PD-AAV-162
49069

Development of Improved Varieties of Soybeans Supporting Cultural and Marketing Practices for Production in the Tropics and Information Delivery Systems

January 1, 1983 - June 30, 1984

IPR-84-1

Development of Improved Varieties of Soybeans Supporting Cultural and Marketing Practices for Production in the Tropics and Information Delivery Systems

Annual Report of
Contract AID/TA-C-1294
January 1, 1983 - June 30, 1984

Submitted to
The U.S. Agency for International Development
Department of State
Washington, D.C.

by
The University of Illinois at Urbana-Champaign
College of Agriculture
International Soybean Program, INTSOY
IPR-84-1

TABLE OF CONTENTS

Preface 1

Summary 3
- Statistical Summary. 3
- Narrative Summary. 4

Report of Progress. 7
- Goals. 7
- Approach 7
- Objectives 7
- Soybean Research and Development Activities in Cooperating Countries - Results of a Survey of INTSOY Cooperators. 8

Research Results:
- Development of Improved Genetic Materials 13
- Improved *Rhizobium Japonicum* Technology for the Tropics 25
- Improved Disease and Insect Control: Viruses 30
- Improved Disease and Insect Control: Insects 47
- Seedborne Pathogens and Factors Influencing Them. 58

Auxiliary Activities 62
- Soybean Insect Research Information Center (SIRIC). 62
- INTSOY Newsletter and Mailing List. 70
- INTSOY Publication Series 70
- Training Activities 76
- Conference and Travel Activities. 77

Administration and Budget. 78

Appendix I: 1983 Cooperators in INTSOY Trials 79

Appendix II: Summary of SIRIC Services, 1983. 87

Appendix III: INTSOY Staff Publications 95

INTSOY Project Staff 102

PREFACE

1983 saw the price of soybeans increase dramatically on the world market, primarily due to increased demand for edible oil in the developing countries coupled with reduced production in the United States because of a serious drought. This led to significant increases in the number of requests to INTSOY for help in strengthening national soybean research and development programs.

For INTSOY 1983 was a transition year, as efforts were made to better improve our capabilities to respond to the increased number of requests. We also began discussions on long-term funding arrangements for INTSOY. During the past decade INTSOY has been funded on a series of 3 research contracts from USAID, with provisions that production would be the major research focus. In the future, INTSOY will increase its focus on processing and utilization.

The productive relationship with the University of Puerto Rico drew to a close and the INTSOY plant breeder moved to Colombia to work on Latin American regional activities. The microbiologist transferred to Taiwan to work on Asian regional activities. INTSOY staff at UIUC increased their collaborative activities with scientists at the International Agriculture Research Centers. These moves reflect the trend towards strengthening international soybean research by establishing networks with the international agriculture research centers and strong national programs to maximize limited resources devoted to soybean research and development.

The ISVEX varietal improvement network continued to benefit many countries. As a result, many national research programs have increased their commitment to soybean improvement research. The increasing activity of national breeding programs is reflected in the gradual shift in the composition of test cultivars in the INTSOY variety trials, from predominately U.S. varieties in the early years, to cultivars from cooperating countries now in the majority. More than 100 soybean breeders have shared their best breeding materials for testing in the trials. The trials have been conducted in 131 countries.

The research results of seed pathology, virology, virus vector interactions and other components of pest management continue to help many countries obtain better seed and reduced losses from disease and insect problems. The scope and quality of INTSOY research during the past year and decade is reflected in the publishing of more than 50 scientific articles by INTSOY staff in 1983, bringing the total to more than 400 for the 10 year life of the program. The INTSOY paper series has now reached 26.

A 1983 survey of ISVEX cooperators clearly showed the growing interest of many developing countries in growing soybeans to help meet their rapidly increasing demands for protein and edible oil. Survey results indicate the need for a concerted international collaborative effort in soybean research and development to help developing countries.

To meet this need INTSOY is working with AVRDC, IITA, and IRRI to establish regional soybean networks. These networks will involve major soybean growing countries such as China, Brazil, and India, and will have close ties with all national programs in each region as well as various international

organizations. Hopefully, a consortium of donors can be formed to provide increased support to international soybean research and development activities in production, marketing, processing and utilization.

STATISTICAL SUMMARY

1. Project Title and Contract Number: Development of Improved Varieties of Soybean Supporting Cultural and Marketing Practices for Production in the Tropics and Information Delivery Systems--AID/TA-C-1294.

2. Principal Investigator, Contractor, and mailing address:

   Harold E. Kauffman, Director
   International Soybean Program, INTSOY
   College of Agriculture
   University of Illinois at Urbana-Champaign
   113 Mumford Hall
   1301 West Gregory Drive
   Urbana, Illinois 61801

3. Contract Period: April 1, 1976-June 30, 1984

4. Period Covered by Report: January 1, 1983-June 30, 1984

5. Total AID Funding of Contract to June 30, 1984: $6,506,831.00*

6. Total Expenditures for Report Period: $1,344,484.00*

*Provisional amount as final statement was not complete when this was printed.

NARRATIVE SUMMARY

Improved Genetic Materials. In 1983, seed for 147 ISVEX trials was sent to 74 countries. Eighty-five Group A (tropical) ISVEX sets were sent to 44 countries. Thirty-nine Group B (subtropical) ISVEX sets were sent to 27 countries. Twenty-three Group C (temperate) ISVEX sets were sent to 17 countries.

Five SIEVE (Soybean Initial Evaluationi Experiment) trials were conducted in 5 countries and 20 SPOT (Soybean Preliminary Observation Trial) trials were conducted in 13 countries to select cultivars for future ISVEX trials.

A study on the extent of promiscuous nodulation was started in cooperation with IITA. Seed of 9 lines supplied by IITA was increased in Puerto Rico in the winter of 1982-83. Seed for 29 promiscuous nodulation trials was sent to 21 countries throughout the world.

In addition to the above planned experiments, seed for 8 special research trials was supplied to cooperators in 5 countries. Thirty-one requests for germplasm were received from 17 countries.

The ISVEX trial cooperators are staff members of Ministries of Agriculture, universities and various non-governmental agencies. Fifty-two National Agricultural Institutes, Departments and/or Research Stations of the Ministries of Agrticulture in 45 countries were involved. In addition, 12 universities in 10 countries participated. Twenty-five philanthropic and international institutes in 21 countries also participated.

At the INTSOY tropical site in Puerto Rico field plantings during the summer season included the three international trials, SIEVE, SPOT and ISVEX, one trial to evaluate free-nodulating cultivars, one trial to evaluate cultivars for seed longevity under ambient storage conditions, and three trials to evaluate lines developed by INTSOY. Breeding materials planted in both seasons included F1 plants and segregating populations from the F2 to the F4 generations. During the summer season a collaborative project with the University of Florida evaluated late maturing soybean germplasm for tropical environments.

The resident plant breeder at the Isabela Research Station was transferred from Puerto Rico to Colombia in August 1983 to initiate a Latin American network on soybean research with the collaboration of CIAT and ICA under the leadership of INTSOY. The field work at Isabela was continued by the INTSOY assistant agronomist until December, 1983. From September to December the project obtained office, clerical assistance and transport facilities at CIAT and established contracts to initiate the field work at the ICA Research Station in Palmira, Colombia.

Improved *Rhizobium Japonicum* Technology for the Tropics. Longevity studies *Rhizobium japonicum* on acid, high aluminum corozal soil in Puerto Rico continued to show significant interaction between cultivars and strains of the *Rhizobium*. Since 1981 research results confirm the trend towards host strain specificity for individual cultivars.

Research on ways to control moisture loss from granular peat indicate that application of mineral oil at approximately 2% (V/W) provides an improvement in moisture retention.

Fast growing strains of *Rhizobium* isolated from soybean nodules in Vietnam were further characterized under different conditions. It is too early, however, to know if they will be efficient nitrogen fixers under a range of environments and cultivars.

Analyses of longevity studies of 12 strains of *Rhizobium japonicum* on acid, high aluminum soils were started as antiserum became available.

The microbiologist was transferred to Taiwan in August to conduct research at AVRDC.

Improved Disease and Insect Control. Breeders and virologists continue to screen advanced breeding material resistant to SMV. Several breeding lines continue to show strong resistance to strain G2 and moderate resistance to strain G7. Results from testing indicate that these strains do have resistance in a number of countries. The rate of seed transmission of SMV was shown to be dependent both on the isolate of the virus and varieties. Arisoy and UFV-1 had the lowest rate of seed infection. Mixed strain infection of SMV showed that the virus strain did change when transmitted from parent to progeny. Tests of SMV induced male sterility resulted in somewhat less reduction than previous experiments indicating that additional work is necessary.

The machismo disease of rice first identified in 1968 in the Cauca Valley of Colombia was tentatively identified to be present in Mexico. Virologists speculate that the micro-plasma like disease may also be present in Asia, the Pacific, and Africa in the form of soybean "witches brooming".

The earlier developed "viral gene fingerprint analysis" identified geminivirus infection in materials from soybeans near Palmira, Colombia. It is suspected that geminiviruses may be among the major disease constraint of legumes in the tropics. This tool can be used widely to identify such geminiviruses. Rhynchosia mosaic virus was studied in detail in Puerto Rico where it affects a wide range of legume species. RMV was successfully purified in 1983. Electron micrographs of the purified virus positively identified it as a geminivirus.

Collaborative work with scientists at ICRISAT at Hyderabad, India helped in the collection of 56 tissue samples from bean yellow mosaic virus-type symptoms. Bean yellow mosaic virus is a potential threat to soybean production in India. This experiment will help identify, purify, and characterize the causal agent.

Studies on the effect of the quality of soybean leaf pubescence on aphid probing behavior suggests that the behavior is modified by the type of pubescence. The effect on probing behavior in turn influences virsu spread. It is not clear, however, whether this can be used to reduce virus spread.

A multi-state cooperative project on the epidemiology of SMV during 1982 and 1983 has evaluated a predictive model to determine seed transmission rates and yield parameters. The predictive accuracy of the present model fell within 20% of the observed values for both infection and yield loss. The model was less accurate in predicting seed tranmission rates.

Studies show that the population of the predator *Orius* which feeds on thrips and mites can be manipulated by adjusting cropping systems. Perhaps this can make *Orius* an increasingly effective biocontrol agent. Studies on the effect of leaf color on the ability of different species of aphids to spread SMV indicate that some species can spread the virus more efficiently in dark green foliage and others more efficiently in plants that are more yellowish.

Studies on the ability of aphids to naturally transfer SMV indicate that aphid inoculation is as effective for producing seed transmission as to manual sap inoculation. The infection must take place however, prior to the flowering stage of development. Individual plants can have seed transmission rates as high as 30% when naturally infected.

Seedborne Pathogens and Factors Influencing Them. Continued studies on soybean pathogens showed that purple seed stain caused by *Cercospora kikuchii* resulted in lower germination and reduced vigor of the seedlings when 50% or more of the surface was stained. *Colletotrichum kikuchii* and *Phomopsis* sp. appear not to have antagonism although incidence of *Phomopsis* sp. on soybean seeds colonized by *Colloctrium kikuchii* is lower.

In Brazil, several weeds were shown to be symptom-less carriers of *Phomopsis* sp. *Phomopsis* spp. were isolated from several common weeds in areas where soybeans are grown.

Studies on non-target effects of herbicides in Brazil showed that herbicides applied at planting may exert non-target effects upon pathogens and seed quality. Some diseases, such as downy mildew, increased in plots treated by Metribuzin, whereas *Bacillus subtilis*, *Fusarium* sp., and *Phomopsis* sp. were significantly lower. Desiccants type non-selective herbicides also effected pathogen development. The stems of Paraquat sprayed plants had optimum development of fruiting structures of *Colletotrichum truncaton* and of *Phomopsis*.

REPORT OF PROGRESS

GOALS

The goals of the project are to increase production of soybeans by small-scale farmers in tropical and subtropical LDCs and to increase utilization of soybeans for food use by rural and urban poor.

APPROACH

Work on this project features a multidisciplinary, interinstitutional approach. The project sustains and improves research output and competence in selected areas, and contributes to the generation of knowledge to be shared with soybean scientists worldwide. The primary focus is the identification of constraints affecting soybean production, protection, and use in tropical and subtropical LDCs, development of research activities to overcome these constraints, and the dissemination of information to LDC and international institutions. Benefits of research are targeted to small-scale farmers and agricultural institutions of tropical LDCs.

OBJECTIVES

Five major objectives, or outputs, are included in the most recent "Statement of Work" covering the period July 16, 1980-November 30, 1983. They are:

1. Develop improved genetic materials for use in LDC research and production programs and improved linkages among soybean breeders.
2. Develop improved technology for *Rhizobium japonicum* production and management under tropical conditions.
3. Improve the knowledge base for disease, insect, and weed control in soybeans produced under tropical conditions.
4. Develop soybean disease, insect, and weed management systems for tropical and subtropical areas.
5. Develop improved production, harvesting, handling, and storage methods for seed and grain under tropical conditions.

Objectives 3 and 4 have been combined for this report. Objective 5 activities focused on seed pathogen problems to improve post-harvest handling and storage of seed.

SOYBEAN RESEARCH AND DEVELOPMENT ACTIVITIES IN COOPERATING COUNTRIES - RESULTS OF A SURVEY OF INTSOY COOPERATORS

During 1983, INTSOY sent a survey questionnaire to scientists who cooperate in the international soybean trial network. The purpose was to better understand the current soybean research, production, and utilization activities in various countries and their current and future needs. Cooperators from 54 countries responded to the survey with 47 nations being in the tropics or subtropics. Most respondents worked with Ministries of Agriculture and Agricultural Universities and on the average had slightly more than 5 years of experience working on soybeans. More than half had Masters' or Ph.D. degrees and devoted half-or full-time to work on soybeans.

The research programs of tropical and subtropical countries were less well-established than those in the temperate regions and the seed and inoculant industries were not well enough established to support the production programs (Table 1). Diseases, insects and drought rated as a more serious problem in the tropics than in the temperate countries. The crops reported as most frequently grown in rotation with soybeans in the tropics in order of importance were maize, rice, and wheat. There was considerable interest in growing soybeans as a single crop as well as to grow in rotation with a number of other minor crops. Twenty-seven percent of the respondents indicated soybean was replacing cotton in cropping patterns in their country.

When comparing various continents, the Americas and Asia had more advanced soybean research programs than did Africa. For example, more than two-thirds of the nations in Asia and the Americas had active breeding efforts, whereas in Africa, less than one-third of the countries had soybean breeding programs. Inoculant and seed industries in African countries were also much less prevalent than in Asia or Latin America. Thus, in Africa, the problems relating to soybean production are greater and the research capabilities are less to overcome these constraints - clearly indicating the need to greatly increase research and development efforts.

Maize/soybean was the most popular cropping system in Africa and the Americas, whereas rice/soybean was the most popular system in Asia. In Asia, maize/soybean/other crops were next most important, whereas in Africa, soybean/other crops was of second most importance and mono-culture of soybeans third. In the Americas, wheat/soybean was second and soybean monoculture was third (Table 2).

Most comments on desired cultivar characteristics for each of the three regions appear to reflect the type of cropping systems in which soybean will be grown. For example, in Asia, short duration cultivars (80-100 days) were top priority to apparently fit into the rice/soybean cropping systems. In Africa, 100-120 day cultivars were most frequently desired to fit into their maize/soybean cropping systems. In the Americas, 120-140 days varieties were listed as most desirable, possibly because of a higher percentage of mono-culture or more flexibility in their cropping rotation.

Disease resistance and tolerance to water stress were rated as the most important breeding objectives in the three regions. Insect resistance was rated high in Asia and the Americas. Tolerance to acid soils was also rated high in Asia and very important in tropical Africa and the Americas.

Table 1: Comparisons Between Tropical/Subtropical and Temperate Areas

	Tropical/Subtropical	Temperate
A. Respondents:		
- Number of countries	47	7
- Location of countries (%)	85	15
B. National Soybean Program		
- Have inoculant industry in country (%)	30	67
- Have seed industry in country (%)	38	67
- Important Cropping Sequence in Countries of Respondents (%)		
- Rice/soybean	42	0
- Wheat/soybean	25	92
- Maize/soybean	57	42
- Soybean/other crop	43	17
- Single crop	40	17
- Replacement for cotton	27	8
C. International Soybean Trials		
- Reasons for yield reduction in trials(%)		
- Drought	37	8
- Disease	28	8
- Insects	13	17

In all three regions protein meal was mentioned as the most important use of soybeans, both currently and as having greatest growth potential (Table 3). Soy foods rates as the second most important use of soybeans in Asia with edible oils a close third. Asian respondents perceive soy foods as having the greatest growth potential. In Africa, soy food and edible oil were a distant second and third in current use but both were expected to become very important in the future. In the Americas, edible oil was nearly as important as protein meal and soy foods were perceived as a significant growth area.

These results clearly illustrate the commonality of breeding, production, and research needs within a given region and differences between regions. To develop appropriate technology for each country, regional cooperation will be essential.

A number of research areas must be addressed to meet the needs of developing countries. The respondents in the survey listed improved germplasm and the training of their scientists as their most important needs for their individual countries (Table 4). Next most important were the needs for improved research facilities and production technologies. Respondents from Africa indicated that production techniques were their most important need.

Table 2: Staffing, Soybean Programs, ISVEX Trials: Comparisons Between Africa, Asia, and the Americas from Survey Respondents

	Africa(20)*	Asia(14)	Americas(14)	Other	Overall Average
A. Educational attainment of respondents(%)					
- Ph.D.	28	33	14	75	30
- M.Sc.	28	38	45	25	35
- B.Sc.	20	21	14	-	16
- Ing. Agr.	16	-	27	-	12
Percentage of staff working 1/2 to full-time	56	38	73	50	54
B. National soybean programs:					
- Have active breeding programs(%)	32	63	77	62	
- Have inoculant industry in country(%)	20	42	40	50	
- Primary cropping sequences in countries of respondents	Maize/Soybean Soybean/Other Soybean	Rice/Soybean Maize/Soybean Soybean/Other	Maize/Soybean Wheat/Soybean Soybean		
- Have soybean seed industry in country(%)	44	29	55	38	
C. ISVEX trials:					
- Average yields at first introduction	2,000 T/Ha	3,000 T/Ha	3,000 T/Ha	2.5 T/Ha	
- Reasons cited for yield reduction in ISVEX trials:					
(1) Drought(%)	32	38	36	13	
(2) Disease(%)	20	38	23	13	
(3) Insects(%)	12	16	14	13	
- Countries which have released varieties from ISVEX(%)	40	42	40	50	

*Number of countries in parenthesis

Table 3: Respondents Comments on Current and Future Uses of Soybean in Africa, Asia, and the Americas

	Africa	Asia	Americas
Current Uses*			
- Protein meal	64	75	82
- Edible oil	28	63	73
- Soy foods	36	67	27
Growth Potential for Future Uses*			
- Protein meal	76	79	82
- Edible oil	68	63	64
- Soy foods	56	79	45

*Percentage of respondents saying was of major importance

Table 4: Perception of Future Need of Respondents (%)

	Africa	Asia	Americas	Other	Overall Importance
Improved germplasm	72*	83	72	50	75
Production techniques	76	42	41	13	49
Training of scientist	64	75	68	63	68
Research facilities	60	46	64	25	53
Marketing and processing facilities	32	50	23	25	34
Development of soy products	32	42	18	13	29

*Percentage of respondents indicating this to be important.

Approximately one-third of the respondents indicated that the marketing and processing facilities and the development of soy products were most important to strengthening their national soybean programs. These needs were much higher in Asia and Africa than in the Americas where the soybean industry is more widely established.

This survey reinforces the views that the following programs must be strengthened through global cooperation in research and development:

(1) Germplasm Preservation, Evaluation and Enhancement: To globally preserve, document, evaluate, and enhance soybean germplasm, a dynamic network of collaborating varietal improvement scientists representing national, regional, and international organizations must be established.

For soybean germplasm preservation, various organizations must work closely with the International Board of Plant Genetic Resources (IBPGR) to make a global inventory of soybean germplasm collections. The primary collection of cultivated species, related wild annual species and perennial species in a number of Asian countries must be speeded up. Financial support must be found to improve maintenance facilities for base collection in Australia, China, Japan, and U.S.A and working collections in various countries.

Germplasm enhancement must be greatly expanded in tropical and subtropical environments. Dynamic breeding programs at regional network centers, AVRDC (Asia), IITA (Africa), and INTSOY/CIAT/ICA (Latin America) and in larger national programs such as Brazil, China, India and the U.S.A. must be expanded to serve as the collaborative base for regional networks to better exploit genetic diversity in gene pools for the tropics and subtropics.

National programs must be strengthened in the tropics and subtropics through regional network collaboration and training activities.

Existing international and regional and national testing programs programs should be integrated to effectively increase the number and diversity of germplasm tested. Tests must be expanded to include conditions common to those experienced in various cropping systems. More on-farm testing will be required.

(2) Improved Production Technology for Various Cropping Systems: The IARCs and national programs must develop appropriate and economical agronomic production practices for a wide range of tropical and subtropical environments. Collaborative activities to develop integrated pest management practices to control diseases, insects and weeds for various cropping systems environments is essential.

Improved technology must be developed for *Rhizobium japonicum* production and management under tropical conditions. This must be done in collaboration with NifTAL, BNF programs of several IARCs and national programs.

(3) Marketing, Processing and Utilization: The most urgent overall goal will be to encourage and increase soybean processing and need in most tropical and subtropical countries to establish processing facilities and soy products tailored to each country's needs and conditions.

There is a significant need to increase soybean utilization for human food on a global basis.

RESEARCH RESULTS: *DEVELOPMENT OF IMPROVED GENETIC MATERIALS*

J. A. Jackobs, Luis Camacho

The INTSOY soybean cultivar improvement program continues to focus on two complimentary operations - cultivar testing and germplasm enhancement. Cultivar screening and breeding work is conducted at a tropical site. From 1973-1983 this site was at the Isabela Sub-Experiment Station in Puerto Rico in cooperation with the University of Puerto Rico, Mayaguez Campus. In 1983 the breeding work was moved to Cali, Colombia to the Instituto Colombiano Agropecuario (ICA). Cultivar evaluation work is accomplished through a series of international cultivar trials in cooperation with soybean workers in approximately 75 countries. These trials are coordinated from the Department of Agronomy at the University of Illinois at Urbana-Champaign. Through 1983 the seed increase for the tropically adapted varieties has been done in Puerto Rico. In 1984 the seed increase will be done in Texas and Colombia.

Cultivar Testing. The genetic improvement program is directed to the development of cultivars demonstrating adaptation to tropical and subtropical environments. Scientists from various national and international programs nominate their best varieties and breeding materials to the cultivar trials. Such cultivars must exhibit high, stable yields, satisfactory photoperiod responses, broad ecological adaptability, and resistance or tolerance to disease pathogens, insect pests, and problems soils. Scientists affiliated with international, national, and private research organizations then utilize this advanced soybean germplasm for their research or cultivar production programs.

INTSOY has the following 3 main research trials: the Soybean Initial Evaluation Variety Experiment (SIEVE), the Soybean Preliminary Observation Trials (SPOT), and the International Soybean Variety Evaluation Experiment (ISVEX). The methodology involved and the research objectives inherent to SIEVE, SPOT, and ISVEX have been detailed elsewhere. The 1983 cooperators are listed in Appendix I.

SIEVE. Cultivars developed by various national programs have improved performance in the trials as cultivar development programs in the tropics and subtropics continue to expand. Since SIEVE's inception in 1978, 197 cultivars have been evaluated, of which 85 were advanced to SPOT. Forty-three cultivars were selected from SPOT and entered in ISVEX. A total of 119 breeders from 28 countries have contributed cultivars to this program.

The best 5 performing entries in the 1982 SIEVE were:

Cultivars	Origin	Average Yield
KHSB-2	India	3168
Supreme	Brazil	3089
PM-78-2-5-25	Sri Lanka	3085
Santa Rosa-R	Brazil	3010
PR 21(339)	Puerto Rico	2963

The 1983 SIEVE is being conducted by collaborating scientists in Colombia, Sri Lanka, Puerto Rico, Texas (U.S.A.), and the Philippines. The advanced germplasm for this research was nominated and contributed to INTSOY by 18 Plant Breeders from 14 countries. These breeders selected and entered 44 of their improved soybean lines for initial screening and evaluation. Cultivars with good agronomic performances were advanced to the Soybean Preliminary Observation Trials (SPOT). A summary of SIEVE composition from 1978 to 1982 is given in Table 5.

SPOT. A preliminary summary has been prepared on the 1982 SPOT. Of the 24 cultivars from tropical and subtropical sites, 18 cultivars were of international origin. The remainder are recent U.S. releases and standard check cultivars. The 14 most promising cultivars were promoted to the 1983 ISVEX.

The 1983 SPOT is currently being conducted at 20 environmentally different sites in 13 countries. There are 24 entries in SPOT 83, of which 16 were selected from SIEVE. Sixteen breeders from 10 countries are responsible for developent of these cultivars.

ISVEX. Large scale evaluation and cultivar distribution are accomplished through the ISVEX program. One hundred-fifty ISVEX 1983 trials were distributed to 75 countries. Eighty-six were group A sent to 45 tropical countries, 41 were group B sent to 27 subtropical countries and 23 were group C sent to 17 temperate countries. A guide for determining ISVEX zones and groups of varieties is shown in Table 6.

Nineteen cultivars of the 1983 ISVEX entries originated from earlier SIEVE's. Nineteen tropical and subtropical cultivars were entered out of a total of twenty-six cultivars. A summary of the ISVEX composition from 1973 through 1982 is given in Table 7.

ISVEX 1980 and 1981 results have been analyzed and the report is being printed. Individual analyses have been returned to the cooperating scientists.

IITA/INTSOY Promiscuous Noduation Experiment. A promiscuous nodulation experiment was initiated in 1983 collaboratively with IITA to study the efficiency of nodulation of selected soybean cultivars with indigenous strains. Seed of 9 lines supplied by IITA was increased in Puerto Rico in the winter of 1982-83. Seed for 29 promiscuous nodulation trials was sent to 21 countries throughout the world. Results will be returned and analyzed in early 1984.

Yield Trial Performance in Puerto Rico. The SIEVE trial comprised 50 entries including four checks (Foster, Davis, Braxton and Jupiter). One of the test cultivars did not have good emergence and was not included in the comparisons. The experiment was planted on July 13 in a randomized complete block design with two replications. Results of yield and other trials are presented in Table 8. Yield figures on Table 8 were not adjusted to 12 percent moisture. Among the high yielding cultivars there were entries from

Table 5. SIEVE Composition from 1978 to 1983

Item	1978 Per year	1978 New	1979 Per year	1979 New	1980 Per Year	1980 New	1981 Per year	1981 New	1982 Per year	1982 New	1983 Per year	1983 New	Total
Germplasm contributors	26	(26)	16	10	11	4	13	2	12	8	18		
Cultivars evaluated	50		30		26		30		30		48	44	
Originating countries	15	(15)	9	3	9	1	10	1	9	1	14		

Table 6. ISVEX Zones and Groups

	Latitude							
	0-10°		10-20°		20-30°		30-40°	
	Zone	Group[a]	Zone	Group	Zone	Group	Zone	Group
0-500 m	I	A	IV	A	VII	B	X	B
500-1,000 m	II	A	V	B	VIII	B	XI	C
1,000-2,000 m	III	B	VI	B	IX	B	XII	C
2,000 m	XII	C	XII	C	XII	C	XII	c

[a]Tropical Group A cultivars includes cultivars of maturity group classification VI through X or greater. Subtropical Group B cultivars includes cultivars of maturity group classification IV through VII. Temperate Group C cultivars includes cultivars of maturity group classification 00 through V.

Table 7. ISVEX Composition From 1973 to 1982

Item	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Trials	90	136	359	292	179	177	151	166	183	179	150
Countries	28	40	67	65	71	81	67	71	75	82	74
New countries[a]	28	20	28	13	8	10	5	4	6	2	7
Cooperators	49	68	106	105	94	118	101	110	155	124	
Cultivars	20	15	25	26	28	36	38	47	38	39	
New Cultivars	--	3	13	6	4	18	2	26	5	--	

[a]Total of 131 countries have evaluated ISVEX.

Taiwan, Thailand, Vietnam and lines selected by INTSOY among germplasm materials donated by the North American Plant Breeders (NAPB) seed company. These lines were IPB-213-81, IPB-163-91 and IPB-189-81.

Relative late date of planting (July 13) induced early maturity and short plant growth in all cultivars. About 75% of the cultivars reached maturity between 75 and 90 days after planting, 15% reached maturity from 91 to 100 days after plantng, and the rest matured after 100 days. Among the late maturing cultivars were Jupiter, two entries from Nigeria and two from Colombia.

