34	75.4
"	6 "	9.22	39.44	3.95	1.31	82.7
July	4 "	10.02	40.11	5.19	1.75	87.5
"	6 "	9.17	43.46	5.53	1.68	91.2
August	6 "	9.28	42.28	5.68	1.79	82.7
Control		9.16	35.33	3.88	1.16	66.9

- No white or Pink rot was observed.

(3) SOLARIZATION OF PLASTICHOUSES SOIL

Data concerning the disease development and yield of cucumber plastic houses will be reported in the next report.

II- REGIONAL COOPERATION ACTIVITY :

This activity limited to the visits of Dr. Y. Katan, Dr. A. Greinstein and Dr. Ariel Dinar to Egypt during Feb., 1986.

III- Results obtained from the Egyptian activities are encouraging and are in complete agreement with the principals of this new method of disease control pointed out by the Israeli Team.

Senior Invest.

M. M. Satour

Principal Invest.

M. F. Abdel-Rahim

N. F. Abdel-Rahim

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Mark Abott

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U.S.A.

August 6, 1986

Re: TECHNICAL PROGRESS REPORT for 1986

Dear Mark,

Under a separate cover, we sent an article on our work on solarization in Egypt. Please, accept this article as a progress report.

Here are additional data related to the propers report, as an addition to the report:

1. Conclusions and Plans.

   Soil solarization is very effective under Egyptian agricultural conditions. At this stage, experiments to analyze the effects of solarization on pathogen and weed control, plant growth and decreased salinity are in progress and will be fully reported in the next report. There are carried out both in the field and in the laboratory.

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2. Cooperative activities.

Mutual visits to Israel and Egypt were done. The Israeli investigators (Katan, Grinstein and Chen) visited Egypt three times amd discussed and evaluated the results of the experiments, jointly with the Egyptian colleagues. Prof. Chen took data on soil salinity.

Sincerely,

J. Katan

J. Katan

Professor

Head of the Department

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Effectiveness of Soil Solarization in Furrow-Irrigated Egyptian Soils.

M.F. ABDEL-RAHIM, M.M. SATOUR, K.Y. MCKAIL, S.A. EL-ERAKI, Institute of Plant Pathology, Agricultural Research Center, Ministry of Agriculture, Giza, Egypt; A. GRINSTEIN, Institute for Agricultural Engineering, A.R.O., The Volcani Center, Bet Dagan 50250, Israel; Y. CHEN, Department of Soil and Water Sciences, and J. KATAN, Department of Plant Pathology and Microbiology, The Hebrew University of Jerusalem, The Faculty of Agriculture, Rehovot 76100, Israel

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A B S T R A C T

Effectiveness of Soil Solarization in Furrow-Irrigated Egyptian Soils.

Plant Disease.

Abdel-Rahim, M.F., Satour, M.M., Mickail, K.Y., El-Eraki, S.A., Grinstein, A., Chen, Y., and Katan, J., 1987. Plant Disease.....

Soil solarization of furrow-irrigated soils in Egypt effectively controlled weeds, broomrape, Rotylenchulus reniformis, other nematodes and corky root and root knot diseases in tomatoes. It also improved plant growth and increased the yields by 25 to 432% in broadbeans, onions, tomatoes and strawberries in various types of soils in experimental and farmers plots. In one experiment with broadbeans, Rhizobium nodulation was adversely affected by solarization and the plants were stunted but recovered later.

Solarization had a long term effect (two or three seasons) in both disease control and yield increase. It also decreased soil salinity.

Additional key words: Electrical conductivity, Meloidogyne, Orobanche, plastic mulching, Pyrenochaeta lycopersici, solar heating, tarping.