Plant height was in the short to medium range for most of the SIEVE cultivars. The check cultivars Davis, Foster and Braxton exhibited the shortest plant growth (41 to 54 cm), and 10 other entries were within the same range of plant growth. Jupiter had a medium plant height of 88 cm and only five entries showed significant longer plant height than this check. Visual observations in the same experiment planted in a tropical latitude in Colombia also indicated that a large proportion of 1983 SIEVE cultivars were in the range of medium maturity and medium plant height. In spite of the short life cycle, satisfactory yield levels above 2000 kg/ha were obtained in 14 out of the 49 cultivars tested (Table 8).

The SPOT trials composed of 24 entries, including the checks Davis, Braxton and Jupiter, were planted on June 20 in a randomized complete block design with three replications. Like in the previous experiment, seed weights were not adjusted for moisture percentage. The analysis of yield showed the cultivars Davis and PM-78-2-5-25 as the top yielders; other entries showing yield levels between 2340 and 2650 kg/ha were also statistically similar to the two top yielders; these included lines PR 21 (309) and IPB-204-77 selected by INTSOY from breeding materials planted at Isabela in previous seasons. Plant maturity was in the range between Davis and Jupiter with the exception of AGS-154 from Taiwan which matured earlier than Davis. None of the entries were later than Jupiter. Early and late types were in the group of high yielding cultivars. Line Jupiter R was similar to its parental genotype in plant height, maturity and yield. Plant height ranged from very short in check cultivar Braxton to very tall in the introduced line PM 78-8-5-19 but most entries exhibited a plant height between Davis (54 cm) and Jupiter (82 cm) (Table 9).

As in previous years, the ISVEX trial had 16 entries including the checks Davis, Braxton, Improved Pelican and Jupiter that provide an appropriate range of maturity and plant height for comparison with testing cultivars. The experiment was planted on June 23 in a randomized complete block design with four replications and four-row plots five meters long. Yield data were obtained in a section of 4.5 m of the central row. All cultivars with yield levels about 2100 kg/ha were similar to Davis and Braxton; these included half of the cultivars tested in the experiment. The other half of the cultivars were approximately equal to Jupiter and Improved Pelican in yielding ability. Maturity ranged from early AGS-8 from Taiwan to late in F75-9207 from Florida, USA. Maturity did not seem to be positively associated with yield since early, medium and late types were equally productive. The two check cultivars Davis and Braxton were significantly shorter in plant height

Table 8. Agronomic Performance of 1983 SIEVE Cultivars Tested at the Isabela Research Sub-station

Cultivar	Kg/ha	Maturity (days)	Plant Height (cm)
1. S-76-2109	2338	82	42
2. IPB-213-81	2316	87	65
3. AGS-147	2240	84	74
4. Buchanan	2194	94	74
5. "86"	2168	85	77
6. Dulker	2112	91	82
7. IPB-163-81	2112	91	70
8. Bradley	2104	85	52
9. AGS-129	2093	83	71
10. SJ-5	2076	91	81
11. Coc Chum	2059	86	80
12. IPB-189-91	2051	85	77
13. MTD 22P	2043	85	64
14. AGS-158	2039	93	89
15. OC-7934	1997	93	67
16. MACS-75	1994	94	94
17. Rinconada	1978	79	52
18. Foster	1974	84	41
19. Almonazar	1960	79	58
20. IPB-212-81	1960	95	67
21. Ocepar 2 IAPO	1879	91	49
22. Davis	1879	85	54
23. Jupiter	1878	102	88
24. Braxton	1847	89	43
25. R-77-84	1816	77	60
26. A-6520	1755	81	41
27. Yaqui-80	1726	86	51
28. Tamazula S-80	1720	88	51
29. MTD 22W	1717	74	67
30. MTD 63	1717	89	99
31. Cayeme	1708	86	64
32. MTD 65	1706	85	77
33. MTD 10	1661	89	116
34. G2261	1641	78	61
35. Sanalona-77	1636	88	50
36. OC-78503	1631	86	76
37. Rocia	1601	81	51
38. Con Khuong	1592	92	93
39. Magaly	1592	95	59
40. ICA-L-135	1570	100	106
41. DH-4	1544	90	98
42. ICA-L-137	1536	103	104
43. ICA-L-139	1478	106	97
44. SJ-2	1459	99	93
45. BS-54	1454	89	89
46. Mayo-80	1355	86	57
47. M-98	1343	105	108
48. Rosales-S-80	1308	87	45

Table 8. (Cont'd)

Cultivar	Kg/ha	Maturity (days)	Plant Height (cm)
49. M-351	819	104	117
Mean	1804	89	72
C.V. .	16	3	9
L.S.D. 0.05	578	5	10

Table 9. Agronomic Performance of 1983 SPOT Cultivars Tested at the Isabela Research Sub-station

Cultivar	Kg/ha	Maturity (days)	Plant Height (cm)
PM-78-2-5-25	2845	105	60
Davis	2840	102	54
AGS-162	2652	102	58
IPB-204-77	2469	100	53
KHSB-2	2457	106	74
UFV-1	2380	116	54
PR-21(309)	2368	117	80
Crowford	2340	103	56
Braxton	2257	109	36
Santa Rosa	2228	108	60
ICA-L-132	2210	103	90
PM-78-8-5-19	2204	109	102
PR 13 (114)	2201	116	86
PR 21 (339)	2199	117	91
ICA-L-131	2196	104	81
Supreme	2094	116	74
PR 142 (3)	2067	111	93
PR 14 (9)	2038	110	86
AGS-154	2026	93	54
269/5/3/2	1988	103	42
Sanalona-77	1948	100	44
ISRA/IRAT-26/72	1931	110	91
Jupiter-R	1918	119	73
Jupiter	1882	118	82
Mean	2235	108	69
C.V.(%)	16	2	8
L.S.D. 0.05	581	3	9

than the rest of the entries tested but their plant growth did not influence their seed yield (Table 10).

Table 10. Agronomic Performance of 1983 ISVEX Cultivars Tested at the Isabela Research Sub-station

Cultivar	Kg/ha	Maturity (days)	Plant Height (cm)
Davis	2506	95	47
Braxton	2442	103	40
EGSY-91-7	2427	102	59
AGS-8	2402	91	93
UFV-1	2310	114	63
IAC-73-5115	2251	106	93
F 75-9207	2166	123	92
SH-1274	2124	102	102
IAC-6	2040	112	111
SIATSA-194	1899	105	126
Jupiter	1763	116	94
Improved Pelican	1729	105	106
ISRA-IRAT-44A/73	1574	106	92
ICA-L-109	1549	116	111
ICA-L-129	1387	103	104
71-38	1245	114	80
Mean	1988	107	88
C.V. (%)	14	2	8
L.S.D. 0.05	398	2	10

A new experiment on longevity of seed in storage was initiated to identify genotypes with ability to maintain seed viability under ambient storage in tropical environments. There were 40 entries nominated by different soybean programs from tropical and subtropical environments. The INTSOY breeding project nominated the breeding lines PR 81, PR 83, PR 93 and PR 99 which were identified in 1982 as promising materials in regard to prolonged storability at Isabela. Entries were planted in a randomized complete block design with single row plots replicated twice. Flower date and plant height was recorded in each plot. In order to minimize the effect of environment during seed maturity, each entry was harvested at the beginning of podyellowing before the whole plant was completely mature. Plants were dried at 40° C for 24 to 36 hours and a sample of seed was immediately stored in a cold room. The evaluation of viability will start at the time of shipping the seeds to Colombia and will continue there under ambient temperature and relative humidity at various locations. Table 11 shows the entry name, flowering time and plant height of the materials included in this experiment.

INTSOY collaborates with soybean researchers of IITA to evaluate soybean lines with ability to nodulate in the presence of rhizobium species different from *Rhizobium japonicum*. INTSOY distributed this experiment among various cooperators to be planted in soil free from *Rhizobium japonicum*. In Puerto Rico, the experiment was planted to observe the nodulating ability of the lines in soil previously inoculated with the bacteria. There were

Table 11. Agronomic Evaluation of Cultivars Tested in the Seed Longevity Study

Cultivar	Flowering (days)	Plant Height (cm)
EAP-1	44	82
PR-93	43	53
TGX 342-351D	51	64
PR-83	46	80
PM 78-13-5-12	43	92
AGS 22	38	65
ISRA-IRAT28/76	42	80
TGx 297-192C	51	79
T-26	37	52
Gc-60011-6-12-638	44	90
Bossier	30	46
ISRA-IRAT 31/76	34	70
EAP-13	58	121
MTD-10	41	67
ISRA-IRAT 81/76	42	52
TGx 340-295D	47	91
PM 78-6-5-13	42	60
G 9448	23	20
ISRA-IRAT 6/76	48	95
PM-78-8-5-19	45	87
AGS-129	34	52
TGx 342-275D	48	63
G-2120	58	94
AGS-102	39	49
ISRA-IRAT 90/76	40	88
Gc-55/7	30	47
EAP-2	58	93
TGm 737p	54	95
PM78-2-5-25	47	85
ISRA-IRAT 26/76	44	82
TGx 252-71C	52	102
ISRA-IRAT 29/76	31	73
EAP - 22	60	94
PR-81	44	86
EAP-16	59	87
Imp. Pellcan	44	94
T-60	31	49
EAP-20	58	72
PR-99	45	89
Duocrop	36	82
Mean	44	76

three checks and eight test lines planted in a randomized complete block design with two replications. At the full flower stage a sample of 10 plants were taken from each plot and the number of large and small nodules counted. The average number of nodules in each group was used for the statistical evaluation shown in Table 12. Meaningful comparisons between cultivars could not be made due to the high variability of the experimental data, however, it was evident that the free-nodulating cultivars also show profuse nodulation with *Rhizobium japonicum* and that the number of small nodules is always greater than the number of large ones.

Table 12. Average of Small and Large Nodules Per Plant of Free-Nodulating Cultivars Planted in Inoculated Soil at the Isabela Research Sub-station

Cultivars		No. of nodules per plant	
		Small	Large
Foster (check)		29.2	4.4
Jupiter (check)		28.5	9.4
Davis (check)		28.6	5.9
M-90		43.4	12.3
TGx 330-054D		73.4	10.1
TGx 442-01C		21.7	5.0
Malayan		62.9	35.9
TGx-306-035D		38.1	12.3
TGx-306-036C		29.2	11.2
TGx-322-019D		32.0	5.0
Hernon		36.3	9.5
	Mean	38.5	11.0
	C.V (%)	53.0	81.0
	L.S.D.0.05	29.0	13.0

Germplasm Hybridization and Generation Advances. First generation crosses to generate F1 plants were planted in the winter and summer planting seasons. During the first of these seasons a total 26 F1 crosses were planted and 34 new cross combinations were produced in 14 parental genotypes. The winter season was also used to advance 64 hybrid populations from the F2 to the F3 generation and 26 hybrid populations from the F3 to the F4 generaton. Materials harvested from this latter generation (F4) were split into early and late maturing groups from planting in the summer season. Breeding materials advanced during the winter season were again planted during the summer for further generation advance in some crosses and for individual plant selection in others. Thus, during the summer season the field planting of breeding materials included 34 F1 crosses, 26 F2 populations, 84 F3 populations and 33 F4 populations. About 750 single plant selections were harvested in 27 of the 33 F4 populations to plant F5 rows in 1984. The single pod descent method was used to advance generations from F2 to F4 and single plants were used to advance the F4 to F5. All seeds were stored in the cold room at Isabela for transfer to Colombia in February 1984. Breeding materials generated in the crossing program contain genes for insect resistance in some cases, seed quality traits in others, and tropical adaptation in others.

Evaluation of Breeding Lines. A group of 99 breeding lines in the F6 generation developed at Isabela by hybridization were tested for yield performance and other agronomic traits. The lines were distributed in three tests having 33 lines and three cultivar checks each. The experimental design was a complete randomized design with three-row plots four meters long and three replications. Heavy rainfall soon after planting caused poor and uneven plant stand in most plots rendering the yield comparisons unreliable. Yield figures, therefore, were not analyzed in this experiment. Other agronomic observations indicated a large amount of viability for plant height, plant architecture, maturity and lodging in these lines. Crosses that generated these lines were made with the purpose of combining improved traits of U.S. varieties with tropical adaptation of exotic germplasm. The lines will be planted in single new plots in Colombia and other cooperating countries in 1984 for further selection and evaluation in different environments. Some of these lines will be tested in the new or modified SIEVE experiment to be initiated in 1984. Table 13 shows the parentage and number of lines tested in each cross.

Table 13. Parentage and Number of Breeding Lines Evaluated at the Isabela Research Substation in 1983

Cross No.	Parentage	No. of Lines
PR 88	Santa Maria x Buffalo	1
PR 89	Imp. Pelican x Buffalo	3
PR 90	P18 x Jupiter	3
PR 91	V 8 x PI341256	2
PR 92	Davis x Alamo	6
PR 95	Santa Maria x Bragg	3
PR 97	Santa Maria x Cobb	4
PR 98	(HLS x PI324068) x (Buffalo x Jupiter)	4
PR 99	Santa Maria x Alamo	4
PR 100	Ottotan x Bossier	2
PR 103	Ottotan x Alamo	1
PR 104	Ottotan x 71-38	1
PR-106	Unknown x UPL-Sy-2	2
PR 107	Impala x Acc 2120	2
PR 111	Davis x 71-38	3
PR 112	Impala x Jupiter	3
PR 113	Williams x Ecuador	2
PR 114	Impala x GH-19-3-2(1)	4
PR 115	Tunia x UFV-1(BP-2)	4
PR 117	Davis x Ecuador 1	1
PR 118	Williams x Tulumayo	4
PR 119	Williams x 71-38	3
PR 121	Rillito x Tulumayo	3
PR 122	Bossier x Tulumayo	8
PR 125	ACC 2120 x Jupiter	2
PR 128	Tunia x Jupiter	2
PR 133	Davis x Tulumayo	4
PR 134	Tunia x Tulumayo	7

Table 13. (Cont'd)

PR 135	Rillito	x Jupiter	3
PR 136	Tunia	x Acc 2120	3
PR 137	Davis	x SIATSA 194	4
PR 138	Rillito	x Ecuador 1	1
Total			99

Seed Increases for International Trials. Seed increases were produced during the winter for the 1983 SPOT and during the summer for the 1984 ISVEX. About 10 kilograms of seeds were produced for each of the 21 cultivars of SPOT and between 30 and 100 kilograms for each of the ISVEX cultivars. All increased seed was shipped to Urbana, Illinois for packing and distribution to cooperating plant breeders in various countries of the world.

RESEARCH RESULTS: *IMPROVED RHIZOBIUM JAPONICUM TECHNOLOGY FOR THE TROPICS*

W. C. Stearn

Serological Assay of Soybean Nodules from Plots Previously Inoculated with Commercial Inoculant. The purpose of this experiment was to ascertain the influence of cultivar on the population and distribution of the *R. japonicum* introduced into the soil in previous experiments utilizing a 4 strain commercial inoculant (see INTSOY Annual Report for 1981).

Sixteen soybean varieties (an INTSOY ISVEX "A" Trial) at two liming levels (native pH approximately 4.7. and enough lime to neutralize the aluminum giving a final pH of approximately 6.5), was planted at the Corozal Experiment Station, Corozal, Puerto Rico. Each variety was replicated twice with normal fertility (P, K and Mg) and herbicide practices utilized. This experiment was started in 1981 and repeated again in 1982. See the 1982 INTSOY Annual Report for additional details.

The initial serology done on nodules collected in 1979 from Lee and Davis varieties showed approximately 85% of the nodules were formed by one of the 4 introduced commerical strains (61A101).

The results of the serological data for the ISVEX 16 variety trial done in 1981 showed a definite shift in distribution of organisms forming the sampled nodules. This same trend was also observed in the 1982 data.

Analysis of variance of cultivar, lime, organism, replications and year indicated significant differences within organism and between cultivar and organisms for both years. A summary of the statistically significant data for each year as pooled means is presented in Tables 14, 15, and 16.

Table 14. Summary of R. japonicum Strain Distribution from Serology Conducted on Nodules Collected at the Corozal Experimental Station in 1981 and 1982.

R. japonicum strain	1981	1982	1981 & 1982
61A101	48.19a*	43.28a**	45.59a*
61A124	31.97b	24.14b	28.05a
61A148	9.69c	8.67c	9.18b
61A118	5.10c	6.88c	5.98b
unknown	5.30c	17.03b	11.02b

*Results of Duncan's Multiple Range Test at 1%.
**Results of Duncan's Multiple Range Test at 5%.
Means with the same letter (within year), are statistically not different.

Table 15. Serological Results for R. japonicum Strain 61A101 Conducted on Nodules Collected in 1981 and 1982 from 16 Varieties of Soybean Grown on Plots Inoculated in 1978 with a 4 Strain Commercial Inoculant.

	Mean percent nodules formed by *R. japonicum* strain 61A101.		
Variety	1981	1982	1981 & 1982
IGH-23	80.00a*	50.00abc*	65.00a**
Williams	73.75ab	52.50ab	60.63ab
UFV-1	57.50abc	62.50a	60.00ab
Alamo	35.00cdef	61.25ab	58.13ab
Jupiter	65.00abc	50.00abc	57.50ab
UFV-1(BP-2)	60.00abc	55.00ab	57.50ab
IGH-24	68.50abc	46.25abc	56.88ab
Bossier	57.50abc	43.75abc	50.63ab
Ecuador-2	51.25abc	50.00abc	50.63ab
Tunia	53.75abc	43.75abc	48.75ab
Foster	40.00bcde	52.50ab	46.25ab
Davis	35.00cdef	48.75abc	41.88b
Caribe	47.50abcd	32.50abc	40.00bc
ACC-2120	13.75def	26.25abc	20.00cd
Imp. Pelican	3.75f	13.75bc	8.75d
SJ-2	10.00ef	3.75c	6.88d

*Results of Duncan's Multiple Range Test at 1%.
**Results of Duncan's Multiple Range Test at 5%.
Means with the same letter (within year), are statistically not different.

Table 16. Serological Results for R. japonicum Strain 61A124 Conducted on Nodules Collected in 1981 and 1982 from 16 Varieties of Soybean Grown on Pilots Inoculated in 1978 with a 4 Strain Commerical Inoculant.

	Mean percent nodules formed by *R. japonicum* strain 61A124.		
Glycine max Variety	1981	1982	1981 & 1982
Imp. Pelican	82.50a*	51.25a**	66.88a**
SJ-2	66.25ab	27.50ab	46.88ab
ACC 2120	50.00abc	36.25ab	43.13bc
Caribe	31.25bc	35.00ab	33.13bcd
Davis	35.00abc	23.75ab	29.38bcd
Bossier	31.25bc	25.00ab	28.13bcd
Tunia	21.25bc	31.25ab	26.25bcd
IGH-24	21.50bc	30.00ab	25.63bcd
Foster	28.75bc	16.25b	22.50bcd
Alamo	25.00bc	18.75ab	21.88cd
Jupiter	20.00bc	21.25ab	20.63cd
UFV-1(BP-2)	23.75bc	16.25b	20.00cd

Table 16. (Cont'd)

Glycine max Variety	Mean percent nodules formed by R. japonicum strain 61A124. 1981	1982	1981 & 1982
Ecuador-2	23.75bc	11.25b	17.50d
UFV-1	22.50bc	10.00b	16.25d
Williams	21.25bc	10.00b	15.63d
IGH-23	7.50c	22.50ab	15.00d

*Results of Duncan's Multiple Range Test at 1%.
**Results of Duncan's Multiple Range Test at 5%.
Means with the same letter (within year), are statistically not different.

In 1982 there was a drop in the percent number of nodules identified as being formed by 61A101, 61A118 and 61A124 as compared to the 1981 data (see Table 14). This can be attributed, in part, to the 321% increase in number of nodules that could not be typed.

The pooled data still shows the trends that were first observed in 1981 indicating the same trend towards host strain specificity for individual cultivars. This information could be used to recommend a specific *R. japonicum* strain when a particular cultivar is selected for growth.

This research has raised additional questions e.g. in a field with a highly competitive indigenous population of *R. japonicum*, can we expect the introduced strain of *R. japonicum* to be more competitive and consequently form more nodules due to the presence of an optimized host cultivar? We hope to continue this line of investigation.

***Rhizobium japonicum* Longevity Study on Acid, High Aluminum Corozal Soil.** A longevity trial was started at the Corozal Experimental Station in 1980 utilizing variety Jupiter with 8 individual strains or a combination of all the strains. Each organism was replicated 4 times at 2 levels of lime (0 and 1800 kg/ha). See the INTSOY Annual Report for 1981 and 1982 for additional details.

This experiment was not repeated in 1983. Serology was not started on the collected nodules until April due to lack of antiserum. Approximately 1/4 of the nodules have been typed. The remaining nodules will be typed as soon as possible.

Continued Greenhouse Studies on the Interaction of Strains of *R. japonicum* in Combination with Various Types of *Azotobacter* spp. and Effect on Growth and Nodulation of Soybean. Greenhouse studies of the interaction between *Rhizobium* spp. and *Azotobacter* spp. were initiated in 1981 and continued in 1982. The results were very encouraging (see INTSOY Annual Reports for 1981 and 1982).

Experiments were designed to look at additional interactions during 1983 but were unable to be conducted due to the failure of the evaporative

cooling system in the greenhouse. Temperatures, during the daytime, were unsuitable for vigorous soybean growth. Presently, we are planning to continue this work at AVRDC when greenhouse space becomes available.

Control of Moisture Loss from Granular Peat. Initial high temperature studies (70° C.) utilizing mineral oil and glycerol to control moisture loss in peat inoculant have been completed.

The results indicate that utilizing mineral oil at approximately 2% (v/w) provided a definite improvement in moisture retention in peat.

Long term experiments were designed to look at the long term effect on the population of introduced *Rhizobium* strains with and without mineral oil but were discontinued due to the impending move from Puerto Rico to AVRDC in Taiwan. These studies will be continued as soon as adequate incubators are available.

Isolation of *R. japonicum* Strains from Nodules Collected in Vietnam. *Rhizobium* strains were isolated from nodules collected in Vietnam as previously described in the INTSOY Annual Report in 1982.

Greenhouse studies were planned utilizing several cultivars of *Glycine max* in conjunction with the isolated strains of *R. japonicum* but were unable to be conducted due to the previously mentioned fact that the evaporative cooling apparatus in the greenhouse had failed and there was no other greenhouse space available.

Presently, several strains have been sent to North Carolina State University for additional biochemical testing. Pouch studies will be conducted here at AVRDC looking at cultivar strain interactions.

Nodule Evaluation of Previous ISVEX Trials (NEPIT). Several NEPIT Trials had been sent out in 1981/1982 as described in the INTSOY Annual Report for 1982. Only one trial has been returned so far and that was from AVRDC in Taiwan. Serology was conducted on the nodules returned and the data is presently being analyzed.

Relocation of INTSOY Soil Microbiology to the Asian Vegetable Research and Development Center (AVRDC) in Taiwan. In July, INTSOY made the decision to move the Soil Microbiology portion of its program from the University of Puerto Rico, Mayaguez Campus to the Asian Vegetable Research and Development Center (AVRDC) in Tainan, Taiwan.

Overall, the move is seen to position INTSOY in the mainstream of soybean activities in the Far East. Being associated with AVRDC will allow INTSOY to quickly come into contact with the various organizations and institutions associated with AVRDC and therefore have a more immediate impact on soybean activities in the region. The following research objectives for Soil Microbiology are seen to serve both the INTSOY and AVRDC programs for soybeans in this region.

1. Determine the feasibility of utilizing alternate methods of *Rhizobium* inoculant production and alternate carriers. Determine the optimum conditions for inoculant transportation and storage.

2. Determine the feasibility of utilizing free-living dinitrogen fixing organisms in association with tropical vegetable varieties to reduce or eliminate the need for inorganic nitrogen fertilizers.

3. Ascertain the susceptibility of tropical varieties of soybean to infection by VA Mycorrhizae (VAM) and determine the potential of utilizing VAM as a co-inoculant to reduce inorganic phosphorus fertilizer inputs. (This objective was also meant to identify those VAM susceptible cultivars that could be used in the INTSOY/AVRDC soybean breeding program to develop lines for minimum input and low fertility production of soybean).

4. Analyze the survival patterns of *Rhizobium* strains in flooded rice/legume (soybean) rotations and ascertain the need and most effective methodology of inoculant introduction.

Other areas that Soil Microbiology has been asked for inputs:

a. Design a composting component for the Garden Extension Program that is now being utilized in Thailand and Indonesia.

b. To initiate the participation and coordination of AVRDC in the International Benchmark Sites Network for Agrotechnology Transfer (IBSNAT) program.

c. Provide *Rhizopus* spp. cultures for the Nutritional Environmental and Management division for studies of the potential of soybean tempeh production in Taiwan.

Overall, the move from the University of Puerto Rico to AVRDC is seen as a very positive step in making INTSOY Soil Microbiology a more effective program in aiding LDC's with their national programs.

RESEARCH RESULTS: *IMPROVED DISEASE AND INSECT CONTROL: VIRUSES*

Jacqueline Fletcher, Jane E. Polston

Screening of Topical Soybean Germplasm Lines for Resistance to SMV. In the spring of 1983, we received seed for four advanced soybean lines selected by Dr. Luis Camacho from primary yield trials done in INTSOY plots in Puerto Rico. These four lines were in the F6 generation and were derived from the cross HLS x PI 324.068. Each line, therefore, has genes for resistance to SMV. We screened the lines to determine the extent of the resistance.

SMV strains G2 and G7 were chosen because HLS has resistance to G4,5,6, and 7, while P.I. 324.068 contains resistance to G1,2,3,4,5 and 6. For each of the four soybean lines, three reps of 30 plants each were planted and inoculated with G2. This was repeated for G7. For each virus strain there were 30 uninoculated controls of each soybean test line, and 30 plants of Williams were inoculated as a positive control. All of the G2 tests were carried out in the greenhouse at the same time, and the G7 tests were done about 3 weeks later in the same greenhouse. The plants were very tall and spindly compared to Williams. Inoculations were done with an airbrush at 80 lbs/in^2. Ten days after inoculation the youngest fully expanded trifoliolate was collected from each plant and was frozen for later analysis by ELISA. The 10 day period should have been long enough for infection to develop, but not long enough for secondary spread to have occurred in the greenhouse. As time allowed, batches of leaves were thawed and tested individually by ELISA. Results are summarized in Table 17.

It appears that lines 103 and 108 carry considerable resistance to strain G2 and are resistant to a lesser degree to G7. Line 112 is almost as susceptible as Williams (there is probably no statistical difference). Line 110 has some resistance to both G2 and G7, but not as much as lines 103 and 108. The different % infections may reflect segregating populations, since selection for SMV resistance was not previously done.

Influence of Different Isolates of SMV on Seed Transmission. Earlier investigation by INTSOY virologists revealed the influence of different temperate and tropical soybean cultivars on the rate of seed transmission of SMV and the existence of cultivars with very low rates of seed transmission. We wanted to determine if the rate of seed transmission was also dependent upon the isolate of SMV. This knowledge would be very useful to plant breeders selecting for low seed transmitting cultivars.

The experiment was conducted at the Estacion Experimental Agricola, Subestacion de Isabela, Isabela, Puerto Rico (18°N). The treatments were laid out in the field as split plots with main plots arranged in a randomized complete block design. Each main plot consisted of 8 soybean accessions randomized within each of four blocks. Each subplot consisted of seven 2 meter rows, each inoculated with a different virus isolate and randomized within the subplot.

The soybean (*Glycine max* (L.) Merr.) germplasm accessions tested were

from maturity groups VIII, IX and X. These included six entries (PI 86736 (Arisoy), PI 203406, PI 325779, PI 341256 Improved Pelican and UFV-1) chosen for their relatively low incidence of seed transmission, and PI 340901 and Jupiter, chosen for their relatively high incidence of seed transmission, based on previous inoculations with SMV, strain G2 (isolates NG2 and IL-severe).

One representative isolate of each strain was chosen from a collection of isolates previously identified to strain. The identities of the isolates were: isolate 019-2 (of strain G1), isolate 60 (strain G2), isolate 83-2 (G3), isolate K 12 (G4), isolate 32-2 (G5), isolate U427 (G6) and isolate U670 (G7). The identity of each isolate was determined by repeated inoculation to sets of differentials, while the inoculum was being produced in Urbana.

Seedlings were thinned to 20-25 plants/m on 2 February, 1981, approximately 29 days after planting and approximately 1-2 weeks before flowering. Young trifoliate leaves of each plant were inoculated using an artist's air brush (Wren #2, Binks Manufacturing Co., Franklin Park, IL), operated at 75 lbs/in^2. Inoculations were done during three days: strains 1,2, and 4 on 3 February, strains 3,5, and 6 on 4 February and strain 7 on 5 February. Inoculum was prepared in ice-chilled glassware immediately before inoculation: SMV-infected 'Williams' soybean leaves were harvested in 14-21 days after inoculation in Illinois, chilled and transported to Puerto Rico on ice, and homogenized in 50 mM sodium phosphate, ph 7.0 (5 ml buffer/g of fresh tissue). The mixture was strained through two layers of cheesecloth and a layer of Miracloth, and 22 m Carborundum (600 mesh) was added at 1.5 g/l. Inoculation success was determined 38 days later (15-22 March 1981) by the appearance of typical SMV symptoms and by enzyme linked immunosorbent assay (ELISA). All plants judged to be uninfected were removed. Leaf samples from randomly chosen plots were collected and assayed for any cross contamination by other strains.

Seed transmission rates were determined by planting 500 seeds (or as many as could be harvested) from each lot in greenhouse sandbenches in Urbana, and counting the number of infected seedlings. Seedling infection was confirmed by ELISA.

An anlysis of variance of the results indicates a highly signficiant interaction of virus isolate and cultivar on the rate of seed transmission (Table 18). A plot analysis of the residual sum of squares of the seed transmission rates for each cultivar over all isolates and for each isolate over all cultivars show a random distribution, adding confidence to the conclusion that the rate of seed transmission is dependent on the isolate of SMV.

The range in seed transmission rates among the isolates varied from 0 to 13.8% with a range of treatment means from 0 to 6.8%. Since there is a significant cultivar-isolate interaction, no valid statistical comparison of different isolates can be made. However, an examination of Figure 1 shows that isolate U670 was the least readily seed transmitted isolate. Isolates 019-2, 60 and U427 were much more frequently seed transmitted. It cannot be determined from these data whether the differences among the isolates reflect a difference in seed transmissibility among strains. Further studies

Figure 1. The mean percent seed transmission of each isolate on eight soybean accessions. Accessions are abbreviated as follows. A = Arisoy, B = Improved Pelican, C = Jupiter, D = PI 203406, E = PI 325779, F = PI 340901, G = PI 341256, and H = UFV-1

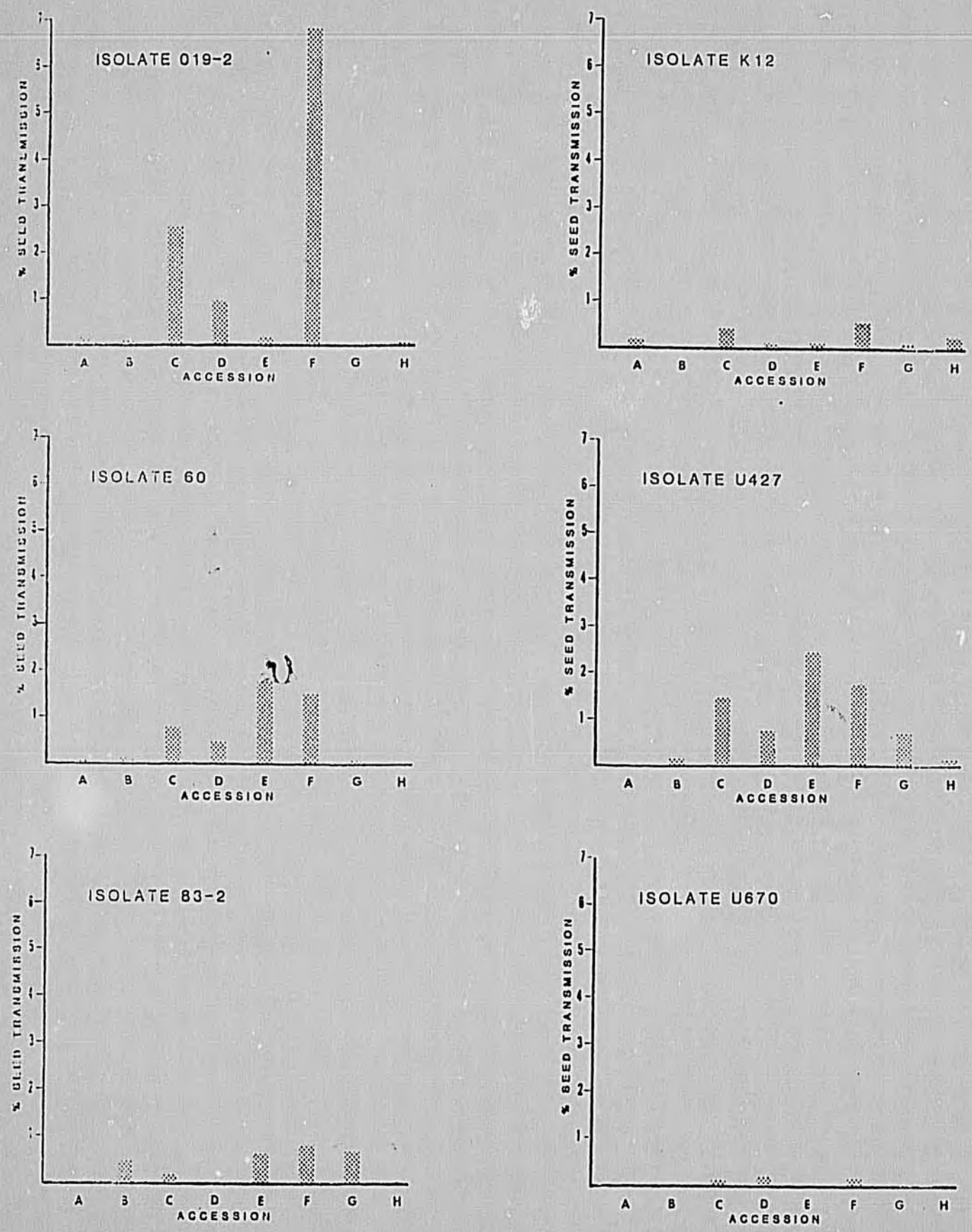


Table 17. Infection of Tropical Soybean Lines to SMV Strains G2 and G7

Soybean Line	Non-inoculated #infected/#germinated		Inoculated #infected/#germinated		Non-inoculated #infected/#germinated		Inoculated #infected/#germinated	
112	0/21	(0)*	51/60	(85)	0/29	(0)	73/84	(86.9)
108	0/24	(0)	1/78	(1.4)	0/29	(0)	14/90	(15.6)
103	0/26	(0)	2/70	(2.8)	0/29	(0)	25/86	(29.1)
110	0/22	(0)	23/61	(37.7)	0/29	(0)	51/84	(60.7)
Williams	0/17	(0)	55/62	(88.7)	0/28	(0)	68/77	(88.3)

* ( ) indicates % infected

Table 18. The Analysis of Variance of the Percent Seed Transmission Six SMV Strains and Eight Cultivars

Source of Variation	DF	MS	F	PR>F
Total	191			
Main plots	31			
Blocks	3	0.8048	1.30	0.3010
Accessions	7	9.7391	15.72	0.0001
Error A	21	186.2521		
Subplots	160			
Strains	5	7.4223	8.27	.0001
Strains x Accession	25	3.6861	4 11	.0001
Error B	120	0.8975	r^2=.6727	cv=158.2709

must be conducted to determine if seed transmissibility is independent of or dependent of strain, and how variable the characteristic is. Such knowledge would be useful to plant breeders developing resistant cultivars to SMV as well as to investigators studying the seed transmission of viruses.

A range in responses among soybean accessions also was observed, but with unexpected results. As with the isolates, statistical comparisons cannot be made among the accessions due to the signficiant interaction of isolate and accession, but trends can be noted from Figure 1. The two accessions with the overall lowest rates of seed tranmission are Arisoy (maximum rate of .5%, highest mean rate of .15%) and UFV-1 (maximum rate of .9%, highest mean rate of .23%). Unexpectedly, Jupiter and PI 340901, chosen for their high rates of seed transmission based on results with isolate NG2 (strain G2) in previous experiments, had much lower rates in this experiment with the isolate 60 (strain G2). Jupiter had a mean rate of 2-3% with isolate NG2, but less than 1% with isolate 60 and PI 340901 had an average rate of 10% with isolate NG2, but only a rate of 1.5% with isolate 60. Further investigations are needed to determine whether these differences are due to the effects of environment or to the existence of differences in seed transmissibility among virus isolates in the same strain.

In conclusion, we have determined that the rate of transmission of SMV varies with the isolate of the virus as well as with the soybean cultivar. A significant interaction between the two factors was also observed. Rates of seed transmission were lower in some cases than expected based on previous experiments, suggesting an influence of another factor or factors on the rate of seed transmission. A follow-up investigation is needed to determine whether the variability among isolates is due to differences among strains or is independent of strain. Two accessions, Arisoy and UFV-1, gave the lowest rates of seed transmission over all isolates tested and may prove

useful to plant breeders developing low seed transmitting lines of soybean. Continued testing with more isolates would give a more accurate picture of their usefulness in this respect.

Influence of Mixed Strain Infection on Seed Transmission of SMV. The primary mode of transmission of SMV is through seed, as documented by previous INTSOY virology programs, although the virus is also nonpersistently transmitted by aphids. In 1979, Cho and Goodman classified 98 isolates of SMV from seeds in the USDA soybean germplasm collection into 7 strains (G1-G7) based on disease reactions in soybean cultivars to these strains. Several years later, Xu, Polston, and Goodman identified several additional strains of SMV from the People's Republic of China. These were more virulent than G1-G7, and produced different reaction patterns on the differential soybean lines than did the seven classified strains.

Recent evidence suggests that even the 7 characterized strains (G1-G7) may possess unstable virulence characteristics when they are transmitted through seeds. Virus isolates recovered from seedlings of parents which were inoculated with a particular strain may not match the differential host reactions of the inoculated strain. Implications of this instability may be significant in breeding programs.

In our experiments, SMV strains G2 and G4 were used to inoculate temperate soybean cultivar Midwest (reported to transmit SMV through seed at a rate of 21.7%). Twenty plants were inoculated with G2, twenty with G4, and twenty with both G2 and G4 (G2 was inoculated onto the youngest trifoliolate, G4 onto the next youngest). Test plants were kept in a greenhouse with supplemental fluorescent lights at 70-80° until they flowered, set seeds, and reached seed maturity (about 11 weeks after inoculation). Shortly before test plants dried, leaves were collected from 4 plants of the G2 group, 4 of the G4 group, 4 of the group with G2 and G4, and 3 of the buffer controls. These samples were used to inoculate the soybean differential lines of Cho and Goodman to confirm the identity of the virus strains. Results of these inoculations showed that each plant tested was infected only with the strain(s) with which it had been inoculated. Buffer-inoculated plants showed no symptoms on differential lines. Seeds from test plants were collected and dried, then planted in sand benches in the greenhouse. Five days later, the primary leaf from each plant was collected from each of the seedlings shown by ELISA to be infected with SMV. This tissue was used to inoculate sets of differential soybean lines to identify the strain(s) of SMV in the seedlings.

Results of the tests are summarized in Table 19. When a virus free soybean seedling CV, 'Midwest' was inoculated with SMV strain G2 or G4, or a combination of the two, these strains could be re-identified as the plant reached maturity. Some of the seeds produced by these plants contained SMV, through seed transmission. However, the identity of the virus strain in the offspring seedling did not necessarily match the strain which was present in the parent plant. Similarly, some 'Midwest' plants which were found to be previously infected with SMV, from their seeds (not inoculated), also produced seeds carrying a different SMV strain. It was not always possible to pinpoint the identity of a strain absolutely. For example, according to Cho and Goodman's scheme, if a sample causes mosaic symptoms in 'Williams' and

necrosis in 'Ogden' and 'Marshall', it could be strain G3 alone or a combination of strains G2 and G3 (see Table 20). Nonetheless, during the transmission of the virus through seeds, the expression of virulence in various soybean cultivars may apparently be altered.

Table 19. Identification of Strains of SMV for Soybean Cultivar 'Midwest' Before and After Transmission Through Seeds

	Strains of SMV[a]		
Used to inoculate virus-free parent plants	Identified in previously infected (uninoculated) parent	Identified in parent plants at plant maturity	Identified in seedlings of parent plant
G2		G2	G3 alone, or G2 and G3
G4		G4	G2 and G3 and G4
G2 and G4		G2 and G4	G3 alone, or G2 and G3
Buffer		No virus	No virus
	G2	Not done	G3 alone, or G2 and G3

[a]Identification of SMV strains was done in inoculation onto differential soybean lines (Cho and Goodman, 1979).

Table 20. Reactions of SMV Strains G2, G3, and G4 on Differential Soybean Lines of Cho and Goodman (1979).

Virus Strain	Soybean Cultivar					
	Williams	York	Ogden	Marshall	Kwanggyo	Buffalo
G2	M[a]	--	--	N	--	--
G3	M	--	N	N	--	--
G4	M	M/N	--	--	--	--

[a]Symbols for symptoms: -- = symptomless, no virus detected by assay on bean; M = mosaic, N - necrosis.

Use of SMV-Induced Male Sterility to Achieve Out-Crossing in Self-Pollinating Soybeans. The objective of this project is to develop the use of virus-induced male sterility for breeding self-pollinating crops such as soybeans. Results of this project could conceivably lead to the first practical method for commerical production of hybrid seed of soybeans and other self-pollinating crop species. Methods which increase the frequency of natural outcrossing or facilitate large numbers of artificial crosses for self-pollinated plants have long been sought by plant breeders and geneticists. Plant breeding would be advanced by such a convenient and readily restorable method for inducing male sterility. This methods would be very

useful because of the importance of self-pollinating crops, such as wheat, soybeans, and rice, in world agriculture.

There are several plant viruses which can cause male sterility in plants. However, very little study has been devoted to the mechanism of this phenomenon, and no study has been reported on the possibility of using virus-induced male sterility in genetics and plant breeding. Virus-induced male sterility would have several advantages over both genic and cytoplasmic male sterility. Fertility would be restored automatically in the next generation without the carryover of recessive sterility genes, as in genic male sterility, and fertility would not require the incorporation of restorer genes as with cytoplasmic sterility. In principle, its effects would be similar to cytoplasmic male sterility, which has not been found in soybeans. Possible disadvantages of the use of viruses for this purpose, such as transmission of the virus via insects and seeds, can be circumvented.

Previous research by INTSOY virologists indicated that certain isolates of SMV caused partial or complete male sterility in inoculated soybeans. We designed two preliminary experiments based on those data to determine the potential of using SMV-induced males sterility as a tool in soybean breeding.

The first experiment was designed to determine which, if any, of 20 randomly selected SMV isolates, including at least one isolate from each SMV group G1 through G7, could induce complete male sterility when inoculated to 'Williams' soybeans. SMV has previously been shown to induce some male sterility in 'Williams', a widely grown Group III soybean cultivar which is also used as a parent in many breeding programs.

'Cumberland' soybeans were planted in June 1982 on the Plant Pathology Farm near Urbana, IL. The field was conventionally tilled and seeds were machine planted in 30-inch rows. Seeds of 'Williams' were hand planted in 3-foot sections within the 'Cumberland' rows. After germination the 'Cumberland' seedlings were removed from the 3-foot sections. The cultivar 'Cumberland' has purple hypocotyls and purple flowers which are dominant traits, easily distinguished from the white hypocotyls and white flowers of 'Williams', which are recessive traits. We designed the experiment as a two-factor factorial to test the effect of time of inoculation and the effect of different isolates on the degree of male sterility. The experimental design used was a randomized complete block with three replications. Each three-row plot consisted of one row of 'Williams' bordered on each side by a row of 'Cumberland'. Each block was adequately separated to minimize interplot inference according to published reports.

The plots were inoculated 10 days (July 5) or 31 days after planting (July 26), using an artist's airbrush. One week after inoculation all uninfected plants, based on symptomatology, were removed from the inoculated plots.

At harvest 10 plants were randomly selected from each row of 'Williams' and the total number of pods, and number of seeds per pod were recorded. Other data taken on the entire 3-foot row included total yield, 100 seed weight, percent moisture, and percent and degree of seed coat mottling.

One hundred seeds from each plot were planted in a greenhouse sandbench during the winter of 1983. The germination, percent SMV seed transmission, and degree of outcrossing were recorded. The extent of outcrossing was determined by noting the percent of purple hypocotyl color in seed from 'Williams' plants since this reflected the frequency of fertilization by 'Cumberland' pollen and therefore, the frequency of male sterility.

The data were analyzed using analysis of variance, and the Waller-Duncan k-ration t test. The rates of outcrossing ranged from 0 to 17.7%, but the treatment means only ranged from 0 to 6% (Table 21). Statistical analysis indicated that these differences were not significant. The rates of outcrossing were very low and were widely distributed among the treatments. The previous experiments, which had indicated that SMV was causing male sterility, had used isolate 60 (treatment 3). Based on data from those experiments we had expected to see higher rates of outcrossing. These results could have been due to the unusually wet weather which occured during part of the experiment, the chance that the particular isolates chosen do not cause very much male sterility, and/or to the unanticipated technical problems which arose during the experiment.

Table 21. The Degree of Outcrossing in 'Williams' Soybeans, Inoculated with Each of 20 Isolates of SMV 10 Days after Planting

Treatment	Isolate	Percent Outcrossing			
		Block 1	Block 2	Block 3	Mean
1.	u670	0.0	0.0	17.2	5.9
2.	83-2	0.0	0.0	0.0	0.0
3.	60	0.0	0.0	3.7	1.2
4.	016-1	0.0	0.0	0.0	0.0
5.	u427	0.0	0.0	0.0	0.0
6.	ATCC pv-94	0.0	0.0	0.0	0.0
7.	017-2	0.0	0.0	0.0	0.0
8.	32-2	0.0	0.0	0.0	0.0
9.	IL-S	0.0	0.0	0.0	0.0
10.	u427	0.0	0.0	0.0	0.0
11.	83-2	0.0	0.0	0.0	0.0
12.	016-6	1.1	0.0	0.0	0.4
13.	K12	0.0	0.0	0.0	0.0
14.	S14-3	0.0	4.2	0.0	1.4
15.	019-2	0.0	0.0	0.0	0.0
16.	u613	0.0	0.0	0.0	0.0
17.	G8	0.0	0.0	0.0	0.0
18.	32-2	0.0	0.0	0.0	0.0
19.	u620III	0.0	1.1	0.0	0.4
20.	u670	1.2	0.0	0.0	0.4
21.	non-inoc.	0.0	0.0	0.0	0.0

We designed a second experiment to confirm our previous reports that the SMV isolate IL-S induced male sterility in 'Williams' soybeans. 'Cumberland' soybean seeds were planted as described for the first experiment. 'Williams' soybean seeds were hand-planted in 10-foot sections within the

'Cumberland' rows. As in the first experiment, the seedlings with purple hypocotyls ('Cumberland') were removed from these 10-foot sections. The experiment was planted in a completely randomized design with three treatments and 20 replications, with each treatment adequately separated to minimize interplot interference. The three treatments were as follows:

(1) Noninoculated 'Williams' ms-2, a genic male-sterile variety. This was included to determine the natural rate of outcrossing in the field.

(2) 'Williams' inoculated with SMV, isolate IL-S. This was used to determine the rate of outcrossing due to virus-induced male sterility. Seedlings were inoculated 10 days after planting with an artist's airbrush. After 1 week all uninfected plants were removed from the inoculated sections.

(3) Noninoculated 'Williams', included as a control to determine the rates of outcrossing which normally occur.

Data on yield were taken to compare with that from our previous experiments on the effect of SMV on yield loss, where virus-induced male sterility was first studied. During the winter of 1983, 100 seeds from each plot were planted in greenhouse sandbenches. The degree of outcrossing, as indicated by the percentage of plants with purple hypocotyl color, the percent seed transmission, percent germination, percent mottling, 100 seed weight and yield were recorded.

A low percent of outcrossing was observed in the virus-infected 'Williams', with a mean of 1.56% and a range from 0 to 20% (Table 22). This percent was much lower than that observed in the genic male sterile treatment, and slightly higher than that for the control.

Though the difference between the virus infected treatment and the noninoculated treatment is not statistically significant, we still feel that the higher percent of outcrossing in the virus infected plants indicates that the infection is inducing some male sterility. The lack of significance is due in part to excessive variability among the replications which could be reduced in the future by larger plot size. We also feel that the percent outcrossing of the virus infected treatment does not accurately reflect the percent of male sterile flowers. We conclude this because the yield of genic male sterile plants was very low indicating that most of the flowers were not fertilized. This same lack of pollination probably occured with the male sterile flowers in the virus infected plants, subsequently biasing the outcrossing results. To get more accurate data, some mechanism for dissiminating pollination should be included when this experiment is repeated.

Significant differences were observed among the treatments with respect to rate of germination, rate of mottling, yield and 100 seed weight. Virus-infected plants produced the smallest seed with the lowest mean rate of germination and the highest mean rate of mottling. These undesirable characteristics of the isolate could be easily selected against, producing an isolate more suited to the needs of plant breeders.

In conclusion, the fact that one isolate resulted in an outcrossing rate of 17.7%, that virus-infected plants had higher rates of outcrossing than

Table 22. The Mean Yield, 100 Seed Weight, and Rates of Outcrossing, Germination, Mottling and Seed Transmission of SMV for Genic Male Sterile 'Williams' and SMV Infected 'Williams'

Treatment	Percent Outcrossing	Percent Germination	Percent Mottling	Yield	100 Seed Weight
Genic Male Sterile	32.68%b[1]	80.35 a	68.95 a	14.50 a	24.94 a
Virus-infected	1.56% a	61.65 B	97.10 b	143.85 b	13.80 b
Non-inoculated, male fertile control	0.28% b	92.20 c	14.20 c	733.89 c	19.02 c

1. Different letters indicate significant differences at .05 level.

non-inoculated plants, that we see some obvious improvements which should be made in the experiments, plus our observations on the effect of SMV on flowering and pod-fill lead us to believe that these are still important investigations which should definitely be repeated. We strongly suspect that should these experiments be repeated, they would generate more conclusive results and would yield some valuable data.

Machismo Disease of Soybeans. The 1982 INTSOY annual report described work initiated on a disease of soybeans called machismo. First reported in the Cauca Valley of Colombia in 1968, the disease became devastating to soybean production in that country by 1979. In 1982, J. Fletcher and M. E. Irwin collected diseased soybean plants (Cv. UFV-1) from the Rosaria Izita substation of the INIA Tapachula Experiment Station. These plants displayed symptoms characteristic of machismo, including delayed maturity, proliferation of branches at lateral nodes, phyllody of flowers, germination of immature beans within pods, and upturned pods. These plants, and others known to be machismo diseased from Colombia, were brought back to UIUC under quarantine regulations.

Tissue sectioning for Dienes' staining (specific for the presence of mycoplasma-like organisms in diseased tissue) gave positive results in diseased plants from both countries. Electron microscopy, done by Dr. O. E. Bradfute of the Ohio Agricultural Research and Development Center, revealed many mycoplasma-like organisms in sieve elements of similarly diseased samples from Mexico and Colombia. Numerous leafhoppers were found in affected Mexican fields. Of these, approximately half were identified as *Scaphytopius fuliginosus*, known vector of the machismo disease agent.

Quarantine restrictions prohibited our use of insect vectors to transmit the disease in the United States. Attempts were made to transmit the pathogen to young soybean plants by grafting and by dodder, but these efforts were unsuccessful due to the age of the source plants. Attempts to determine seed transmissibility of the pathogen also failed as none of the seeds from source plants were viable.

In Colombia, cooperator G. A. Gustavo exposed plants of the Mexican cultivar (UFV-1) and a Colombian cultivar to *S. fuliginosus* carrying the machismo agent. Symptoms in the two cultivars were the same, and both cultivars were judged to be equally susceptible.

Based on symptomatology, positive Dienes' staining, electron microscopic evidence of MLO's in diseased tissue, and the presence of many vector leafhoppers in diseased Mexican fields, we believe there is strong evidence that machismo disease is present in Mexico. Thus, the disease is more widespread than previously thought. Soybean "witches' brooming" in several other countries, especially in Asia, the Pacific, and Africa, may also be caused by the same agent. Answers to questions of identify and relatedness must wait until these fastidious microorganisms can be cultured in artifical medium or otherwise positively identified.

A manuscript detailing this work is in preparation.

Development and Testing of New Methods for Sensitive Detection of Whitefly-Borne Geminiviruses. In 1982, we reported here the use of a new approach to the sensitive and definitive diagnosis of whitefly-transmitted disease agents belonging to the recently described geminiviruses. Very pure, radio-actively labelled genes of just one member of the geminivirus group, bean golden mosaic virus (BGMV), were used to detect genes of other related geminiviruses from only a few grams of infected dried tissue. The new method could not only detect the presence of genes of related geminiviruses, but also enabled a precise diagnosis of the specific strain of geminivirus infecting the plant tissue. This was possible because the material of the replicating form (RF) of the geminivirus genes, DNA, can be cut in precise locations with so-called restriction enzymes, generating a characteristic array of fragments. These arrays of fragments, specific for each distinct geminivirus strain, were termed "fingerprints" because of their reliable use in precisely diagnosing which geminivirus was infecting the plant.

The considerable power of this diagnostic approach of "viral gene fingerprint analysis" was demonstrated when a number of plant diseases in Puerto Rico long suspected of being related to bean golden mosaic were found to contain genes closely related to those of BGMV, but with distinct fingerprints.

While INTSOY could take satisfaction from having recognized early the value of studying BGMV and exploiting the discoveries of its novel virological properties, the new research tool had not yet directly benefited soybean research. The foresight paid off in 1983. Two INTSOY-supported researchers noticed symptoms reminiscent of known geminivirus infections in fields of soybeans near Palmira, Colombia. Earlier work in that area suggested that whiteflies were involved in transmitting the disease agent. Noting that the symptoms were of two different kinds, the researchers collected separately specimens of diseased soybeans displaying each kind of symptom and returned the frozen samples to Urbana. The fingerprint analysis of these two samples revealed that the sample with symptoms of dwarfing and yellow mosaic was likely infected not by one, but two geminiviruses; the other sample afflicted with symptoms of swollen stems and mosaic revealed no evidence of geminivirus infection, under conditions that permitted the detection of

one-trillionth of a gram of DNA related to that of BGMV. Indeed, the second disease now appears to be beetle-transmitted, while inquiries made after the analysis revealed that the first sample had actually been collected from two, albeit very nearby, plants.

While further work must clearly be done to follow up and substantiate these clues, the value of the viral gene fingerprint analysis for detecting and identifying geminivirus infections is already apparent; the whitefly-spread agents of diseases of legumes, for the most part geminiviruses, are known to be among the major constraints to increased production in the tropics. It should be noted here that the results of the analysis were available two weeks after the samples began to be processed. The infected samples went straight from their frozen state to the analysis for geminivirus gene fingerprints and never made contact with another living plant once they left the field. This aspect of the approach should be a useful feature in projects of international collaboration in crop improvement.

Purification of Rhynchosia Mosaic Virus, a Geminivirus. Work was begun in March 1982 to purify several gemini virus-like viruses which infect soybean and are found in Puerto Rico. These geminivirus-like agents are difficult to work with. They are generally not mechanically transmissible, occur naturally in weeds which contain latex and other substances which complicate working with them, are unstable at standard temperatures, and are transmitted by *Bemisia tabaci* (a tropical whitefly). Geminiviruses in general cause a yellow mosaic in infected plants, and are suspected as the cause of several soybean and many non-soybean diseases in the tropics. The purification of these agents permits the development of serological assays for detection of the viruses and also permits the comparison of the agents with those of other diseases, leading to a better understanding of these viruses and the diseases they incite.

Rhynchosia mosaic virus (RMV), suspected to be a geminivirus based on the association of doublet virus-like particles with infected plants, causes yellow mosaic and leaf curl diseases on such hosts as *Phaseolus vulgaris* (French bean) *Nicotiana tabacum* (tobacco), *Phaseolus lunatus* (mungbean), and *Glycine max* (soybean). It can be found infecting numerous wild legume species throughout Puerto Rico and probably occurs in other areas of the Caribbean. This virus may be the cause of some economically important yellow mosaic diseases reported on legumes from countries in Latin and South America.

INTSOY virologist J. E. Polston spent several months in Puerto Rico and in Illinois in 1982 manipulating the conditions of mechanical transmission until the virus could be readily transferred with high rates of infection. Large amounts of infected tissue were produced and harvested, and in early 1983 RMV was successfully purified, using a modification of the procedure for purification of bean golden mosaic virus (BGMV). Electron micrographs of the purified virus showed numerous doublet particles characteristic of geminiviruses. The protein coat of RMV was compared by a serological assay (enzyme linked immunosorbent assay) to BGMV and the two viruses were antigenically similar. A Southern hybridization analysis of RMV, using a probe to BGMV, revealed that the genome of RMV was DNA, was similar in size to

that of BGMV, but had a different nucleotide sequence. A comparison of the host ranges of BGMV and RMV showed 25 species in common and three different (Figure 2) (from J. Polston and J. Bird, unpublished). Further investigations will be necessary to determine if RMV is a stain of BGMV or a separate virus, and to establish which diseases reported from the Caribbean are caused by RMV.