Soil solarization is a relatively new method for controlling soilborne pests(14). It was tested with a variety of crops and diseases, in several countries, frequently with successful results for both short and long terms (7,8,10,12,13,14,15,16,19,20 and others). Since most of these studies were carried out under sprinkler or drip irrigation, they do not ensure similar success in furrow-irrigated soils, where pathogen spread is enhanced (6), leading to possible recontamination of disinfested soils. In Egypt, furrow irrigation is very common, many soils have a long history of cropping and the agricultural regimes for certain crops differ from those in countries where solarization was tested. Increased plant growth (IGR) by solarization is a common phenomenon, evident even in the absence of known pathogens (1, 10,22). Higher quantities of mineral nutrients were recorded in solutions of the solarized soils, but other factors might be also involved in the IGR phenomenon.

The purpose of this study was to investigate the short and long term effects of solarization, in furrow-irrigated soils in Egypt, on soilborne pests, plant growth and yield and soil salinity. Solarization of farmers plots was also studied.

MATERIALS AND METHODS

Field experiments and demonstration plots were set up, during 1981-5, in various furrow-irrigated sites in Egypt with a variety of crops. The selected plots had a long history of cropping. Soil types were clay loam at Giza and loamy sandy or sandy in the other sites.

Experiment design: All experiments, carried out in 4-5 replicates were based on a basic unit (replicate) consisting of a bed 7m wide and 14 to 24 long, devided by eight irrigation furrows. Irrigation water was directed either separately to each plot or from solarized to nonsolarized plots to reduce the chances of contamination. The supply canals were also solarized.

Soil solarization: Solarized and nonsolarized plots were flooded and 1-4 days later, according to soil type, irrigation furrows were opened manually. Solarized plots were covered continuously (7), above the ridges using two transparent polyethylene sheets (450cm wide and 0.04 mm thick) (Ginegar Plastic Products, Israel) containing ultra violet absorbent. Solarization started usually in mid July and lasted 5-10 weeks. Soil temperatures were measured by a distance thermograph (Lambrecht, Germany). Typical maximal temperatures of nonsolarized soil, recorded in August 1983 at Giza and Fayed at a depth of 20 cm, were 33-34C, while temperatures of the solarized soil were usually 7-8C higher. Parameters used to evaluate the effectiveness of solarization, includes soilborne pest counts, disease rating, assessement of plant development at various stages and yield component measurements.

After harvest, some experimental plots were replanted in order to assess the prolonged effects of soil solarization.

Nematode counts. Recovery of nematodes from soil samples was carried out by the sieve technique (2). The resulting suspension was left for 49 hrs in Baermann pan for extraction before counting.

Salinity measurements. For the Fayed loamy sand soil, a saturated paste was prepared and extracted and then electrical conductivity (EC), anions and cations were determined (17). SO_4^{2-} was calculated from the difference between the sums of cations ($Ca^{2+}+Mg^{2+}+Na^{2+}+K^{+}$) and the anions ($HCO_3^{-}+Cl^{-}$) concentrations. For the Youth Farms-Sinai sandy soil, a 1:1 paste was prepared and EC was determined in the extract. Data were then corrected for saturation (26% w/w) by multiplication.

Demonstration plots. Selected farmers' plots were solarized manually to assess and demonstrate its effectiveness under semi commercial conditions. There were two to three replicates (1000-4000 m^2 each) of either solarized or nonsolarized treatments in each site. Plants were sampled periodically to assess growth and yield.

RESULTS

Effect of soil solarization on weeds, pathogens and crops. The first soil solarization experiment in Egypt was carried out at the Giza Experiment Station (ARC) in 1981-2. A pronounced reduction in weed populations, was observed soon after removal of the polyethylene sheets and remained significant throughout the growing period (Table 1). *Amaranthus*,

Chaenopodium, Plantago, Portulaca and Solanum nigrum were controlled, while Mellilotus and Cyperus rotundus were not. A similar weed control was evident in all solarization experiments. Broadbean plants were stunted during the first stages of growth in the solarized soil, but recovered later in the season (Table 1). The stunted plants had significantly less Rhizobium nodules. Broomrape (Orobanche crenata), first detected 3 mo after planting, was eradicated by solarization. Yield was increased by 25%.