Figure 2. Host Range of Rhynchosia Mosaic Virus Compared with that of Bean Golden Mosaic Virus by Transmission with Bemesia tabaci

Differences

	RMV	BGMV
Nicotiana tabacum 'V12'	+	-
Rhynchosia minima	+	-
Glycine max	+	-
(Several varieties tested)		
Phaseolus vulgaris		
(4 out of 33 tested		
'Black Valentine'	+	-
'Blanca no. 1'	-	+
'Bonita'	-	+
'Naranjito'	-	+

Similarities

Althea rosa	-	*Merremia quinquifolia*	-
Apium graveolens	-	*Pachyrhizus erosus*	+
Cassia occidentalis	-	*Phaseolus aconetifolius*	-
Cicer arietinum	-	*Phaseolus acutifolius*	+
Dolichos lablab	-	*Phaseolus angularis*	-
Helianthus annus	-	*Phaseolus aureus*	-
Hibiscus cannabinus	-	*Phaseolus calcaratus*	-
Macroptilium lathyroides	+	*Phaseolus coccineus*	-
Phaseolus lunatus	+		
Phaseolus mungo	-		
Phaseolus ricardianus	-		
Phaseolus vulgaris			
'Caraota'	+		
'Colorado'	+		
'Contender'	+		
'Marca Diablo'	+		
'Rosita'	+		
'Sta. Anna'	+		
'US no. 5 Green Refuge'	+		
and others			
Pisum sativum	-		
Sida acuta	-		
Sida rhombifolia	-		
Solanum torvum	-		
Vigna sinensis	-		

Investigation of Soybean Yellow Mosaic in India. Soybean production in India expanded over the past 15 years from 300 hectares to over 1 million hectares. As soybeans became established the incidence of a disease called yellow mosaic increased until now this disease can be found throughout India and even limits production in some areas. The causal agent of yellow mosaic of soybean is probably the same as the one which causes yellow mosaic of mungbean and is know as mungbean yellow mosaic virus (MYMV). Several hosts of MYMV have been identified by insect transmission studies, and include pigeon pea, mungbean and urdbean. MYMV is transmitted by the tropical whitefly *Bemesia tabaci* (Genn.) in a circulative manner (for the life of the insect). This vector has a very wide host range (over 200 plant species), a wide geographic range, and is the vector of a number of plant viruses in the geminivirus and carlavirus groups. The yellow mosaic of soybean from India resembles other diseases in Thailand, Pakistan and Latin America. The MYMV of Thailand, similar to the MYMV from India in host range, symptomatology and method of insect transmission, has been identified as a geminivirus based on particle morphology. Therefore, we believe the MYMV of India is very likely a geminivirus.

Though annual losses in dollars have not been estimated, in India yellow mosaic infections have resulted in yield losses up to 80%. Resistant varieties and insecticides have not proven highly successful in giving control. Cultural practice manipulation could offer some hope for control, but little is known of the epidemiology of the disease.

The objectives of this investigation are to characterize the causal agent of soybean yellow mosaic of India and to identify the natural hosts of the agent. Characterization will allow for the production of antisera and generate knowledge about manipulation of the agent, both of which will be very useful to plant breeders developing resistant lines. The identification of the natural hosts of the causal agent may help in control by adding to our understanding of the disease cycle.

The hosts of the causal agent will be identified using Southern hybridization. This is a very sensitive technique which can detect small quantities of DNA ($1x10^{-12}$g.), can reveal sequence homologies between various DNAs and can be used to detect differences between similar sequences of DNA. Since geminivirueses have a DNA genome, this technique is extremely useful and sensitive for comparing and identifying different geminiviruses. DNA will be extracted from samples of plants collected in India and compared by Southern hybridization to the DNA sequence of MYMV.

We began our investigation this past summer in cooperation with scientists from the Institute for Crops Research in the Semi Arid Tropics (ICRISAT) near Hyderabad in Andhra Pradesh. Fifty-six tissue samples were collected from wild and cultivated plants in and around ICRISAT and from Pantnagar, Uttar Pradesh. These represented 11 families, 28 genera and 35 species. Thirty-three samples were from ICRISAT and 23 from Pantnagar (Figure 3). DNA extraction was completed on half of the samples in 1983.

In addition, the investigator spent several days at the British Museum of Natural History to learn how to mount and identify *Bemesia tabaci*.

Figure 3. Plant Species Collected July-August 1983 in Hyderabad, Andhra Pradesh, and Pantnagar, Uttar Pradesh for Southern Hybridization Analysis

Family	Genus	Species	Location
Leguminosae	Cajanus	cajan	AP[1/]
	Cajanus	scarabaloides	AP
	Cassia	tora	AP
	Cassia	tora	UP[2/]
	Dolichos	lablab	UP
	Glycine	max	UP
	Macroptilium	atropurpureum	AP
	Macroptilium	lathyroides	AP
	Vigna	mungo	UP
	Vigna	radiata	UP
	Vigna	unguiculata	UP
Malvaceae	Abelmoschus	esculentus	AP
	Abelmoschus	esculentus	UP
	Ablemoschus	ficulneus	AP
	Malvastrum	coromandelianum	AP
	Malvastrum	coromandelianum	UP
	Malvaviscus	arboreus	UP
	Sida	acuta	AP
	Sida	acuta	UP
	Sida	species	AP
Euphorbiaceae	Acalypha	fallax	AP
	Croton	bonplandianus	AP
	Euphorbia	heterophylla	AP
	Euphorbia	hirta	UP
	Jatropha	gossypifolia	AP
Solanaceae	Capsicum	annum	UP
	Lycopersicon	esculentum	UP
	Solanum	melongena	AP
Oleaceae	Jasminum	sambac	AP
Compositae	Zinnia	elegans	UP
Asteraceae	Ageratum	conyzoides	UP
	Eclipta	alba	AP
	Lagascea	mollis	AP
	Xanthium	strumarium	UP
Poaceae	Cynodon	dactylon	AP
Verbenaceae	Lantana	camara	UP
	Duranta	plumarii	UP
Apocynaceae	Tabernaemontana	divaricata	UP

1/ Andhra Pradesh
2/ Uttar Pradesh

This knowledge was necessary for establishment of whitefly colonies for insect transmission studies.

In the coming year, the causal agent will be purified and characterization begun. The remaining samples of various plants collected this summer will be processed for DNA extraction, and all will be analyzed by Southern hybridization.

RESEARCH RESULTS: *IMPROVED DISEASE AND INSECT CONTROL: INSECTS*

Michael E. Irwin, Gail E. Kampmeier, and U. B. Gunasinghe

Effect of Pubescence Quality on Aphid Probing Behavior and Subsequent Spread of SMV. Plant trichomes of various agricultural crops have been shown to provide protective barriers against insect attack. The trichomes act by deterring feeding and movement within crop canopies. The effect of soybean leaf trichomes is well established for the potato leafhopper, *Empoasca fabae*, but to date no knowledge exists about the effect of trichomes on the probing behavior of aphids.

One of the critical steps in the transmission of soybean mosaic virus by aphids is the probing activity of the aphid vector. The fewer the probes, the lower the rate of transmission. Therefore, if trichome differences induced differences in aphid probing, we would expect a corresponding difference in the rate of spread of SMV.

Preliminary tests were conducted in the laboratory. Aphids were observed to probe on twelve different pubescent isolines of cv. Clark. From these isolines, five were selected from greenhouse studies: sparse, Clark normal, curly, dense, and glabrous. Probing behavior, trichome density and trichome orientation were used in selecting the five pubescent types.

Myzus persicae, a good aphid vector, was observed to probe on the leaves of each of the pubescent isolines for 10 minutes. Time spent probing and number of probes were recorded. The longest time spent probing was observed for the sparse and glabrous isolines. Probing time was very short on the dense isoline with vectors probing fewer times and sometimes not at all.

In the 1983 growing season, a field experiment was conducted in central Illinois. Three isolines were used: L-71-149 (sparse), Clark normal, and L-63-2435 (curly) along with an SMV resistant Clark isoline. Isoline dense was not used because of lack of seed for a large field experiment. A randomized complete block designed with five replications was used. A mosaic green (Cambridge 815) tile trap filled with a 50% aqueous solution of ethylene glycol was placed in the center of each plot to measure landing rates of aphids. Aphids were collected daily. Two weeks after planting, every 40th plant was mechanically inoculated with the G5 isolate of SMV. This produced a uniform initial inoculum of 2.5%. The incidence of SMV and percentage canopy cover were recorded at weekly intervals.

Preliminary analysis of results suggests that virus spread differed in the various treatments. The curly isoline had the greatest amount of spread, but it also had the largest numbers of aphid landings because of a lower percentage of ground cover. The sparse isoline had a higher incidence of virus than did the Clark normal treatment. Numbers of aphids trapped and amount of canopy cover appeared to be similar. The SMV resistant isoline had no virus spread at all even though the number of aphids caught in that treatment was equal to those collected in the Clark normal treatment.

The data suggest that probing behavior is modified by pubescent type, and that this in turn influences virus spread. These data further suggest that the virus-resistant isoline is inherently resistant to SMV and that this isoline does not modify aphid behavior.

Cooperative Studies on the Epidemiology of Soybean Mosaic Virus. As stated in IPR-83-1, Illinois is coordinating a multistate project examining the epidemiology of SMV. The three-year project, having completed its second year, was designed to study and determine tolerable SMV seed transmission rates as affected by local vector species, timings and abundances. Seed transmission rates and yield parameters are predicted by a model developed by Dr. W. G. Ruesink of the Illinois Natural History Survey.

The results of the 1982 season have not been analyzed and those from 1983 are currently undergoing analysis.

Over 70 species of aphids (10,391 specimens processed) were trapped during the first year of the study. Not all are important or have known capabilities as vectors. The model uses a factor called "vector intensity" which utilizes estimates obtained from field assays for vector efficiency and pools them to the generic level. Thus the proportion of aphids transmitting SMV for the genus *Rhopalosiphum* was 0.032, for *Aphis* 0.105, for *Myzus* 0.121, for *Macrosiphum* 0.078, and for all other genera 0.005. Figures 4, 6, 8, 10, and 12 show the vector intensity in the 2.5% inoculated plot during the 1982 season for each state (Note: Workers in Louisiana did not collect aphids between Julian dates 170 and 210).

The model assumes that immigrant aphids are not bringing the virus with them into the field and that they will not colonize the soybean plants.

Three types of plants are considered in the model: healthy, latent (ie. infected but not yet aphid-available sources of the virus) and infected. The Nicholson-Bailey model was chosen to predict the rate of infection and appears mathematically as

$$N_i = N_h \; 1-\exp(-aI_vN_s)$$

where N_i = number infected per day
N_h = number healthy plants
N_s = proportion of source plants among total
I_v = vector intensity assuming random encounters
a = instantaneous rate of infection (no direct measurement is available; it should vary with virus strains and soybean cultivars).

Figures 5, 7, 9, 11, & 13 show predicted and observed rates of virus spread. Since data from Illinois were used in construction of the model, observed values coincide with those predicted.

Yield loss and percent seed transmission are affected by time of inoculation. Plants infected after blooming may have near normal amounts of grain and little if any seed transmission. Plants infected prior to blooming may

lose up to 100% of their yield, although this factor is also complicated by competition which has not yet been taken into account in the model. Seed transmission may be as high as 30% in plants inoculated prior to bloom. Figures 14 & 15 give a summary of the observed vs. predicted values of these parameters.

The predictive accuracy of the present model fell within 20% of the observed values for both the infection and yield loss curves. Less accurate was the model's forecast of seed transmission rates. By continuing this study in 1983 and 1984 we hope to increase the accuracy of the model's predictions before initiating the experiment internationally.

Generally the model predicts that areas with very low early season vector intensities can risk planting seed with as much as 1% seedborne SMV infection. Such regions will see a yearly decline in seed transmission levels and can safely replant their own seed. Geographical regions with consistently high early season vector intensities will suffer major losses in yield at even a .01% level of initial inoculum and should obtain an alternate source of virus-free seed for planting. Areas with a mixture of the above conditions will experience sporatic outbreaks of the virus unless care is taken to plant only relatively clean seed each year.

As was previously stated, the data from 1983 are currently being analyzed. Three major additions were made in the procedures for the 1983 season (see IPR-83-1). A third plot was added, using seed from the 1982 2.5% initially inoculated plot. Each state had different amounts of initial seedborne inoculum so the effect of planting one's own seed could be measured. The 1984 season will include a fourth plot with seed collected from the 1983 plot with 2.5% initial infection. We also asked that all states look for virus symptoms in their subplots on a weekly basis to faciliate the recognition of symptoms by the researcher and gain more accurate data for the disease progress curve. These readings were further validated by the use of a mail-in ELISA (Enzyme-linked Immunosorbant Assay, a serological technique for detecting virus) procedure, tested in the lab last spring for feasibility of use in the 1983 trials. Cooperators were mailed sensitized plates in padded envelopes via first class mail. The plates, then refrigerated until use, were filled with samples collected during the weekly inspection of plants for disease symptoms. After incubating the plate overnight at 4°C, it was rinsed and sent back to UIUC to complete the processing. Results were mailed back to cooperators, generally before their next reading. This procedure provided the necessary feedback increasing the accuracy of disease symptom readings taken and solving a major problem of cooperators in 1982 who complained that they were often unable to distinguish SMV in the field from other similarly appearing viruses such as peanut mottle virus and bean pod mottle virus.

In Illinois, vector intensity was not as great in 1983 as it had been in 1982 and 100% infection was not reached. At the initiation of flowering in 1982 plants were 100% infected, whereas in 1983 the percentage was only 22% in the 2.5% initially inoculated plot and 44% in the plot planted with seed from the 1982 2.5% initially inoculated plot, which had 4.5% seedborne infection.

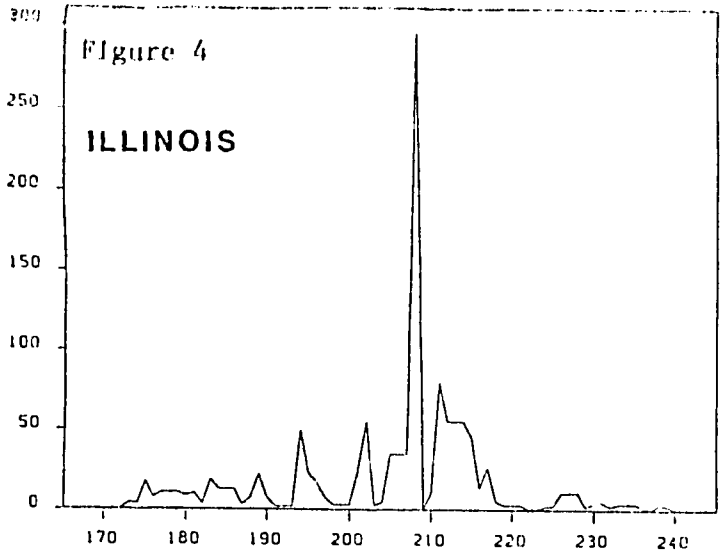


Figure 4
ILLINOIS
300
250
200
150
100
50
0
170
180
190
200
210
220
230
240

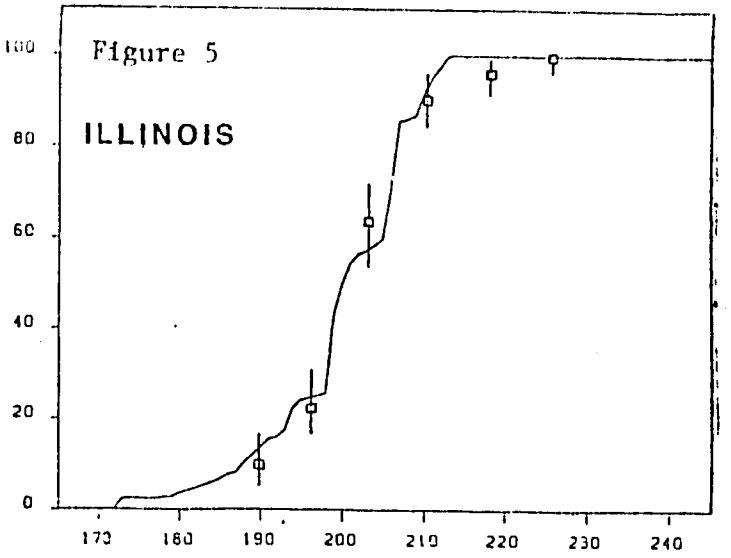


Figure 5
ILLINOIS
100
80
60
40
20
0
170
180
190
200
210
220
230
240

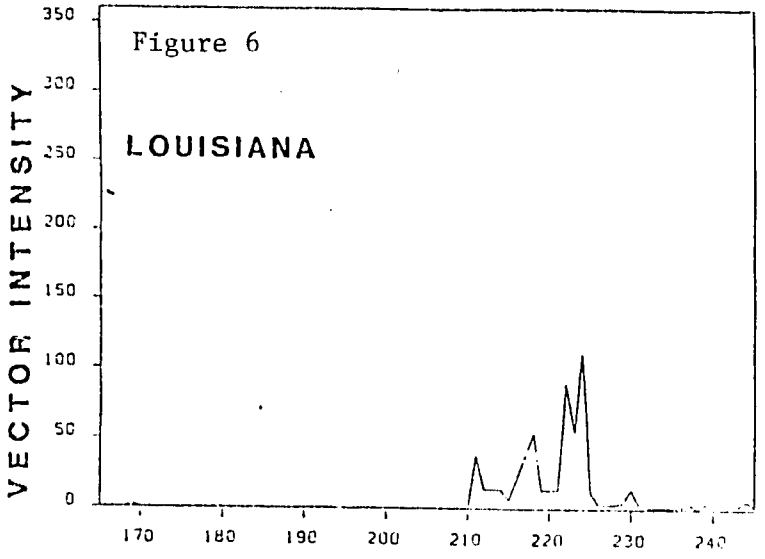


Figure 6
LOUISIANA
VECTOR INTENSITY
350
300
250
200
150
100
50
0
170
180
190
200
210
220
230
240

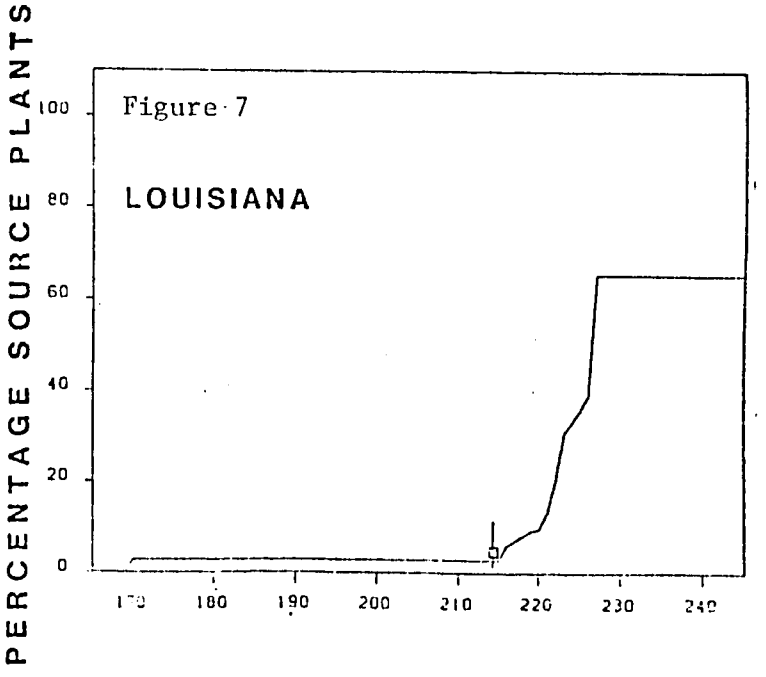


Figure 7
LOUISIANA
PERCENTAGE SOURCE PLANTS
100
80
60
40
20
0
170
180
190
200
210
220
230
240

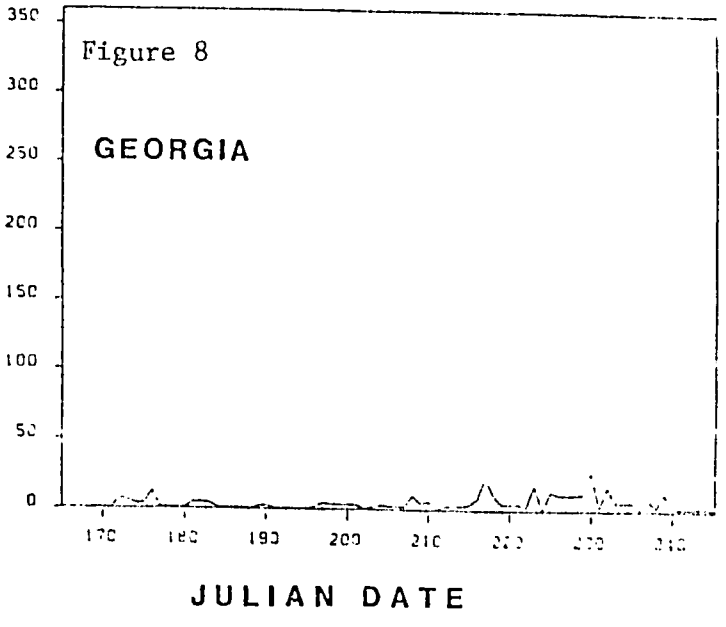


Figure 8
GEORGIA
350
300
250
200
150
100
50
0
JULIAN DATE

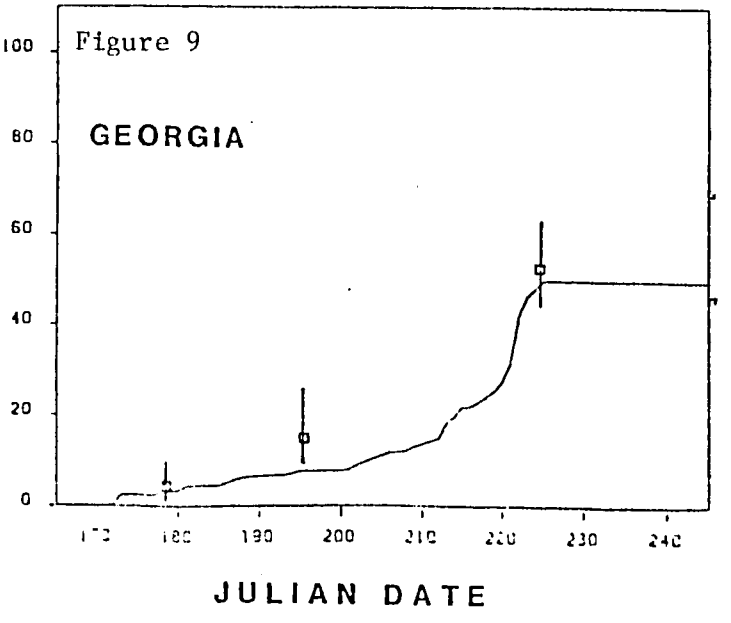
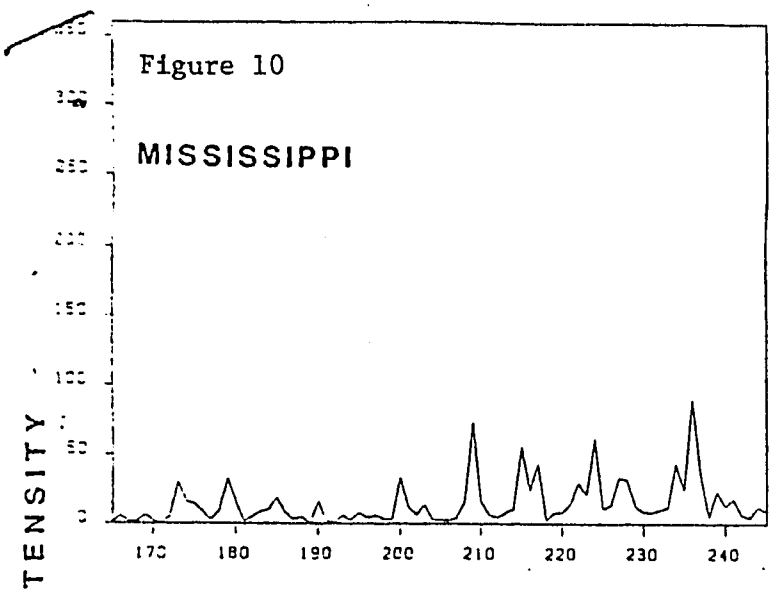
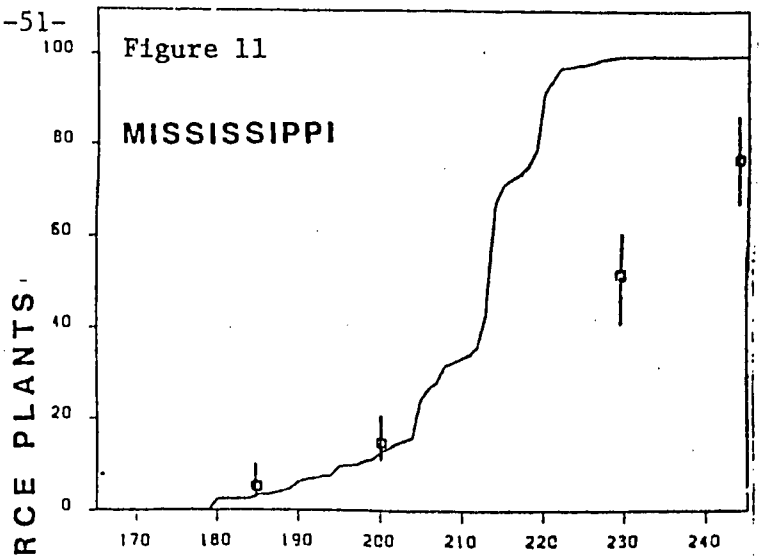
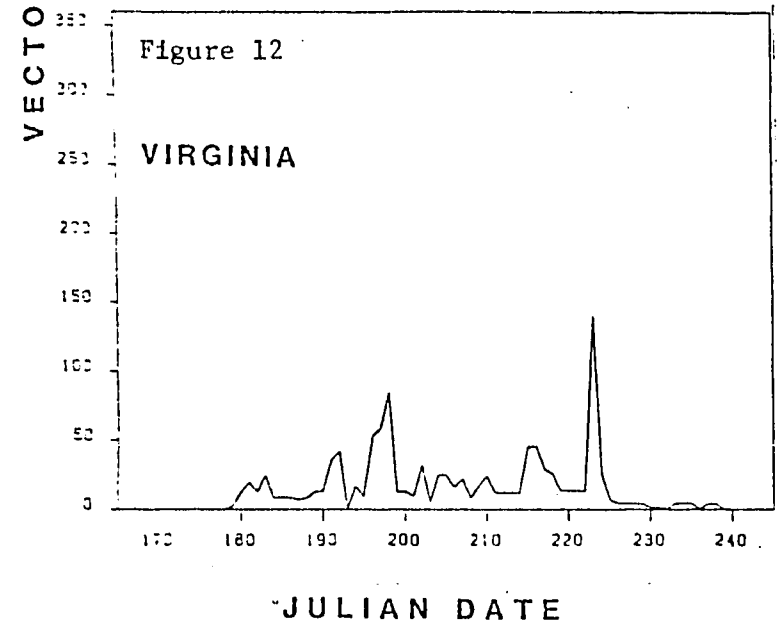


Figure 9
GEORGIA
100
80
60
40
20
0
JULIAN DATE







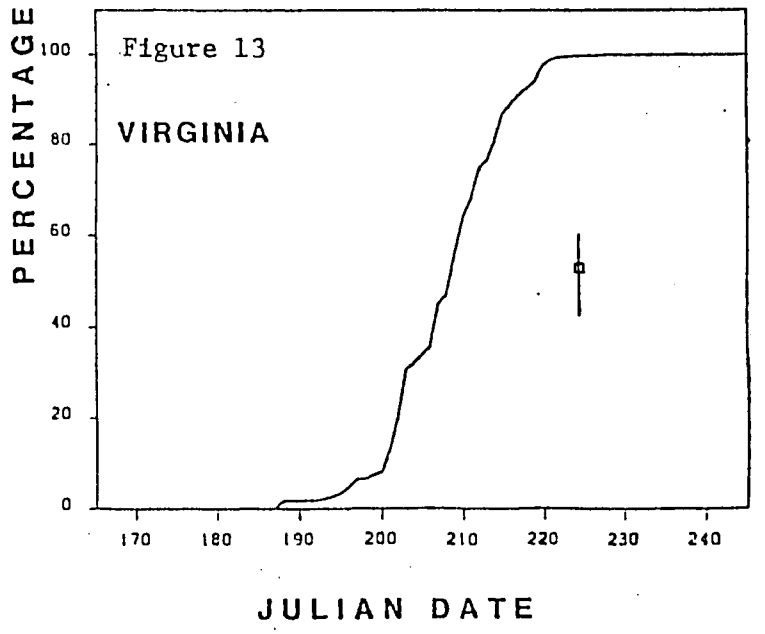


Figure 14

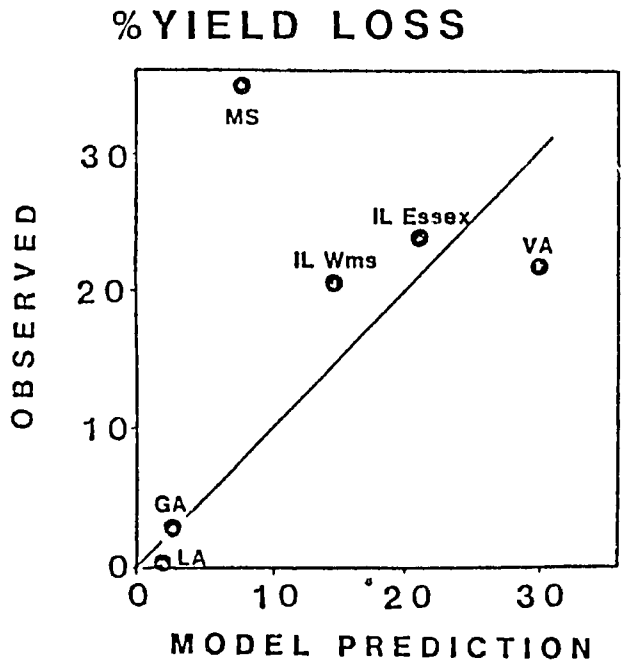
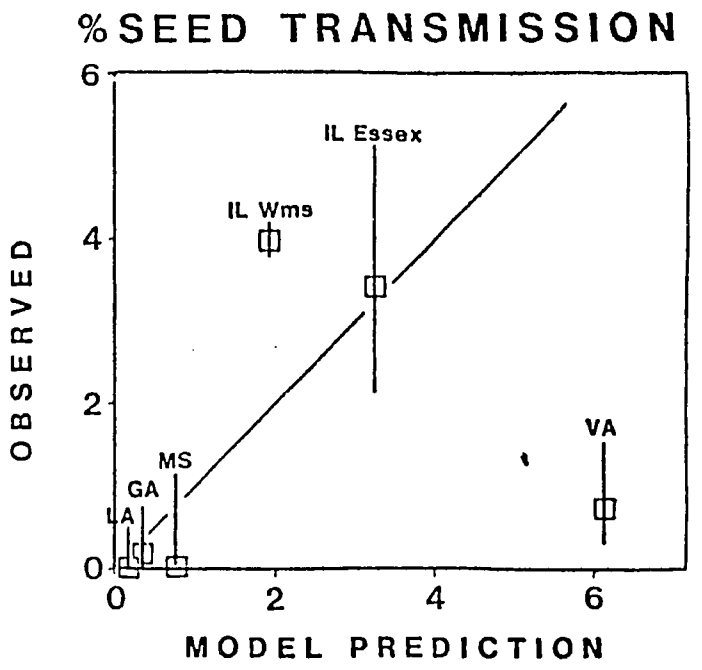


Figure 15



These changes within geographic regions emphasize the importance of running this experiment yet another year to improve the accuracy of the predictions made by the model.

Development of Sampling Methodology and Monitoring Systems for *Orius insidiosus* (Say) (Hemiptera: Anthocoridae).

Results of the experiment conducted in 1982 (see IPR-83-1) regarding the reproductive potential of *O. insidiosus* indicated that the greatest numbers of eggs were laid by females at the beginning of the season when the fewest numbers of adults were present in the field. Fecundity declined throughout the rest of the season although actual numbers of females present in the field increased to a peak during flowering so that the reproductive potential of the population also peaked during this time.

These results suggested that fecundity may not be a function of plant phenology but of time of year or prey availability. Accordingly, in 1983, an experiment was designed in a randomized complete block with 5 replicates using as treatments three cv. Clark isolines that differed only in maturity dates.

Orius were again sampled weekly by shaking plants for 30 seconds over a beat cloth placed between two rows in each plot. All adults and nymphs were collected with an aspirator and returned to the lab for counting.

No more than seven females per treatment were then isolated for three days with adequate food and water and a fresh greenbean as an oviposition substrate. Eggs were counted each day and a measure of reproductive potential (mean number of eggs laid per female per day multiplied by the mean number of females trapped per meter of row) was calculated.

Only preliminary analyses have been done thus far on the bulk of the data collected for this experiment. Few significant differences have been found between treatments within weekly sampling dates, however those that do surface are striking. There was a highly significant difference in the number of females trapped as the first treatment flowered, which disappeared by the following week. All three treatments peaked during early August and again three weeks later, representing immigration and maturation of the progeny left by the immigrants. Immigration was significantly greater at the end of the field near the alfalfa plots. This suggests that the *Orius* may have migrated from the alfalfa to soybean but further experiments would have to be conducted for adequate support of this hypothesis.

Unlike 1982, reproductive potential also had two peaks, perhaps due to abundant prey, but more likely due to the exceedingly long hot conditions which may have resulted in adults producing yet another generation before overwintering. Most adults moved out of the field by the following week, leaving only late emerging adults in soybean fields at various stages of pod fill. Although reproductive potential was high during the fourth week in August, it is likely that eggs were not laid in the maturing soybean, even though adequate prey was present in the form of thrips (*Sericothrips variabilis* (Beach)) and mites, (*Tetranychus* sp.).

The genus *Orius* is found worldwide and is of importance in many major cropping systems. It preys on a number of pest species, most notably thrips and mites. In Illinois soybean there are two major species of thrips, *S. variabilis* found principally on leaves and *Frankliniella tritici* (Fitch) (Thysanoptera: Thripidae) in terminal buds and flowers. Each species was sampled weekly by putting plant parts in soapy water and counting dislodged thrips upon return to the lab. The only significant difference found corresponds to an increased number of *F. tritici* when the latest maturing group flowered. Numbers of thrips peaked with those of immigrating *Orius*, but not before. The factor(s) drawing *O. insidiosus* into the soybean field are probably not prey availability, given the simultaneous arrival of *Orius* in the different treatments.

These experiments suggest possible ways of manipulating the cropping system to maximize numbers of *Orius* and capitalize on the predator's reproductive potential in soybean. Perhaps the planting of an early flowering variety as a border to a main crop would lure more *Orius* into the field at the time their fecundity is higher. These interactions are complex and need further study before any attempt can be made to use them as pest management tools.

Comparison of Two Green Traps for Determining Aphid Landing Rates. Two trap types, both of a green color, were compared for landing rates of various species of aphids. The traps were set up in a soybean plot and in a green pepper plot in central Illinois and in Massachusetts, in the summer of 1982. This was done as a cooperative experiment between Dr. David Ferro of the University of Massachusetts and INTSOY. Dr. Ferro had decided that the concept of using green traps instead of yellow ones was sound, an idea he developed after viewing our INTSOY SMV project. However, he had been less than satisfied with the trap results, suggesting that the green traps he used were underestimating aphid landings. His trap was a clear plastic dish painted on the underside with a mixture of acrylic pigments that approximated the color of green peppers. Our trap is a clear plastic dish with a Cambridge 815 green mosaic tile set in the bottom. The reflectance spectra across visible light wavelengths of each green trap and a soybean leaf are presented in Fig. 16. Note the major areas of difference in reflectance are between 680 and 800 nm, where the tile reflects a large proportion of the near infrared spectrum and the painted dish reflects a very small proportion of the same part of the spectrum.

Results of the 1982 season have not been fully tallied, but a single collecting day, July 26, during which a large number of aphids were trapped will illustrate the trapping ability of these two trap types (Fig. 17). Enough specimens of six species were collected in a paired trap design. Four of these species were trapped in significantly higher numbers in the tile (mosaic green) than in the painted (Ferro's) trap: *Capitophorus hippophaes*, *Macrosiphum euphorbiae*, *Aphis citricola*, and *Rhopalosiphum maidis*. Two other species were caught in similar numbers: *Myzocallis punctatus* and *Pemphigus populi-transversus*. Interestingly, the species showing differences are good vectors of SMV while those showing no difference are not known vector species.

Figure 16

SPECTROGRAPH OF TWO GREEN TRAPS

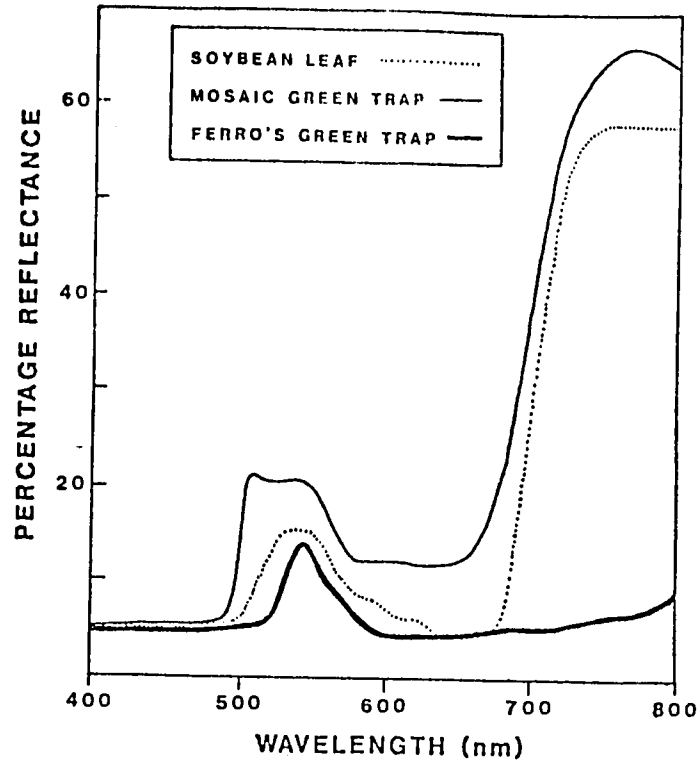
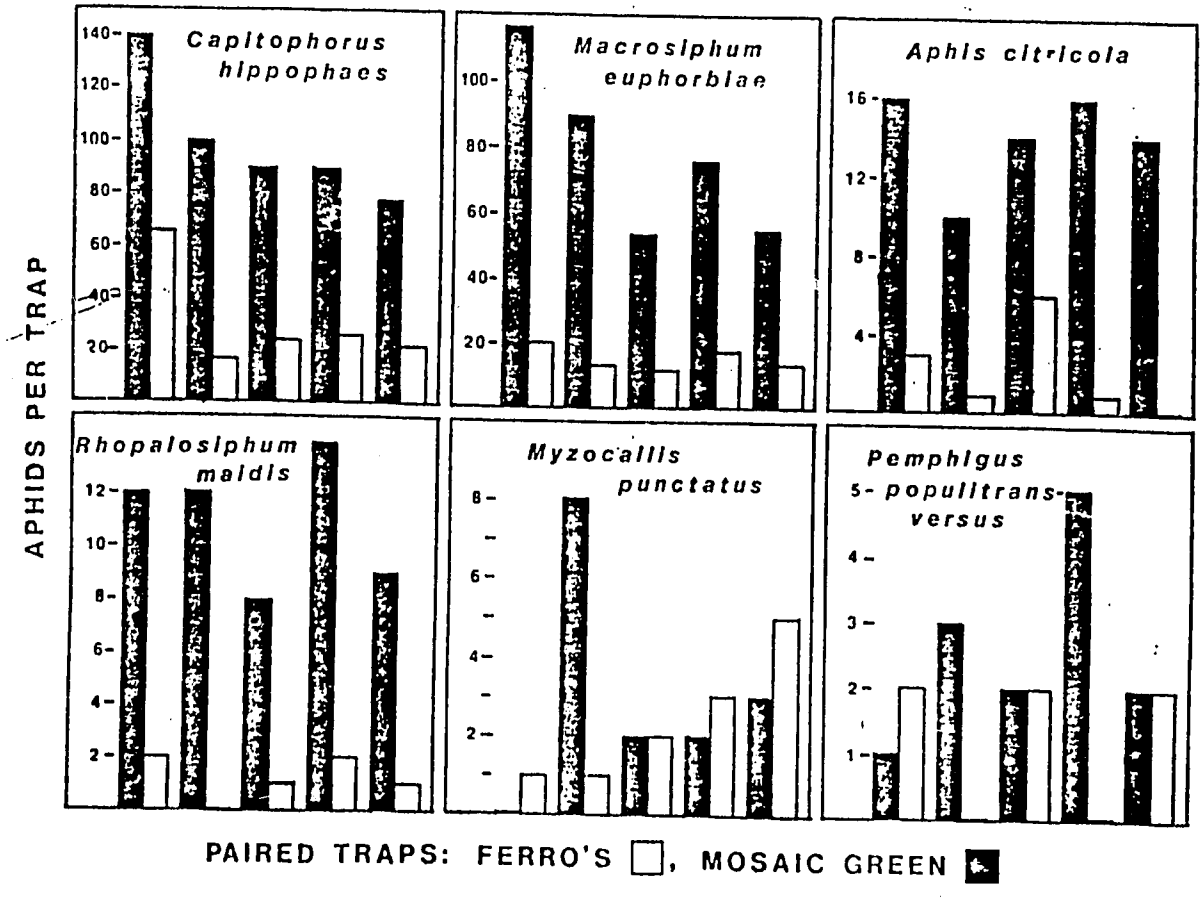


Figure 17

COMPARISON OF APHID CATCHES



The Effect of Leaf Color on the Ability of Different Species of Aphids to Spread SMV in laboratory Tests. Our past field studies have indicated that SMV spread is greater in soybean plots of a normal dark green color than in similar plots that are chlorophyll deficient and appear to us as yellowish green in color. Likewise, aphid landings are, in general, more numerous in the dark green than in the light green foliage. These tests used two isolines of soybean cv. Clark, one normal (Clark 69), the other a line that differed only in that it was chlorophyll deficient (Clark Y9).

To determine if the difference in the movement of the virus was due to the difference in foliage color as we suspected or due to some inherent difference in infection rate of the virus to the two plant isolines, an experiment was performed in the greenhouse testing four species of aphid vectors for their preference to transmit SMV to pots containing eight soybean seedings in each of 10 clay pots. The seedlings were either (1) all dark green (Clark 63), (2) all light green (Clark Y9), (3) 4 dark, 4 light, occupying different halves of the pot (half and half), and (4) 4 dark, 4 light in an alternating design (alternating). The results are presented in Table 23.

The results are preliminary, but they suggest several things:

1. Aphid behavior is responsible for the difference in landing rates and consequent spread of SMV in the two color types of soybean.

2. Some species of aphids probe more readily if they are presented with dark over yellowish-green foliage (e.g. *Aphis craccivora*).

3. Some species apparently do not modify their behavioral patterns when given either foliage color or some choice between them (e.g. *Myzus persicae*, *Aphis citricola*).

4. Some species of aphids (e.g. *Rhopalosiphum maidis*) are more attracted to the yellowish than dark green plants when given a choice.

What seems important is that various vector species differ in their behavioral patterns with respect to foliage color, at least under laboratory conditions.

Seed Quality of Naturally SMV Infected Williams Soybean. An experiment was performed where plants that became infected by aphid vectors form an initial inoculum source (see A2 for details) were tagged on a weekly basis. Plants were individually harvested and the seeds from each grown out in a greenhouse sand bench. The number of seedlings with SMV were noted. This experiment demonstrated for the first time the percentage of seed transmission from natural spread at different stages of plant development.

The results confirm our previous supposition that most, if not all, seed transmission occurs when parent plants are infected prior to or at the flowering stage of development. It further shows that aphid inoculation is at least as effective for producing seed transmission as is manual sap inoculation. In fact, the amount of seed transmission appears to be slightly greater if plants are infected by aphid vectors. Additionally, this

Table 23. Percentage SMV (isolate of G5) Tranmission by Four Aphid Species to Soybean cv. Clark of Dark Green Foliage (Clark 63) and Light Green Foliage (Clark Y9). Mean Percentage from 10 Replicates

	Aphid species and number used per replicate				
Treatment	M. pesicae (6)[2]	A. craccivor (6)	A. craccivora (16)	A. citricola (16)	R. maidis (32)
Clark 63	43.8a[1]	22.5a	32.5a	36.3a	17.5a
Clark Y9	41.3a	12.5a	12.5b	31.3a	36.3a
Half and Half					
Clark 63	35.0a	35.0a	45.0a	15.0a	30.0a
Clark Y9	45.0a	5.0 b	10.0 b	35.0a	40.0a
Alternating					
Clark 63	42.5a	37.5a	45.0a	22.5a	20.0 b
Clark Y9	47.5a	5.0 b	10.0 b	12.5a	45.0a

[1]Paired t-test. Vertical pairs significantly different at the 5% level if letters are different.
[2]Numbers in parenthesis indicate number of aphid specimens used per replicate.

experiment demonstrated that individual plants of soybean cv. Williams can have seed transmission rates as high as 30% even though mean seed transmission is no greater than 12%.

Auxiliary Activities - Collecting Insects from Wild Soybeans in Australia. Between 1 September and 1 November, 1983, an expedition was undertaken to make an inventory of insects associated with wild, perennial Glycine. Dr. Eert I. Schlinger, University of California at Berkeley, joined Dr. Michael E. Irwin of INTSOY in Melbourne, Australia, and for two months, the pair of scientists, using personal funds and vacation time, rented a camper van and traveled the interior of Australia. Most of the collecting was done in Western Australia, especially around Ellery Creek Gorge, and Queensland, especially around Townesville. Insect specimens were collected from several species of *Glycine*, but the insect specimens are still undergoing curatorial processing at the International Soybean Arthropod Collection, it is premature to say much about the species that were found. However, an agrmyzid pod fly, *Melanagramyza pseudograta*, was particularly abundant in the Northern territory and Queensland. It consumed a large portion of the seeds of maturing wild soybean pods and was parasitized in some areas by a chalid wasp. The fly has been reported to attack cultivated soybean in southeastern Queensland. It can be considered as a potential pest of soybean, if and when it gets to soybean producing areas around the world.

Auxiliary Activities - Pest Migration Studies. During the past year, a study was initiated with the objective of developing techniques for understanding movement of small insect pests, primarily aphids and leafhoppers. We are looking at ways to predict long-range as well as local movement patterns and have begun by studying movement of *Rhopalosiphum maidus*, a vector of soybean mosaic virus. This pest is cosmopolitan, occurring in the tropics and in the temperate zones of all agricultural regions of the world.

We have begun by studying the genetics of various populations of this species in the southern USA by characterizing differences in several enzyme systems using an electrophoresis method. Our initial studies have uncovered four enzyme systems that show differences among populations of *R. maidis*. When a flying aphid is assayed for these enzymes, it is possible to tell from which genetic pool it came. This helps us determine from where it, or its parents, originated.

We are also developing a project on flight energetics. When these small insects move, they expend energy. By determining how much fuel (as fatty acids) are used in flight, it is possible to estimate how long the insect remained in flight. Coupling this with studies on wind trajectories, we are hoping to be able to say over what distance a given insect flew. This will let us know whether the insect was of local or distant origin, and pave the way for understanding differences in pest status of insects moving locally and long instances. This could be of enormous help in understanding pest management in the tropics because it is known that many pests in those areas move long distances. All of our migration studies are done with a group of scientists from the Illinois Water Survey and the Illinois Natural History Survey, and good meteorological data are correlated with our pest movement findings.

RESEARCH RESULTS: *SEEDBORNE PATHOGENS AND FACTORS INFLUENCING THEM*

James B. Sinclair

Diseased Seeds and Seed Quality and Assessment of Factors Influencing Them. Research in this area concentrated on: soybean pathogens that affect seed and seed quality in Puerto Rico; the interaction of seed- and soilborne microorganisms that affect soybeans with one another in the U.S., and with weeds found in soybean fields in Brazil; and the effect of herbicides on soybean pathogens in Brazil and the U.S. The effect of the nematicide aldicarb used to control the soybean cyst nematode on yield components in the field also was studied.

Soybean anthracnose and its seed assay was studied in Puerto Rico. The frequency of seed discoloration caused by *Collectotrichum truncatum*, causal fungus of anthracnose, averaged 5 to 30% in mid-February and mid-April plantings; and from 0 to 3% for the May to October plantings. Recovery of *C. dematium* was less than 20% from surface-sterilized seeds plated on potato-dextrose agar (PDA) of the mid-February to mid-April plantings. Up to 70% of nondisinfected seeds placed on moist cellulose pads developed acervuli. When seedlings on cellulose pads, with either fruiting structures of *C. truncatum* or *Phomopsis* sp., were disinfested and plated on PDA, less than 20% *C. truncatum* and over 60% *Phomopsis* sp. were recovered. The agar plate method gave a better estimation of seeds carrying *Phomopsis* sp. than those carrying *C. truncatum*. Seed populations of *Phomopsis* sp. were inversely proportional to those of *C. dematium* ($r = -0.71$) when seed when seed lots were assayed on cellulose pads.

Similarly, the greater the amount of the seed coat showing purple seed stain, caused by *Cercospora kikuchii*, the greater the reduction in germination; and germination was always highest on PDA and lowest on cellulose pads. Stunted and low vigor seedlings resulted from seeds with 50% or more of the surface stained. No antagonism was noted between *C. kikuchii* and *Phomopsis* sp. in dual culture on PDA. However, culture filtrates from *C. kikuchii* stimulated growth of *Phomopsis* sp. However, culture filtrates and/or competition for space in the seed tissue are suggested to explain the low incidence of *Phomopsis* sp. in soybean seeds colonized by *C. kikuchii*.

In another interaction study, two soybean cultivars--Corsoy-79, susceptible, and Wells, resistant, to *Cercospora sojina* race 10A and equally susceptible to *Phomopsis* spp.--were inoculated with either fungus alone orgin combination in field plots in 1981 and 1982.

Frogeye leafspot of soybean, caused by *C. sojina*, occurred at a higher rate in Corsoy-79 and was greater in 1981 than 1982. The disease was higher in *C. sojina* inoculated plots in both years and correlated with yield ($r = -0.56$) and 1000-seed weight ($r = -0.50$). Seed germination was lowest in plots inoculated with both fungi, intermediate from plots inoculated with either fungus alone, and highest in the control. *C. sojina* and *Phomopsis* spp. acted independently and had an additive effect.

Isolates of *Bacillus subtilis* were tested for their antagonism to fungi, associated with soybeans. In dual cultures on PDA and soil-extract agar,

zones of inhibition developed between the 25 fungi, including *Cercospora*, *Colletotrichum*, and *Phomopsis* spp. Autoclaved culture filtrates of *B. subtilis* grown for 24 and 48 hours at 28°C and 37°C and mixed with PDA inhibited radial growth of *Phomopsis* spp. at 5, 10, and 20% v/v. Suspensions of *B. subtilis* applied as a seed treatment significantly reduced stem infection in the field, but not in the greenhouse or growth chamber. Germination and seedling vigor were significantly below the control. Suspensions of *B. subtilis* sprayed on plants in the growth chamber and field showed no reduction in *Phomopsis* spp. on inoculated plants.

The interaction between soilborne pathogens was studied in the greenhouse. Six-day-old Wells II seedlings were planted in 7.5-cm peat pots containing soil infested with either 0.04 g/g of *Rhizoctonia solani* or 2.4 x 10^6 spores/g of *Fusarium oxysporum*, alone or in combination and transplanted to the field. Data were taken at 2-week intervals. Topweights and plant heights were significantly ($P=0.01$) lower in plots with *R. solani* and the the mixture of the two fungi, but not from each other. Topweights, but not heights, were significantly reduced by *Fusarium oxyysporum*. Severity ratings of *R. solani* and a combination of the two fungi did not differ from one another, but were significantly different from the controls. Root infection did not differ among treatments. No apparent interaction exists between *R. solani* and *F. oxysporum*.

Phomopsis spp. were isolated from *Amaranthus spinosus*, *Leonotis nepetaefolia*, and *Leonurus sibiricus*, common weeds in soybeans grown in Brazil. The latter two hosts were symptomless carriers of *Phomopsis* spp. Pycnidia produced by cultures of *Phomopsis* spp. isolated from the three weed hosts gave rise to alpha and beta conidia typical of *Diaporthe phaesolorum*. The *Phomopsis* spp. isolated from *L. nepetaefolia* and *L. sibiricus*, but not from *A. spinosus*, reduced seed germination, radicle length, and emergence of UFV_1 soybeans but not of Rico 23 common bean grown in infested sand and soil. These weed isolates colonized soybean stems and produced pycnidia. Isolates from *A. spinosus* did not produce pycnidia on common bean stems.

The nontarget effects of five herbicides on soybean diseases and seed quality were studied at three locations in Parana, Brazil. Rates used at Lago and Palmira were: cloramben, 5.0; metolachlor, 3.6; metribuzin, 0.7; trifluralin, 1.3 and vernolate, 5.0 kg active ingredient/ha, whereas rates at Londrina were slightly higher. At Lago, there was a significantly ($P = 0.05$) higher incidence of *Peronospora manchurica* (downy mildew) in the metribuzin plots at both 6 and 9 weeks after planting; and the percentage recovery of *Bacillus subtilis*, *Fusarium* spp., and *Phomopsis* spp.from the harvested seeds was significantly lower in all the herbicide-treated plots compared to the control. At Londrina, the incidence of *Septoria glycines* (leafspot) was significantly reduced, and that of *P. manchurica* significantly increased in cloramben and vernolate-treated plots. Hypocotyls were sampled for *Rhizoctonia solani* at all locations at 3, 6, 9, and 12 weeks after planting, but no significant differences were found between treatments. It was concluded that herbicides applied at planting may exert nontarget effects upon fungal pathogens and seed quality in Parana.

Soybean cultivars UFV_1 and UFV_2 grown at Florestal and Vicosa, Brazil and cultivars Bonus and Wells grown at Urbana, IL were sprayed at growth stages R5.5-6 (full pod) or R7 (physiologic maturity) with one of three desiccant-type, nonselective herbicides: glyphosate, paraquat or sodium chlorate:sodium borate (50:50). The stems of all paraquat-sprayed plants had optimum development of fruiting structures of *Colletotrichum truncatum*, causal fungus of soybean anthracnose, and of *Phomposis* spp., causal fungi of soybean pod and stem blight, stem canker, and seed decay as much as 3 weeks earlier than nonsprayed plants. Glyphosate-sprayed plants of Bonus and UFV_1 gave similar results. No differences were noted between plants nonsprayed or sprayed with sodium chlorate:sodium borate. Parallel increases in the development of fruiting structures with time were recorded on stems of nonsprayed and sprayed plants. Treatment, time of treatment, and location influenced the development of the fruiting structures of the test fungi.

Soybean cultivars--Williams 79, susceptible, and Fayette, resistant to the soybean cyst nematode *Heterodera glycines*--were grown in a field naturally infested with more than 200 gravid cysts/250 cc soil. Each cultivar was treated or nontreated with aldicarb (208 g/100 m row). Throughout the growing season height, fresh weight, number of nodes, and defoliation were recorded at 2-week intervals for 10 plants from six replications. Leaf area and number were recorded at the R3 (mid pod) stage; yield and pod number at harvest. Height, fresh weight, and number of nodes were significantly ($\underline{P}$ = 0.05) greater for Fayette without aldicarb than Williams 79 without aldicarb over all sampling dates. Yield, leaf area, number of leaves, and pod number were significantly greater for Fayette without aldicarb than Williams 79 without aldicarb. Yield of Fayette without aldicarb was equal to that of Williams 79 with aldicarb. Aldicarb significantly increased all variables for both cultivars. Percentage defoliation was greatest for Williams 79 without aldicarb.

Improved Control of Seedborne Pathogens. Studies on innovative methods for the control of seedborne pathogens of soybean was continued. The storage of soybean seeds under oil was studied. The use of directly applied chemicals or biological methods for controlling seedborne pathogens in the field was studied. A major effort was made this year to publicize the use of integrated disease control practices for the control of soybean diseases and those that are seedborne.

A computer-based advisory system for the diagnosis of soybean diseases was developed and tested in cooperation with the Computer Science Department at the University of Illinois at Urbana-Champaign. It is now available to the Illinois Cooperative Extension Service. The development of the program has been publicized at national and international professional meetings.