The effects of solarization, with or without Rhizobium inoculation of seeds, was examined in a second experiment at Giza (Table 2). In this experiment, plant growth was not adversely affected by solarization. The effect of inoculation with Rhizobium on the yield was very pronounced in nonsolarized plots (241 % yield increase) but not in solarized ones. Solarization increased the yield by 66-432%. As in the previous experiment, broomrape was completely controlled by solarization. Rate of broomrape infection in nonsolarized plots was not affected by Rhizobium inoculation.

The above two Giza experiments were carried out in a clay loam soil. Two other experiments were carried out in sandy loam or sandy soils in the Ismailia region. In the solarized plots, the improved growth of onion plants was visible shortly after planting and throughout the growth period, and was expressed in the various parameters of plant growth (Fig. 1). Few plants with the pink root disease were detected only in the nontreated plots.

Solarization improved stand and growth of tomato plants (Table 3). Stand reduction in the nonsolarized plots resulted mainly from mortality due to

Phytophthora parasitica and plant uprooting occuring during manual weeding. Solarization effectively controlled root knot disease. In addition, disease severity of the few diseased plants in the solarized plots was lower than that of plants in the nontreated plots. Corky root disease was detected only in the nonsolarized plots. Solarization positively affected all yield components.

Effect on nematodes. Nematode counts were made in experimental and other nonsolarized and solarized plots. Rotylenchulus reniformis populations were significantly reduced by 93-95% in the first two soil samplings at the first Giza experiment but later the differences diminished (Fig. 2). Population of this nematode was significantly reduced also in the second Giza experiment (Table 4). Populations of five other nematode genera were significantly reduced by 69-100% in experiments carried out in different sites (Table 4).

Prolonged effects of solarization. The first three described experimental plots were replanted to examine the long term effect of solarization extending during the following growing seasons. Plots in the 1981-2 and 1983-4 Giza experiments (referred to in Tables 1 and 2) planted with corn and sunflower , respectively, were harvested, cultivated and both replanted with broadbeans, as a third crop after solarization. In both experiments, significant (P=0.05) long term broomrape control was evident. Broomrape populations (per m^2) in nonsolarized and solarized plots numbered 6.9 and 0.6 in the 1981-2 Giza experiment, and 5.1 and 0 in the 1983-4 one, respectively.

The onion plot at Ismailia (referred to in Fig. 1) was replanted with tomatoes. Results (Table 5) show a long term effect of solarization

regarding plant growth, increased yield and control of the corky root disease but not of root knot nematodes.

In another experiment carried out in Fayed (1983-4), solarization significantly increased height and yield of tomato plants (the first crop) by 27.3 and 172%, respectively. Clover was planted as a second crop in fall 1984. The total yield (two harvests) was 6.7 and 10.0 kg/m^2, in nonsolarized and solarized plots respectively (49% increase).

Effects on soil salinity. Soil samples were collected from the experimental site at Fayed (described above) 4 mo after planting tomatoes (from the upper 15cm layer) and were analyzed. Data for the solarized soil were: EC=17.6 d Sim/m, total cations or total anions = 179.8 meq/l. For the nonsolarized soil: EC=29.7 d Sim/m, total cations or total anions 384 meq/l. Such high salt concentrations in loamy sand soil (saturated paste, 30-32%) resulted in a distinct white film of dried salts on the soil surface in the nonsolarized soil.

The effect of solarization on salts distribution in the soil was demonstrated in another experiment in the sandy soil at the Youth Farms-Sinai. Two mo after the termination of solarization, soil was sampled to a depth of 50 cm at 10 cm increments before planting. Results (Table 6) show that EC values were lower in four of the solarized samples, as compared to the nonsolarized ones.

Observation and demonstration plots. Solarization of farmers plots, under semi-commercial conditions, was examined at three different sites. Tomato (Sarabium 1983-4) stand, yield per plant and yield per unit area were significantly (P=0.05) increased by 24, 211 and 287%, respectively by solarization. In a second tomato plot (Youth Farms-Sinai, 1984-5), solarization increased yield per unit area by 71% and extended the harvest period (eight pickings compared to five in the nonsolarized plot). Strawberry (Kalyubya 1983-4) yield per plant and per unit area were significantly (P=0.05) increased by 52 and 75%, respectively, by solarization. In all cases, there were distinct visible differences in plant development between solarized and nonsolarized plots.