A survey conducted in Nepal showed that sixteen fungal, three bacterial and three viral diseases occur. The occurrence of the following diseases varied with elevation: frogeye leafspot, a blight associated with *Cercosporella* sp., anthracnose, charcoal rot, bacterial pustule, and yellow mosaic. Soybean rust was reported for all elevations. The following fungi and bacteria were recovered from soybean seeds grown in Nepal and reduced

seed quality: *Phomopsis* sp. *Colletotrichum truncatum* (anthracnose), *Macrophomina phaseolina* (charcoal rot), *Cercospora kikuchii* (purple seed stain), *C. sojina* (frogeye leafspot), and Bacillus subtilis (seed decay). Seeds showing symptoms of soybean mosaic virus were recorded. Indigenous soybean cultivars were resistant to *C. sojina* but susceptible to Xanthomonas campestris pv. *phaseoli* (bacterial blight).

Cumberland soybean seeds were stored either in an open beaker or under soybean oil for 108 weeks at 26+2°C. There was no significant ($\underline{P}$ = 0.05) difference between treatments up to 50 weeks; between 54 and 68 weeks, germination was equal to or higher than the control. After 68 weeks, germination and seedling vigor was significantly higher than the control. Microflora recovery was low and thus no differences could be detected.

A study was made on the effect of aldicarb on yield components, population dynamics of *Heterodera glycines* (soybean cyst nematode), and fungi on SCN susceptible and resistant soybean cultivars. At each survey date, SCN infestations were higher in Williams 79, more susceptible to SCN than in the other three treatments, which did not differ among themselves. All aldicarb-treated plants had greater height and yield than did nontreated plants. Recovery of *phaseolina* from epicotyls overall sampling dates was higher than aldicarb-treated than non-treated plots. Recovery of *Phomopsis* spp. from hypocotyls and epicotyls was lower than from aldicarb-treated and nontreated plots. Recovery of fungi from roots was unaffected by aldicarb application.

In three separate soybean seed treatment trials using chemicals and non-chemical/biological control methods, it was found that Chitosan reduced emergence below the control as did four fungal antagonists and the incorporation of fungicides using polyethyleneglycol. Captan and PH51-04 resulted in higher or significantly ($\underline{P}$ = 0.05) higher germination above the control.

Through a variety of outreach and extension-type publications and various invitational national and internatiaonal papers and presentations, an integrated disease management system is supported for the control of soybean seed and seedling diseases.

AUXILIARY ACTIVITIES: *SOYBEAN INSECT RESEARCH INFORMATION CENTER (SIRIC)*

Jenny Kogan

Modern society incessantly produces and uses information. Scientific activity takes place in such a complex environment that it must be based on specially acquired information. To find the needed information within the mass of published documents becomes increasingly more difficult. If information is to be acessible it must be organized.

In the late 1960's soybean entomology was taking its initial steps as an independently defined area of endeavor in agricultural entomology. In the 1960's only 3 entomologists were hired to work full time in soybeans in South Carolina, Iowa, and Illinois (Turnipseed and Kogan 1976); in the 1980's experiment stations in each of the 23 major soybean producing states had at least one part time researcher and/or an extension specialist in soybean entomology (unpublished reports of Technical Committee S-157), and the major Land Grant universities have been offering graduate training in this field to both American and foreign students. The flurry of interest in soybean entomology has closely followed the rise in the economic importance of the crop and its expansion into the less traditional areas of production in the sub-tropical zones. In these regions insect problems generally are more severe than those encountered in the more traditional temperate zone fields (Kogan 1981).

The increase in numbers of researchers and higher levels of financial support for soybean research (USDA data) led to a doubling of the literature produced during the quinquennium 1975-1979 over the previous quinquennium (Figure 18). Indeed, based on SIRIC's holdings 39.3 percent of the global soybean entomology literature was published during that five year period. In other words, in five years one third as many papers were published as in the previous 75 years. Expansion in production in the USA and in the world has parallelled this increase in scientific output. Similar trends have been observed also in Brazil and in India where both production and research have expanded in the 1970's and 80's. But in traditional producing countries such as China, Korea, and Japan there might have been a peak of research and literature output in the 1930's and 40's (Figure 19).

The SIRIC Concept. A unique approach to information needs in a narrow field was taken by the soybean entomology program at Illinois. This program was established in the late 1960's (Kogan and Luckmann 1971). With the realization that the program would operate within a period of rapidily expanding research activity, efforts were made to organize a small information storage and retrieval system while the literature was still manageable.

The Soybean Insect Research Information Center (SIRIC) was soon computerized to store and retrieve the world literature of soybean associated arthropods. This commodity-oriented information system provides literature searches, copies of documents, and referral services. Due to the broad scope of its data base SIRIC has been able to attend requests from researchers interested in corn, alfalfa, vegetable, and other grain legumes as well as on nearly 5,000 specific insects. SIRIC's holdings currently include over 21,000 documents. Table 24 provides a chronology of the development of SIRIC.

Figure 18

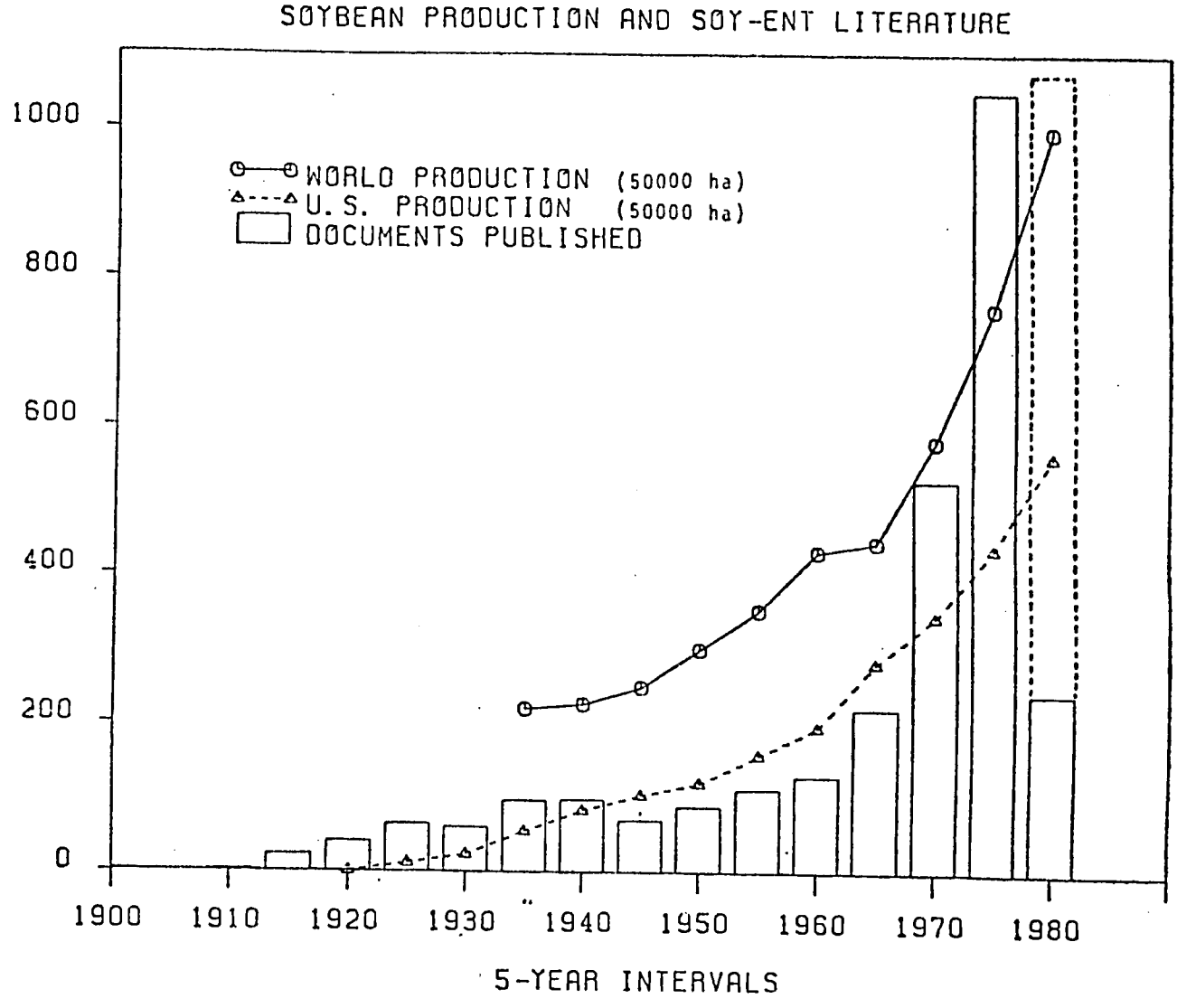


Figure 18. Increase of the world literature on soybean entomology based on the holdings of SIRIC and the parallel expansion of soybean production in the USA and the World. The bar for the 1980-1984 quinquennium projects a trend towards leveling off of the bibliographic output based on 1980 and 1981 data.

Figure 19

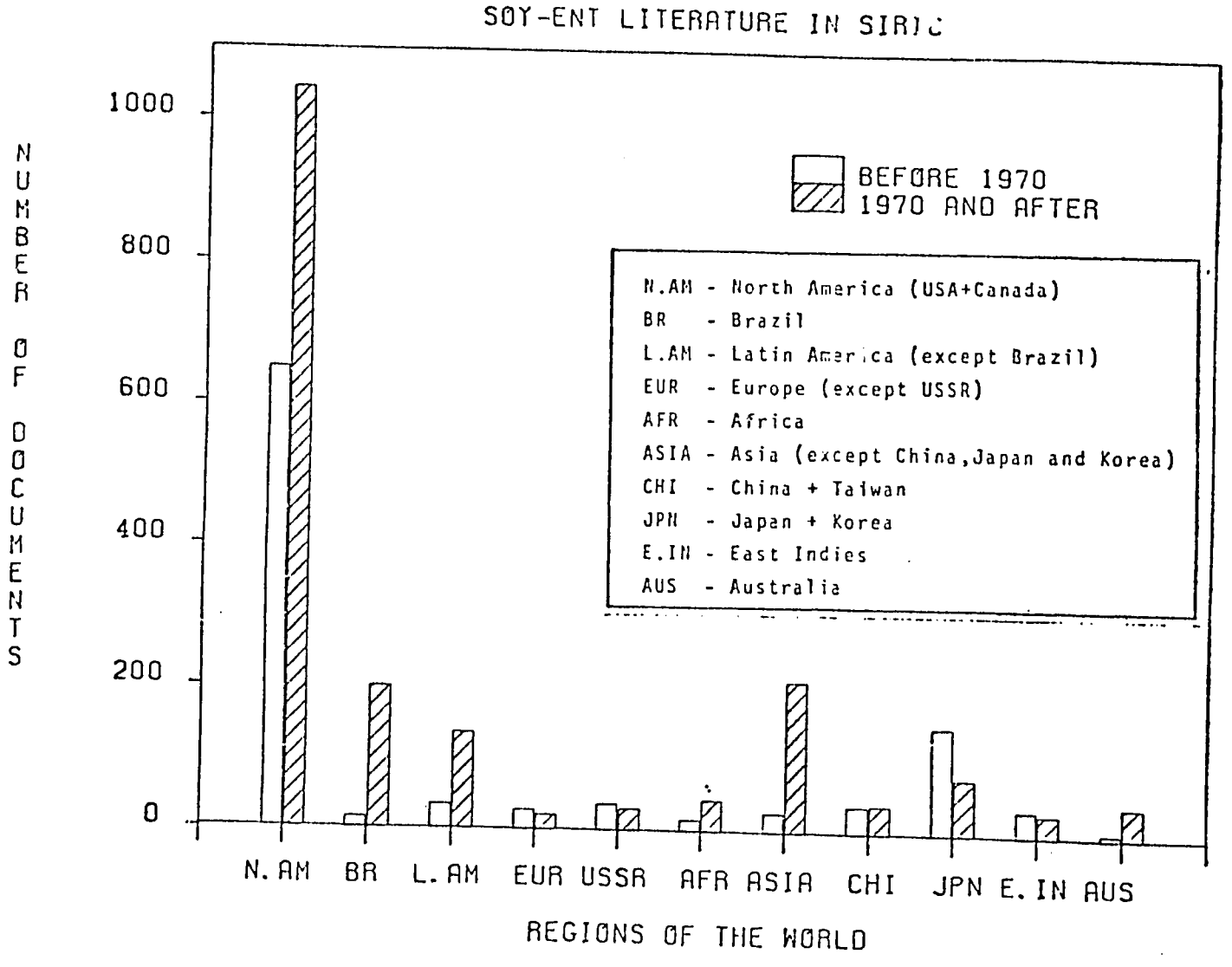


Figure 19. Number of documents in the SIRIC collection distributed per region and for each region divided into those published up to 1969 and 1970 and after.

Table 24. Chronology of the Development and Principal Accomplishments Soybean Research Information Center (SIRIC)

Year	Stage in Development of Principal Achievements
1969	Establishment - Manual system - edge notched cards
1970-71	Thesaurus development
1971	First attempt to computerize storage and retrieval (Fortran II and PL-I programs); 4,500 titles in collection
1972	Bibliographies: Epilachna (591 entries) Nezara (629 entries)
1973	Updating of programs in Fortran IV on IBM 360/75
1974	Bibliography: Cerotoma (409 entries)
1975	Bibliography: Anticarsia (327 entries)
1977	Conversion to Cyber 175
1978	Bibliography: Heliothis (5,178 entries)
1979	Intensification of survey of soybean entomology literature Language codes added
1980	On-line data entry program
1981	Insecticide codes added
1983	21,000 titles in collection
1984	Target date for publication of soy entomologists directory
1985	Target date for publication of comprehensive soy + arthropods bibliography

Accomplishments in 1983. The existence in SIRIC of a nucleus of a data base on grain legume entomology and the past experience in interactions with centers for information on grain legumes at CIAT, IITA, AVRDC and EMBRAPA, and with many of their users, prompted us to propose the establishment of closer cooperation among grain legume information centers. As an initial step emphasis would be placed on crop protection.

Early in 1983 INTSOY joined several other organizations to sponsor the International Workshop in Integrated Pest Control for Grain Legumes (Goiania, Brazil, April 3-9, 1983). At this conference we formally introduced a proposal for the establishment of a network of grain legume entomology information. The workshop was attended by researchers from twenty countries, representing most international centers where grain legume information is available. Figure 20 is a diagram of the proposed network.

Also in 1983 SIRIC was asked to host a visiting scholar from the People's Republic of China interested in training in modern bibliographic research methods and management of scientific information. Mrs. Yalian Qu from the Institute of Information of Agricultural Science and Technology of the Chinese Academy of Agricultural Sciences in Beijing is going to be observing and working within the soybean project from October 1983-October 1984.

In 1983 we provided services to individuals in 23 countries answering different kinds of requests (see Table 25). The number and nature of requests fluctuated over the months. A total of 465 requests were processed, 50% of them generated outside the U.S. (see Table 26). These requests came from individuals and institutions in the following countries: Argentina,

Figure 20

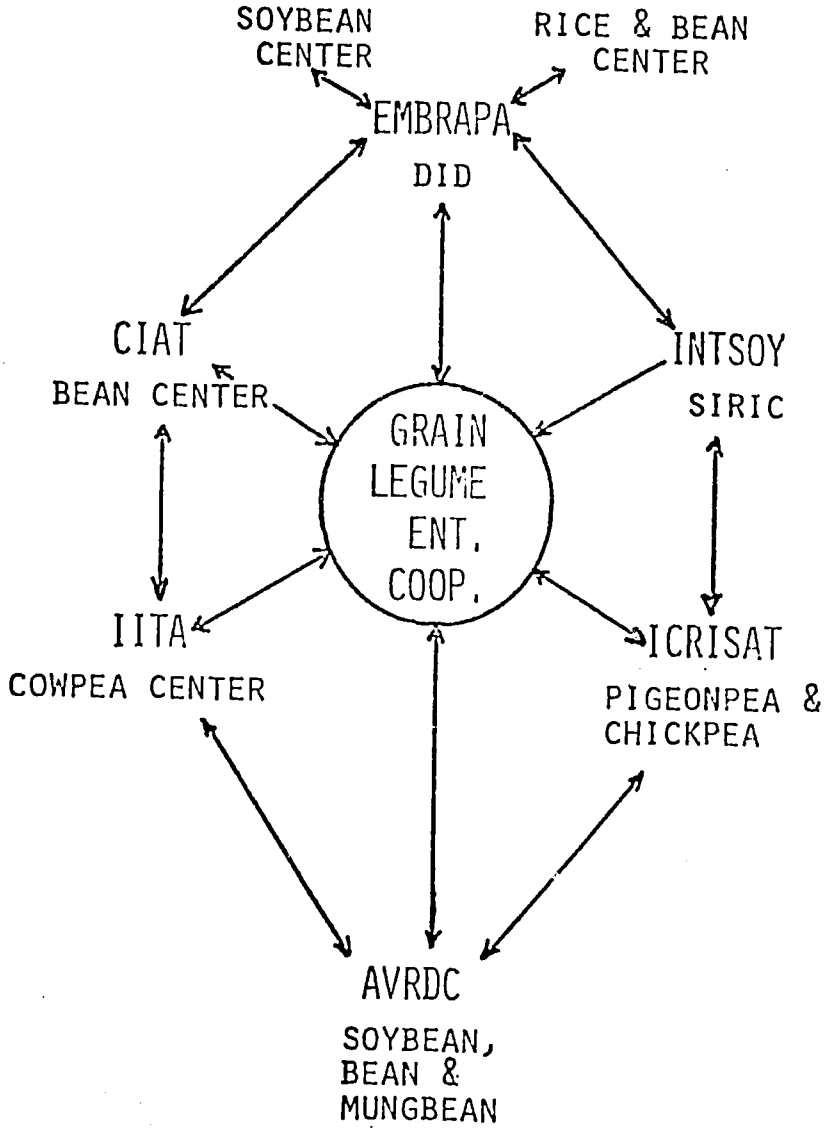


Figure 20. Diagram of a proposed network of institutions and centers with strength in grain legume crop protection information.

Table 25. Summary by Country of Services Rendered by SIRIC During 1983

Country	Number of Requests	Type of Request
Argentina	1	SB
Belgium	7	CB,SB
Botswana	2	CB
Brazil	87	CB,SB,CS,CD
Canada	5	CB
Colombia	42	CB,SB,CS,CD
Cyprus	1	CS
Costa Rica	11	CB,CS
Cuba	7	CB,SB,CD
India	22	CB,SB,CS,CD
Indonesia	10	CB,SB,CS,CD
Japan	16	CB,SB,CD,CS
Kenya	2	CB,SB
Mauritania	5	CB
Mexico	1	SB
Nigeria	4	CB,SB,CS
Pakistan	1	SB
People's Republic of China	7	CB,CD,CS
Portugal	1	CD
Senegal	62	CB,SB,CS,CD
Sri Lanka	6	CS,CD
Taiwan	1	CB
Tanzania	3	CB
Thailand	5	SB,CS,CD
Upper Volta	2	CB
Uruguay	2	SB
U.S.	294	CB,SB,CS,CD
Zimbabwe	1	SB
Total	610	

CB = Copies of bibliographies, CD = Copies of documents, CS = Computer searches, SB = Soybean insects bulletin

Table 26. Monthly Services Provided to Individuals and Institutions, January 1983-June 1984

Month	Bibliographies Total	Bibliographies Foreign	Soy Bulletin Total	Soy Bulletin Foreign	Copies of Documents Total	Copies of Documents Foreign	Computer Searches Total	Computer Searches Foreign	Total Services Total	Total Services Foreign
1983										
January	8	(2)[a]	1	(0)	14	(6)	8	(0)	31	(8)
February	4	(0)	2	(2)	16	(0)	14	(0)	36	(2)
March	11	(0)	3	(2)	24	(1)	5	(5)	43	(8)
April	2	(1)	0		35	(0)	0		37	(1)
May	91	(80)	6	(6)	41	(21)	12	(6)	150	(113)
June	1	(1)	1	(1)	3	(3)	4	(3)	9	(8)
July	5	(0)	3	(2)	8	(3)	5	(2)	21	(7)
August	6	(5)	2	(2)	13	(3)	2	(0)	23	(10)
September	1	(0)	0		0		4	(0)	5	(0)
October	0		0		16	(0)	6	(1)	22	(1)
November	5	(5)	1	(1)	49	(46)	7	(3)	62	(55)
December	16	(15)	2	(2)	1	(1)	7	(2)	26	(20)
1984										
January	2	(0)[a]	5	(2)	17	(14)	15	(7)	39	(23)
February	6	(4)	1	(1)	29	(29)	13	(8)	49	(42)
March	5	(0)	1	(1)	9	(2)	10	(3)	25	(6)
April	9	(4)	0		6	(0)	4	(0)	19	(4)
May	1	(1)	0		0		0		1	(1)
June	5	(0)	2	(2)	0		5	(3)	12	(5)
Total	178	118	30	(24)	281	(129)	121	(43)	610	(314)

[a]Numbers in parenthesis refer to requests originating outside the continental U.S.

Belgium, Botswana, Brazil, Canada, Colombia, Costa Rica, Cuba, India, Japan, Kenya, Mauritania, Mexico, Nigeria, Pakistan, People's Republic of China, Senegal, Sri Lanka, Tanzania, Upper Volta, Uruguay, U.S., Zimbabwe, (see Appendix I). We established exchanges of scientific literature with some of the foreign countries listed. As a result, our collection of reprints has been increased by over 200 documents from Brazil and around 50 documents from Japan.

Professional Meetings Attended: International Workshop in Integrated Pest Control for Grain Legumes, April 3-9, 1983, Goiania, Brazil. Annual Meetings of the Entomological Society of America, November 28-December 2, 1983, Detroit, Michigan.

Future Plans

1. Continuous improvement of computerized operations.
2. Completion of coding and processing of soybean entomology (SoyEnt) literature.
3. Editing of SoyEnt literature for publication.
4. Completion and publication of an International Directory of Soybean Entomologists.
5. Strengthen cooperation with other institutions for the exchange of information on soybeans and other grain legumes.

References

Kogan, J. and M. Kogan (in press). Soybean Research Insect Research Information Center: Suggestions to improve library cooperation in grain legume protection. In P. Matteson, ed. Proceedings of the International Workshop in Integrated Pest Control for Grain Legumes Centra Nacional de Pesquisa de Arroz e feijao, Goiania, Goias, Brazil, April 1983.

Kogan, M. 1981. Dynamics of insect adaptations to soybean: impact of integrated pest management. Environmental Entomology 10(3):263:371.

Kogan, M., and W. H. Luckmann. 1971. A comprehensive program of research and information on soybean insects. Bulletin of the Entomological Society of America 17(2):92-93.

Turnipseed, S.G., and M. Kogan. 1976. Soybean entomology. Annual Review of Entomology. 21:247-282.

INTSOY NEWSLETTER AND MAILING LIST

Bonnie J. Irwin

The INTSOY Newsletter was issued in August 1983 and November 1983 in English, French, and Spanish. The August issue (number 32) was entitled "Sri Lanka: A Model for Soybean Development" and the November issue (Number 33) was entitled "INTSOY Research Highlights: Soybean Virology."

There are approximately 2,000 entries on the mailing list. Nearly two-thirds are mailed overseas. All mailings are by bulk rate or surface mail.

INTSOY PUBLICATION SERIES

Bonnie J. Irwin

Four new items in the INTSOY Publications Series have been issued:

- Number 23 - International Inoculant Shipping Evaluation by R. S. Smith, W. H. Judy, and W. C. Stearn;
- Number 24 - International Soybean Variety Experiment, Seventh Report of Results by J. A. Jackobs, M. D. Staggs, and D. R. Erickson;
- Number 25 - Soybean Research in China and the United States. Proceedings of the First China/USA Soybean Symposium and Working Group Meeting by B. J. Irwin, J. B. Sinclair, and Wang Jin-ling, eds.;
- Number 26 - International Soybean Variety Experiment, Eighth Report of Results, 1980-1981, by J. A. Jackobs, C. A. Smyth, and D. R. Erickson. 1984.

Publication Number 26 is the first INTSOY publication prepared by electronic typesetting. The printing is clearer than the previous process of photo-offset of computer print-outs, and it is more timely.

Demand for INTSOY publications continues. INTSOY Publication Number 1 is out of print. INTSOY Publications Numbers 2, 4, and 5 were reprinted in 1983 (see Table 27). From January 1983 through June 1984, INTSOY mailed out 2,455 items to 77 countries (Table 28). Nearly 54% of the items went to developing countries. Other distribution statistics are shown in Tables 29 through 32.

Twelve items were issued in the INTSOY Staff Report Series (Table 33).

Table 27. List of INTSOY Publications

Number	Title and Author(s)
1	Selected Literature of Soybean Entomology, G. L. Godfrey, ed. 1974.
2	Proceedings of the Workshop on Soybeans for Tropical and Subtropical Conditions. 1974.
3	A Case Study of Expeller Production of Soybean Flour in India, S. W. Williams and K. L. Rathod. 1974.
4	Soybean Processing in India: A Location Study on an Industry to Come, Mattias von Oppen. 1974.
5	Potential Production of Soybeans in North Central India, S. W. Williams, W. E. Hendrix, and M. K. von Oppen. 1974.
6	Soybean Production, Protection, and Utilization: Proceedings of a Conference for Scientists of Africa, the Middle East, and South Asia, D. K. Whigham, ed. 1975.
7	An Annotated Bibliography of Soybean Diseases, J. B. Sinclair and O. D. Dhingra. 1975.
8	International Soybean Variety Experiment, First Report of Results, D. K. Whigham. 1975.
9	Soybean Cultivars Released in the United States and Canada: Morphological Descriptions and Responses to Selected Foliar, Stem and Root Diseases, T. Hymowitz, S. G. Carmer, and C. A. Newell, comp. 1976.
10	Expanding the Use of Soybean: Proceedings of a Conference for Asia and Oceania, R. M. Goodman, ed. 1976.
11	International Soybean Variety Experiment, Second Report of Results, D. K. Whigham. 1976.
12	Rust of Soybeans: The Problem and Research Needs, Report of a workshop held in Manila, Philippines, February 28-March 4, 1977, R. E. Ford and J. B. Sinclair, eds. 1977.
13	Pedigrees of Soybean Cultivars Released in the United States and Canada, T. Hymowitz, C. A. Newell, and S. G. Carmer. 1977.
14	Whole Soybean Foods for Home and Village Use, A. I. Nelson, M. P. Steinberg, and L. S. Wei. 1978.
15	International Soybean Variety Experiment, Third Report of Results, D. K. Whigham and W. H. Judy. 1978.
16	International Soybean Variety Experiment, Fourth Report of Results, W. H. Judy and D. K. Whigham. 1978.
17	The Literature of Arthropods Associated with Soybean. V. A Bibliography of *Heliothis zea* (Boddie) and *H. Virescens* (F.) (Lepidoptera: Noctuidae), J. Kogan, D. K:. Sell, R. E. Stinner, J. R. Bradley, Jr., and M. Kogan. 1978.
18	Sources of Resistance to Selected Fungal, Bacterial, Viral and Nematode Diseases of Soybeans, O. Tisselli, T. Hymowitz, and J. B. Sinclair. 1979.
19	International Soybean Variety Experiment, Fifth Report of Results, 1977, W. H. Judy and H. J. Hill. 1979.
20	Irrigated Soybean Production in Arid and Semi-Arid Regions, W. H. Judy and J. A. Jackobs, eds. 1981.
21	International Soybean Variety Experiment, Sixth Report of Results, 1978, W. H. Judy, J. A. Jackobs, and E. A. Engelbrecht-Wiggans. 1981.

Table 27. (Cont'd)

Number	Title and Author(s)
22	Soybean Seed Quality and Stand Establishment; Proceedings of a Conference of Scientists for Asia, J. B. Sinclair and J. A. Jackobs, eds. 1982.
23	International Inoculant Shipping Evaluation, R. S. Smith, W. H. Judy, and W. C. Stearn. 1983.
24	International Soybean Variety Experiment, Seventh Report of Results, 1979. J. A. Jackobs, M. D. Staggs, and D. R. Erickson. 1983.
25	Soybean Research in China and the United States. Proceedings of the First China/USA Soybean Symposium and Working Group Meeting. B. J. Irwin, J. B. Sinclair, and Wang Jin-ling, eds. 1983.
26	International Soybean Variety Experiment, Ninth Report of Results, 1982, by J. A. Jackobs, C. A. Smyth, and D. R. Erickson. 1984.