DISCUSSION

Soil solarization is effective in controlling soilborne pests and improving plant growth and yield in a variety of Egyptian soils and crops, under furrow irrigation. This is in agreement with other studies regarding effective control of broomrape, corky root disease, various nematodes, *Rhizoctonia solani* and weeds (7,8,10,15,16,20,21). Control of broomrape and the corky root disease, as well as yield increase, lasted for two or three successive seasons, as was also shown with several diseases in other countries, with crops under sprinkler or drip irrigation (10,12,13). The long term effect found in this study, takes place in spite of the fact that, due to furrow irrigation and the continuous cultivation of successive crops, certain levels of recontamination cannot be avoided. The two prerequisites for a long term effect by solarization (or any disinfestation

method), a drastic reduction of pathogen inocula to considerable soil depths and the induction of soil suppressiveness to retard reinfestation from various sources, were demonstrated with solarization in several cases (5,9,10,18). It is possible that these mechanisms operate in Egyptian soils as well, resulting in the prolonged effect of solarization. This long term effect, can possibly, be improved by various means such as solarizing larger plots, using filtered water or applying sanitation measures. The reproducibility of results, a major prerequisite for introducing a new method of control, was shown, during six years under various conditions, including farmers plots.

Improved plant growth that has frequently been shown in disinfested soils in the absence of known pathogens, was attributed to a variety of chemical, physical and biological factors (1,10,22). An additional chemical mechanism by solarization, demonstrated here for the first time, is the decreased salt concentrations in the upper soil layers in soils maintaining shallow ground water. These changes in the distribution of salts in the soil profile propably result from the fact that the plastic mulch prevents evaporation thereby slowing down the upward movement of salts from relatively shallow (60-80cm), possibly salty, ground water. Excess salinity may cause great damage to crops in certain soils. This beneficial side-effect of solarization should be taken into consideration whenever applicable. A detailed simulation and field work on this specific subject is presently performed.

Integrating solarization with other means of control or crop menagement should be investigated. For example, combining solarization with *Rhizobium* inoculation is a potential means for counteracting the adverse effect of solarization on this bacterium. Combination with adequate herbicides (20), possibly at reduced dosages, may effectively control weeds, which escape solarization. Combining solarization with biological or chemicals means of control improved results (3,4). In the present studies, the yields were frequently increased by solarization to high levels. This might be attributed, among other factors, to the long history of cropping of these soils, resulting in an accumulation of abiotic and biotic detrimental factors (11) including unidentified pests. Hence, soil disinfestation may also be used as a tool for identifying the causes for yield decline.

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Legends to Figures

Fig.1. Effect of soil solarization on onion (cv Giza 6) growth, at various periods after planting in sandy soil (Ismailia 1983-4). In all cases, the solarized treatment was significantly higher (P=0.05) than its respective nonsolarized one.

Fig.2. Effect of soil solarization on *Rotylenchulus reniformis* populations at various periods after the termination of solarization on Oct. 1, 1981 (Giza 1981-2). Arrow indicates broadbean planting time. Numbers followed by the same letter, at the same sampling date, are not significantly different (P=0.05).