Table 28. Distribution of INTSOY Publications by Country January 1983-June 1984

Argentina	38	Honduras	21	Poland	6
Australia	24	Hong Kong	3	Rwanda	9
Bangladesh	4	India	104	Saudi Arabia	18
Belgium	8	Indonesia	125	Senegal	7
Bolivia	4	Iraq	2	South Africa	19
Brazil	87	Israel	1	Spain	11
Burma	2	Italy	7	Sri Lanka	25
Cameroon	2	Japan	17	Sudan	2
Canada	119	Korea	3	Sweden	4
Chile	6	Lesotho	1	Switzerland	7
China(PRC)	93	Madagascar	25	Syria	1
Colombia	41	Malaysia	3	Taiwan	42
Costa Rica	46	Mali	3	Tanzania	30
Cuba	9	Mauritius	3	Thailand	31
Czechoslovakia	28	Mexico	18	Turkey	41
Denmark	6	Morocco	5	Upper Volta	16
Dominican Rep.	9	Nepal	20	USSR	7
Ecuador	29	Netherlands	1	Uruguay	10
Egypt	41	New Zealand	3	Venezuela	61
England & Wales	15	Nicaragua	2	West Indies	4
Ethiopia	4	Nigeria	95	Yugoslavia	2
France	5	Pakistan	95	Zaire	23
Gabon	2	Panama	3	Zambia	19
Germany	10	Peru	19	Zimbabwe	23
Ghana	25	Philippines	40	USA	729
Guatemala	7				

2,455 publications to 77 countries

Table 29. Distribution of INTSOY Publications by Publication Number and Geographical Region, January 1983-June 1984

Publications	U.S. & Canada	Latin America	Asia, Middle East, Australia	Europe	Africa	Total
2	21	17	30	5	22	95
3	5	7	13	1	8	34
4	7	9	15	1	13	45
5	7	8	17	1	7	40
6	23	23	35	8	27	114
7	37	23	25	9	23	117
8	16	10	17	3	13	59
9	34	23	29	3	20	109
10	19	15	31	5	21	91
11	26	11	16	3	15	71
12	21	20	15	5	14	75
13	48	13	22	2	14	99
14	22	16	27	5	15	85
15	19	10	16	3	14	62
16	19	11	16	3	14	63
17	23	21	16	3	15	78
18	42	26	28	7	21	124
19	31	14	18	3	17	83
20	48	33	37	11	23	152
21	39	16	29	9	14	107
22	51	32	43	10	26	162
23	51	18	54	5	11	139
24	67	17	51	4	14	153
25	159	19	74	8	11	271
26	13	2	5	-	5	25
Total	848	414	679	117	397	2,455

Table 30. Distribution of INTSOY Publications by Regions, January 1983-June 1984

Region	Number	Percent
U.S. and Canada	848	34
Asia, Middle East, and Australasia	679	28
Latin America, Caribbean	414	17
Africa	397	16
Europe	117	5
	2,455	100

Table 31. Distribution of INTSOY Publications by Subjects, January 1983-June 1984

Subject	Number	Percent
Conferences (2,6,10,20,22,25)	888	36
ISVEX (8,11,14,17,19,21,24,26)	624	26
Crop Protection (7,12,17,18)	394	16
Germplasm, Inoculum (9,13,23)	345	14
Utilization (3,4,5,14)	204	8
Total	2,455	100

Table 32. Distribution of INTSOY Publications in Developing Countries, January 1983-June 1984

Subject	Number	Percent
Conferences (2,6,10,20,22,25)	463	35
ISVEX (8,11,15,16,19,21,24)	321	24
Crop Protection (7,12,17,18)	216	17
Germplasm, Inoculum (9,13,23)	166	13
Utilization (3,4,5,14)	150	11
	1,316	100

Table 33. INTSOY Staff Reports, January 1983-June 1984

Publication Number	Title	Date	Author
ISR-83-1	S-122/S-170 Meeting in Atlanta, Georgia and visit to N. Carolina State Univ., Raleigh, North Carolina	Feb. 83	W. C. Stearn
ISR-83-2	Costa Rica Trip Report	Feb. 83	J. W. Santas
ISR-83-3	Washington D. C. Trip Report	Feb. 83	H. E. Kauffman
ISR-83-4	Trip Report - Brazil	April 83	J. B. Sinclair
ISR-83-5	Trip Report Brazil	April 83	Jenny Kogan
ISR-83-6	Trip Report - Taiwan, Indonesia, Sri Lanka and Colombia	June 83	H. E. Kauffman
ISR-83-7	Trip Report - Puerto Rico	July 83	H. E. Kauffman
ISR-83-8	Trip Report - India, England	June/ August 83	Jane Polston
ISR-83-9	Trip Report - China Symposium	July 83	H. E. Kauffman
ISR-83-10	Trip Report - IITA, Ibadan, Nigeria	Dec. 83	H. E. Kauffman
ISR-83-11	Visit to the Asian Vegetable Research and Development Center (AVRDC), Taiwan and Participation in the Workshop "CoPublication: Strategies for Multi-language Publication in Agriculture," IRRI, Los Banos, the Philippines	Nov. 83	B. J. Irwin

Table 33 (Cont'd)

Publication Number	Title	Date	Author
ISR-83-12	Trip to Japan, China (Taiwan), Bangladesh, Nepal, Turkey, Nigeria, and Ivory Coast	Sept./ Oct. 83	J. A. Jackobs
ISR-84-1	Visit to the Philippines & Taiwan	April/May	H. E. Kauffman

TRAINING ACTIVITIES

John W. Santas

Training, while not a specific objective of the research contract, involves the INTSOY staff and contributes to the overall goal of the project by imparting knowledge to soybean workers that can translate into action programs in LDCs. INTSOY training has concentrated on short courses offered on the UIUC campus and abroad, as well as specialized programs arranged for individuals and groups coming to campus as short-term visitors.

Two types of short courses have been conducted on the UIUC campus since 1975. The twelve-week course, "Technical and Economic Aspects of Soybean Production" has been conducted a total of eight times during that period and was attended by 101 persons from 42 countries. The companion seven-week course, "Soybean Processing for Food Uses," has been held seven times and reached a total of 79 persons from 36 countries.

In 1979 a three-week soybean production course was held in Palmira, Colombia in cooperation with ICA for 17 extension agents who were involved in the AID/INTSOY soybean development project in Peru. The same type of course was offered again in 1980 and 1982 with enrollment opened to all Latin American and Caribbean scientists able to arrange financial support. To date, 69 persons from 14 countries have participated in this Colombia-based training program which is conducted entirely in Spanish. In June of 1983, ICA and INTSOY cooperated in conducting a four-day workshop for soybean breeders. Twenty-two scientists from throughout Latin America and the U.S. gathered at the Palmira Center to exchange information on their respective varietal improvement programs.

The experience in Colombia demonstrated that INTSOY could effectively combine resources with other organizations to present various types of training overseas. Recent emphasis has been on expanding this dimension of INTSOY's training program to serve other regions of the world. In December of 1983, INTSOY collaborated with the International Institute of Tropical Agriculture (IITA) and the American Soybean Assocation (ASA) to conduct a five-day Soybean Utilization Workshop in Nigeria. Approximately 60 participants from various African countries gathered at IITA to work with soybean processing specialists and become better acquainted with ways to exploit the human nutrition potential of the soybean.

A large percentage of the international visitors who come to the University of Illinois appear on campus specifically because of INTSOY. In 1983 the training officer worked with a total of 84 visitors from 12 different countries who came to learn about INTSOY or confer with INTSOY staff. Records indicate that over the past three years, a total of 341 persons from all regions of the world have come to UIUC as INTSOY visitors.

During 1984, both on-campus courses will be held and a five-day training session on soybean production will be conducted in Antalya, Turkey for staff of their national extension service. In addition, plans are underway to offer a two-week soybean utilization course in Sri Lanka in late 1984 which would be open to participants from throughout Asia.

CONFERENCE AND TRAVEL ACTIVITIES

Conferences. During 1983, INTSOY sponsored with other organizations the following activities:

(1) Latin American Soybean Improvement Network Planning Meeting, June 20-22 - A workshop of 22 Latin American and Caribbean scientists from 15 countries reviewed the current status of soybean research in the region. Plans were developed to strengthen network activities in soybean resesarch and development. Dr. Luis Camacho will coordinate network activities from his station in Colombia.

(2) The 2nd China/USA Soybean Symposium - The second symposium was held in Changchung, Jilin Province, People's Republic of China, July 28-August 2. The USDA and the Ministry of Agriculture, Animal Husbandry, and Forestry sponsored the symposium. One INTSOY scientist participated in the symposium. Recommendations were made for collaborative research activities between China and U.S. soybean scientists.

(3) International Symposium on Soybeans in Tropical and Subtropical Cropping Systems - INTSOY was a joint sponsor of this symposium with the Asian Vegetable Research and Development Center (AVRDC) and the Tropical Agriculture Research Center (TARC) of Japan. More than 100 scientists from 27 countries participated in the symposium where 79 papers summarized recent gains in soybean and cropping systems research.

(4) African Soybean Utilization Workshop - IITA, INTSOY and the American Soybean Association sponsored a workshop for African scientists on soybean utilization. Approximately 60 participants discussed current activities and ways to strengthen soybean production and utilization in Africa.

Travel. During the year, INTSOY scientists visited the following countries: Australia, Bangladesh, Brazil, China, Colombia, Ivory Coast, Indonesia, Japan, Nepal, Nigeria, Sri Lanka, and Taiwan. Visits were made to these countries to observe ISVEX trials, conduct and discuss collaborative research and to attend meetings.

ADMINISTRATION AND BUDGET

EXPENDITURES AND PROJECT STAFF

PROGRAM OF EXPENDITURES

	Contract Period 4/1/76-12/31/82	Report Period 1/1/84-06/30/84*	Total Expenditures 4/1/76-06/30/84*
1. Salary and Wages	$2,391,330.00	$650,135.00	$3,041,465.00
A. Professional	(1,646,310.00)	(557,510.00)	(2,203,820.00)
B. Support	(745,020.00)	(92,625.00)	(837,645.00)
2. Fringe Benefits	261,212.00	70,507.00	331,719.00
3. Indirect Costs	1,499,155.00	364,233.00	1,863,338.00
4. Travel and Transportation	298,889.00	68,437.00	368,326.00
5. Other Direct Costs	370,539.00	132,101.00	502,640.00
6. Equipment and Supplies	342,222.00	58,071.00	400,293.00
TOTAL	$5,163,347.00	$1,344,484.00	$6,507,831.00

*Provisional amount as final statement was not complete when this was printed.

APPENDIX I: 1983 COOPERATORS IN INTSOY TRIALS

No.	Country	Cooperator	Organization	Research Trial Numbers*
1.	Antigua	Sligh	PLENTY	83140
2.	Argentina	Siciliano		83526
		Zelarayan	INTA	83185, 83441
3.	Australia	Rose	Hermitage Research Station	83301, 83302
4.	Bangladesh	Khaleque	Bangladesh Agricultural Research Station	83157
		Rahman	Bangladesh Agricultural University	83632
		Webster	Mennonite Central Committee	83437
5.	Bolivia	Delgadillo	IBTA	83439
		Ferreiro	CORGEPAI	83625
		Ovando	Centro de Investigacion Agricola Tropical	83717
		Vasquez	CORGEPAI	83183
6.	Brazil	Carraro, Fonseca	OCEPAR	83442
7.	Burma	Hlaing	Agriculture Corporation	83177
		Simkins	Agriculture Corporation	83151, 83154, 83429
8.	Cameroon	Angell	Peace Corps - Ecole Technique d'Agriculture	83112
		Hadi		83409
		Salez	IRA	83408, 83620
9.	Central African Republic	Elkstrand	Institute Technique Agricole	83101
10.	Chile	Parodi	Catholic University of Chile	83525
11.	China	Xiuying	Academy of Agricultural Sciences	83905

APPENDIX I: 1983 COOPERATORS IN INTSOY TRIALS

No.	Country	Cooperator	Organization	Research Trial Numbers*
12.	China(Taiwan)	Shanmugasundaram	AVRDC	83400, 83609
13.	Colombia	Bastidas	ICA	83108, 83138, 83304, 83623, 83713, 83714, 83803
		Granada	ICA	83303
14.	Costa Rica	Alfaro, Morales	Ministerio de Agricultura y Ganaderia	83163, 83174, 83175
		Mata	CARE-Costa Rica	83162, 83173, 83624
		Villalobas	Universidad de Costa Rica	83432
15.	Cuba	Director	Ministerio de la Agricultura	83153, 83427
16.	Czechoslovakia	Bares		83605
		Sinsky, Pastucha	Ustav genetiky a slechtni	83906
17.	Dominica	Sligh	PLENTY	83140
18.	Ecuador	Agronomist	Agrolandia	83155
		Diaz	INIAP	83910
		Maldonado	INIAP	83125, 83128
19.	Egypt	Ashour	National Research Center	83603
		Cassman	EMCIP-NMSU, N.R.C.	83601
		Cassman, Nassib	Ministry of Agriculture	83402, 83501
20.	El Salvador	Vasquez	M.A.G. - CENTA	83164, 83166
21.	Ethiopia	Belay	Institute of Agricultural Research	83111, 83410
22.	Fiji	Viner	Department of Agriculture	83306
23.	Gabon	Van de Plas	Project UTF/GAB/005 CIAM	83102

APPENDIX I: 1983 COOPERATORS IN INTSOY TRIALS

No.	Country	Cooperator	Organization	Research Trial Numbers*
24.	The Gambia	Director	Ministry of Agriculture and Natural Resources	83149, 83165
25.	Germany(West)	Schneider	Biologische Station	83307
26.	Ghana	Acquaah	University of Cape Coast	83130
		Agyemang	Grains Development Board	83619
		Asafo-Adjei	Crops Research Institute	83618
		Atuahene-Amankwa	Crops Research Institute	83106
		Marenah	FAO Regional Office for Africa	83308
		Schmidt	AGRO INDUSTRIES, MIM, LTD.	83102
27.	Greece	Skaracis	Hellenic Sugar Industry S.A.	83503, 83510
28.	Guatamala	Arauz	ICTA	83147, 83148, 83502
29.	Guinea Bissau	Schwarz	DEPA	83109
30.	Haiti	Galax Inc.	Galax Inc.	83598
31.	Honduras	Chang	Escuela Agricola Panamericana	83172, 83176
		Tigchelaar		83166
32.	India	Director	I.A.R.I. Campus	83309, 83311
		Polston		83310
33.	Indonesia	Schmidt		83312
		Sumarno, Dimyati	Central Research and Development Institute for Food Crops	83126
34.	Iraq	Elsahookie	College of Agriculture	83611
35.	Italy	Cavicchioli	University of Florence	83313

APPENDIX I: 1983 COOPERATORS IN INTSOY TRIALS

No.	Country	Cooperator	Organization	Research Trial Numbers*
		Porreca	Laboratorio Agronomia	83507, 83508
36.	Ivory Coast	Roger	Project Soja	83142, 83143
37.	Jamaica	Dixon	PLENTY	83141, 83144
38.	Jordan	Haddad	University of Jordan	83314
39.	Kenya	Nzabi	Nyanza Agricultural Research Station	83160, 83430
40.	Korea	Hong	Crop Experiment Station, ORD	83517
41.	Kuwait	Elshawareb	Ministry of Public Works	83499
42.	Laos	Marchionneschi	United Nations Development Program (UNDP)	83192
43.	Lebanon	Solh	Faculty of Agricultural and Food Sciences	83511
44.	Malagasy	Randriamaholy	MAMISOA	83184, 83435, 83627
45.	Malawi	Chikasema	Chitedze Research Station	83628
46.	Mali	Soumano	ICRISAT	83124
47.	Mauritius	Owadally	Ministry of Agriculture	83103, 83426
48.	Mexico	Alfonso	Comision nacional de Las Zona Aridas	83404, 83407
		Hatem	INIA-CIAGON	83145, 83146, 83161,
		Rivers	INIA	83631

APPENDIX I: 1983 COOPERATORS IN INTSOY TRIALS

No.	Country	Cooperator	Organization	Research Trial Numbers*
49.	Morocco	Driss	Ministere de l'Agriculture et de la Reforma Agraire	83412, 83509
50.	Nepal	Chaudhary	Agronomy Division	83120, 83413, 83514
51.	Pakistan	Beg	National Agriculture Research	83411, 83518, 83519, 83520, 83521, 83610, 83709, 83710
		Chaudhry	Agricultural Research Institute	83418
		Khan	Nuclear Institute for Food & Agriculture	83433
		Lockman	Tech. Services Assoc. Agricultural Project	83316, 83900, 83901, 83902, 83903
		Mailk	Chitral Volunteer Mission	83599
52.	Paraguay	Aguilera	Instituto Agronomico Nacional	83626
		Casaccia, Aguilera Alvarez	Instituto Agronomico Nacional	83434
		Wang	Mision Technica Agricola de China	83444, 83447
53.	Peru	Celada	Estacion Experimental Vista Florida	83318
54.	Philippines	Agbisit	Cagayan State University	83131, 83133
		Ballon	Botanique Philippines, Inc.	83129, 83170, 83186
		Furoc	IRRI	83100
		Punto	University of the Philippines	83705
		Sison, Lantican	University of the Philippins	83804
55.	Portugal	Gaspar	INIA	83506

APPENDIX I: 1983 COOPERATORS IN INTSOY TRIALS

No.	Country	Cooperator	Organization	Research Trial Numbers*
56.	Puerto Rico	Camacho	INTSOY	83320
		Camacho, Bravo	INTSOY	83150, 83319, 83614
		Stearn	INTSOY	83321
57.	Reunion	Marchand	IRAT	83440
58.	St. Lucia	Sligh	PLENTY	83115
59.	St. Vincent	Sligh	PLENTY	83123
60.	Saudi Arabia	Al-Jowairah	Ministry of Agriculture and Water	83742, 83743
		Lin	Chinese Agricultural Technical Mission	83117, 83118, 83415, 83416, 83512, 83513
		Samarraie	King Abdulaziz University	83420
61.	Senegal	Larcher	C.N.R.A.	83156, 83612, 83613
62.	Sierra Leone	Williams	Rice Research Station	83167
63.	Somalia	Backshi, Shawki	UNDP	83104, 81305
64.	South Africa	Director	Department of Agriculture and Fisheries	83401, 83500
65.	Sri Lanka	Dharmasena	Soybean Foods Research Center	83108, 83805
66.	Sudan	Ageeb	Gezira Research Station	83134, 83421, 83602, 83706
		Ghobrial	Kenana Research Station	83152, 83414
		Mohamed	Hudeiba Research Station	83119, 83417
		A.R.C.	A.R.C.	83322, 83405, 83406, 83606, 83607, 83608, 83616, 83617
		Russell	Episcopal Church Center	83113, 83114
67.	Tanzania	Carpenter	FAO	83110, 83181, 83182

APPENDIX I: 1983 COOPERATORS IN INTSOY TRIALS

No.	Country	Cooperator	Organization	Research Trial Numbers*
68.	Thailand	Gypmantasiri	Chiang Mai University	83121
		NaLampang	Department of Agriculture	83132, 83704
		Srinives	Kasetsart University	83168
	Thailand	Tongdee	Takli Field Crops Research Center	83171
69.	Turkey	Altunay	Regional Agricultural Research Institute	83323, 83505
70.	United States	Bowers	Texas A&M University	83329, 83802
		Buckholz		833289
		Creelman	Texas Agricultural Experimental Station	83438, 83716
		Fletcher, Rheinigans	University of Illinois	83324
		Petersen	Kanuga Conf. Center	83327
		Price	ECHO	83326
		Singh	CARDI	83325
		Singhe	University of Illinois	83320
71.	Upper Volta	Vanounou	C.E.R.C.I.	83122, 83127
72.	Venezuela	Lastra	IVIV	83331
		Nino	Fundacion Servicio para el Agricultor	83159
73.	Yugoslavia	Belic	Institute of Field and Vegetable Crops	83504
		Director	Institute for Agricultural Economic and Food	83907
		Spanring	Univ. Prof. Field Crops	83332
74.	Zaire	Nguyen	MASI/INERA Team	83169, 83187, 83431, 83443, 83621, 83622, 83712

APPENDIX I: 1983 COOPERATORS IN INTSOY TRIALS

No.	Country	Cooperator	Organization	Research Trial Numbers*
75.	Zambia	Joshi, Nkumbula, Javaheri	USAID, Zamare Project	83178, 83179, 83180, 83718, 83719
76.	Zimbabwe	Tatterfield	Seed Maize Co-Op Company of Zimbabwe, Ltd.	83419
		Tichagwa	Crop Breeding Institute	83333, 83334, 83428, 83615, 83708

44 Countries received 85 Tropical Research Trials (ISVEX).
27 Countries received 39 Subtropical Research Trials, (ISVEX).
17 Countries received 23 Temperate Research Trials, (ISVEX).

74 total countries received 147 ISVEX Research Trials.

17 Countries made 31 requests for Germplasm, (SEEDS).
21 Countries received 29 Promiscuous Nodulation Trials, (PROM NOD).
13 Countries received 20 Preliminary Observation Research Trials, (SPOT).
5 Countries received 5 Initial Evaluation Research Trials, (SIEVE).
5 Countries received 8 Special Research Trials.

12 Universities in 10 countries were involved in this research.
52 National Agricultural Institutes, Departments and/or Research Stations from 45 countries were involved.
25 Philanthropic and/or International Institutes were involved in 21 countries with this research.

*83100 numbers indicate Tropical Research Trials (ISVEX).
83300 numbers indicate Germplasm requests.
83400 numbers indicate Subtropical Research Trials (ISVEX).
83500 numbers indicate Temperate Research Trials (ISVEX).
83600 numbers indcate Promiscuous Nodulation Research Trials (PROM NOD).
83700 numbers indicate Preliminary Observation Research Trials (SPOT).
83800 numbers indicate Initial Evaluation Research Trials (SIEVE).
83900 numbers indicate Special Research Trials.

APPENDIX II: SUMMARY BY MONTH, COUNTRY, AND INSTITUTIONS OF SERVICES RENDERED BY SIRIC 1/1/83-6/30/84

Month	Country	Institution	Name	Number of Bibliographies	Number of Documents	Number of Computer Searches
1983						
January	Honduras	Panamerican School ofd Agriculture	F. E. Bencosem	5	2	-
	Nigeria	International Institute of Tropical Agriculture	R. I. Egwatu	1	9	1
	Nigeria	International Institute of Tropical Agriculture	L. Jackai	1	-	2
	Pakistan	Pakistan Agricultural Research Council	A. Beg	5	7	-
	Vietnam	Faculty of Agric. Univ. of Cantho	Vo-Tong Xuan	5	-	-
February	Australia	Division of Agriculture and Stock	A. Allwood	2	-	-
	Ethiopia	Institute of Agricultural Research	T. Abate	5	5	-
March	Brazil	EMBRAPA	B.P. das Neves	1	-	5
	Peru	--	C. H. Vilcarraomero Detquizan	-	4	-
April	Brazil	CNPSoja/EMBRAPA	D. Gazzoni	-	-	1
	Chile	--	M. A. Habit	5	2	-
	Colombia	--	E. P. Torres	3	-	-
	Honduras	DARCO	L. A. G. Arias	1	-	-
	Honduras	Dept. of Agronomy	A. J. Caballero	1	-	-
	Honduras	--	M. G. Chavez	1	-	-
	Honduras	--	E. Dalyrmple	5	-	-
	Honduras	Dept. of Agriculture	R.E.R. Espinoza	2	-	-
	Honduras	--	G. Evans	5	-	-
	Honduras	--	J. B. G. Funes	5	-	-
	Honduras	Office of Natural Resources	B. Mejia Y.M.	5	-	-
	Honduras	Dept. of Agriculture	F. A. Montenegro	3	-	-

APPENDIX II: SUMMARY BY MONTH, COUNTRY, AND INSTITUTIONS OF SERVICES RENDERED BY SIRIC 1/1/83-6/30/84

Month	Country	Institution	Name	Number of Bibliographies	Number of Documents	Number of Computer Searches
April	Honduras	Dept. of Agriculture	F. A. Montenegro	3	-	-
	Honduras	Dept. of Agriculture	R. Ordonez A.	5	-	-
	Honduras	--	J. T. Pereira A.	2	-	-
	Honduras	Dept. of Agriculture	C.A.N. Piro	5	-	-
	Honduras	National Program of Agriculture Research	H. Rittenhouse	2	-	-
	Honduras	Office of Natural Resources	S. Q. Rivera	2	-	-
	Honduras	National Center of Agriculture	L. A. Sarantez	1	-	-
	Honduras	National Program of Agricultural Research	J. A. Sauter	5	-	-
	Honduras	--	R. Valdez	1	-	-
	Honduras	Office of Natural Resources	G.A.F. Valladares	1	-	-
	Honduras	DARCO	M.M. Valle	3	-	-
	Honduras	Office of Natural Resources	M. de J. Viera	3	-	-
	India	--	R. Singh	-	-	1
	Turkey	Arastirma Enstitusu	K. Turkuglu	-	1	-
May	Australia	Dept. of Agriculture-Western Australia	M. Heap	-	2	2
	Australia	Dept. of Primary Industries	J.J. Titmarsh	1	-	-
	Bolivia	CIAGRO	J. S. Landivar	5	-	1
	India	Division of Entomology-Indian Agriculture Research Institute	H. P. Saxena	-	-	1
	India	--	R. Singh	1	-	-
	Japan	Faculty of Agriculture	Editor of Esakia	5	-	-
	Uruguay	Dept. of Plant Pathology	W. Chiaravalle	5	5	-
June	Brazil	Federal University of Parana	E. R. Silveira	5	-	-

APPENDIX II: SUMMARY BY MONTH, COUNTRY, AND INSTITUTIONS OF SERVICES RENDERED BY SIRIC 1/1/83-6/30/84

Month	Country	Institution	Name	Number of Bibliographies	Number of Documents	Number of Computer Searches
June	Chile	Experimental Station La Platina	V. Valdira	5	-	-
	Egypt	Plant Protection Research Institute	M. Fahmi A. H.	5	1	1
	Egypt	Food Legume Research Station	M. Z. Hassam	4	-	-
	Egypt	Plant Protection Research Institute	Z. R. Sawries	5	1	1
	India	International Center for Agricultural Research	K. A. Pathak	5	1	1
	India	Oilseeds Growers Assoc.	M. S. Singh Deo	5	-	-
	India	Oilseeds Growers Assoc.	M. D. Tedia	5	-	-
	Indonesia	Bogor Research Institute for Food Crops	A. Dimyati	5	-	-
	Kenya	Nyanza Agricultural Research Station	W. A. Nzabi	5	-	-
	People's Republic of China	Institute of Plant Protection	Q. Yuan	3	-	-
	Syria	Plant Production Dept. of Damascus Univ.	M. Sabbouh	5	-	-
	Tanzania	--	E. T. Marenge	5	-	-
	Venezuela	Central University of Venezuela	H. Geraldo V.	5	-	-
	Zaire	INERA	P. M. Mulendo	5	-	-
	Zaire	INERA	M. N . Tshidimba	5	-	-
July	Brazil	Institute of Agronomy	--	5	-	-
	Cuba	Institute for Fundamental Investigations in Tropical Agriculture	M. Gonzalez	5	-	-
	Egypt	--	M. Hassan	-	-	3
	Honduras	--	S. Rivera	-	2	-
	India	ICAR Research Complex for N.E.A. Region Shillong	K. A. Pathak	-	-	1

APPENDIX II: SUMMARY BY MONTH, COUNTRY, AND INSTITUTIONS OF SERVICES RENDERED BY SIRIC 1/1/83-6/30/84

Month	Country	Institution	Name	Number of Biblio-graphies	Number of Documents	Number of Computer Searches
August	People's Republic of China	Institute of Plant protection	Q. Yuan	5	-	-
	Uruguay	Dept. of Plant Pathology	W. Chiavaralle	5	-	-
	Venezuela	--	J. Gonzalez	5	3	1
	Cuba	Dept. of Plant Pathology	A. Castineiras	-	6	1
	India	Division of Entomology-Indian Agricultural Research Institute	H. P. Saxena	-	13	-
	People's Republic of China	Institute of Plant Protection	Q. Yuan	-	-	3
September	Brazil	Union Carbide	M. Margulis	2	5	1
	Brazil	Univ. of Piracicaba	J. Parra	-	1	-
	Cuba	Dept. of Plant Pathology	A. Castineiras	5	4	-
	People's Republic of China	Institute of Plant Protection	Q. Yuan	-	-	2
October	Argentina	Dept. of Agricultural Sciences	R. E. Breredon	5	4	-
	Argentina	Faculty of Agronony and Veterinary Medicine	L. Cholsky	-	3	-
	Brazil	National Institute of Agricultural Technology	H. G. Bimboni	5	4	-
	Brazil	--	U. D. Machado	5	4	-
	India	Dept. of Entomology and Apiculture	N. P. Kashyap	5	4	-
	Malaysia	Agricultural Research Center	E. S. Sim	5	4	1
	Uruguay	Ministry of Agriculture and Fisheries	L. A. Amendola	5	1	-