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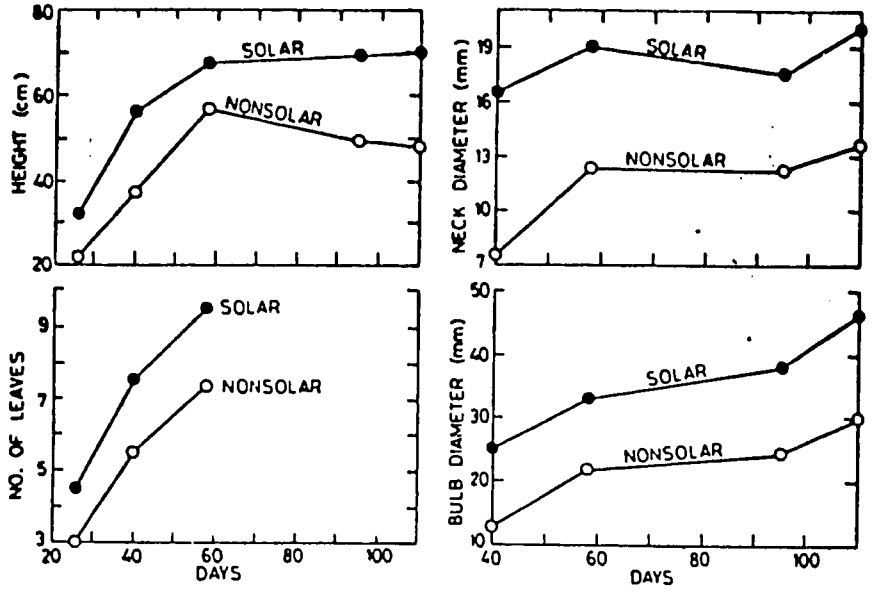

Fig 2

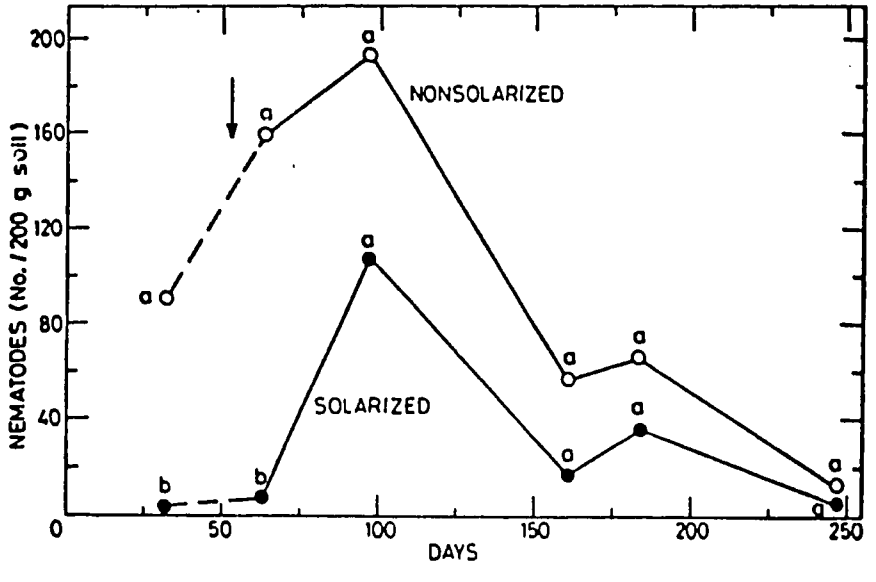

Fig 1.

Table 1. Effect of soil solarization on broomrape and weed populations, broadbean growth, nodulation, and yield (Giza 1981-2[w]).

Soil Treatment	No. weeds/m^2[x] Without *Mellilotus*	No. weeds/m^2[x] *Mellilotus*	Broomrape[x] (No/m^2)	Plant height (cm) 12Feb.	Plant height (cm) 27March	Nodules[y] (No/ plant)	Yield (Kg/ha)
Nonsolarized	109a[z]	22a	1.3a	64a	126a	88a	2384b
Solarized	33b	33a	0 b	52b	114a	20b	2992a

[w] Broadbeans (cv Giza 2) were planted on Nov. 19, 1981 and harvested in May 1982.

[x] Counts made on March 6, 1982.

[y] Counts made on Feb. 12, 1982.

[z] Numbers in each column followed by the same letter are not significantly different (*P*=0.05).

Table 2. Effect of soil solarization and *Rhizobium* (R) inoculation on broomrape population, and on broadbean growth and yield (Giza 1983-4[w]).

Treatment	R	Broomrape[x] (No./m^2)	Plant height[y] (cm)	Branches[y] (No./plant)	Yield (Kg/ha)	Yield (%)
Nonsolarized	+	30.2a[z]	86.2a	5.7b	1,480b	314
Nonsolarized	-	30.0a	80.2a	6.0b	472c	100
Solarized	+	0 b	98.2a	8.1a	2,456a	520
Solarized	-	0 b	89.6a	7.7a	2,512a	532

[w] Broadbeans (cv Giza 4) were planted on Oct. 30, 1983 and harvested on May, 1984.

[x] Counts made on May 23, 1984.

[y] Counts made on Feb. 2, 1984.

[z] Numbers in each column followed by the same letter are not significantly different (P=0.05).

Table 3. Effect of soil solarization on root diseases, growth and yield of tomatoes (El Menayef, 1985-6)[y].

Soil Treatment	Plant Stand (No/m)	Plant fresh wt (g)	Root knot (%)	Corky root (%)	No. fruits/plant	Av. fruit wt (g)	Yield g/plant	Yield Kg/ha
Nonsolarized	1.5b[z]	266b	48a	6a	31.7a	26.6b	844b	15,832b
Solarized	3.0a	484a	6b	0a	37.8a	38.2a	1,443a	54,142a

[y] Tomatoes (cv Peto 6) were transplanted on Sept 21,1985. Measurements were made on Feb. 10, 1986, with 50 individual plants for each treatment.

[z] Numbers in each column followed by the same letter are not significantly different (P=0.05).

Table 4. Nematode populations in nonsolarized (NS) and solarized (S) soils at various sites in Egypt.

Treatment	Site	No. nematodes per 200g soil					
		Tylen.[v]	Long.[v]	Hpl.[v]	Hel.[v]	Prat.[v]	Rot.[v]
NS	Ismailia[w]	120a[x]	20a	40a	560a	-	-
S	Ismailia[w]	0b	0b	0b	0b	-	-
NS	Fayed[y]	440a	87a	61a	33a	-	-
S	Fayed[y]	100b	27b	13b	0b	-	-
NS	Giza[z]	-	-	-	-	-	53a
S	Giza[z]	-	-	-	-	-	27b
NS	Kalyubya[z]	-	-	-	53a	13a	-
S	Kalyubya[z]	-	-	-	13b	0b	-
NS	Kfar Hakeem[z]	80a	-	-	-	10a	-
S	Kfar Hakeem[z]	23b	-	-	-	0b	-

[v] Tyl. = Tylenchorhynchus, Long. = Longidorus, Hopl. = Hoplolaimus, Helic. = Helicotylenchus, Prat. = Pratylenchus, Rot. = Rotylenchus.

[w] Determined on Oct. 1981, shortly after polyethylene removal, before planting.

[x] At each site, numbers followed by the same letter are not significantly different (P=0.05).

[y] Determined on Dec. 1981, 2 mo after planting beans.

[z] Determined on Oct. 1983, shortly after polyethylene removal, before planting.

Table 5. Long term effect of soil solarization, on root diseases, growth and yield of tomatoes (Ismailia 1985)[y].

Treatment	Plant wt (g)	Corky root (%)	Root knot (%)	Fruits No/ plant	Av. fruit wt. (g)	Yield Kg/ha
Nonsolarized	175a[z]	60a	52a	24a	24.8b	24,103a
Solarized	498b	24b	56a	22a	38.3a	33,497b

[y] Soil was solarized in the summer of 1983, planted with onions and after harvesting, the soil was planted with tomatoes cv UC 82 on Nov. 15, 1984. Measurements and harvest were carried out on June 4, 1985.

[z] Numbers in each column followed by the same letter are not significantly different (P=0.05).

Table 6. Electrical conductivity determined in solarized and nonsolarized soils at Youth Farms-Sinai.

Soil depth (cm)	Electrical conductivity (dSim/m)	
	Solarized	Nonsolarized
0 - 10	5.40	7.84
10 - 20	6.72	9.28
20 - 30	8.80	9.80
30 - 40	8.08	7.16
40 - 50	6.64	8.10