APPENDIX II: SUMMARY BY MONTH, COUNTRY, AND INSTITUTIONS OF SERVICES RENDERED BY SIRIC 1/1/83-6/30/84

Month	Country	Institution	Name	Number of Biblio-graphies	Number of Documents	Number of Computer Searches
November	Argentina	—	O. Giayetto	-	1	-
	Brazil	EMBRAPA	E. Bleicher	-	1	-
	Brazil	EMBRAPA	U. Dantas	-	2	-
	Brazil	EMBRAPA	U. Dantas	5	-	-
	Indonesia	Pengamatan Dan Laboratory	Dr. Zulkaranaen	5	4	-
	Kenya	International Center of Insect Physiology and Ecology	R. P. Ortega	5	4	-
	Mexico	UNACH	J. Telford	10	20	3
December	India	IARI	B. Upendranath	1	-	-
	Nigeria	International Institute of Tropical Agriculture	L. Jackai	-	15	-
	Nigeria	International Institute of Tropical Agriculture	S. Singh	-	-	1
	People's Republic of China	Institute of Plant	Q. Yuan			

APPENDIX II: SUMMARY BY MONTH, COUNTRY, AND INSTITUTIONS OF SERVICES RENDERED BY SIRIC 1/1/83-6/30/84

Month	Country	Institution	Name	Number of Biblio-graphies	Number of Documents	Number of Soy Insects Bulletin	Number of Computer Searches
1984							
January	Belgium	University Gent	Abu Kassim B. Abu Bakar	-	-	1	-
	Brazil	EMBRAPA/CNPSoja	E. Oliveira	-	-	10	1
	Brazil	EMBRAPA/Dourados	D. L. Gazzoni	-	-	-	1
	Brazil	EMBRAPA/CNPSoja	G.L. Villas Boas	-	-	-	1
	Costa Rica	Consejo National de Produccion-Departa-mento Agrotecnico	Moreira, A.G.	-	4	1	-
	USA	Tidewater Research Center, VPI & SU	Smith, J.C.	1	-	3	-
	USA	Ill. Natural History Survey, Section Econ. Entomology	M. Kogan	-	3	-	-
	USA	Ill. Natural History Survey, Section Econ. Entomol.	J. Appleby	-	-	-	1
	USA	Visiting Scholar People's Republic of China	Qu Yalin	-	-	-	4
	USA	Ill. Natural History Survey, Section Econ. Entomol.	Soybean Project	-	-	-	6
	USA	BARC-USDA	Raina, A.K.	1	-	-	-
February							
	Brazil	EMBRAPA/CNPSoja	G.L. Villas Boas	-	-	-	2
	Brazil	EMBRAPA/CNPSoja	Library	-	9	-	-
	Colombia	CIAT	G. Hallman	-	-	-	2
	Colombia	CIAT/Library	S. J. Lopez	-	17	-	-
	Indonesia	Entomologist/MORIF	W. A. Akib	4	2	1	3

APPENDIX II: SUMMARY BY MONTH, COUNTRY, AND INSTITUTIONS OF SERVICES RENDERED BY SIRIC 1/1/83-6/30/84

Month	Country	Institution	Name	Number of Biblio-graphies	Number of Documents	Number of Soy Insects Bulletin	Number of Computer Searches
February (cont'd)	Portugal	Centro de	E. Luna de Carvalo	-	1	-	-
	Thailand	Kiu Lom Land Settlement	L. Le Coump	-	-	-	1
	USA	Ill. Natural History Survey, Section Econm. Entomol.	Soybean Project	-	-	-	4
	USA	Kansas State Univ.	J. Reese	2	-	-	1
March	Colombia	CIAT	G. Hallman	-	-	-	2
	Thailand	Kiu Lom Land Settlement	L. Le Coump	-	2	1	1
	USA	Crop Science Engineering Lab., Boll Weevil Mississippi St. Univ.	J. N. Jenkins	2	-	-	-
	USA	Entomologist/TAES	B. M. Drees	3	-	-	-
	USA	Ill. Natural History Survey, Section Econ. Entomol.	M. Kogan	-	-	-	5
	USA	Ill. Natural History Survey, Section Econ. Entomol.	D. Kuhlman	-	1	-	-
April							
	India	Inst. Agr. Sci. Banaras Hindu Univ.	R. N. Singh	4	-	-	-
	USA	Crop Sci. Res. Lab. Mississippi State	R. E. Fye	5	-	-	-
	USA	Dept. of Entomol. Univ. of Illinois	G. Waldbauer	-	-	-	1
	USA	Dept. of Entomol. Univ. of Illinois	C. Reid	-	-	-	1

APPENDIX II: SUMMARY BY MONTH, COUNTRY, AND INSTITUTIONS OF SERVICES RENDERED BY SIRIC 1/1/83-6/30/84

Month	Country	Institution	Name	Number of Biblio-graphies	Number of Documents	Number of Soy Insects Bulletin	Number of Computer Searches
April cont'd	USA	Land of Lakes Res. Farm, Iowa	D. Ivers	-	6	-	2
May	Taiwan	Plant Protection Center	S. S. Kao	1	-	-	-
June	Cyprus	Dept. of Agric. Ministry of Agric. and nat. Res.	Th. Photiado	-	-	-	1
	India	ICAR Res. Complex, India	K. A. Pathak	-	-	1	-
	Japan	Agr. Res. Center Yatabe	A. Naito	-	-	-2	
	Uruguay	Proyecto Cultivos Estacion Exp. la Estanzuela	V. Trucillo	-	1	-	-
	USA	Dept. Entomol. Mississippi St. Univ.	S.M. Ali	5	-	-	1
	USA	Ill. Natural History Survey, Section Econ. Entomol.	N. Liquido	-	-	-	1
	USA	Dept. of Entomol. Univ. of Illinois	C. Boulton	-	-	-	1
			TOTALS	311	246	9	78

APPENDIX III: LIST OF PUBLICATIONS BY INTSOY STAFF APPEARING OR SUBMITTED JANUARY 1983-JUNE 1984

Bisht, V. S., and J. B. Sinclair. 1983. Effect of *Cercospora sojina* and *Phomopsis* spp. on soybean seed quality and yield (Abstr.) Phytopathology 73:804.

Bowman, J. E., J. T. Yorinori, and J. B. Sinclair. 1983. (Nontarget effects of herbicides on soybean fungal pathogens and seed quality). Proc. XVI Brasilian Cong. (Abstra.) Phytopathology 73:153.

Bowman, J. E., J. T. Yorinori, and J. B. Sinclair. 1983. (Nontarget effects of herbicides on soybean fungal pathogens on seed quality in Parana, Brazil) (Abstr.) Fitopatologia Brasileira 8:608. In Portugese.

Bowers, G. R., Jr., and R. M. Goodman. Effect of strains of soybean mosaic virus on soybean seed characters. In preparation for Phytopathology.

Bowers, G. R., Jr., E. H. Paschal II, R. L. Bernard, and R. M. Goodman. Inheritance of resistance to soybean mosaic virus. In preparation for Crop Science.

Cerkauskas, R. F., O. D. Dhingra, and J. B. Sinclair. 1983. Effect of three dessicant-type herbicides on fruiting structures of *Colletotrichum truncatum* and *Phomopsis* spp. on soybean stems. Plant Disease 67:620-622.

Cerkauskas, R. F., O. D. Dhingra, J. B. Sinclair, and G. Asmus. 1983. *Amaranthus spinosus*, *Leonotis nepetaefolia*, and *Leonurus sibiricus*: new host of *Phomopsis* spp. in Brazil. Plant Disease 67:821-824.

Cho, E. K., and R. M. Goodman. 1982. Field spread of soybean mosaic virus strains. Korean J. Plant Protection. In press.

Cho, E. K., and R. M. Goodman. 1982. Evaluation of resistance in soybeans to soybean mosaic virus strains. In press.

Cubeta, M. A., L. E. Datnoff, and J. B. Sinclair. 1983. Soybean (*Glycine max* 'Wells'), pre- and postemergence damping off; *Cercospora kikuchii Phomopsis* spp. and seed and soilborne microorganisms. Fungicide Nematicide Tests 38:31.

Cubeta, M. A., and J. B. Sinclair. 1983. Effect of *Bacillus subtilis* on fungi associated with soybeans. (Abstr.) Phytopathology 73:799.

Datnoff, L. E., M. A. Cubeta, V. S. Bisht, P. N. Thapliyal, and J. B. Sinclair. 1983. Soybean (*Glycine max* cv. 'Wells"), pre- and postemergence damping off, seed and soilborne microorganisms. Fungacide Nematicide Tests 38:32.

Datnoff, L. E., and J. B. Sinclair. 1983. Field interaction between *Rhizoctonia solani* and *Fusarium oxysporum* on soybeans. (Abstr.) Phytopathology 73:843.

APPENDIX III: LIST OF PUBLICATIONS BY INTSOY STAFF APPEARING OR SUBMITTED JANUARY 1983-JUNE 1984

Elmore, R. W., and J. A. Jackobs. 1983. Yield components of sorghum and soybeans when intercropped. Amer. Soc. Agron. (Submitted for publication).

Elmore, R. W., and J. A. Jackobs. 1984. Yield and yield components of sorghum and soybeans of varying plant heights when intercropped. Agron. J. In press.

Fletcher, J., and R. M. Goodman. 1984. Instability characters of soybean mosaic virus strains after seed transmission. Submitted to Soybean Genetics Newsletter.

Fletcher, J., M. E. Irwin, O. E. Bradfute and G. A. Grandada. 1984. A machismo-like disease of soybeans in Mexico. Abstract. Phytopathology. (in press).

Fletcher, J., M. E. Irwin, O. E. Bradfute, and G. A. Granada. 1984. A machismo-like disease of soybeans in Mexico. Submitted to Plant Disease.

Fletcher, J., M. E. Irwin, O. E. Bradfute and G. A. Granada. Discovery of a mycoplasmalike organism associated with diseased soybeans in Mexico. Plant Disease. (in press).

Goodman, R. M. 1982. Ultrasensitive methods for detection of geminiviruses and their genomes. In Workshop on Plant Virus Detection, 29 March - April, 1982. Agric. Exp. Sta., Univ. of Puerto Rico, Rio Piedras, Puerto Rico.

Goodman, R. M., and M. E. Irwin. 1981. Whitefly-transmitted viruses in tropical agriculture. Programme and Abstracts Int. Workshop on Pathogens Transmitted by Whiteflies. Oxford, England. pp. 2-4.

Haber, S. 1982. The genome of bean golden mosaic virus, a geminivirus. In Workshop on Plant Virus Detection, 29 March - 2 April, 1982. Agric. Exp. Station, University of Puerto Rico, Rio Piedras, Puerto Rico.

Haber, S., J. E. Polston, and J. Bird. A Malvaceous perennial weed is a host of bean golden mosaic virus in Puerto Rico. In preparation for Plant Disease.

Haber, S., R. M. Goodman, and J. Bird. Detection and identification of geminivirus strains from Puerto Rico by Southern analysis. In preparation for Phytopathology.

Halbert, S. E., M. E. Irwin, and R. M. Goodman. 1983. Dynamics of aphid transmission of soybean mosaic virus. Pages 173-179 in B. J. Irwin and J. B. Sinclair, Eds., Soybean Research in China and the United States. July 26-30, 1982. Proc. First China/USA Soybean Symposium and Working Group Meeting. INTSOY Series 25, Col. Ag. Univ. IL.

APPENDIX III: LIST OF PUBLICATIONS BY INTSOY STAFF APPEARING OR SUBMITTED JANUARY 1983-JUNE 1984

Halbert, S. E., and M. E. Irwin. 1981. Effect of soybean canopy closure on landing rates of aphids with implications for restricting spread of soybean mosaic virus. Ann. Appl. Biol. 998(1):15-19.

Halbert, S. E., M. E. Irwin, and R. M. Goodman. 1981. A late aphid (Homoptera: Aphididae) species and their relative importance as field vectors of soybean mosaic virus. Ann. Appl. Biol. 97:1-9.

Halbert, S. E., M. E. Irwin, and R. M. Goodman. 1983. Dynamics of aphid transmission of soybean mosaic virus. pages 175-179 in B. J. Irwin and J. B. Sinclair, Eds., Soybean Research in China and the United States. July 26-30, 1982. Proc. First China/USA Soybean Symposium and Working Group Meeting. INTSOY Series 25, Col. Ag. Univ. Ill.

Hartman, G. L., R. P. McClary, J. B. Sinclair, and J. W. Hummel. 1983. Effect of tillage systems on corn stalk rot. (Abstr.) Phytopathology 73:843.

Hartman, G. L., J. B. Manandhar, C. C. Machado, and J. B. Sinclair. 1984. Soybean seed treatments, 1983. Fungicide and Nematicide Tests 39: 159.

Hepperly, P. R., J. S. Mignucci, J. B. Sinclair, and J. B. Mendoza. 1933. Soybean anthracnose and its seed assay in Puerto Rico. Seed Sci. Technol. 11:371-380.

Irwin, B. J., J. B. Sinclair, and Jin-Ling Wang. 1983. Soybean Research in China and the United States. University of Illinois at Urbana-Champaign Col. Agr. INTSOY Series No. 25, Urbana, IL. 194 pp.

Irwin, M. E. 1983. Factors that influence alighting in aphids. Abstracts of Proceedings, page 8. International Working Group on Legume Viruses. Binna Buna Lodge, Queensland, Australia. August 11-13, 1983.

Irwin, M. E., and W. G. Ruesink. 1983. Quantitative assessment and monitoring of aphids as vectors of plant viruses. Abstracts of Papers, page 15. In Plant Virus Epidemiology, Monitoring, Modeiling and Predicting Outbreaks of Virus and Virus Vectors. Corowa, New South Wales, Queensland, August 25-27, 1983.

Irwin, M. E. 1983. The *boharti* species group of the genus *pherocera* (Diptera: Therevidae: Phycinae). Pan-Pac. Entomol. 59:113-139.

Irwin, M. E. 1980. Sampling aphids in soybean fields. pp. 239-259 *in* M. Kogan and D. C. Herzog, eds. Sampling Methods in Soybean Entomology. Springer-Verlag, New York. 587 pp.

Irwin, M. E., and K. V. Yeargan. 1980. Sampling phytophagous thrips on soybean. pp. 283-304 *in* M. Kogan and D. C. Herzog, eds. Sampling Methods in Soybean Entomology. Springer-Verlag, New York. 587 pp.

APPENDIX III: LIST OF PUBLICATIONS BY INTSOY STAFF APPEARING OR SUBMITTED JANUARY 1983-JUNE 1984

Irwin, M. E., J. M. McGrann, R. E. Stuckey, G. F. Warren and D. E. Broersma. 1980. A multi-disciplinary integrated crop protection site team report for Latin America, emphasizing Guatemala, Costa Rica, Colombia, and Peru. Part of a Title XII Planning Grant to Purdue University. 84 p. plus 8 appendices.

Irwin, M. E., J. M. McGrann, R. E. Stuckey, G. F. Warren and D. E. Broersma. 1980. A multi-disciplinary inetgrated crop protection site team report for Latin America, emphasizing Guatemala, Costa Rica, Colombia, and Peru. Part of a Title XII Planning Grant to Purdue University. 84 p. plus 8 appendices.

Irwin, M. E., F. Avalos, F. Chicoma, J. Chiroque, P. Acala, and E. Cardenas. 1981. The soybean insect pest management program in the Selva Alta of Peru. Univ. Ill., Int. Agric. Publ. INTSOY Country Reports 81-2, 33 p.

Irwin, M. E., S. E. Halbert, G. A. Schultz, and R. M. Goodman. 1981. Environmental factors that alter landing rates of aphid species and the subsequent spread of an aphid-borne, nonpersistently vectored virus. Int. Conf. on Plant Virus Disease Epidemiology. Abstracts of papers. 1981:19.

Irwin, M. E., and G. A. Schultz. 1981. Soybean mosaic virus. FAO Plant Protection Bull. 29:41-55.

Irwin, M. E., and L. Lyneborg. 1981. The general of Nearctic Therevidae. Ill. Nat. Histo. Surv. Bull. 32:193-277.

Irwin, M. E. and W. G. Ruesink. Vector intensity: a product of propensity and activity. *In* G. D. McLean, et al., eds. Plant Virus Epidemiology: Monitoring, Modelling and Predicting Outbreaks. Academic Press, Sydney. (In press).

Kelley, T. G. and J. A. Jackobs. 1983. A comparison of yield stability under solecrop and intercrop systems of planting with soybeans. Proc. First International Symposium on Soybean in Tropical and Subtropical Cropping Systems, Tsukuba, Japan. (In press).

Kogan, J. and M. Kogan (in press). Soybean Insect Research Information Center: Suggestions to improve library cooperation in grain legume protection. In P. Matterson, ed. Proceedings of the International Workshop in Integrated Pest Control for Grain Legumes. Centro nacional de Pesquisa do Arrox e Feijao, Goiania, Goias, Brazil, April 1983.

Liquido, N. J. and M. E. Irwin. Influence of developmental stage, age, and degree of gravidity on fat content of *Rhopalosiphum maidis* (Fitch). Ann. Appl. Biol. (submitted).

Manandhar, J. B. and J. B. Sinclair. 1983. Occurrence of soybean diseases and their importance in Nepal. FAO Plant Protection Bull. 30:13-16.

APPENDIX III: LIST OF PUBLICATIONS BY INTSOY STAFF APPEARING OR SUBMITTED JANUARY 1983-JUNE 1984

Michalski, R. S., J. H. Davis, V. S. Visht, and J. B. Sinclair. 1983. A computer-based advisory system for diagnosing soybean diseases ini Illinois. plant Disease 67:459-463.

Mueller, J. D., G. R. Noel, and J. B. Sinclair. 1983. Effect of aldicarb on yield components, population dynamics of *Heterodera glycines*, and fungi on soyean cyst nematode susceptible and resistant cultivars. (Abstr.) J. Nematology 14:458.

Mueller, J. D., B. J. Shortt, and J. B. Sinclair. 1983. Yield components of field-grown, aldicarb-treated soybean cultivars resistant and susceptible to *Heterodera glycines*. (Abstr.) J. Nematology 15: (in press).

Mueller, J. D., B. J. Shortt, and J. B. Sinclair. 1981. Chemical and biological soybean seed treatments. Fungicide Nematicide Tests 36: 163.

Polston, J. E., R. M. GOodman, and J. Bravo. The effect of different isolates of soybean mosaic virus on the rate of seed transmission in eight tropical soybean accessions. In preparation for the Soybean Genetics Newsletter.

Ruesink, W. G., and M. E. Irwin. 1983. A model for the impact of soybean mosaic virus in soybean. Proceedings 10th International Congress of Plant Protection 1:163.

Ruesink, W. G., and M. E. Irwin. Soybean mosaic virus epidemiology: A model and some implications. *In* G. D. McLean, et al., eds. Plant Virus Epidemiology: Monitoring, Modelling and Predicting Outbreaks. Academic Press, Sydney. (In press).

Schultz, G. A., M. E. Irwin, and R. M. Goodman. 1983. Aphid transmission of soybean mosaic virus: Factors affecting virus acquisition and transmission frequency. Ann. Appl. Biol. 103:87-96.

Schultz, G. A., M. E. Irwin, and R. M. Goodman. 1983. Factors affecting aphid acquisition and transmission of soybean mosaic virus. Ann. Appl. Biol. 103:87-96.

Schultz, G. A., M. E. Irwin and R. M. Goodman. Relationship of aphid landing rates to the field spread of soybean mosaic virus. J. Econm. Entomol. (In press).

Shurtleff, M. C., B. J. Jacobsen, and J. B. Sinclair. 1983. Fungicides, disinfectants, grain preservatives, surfactants and soil-disinfesting chemicals. 35th Ill. Custom Spray Operators Training Manual, Univ. of Illinois at Urbana-Champaign, pp. 351-376.

APPENDIX III: LIST OF PUBLICATIONS BY INTSOY STAFF APPEARING OR SUBMITTED JANUARY 1983-JUNE 1984

Shurtleff, M. C., J. B. Jacobsen, and J. B. Sinclair. 1983. Fungicides, disinfectants, grain preservatives, surfactants, and soil-disinfesting chemicals. Univ. of Illinois Dept. Plant Path., Rpt. Plant Disease no. 1002 (revised). 26 pp.

Shurtleff, M. C., B. J. Jacobsen, and J. B. Sinclair. 1984. Fungicides, disinfectants, grain preservatives, surfactants and soil-disinfesting chemicals. 36th Illinois Custom Spray Operators Training School Manual: 389-414.

Shurtleff, M. C., B. J. Jacobsen, and J. B. Sinclair. 1984. Fungicides, disinfectants, grain preservatives, surfactants and soil-disinfesting chemicals. 36th Illinois Custom Spray Operators Training School Manual: 389-414.

Sinclair, J. B. 1983. See pathology - an expanding discipline. 4th Intern. Cong. Plant Path., Abstrs. of Papers: 6.

Sinclair, J. B. 1983. Integrated disease control in soybeans. 4th Intern. Cong. Plant Path., Abstrs. of Papers: 69.

Sinclair, J. B. 1983. Fungicide sprays in seed production fields. 4th Intern. Cong. Plant Path., Abstrs. of Papers: 101.

Sinclair, J. B. 1983. Making sure seeds germinate. Illinois Agr. 25 (Spring 1983): 6.

Sinclair, J. B. 1983. Stragegies of soybean disease control in the tropics and subtropics. Intern. Symposium on Soybean, Tsukuba, Japan, Abstracts: 28.

Sinclair, J. B. 1983. Maintaining seed quality by plant pathogen control. Proc. 2nd Ann. Florida Seedmen's Conf., Gainesville: 1-2.

Sinclair, J. B. 1983. Challenges for student programs. (Abstr.) Phytopathology 73:779.

Sinclair, J. B. and R. S. Michalski. 1983. A computer-based consulting system for diagnosing soybean diseases. 4th Intern. Cong. Plant Path., Abstrs. of Papers: 96.

Stannard, L. J., E. J. Armbrust, P. L. Watson, and M. E. Irwin. 1982. New records of thrips in Illinois (Insecta, Thysanoptera). Trans. Ill. Acad. Sci. 75:109-111.

Thapliyal, P. N. T. M. Zinnen, and J. B. Sinclair. 1983. Long-term storage of soybean seeds (Abstr.) Phytopathology 83:806.

APPENDIX IV: INTSOY PROJECT STAFF ASSIGNED TO RESEARCH CONTRACT AID/TA/C-1294 January 1, 1983-June 30, 1984

Urbanski, G. E., L. S Wei, A. I. Nelson, and M. P. Steinberg. 1983. Flow characteristics of soybean constitutents controlled by ration of total to imbibed water. J. Food Science 48, p. 691-694.

Urbanski, G. E., L. W. Wei, A. I. Nelson, and M. P. Steinberg. 1983. Rheology models for pseudoplastic soy systems based on water binding. J. of Food Science, 48:1436-1939.

Yao, J. J., L. S. Wei, and M. P. Steinberg. 1983. Effect of maturity on chemical composition and storage stability of soybeans. JAOCS, vol. 60, No. 7, July.

Yeh, C. C., and J. B. Sinclair. 1982. Effect of *Cercospora kikuchii* on soybean seed germination and its interaction with *Phomposis* sp. Phytopath. Z. 105:265-270.

Yorinori, J. T., and J. B. Sinclair. 1983. Harvest and assay methods for seedborne fungi in soybeans and their pathogenicity. International Journal of Tropical Plant Diseases 1: 53-59.

Zhigang, Xu, J. E. Polston, and R. M. Goodman. Identification of three soybean viruses from the People's Republic of China. In preparation for Plant Disease.

APPENDIX IV: INTSOY PROJECT STAFF ASSIGNED TO RESEARCH CONTRACT AID/TA/C-1294 January 1, 1983-June 30, 1984

Name	Rank/Title	Department	FTE
Professional Staff			
Bravo, J. A.	Asst. Agronomist	Agronomy (from 12/1/79 to 12/25/83)	1.00
Camacho, Luis H.	Research Agronomist	Agronomy (from 9/21/78)	1.00
Erickson, D. R.	Asst. Agronomist	Agronomy (from 10/8/80)	1.00
Fletcher, Jacqueline	Asst. Professor	Plant Pathology (from 8/21/82 to 9/14/83)	1.00
Irwin, M. E.	Assoc. Professor	Ag. Entomology (from 10/28/74)	1.00
Jackobs, J. A.	Professor	Agronomy (from 8/21/78 to 6/30/80)	.50
		(from 8/21/81)	.75
Kauffman, H. E.	Director	INTSOY Administration (from 12/21/81)	1.00
Leath, Janet	Asst. Plant Pathologist	Plant Pathology (from 5/17/82 to 5/16/83)	1.00
McCowen, T. A.	Asst. Director	INTSOY Administration (to 2/15/84)	.25
Paris, G. P.	Asst. Plant Pathologist	Plant Pathology (from 8/20/82)	1.00
Polston, J. E.	Asst. Plant Pathologist	Plant Pathology (from 1/14/80 to 8/20/82)	1.00
		(from 8/21/83 to 5/25/83)	.50
Shettel, Nancy	Ass. Plant Pathologist	Plant Pathology (from 3/19/84)	1.00

APPENDIX IV: INTSOY PROJECT STAFF ASSIGNED TO RESEARCH CONTRACT AID/TA/C-1294 January 1, 1983-June 30, 1984

Professional Staff (cont'd)			
Sinclair, J. B.	Professor	Plant Pathology (from 8/21/81)	.25
Stearn, W. C.	Asst. Professor	Agronomy (From 3/21/80)	1.00
Wei, L. S.	Professor	Food Science (from 10/21/77)	.25
Support Staff			
Bajet, N. B.	Res. Assistant	Plant Pathology (from 8/21/78 to 8/20/83)	.50
Bowman, J. E.	Res. Assistant	Plant Pathology (from 8/21/81 from 8/21/83	.25 .50
Creswell, Jean	Clerk Typist III	Agronomy (from 3/10/81)	1.00
Cunningham, Patricia	Clerk Typist III	INTSOY Administration (to 8/27/83)	.75
Datnoff, L.	Research. Assistant	Plant Pathology (from 7/21/81 to 10/14/83)	.50
Hansens Judy A.	Secretary	INTSOY Administration (from 4/24/82)	1.00
Irvin, Gloria	Clerk Typist III	Food Science (from 6/3/81)	.50
Irwin, Bonnie J.	Res. Associate	INTSOY Editor (from 7/21/79)	.50
Kampmeier, Gail	Res. Technician	Ag. Entomology (from 10/19/83)	1.00
King, Phylis	Clerk Typist III	Plant Pathology (from 10/19/83)	.50
Kogan, Jenny	Res. Associate	Ag. Entomology (from 1/21/77 from 2/1/84	.75 .50

APPENDIX IV: INTSOY PROJECT STAFF ASSIGNED TO RESEARCH CONTRACT AID/TA/C-1294 January 1, 1983-June 30, 1984

Support Staff (cont'd)

Smyth, Charles A.	Statistician	Agronomy (from 8/21/83)	.50
Towes, Vicki L.	Clerk Typist III	Plant Pathology (from 5/29/79 to 8/27/83)	.50
Wijeratne, Wilmot	Research Assistant	Food Science (from 2/21/84)	.50

APPENDIX IV: INTSOY PROJECT STAFF ASSIGNED TO RESEARCH CONTRACT AID/TA/C-1294 Prior to 1983

Name	Rank/Title	Department	FTE
Professional Staff			
Abrams, Raul	Assoc. Director	INTSOY Administration (to 1/31/80)	.25
Bouseman, J. K.	Asst. Entomologist	Ag. Entomology (from 8/21/77 to 8/31/79)	.50
Chou, Chung-Mei Hus	Asst. Food Scientist	Food Science (from 8/13/79 to 5/15/80)	1.00
Dunker, R. E.	Asst. Agronomist	Agronomy (from 7/1/75 to 9/20/77	1.00
Edwards. S. K.	Asst. Plant Pathologist	Plant Pathology (from 7/13/81 to 7/12/82)	1.00
Ferrier, L. K.	Asst. Professor	Food Science (from 10/5/77 to 8/20/78)	.75
Franklin, K.	Asst. Plant Pathologist	Plant Pathology (from 1/5/81 to 2/20/82)	.35
Goodman, R. M.	Professor	Plant Pathology (from 8/74 to 9/14/82)	.75
Hill, H. J.	Asst. Agronomist	Agronomy (from 12/1/76 to 9/10/80)	1.00
Hittle, C. N.	Professor	Agronomy (to 7/9/76)	.25
		(from 8/8/81 to 8/20/82)	1.00
Hruska, Mary C.	Asst. Plant Pathologist	Plant Pathology (from 2/12/80 to 7/20/81)	1.00
Judy, W. H.	Assoc. Professor	Agronomy (from 6/1/77 to 3/4/81)	.75

APPENDIX IV: INTSOY PROJECT STAFF ASSIGNED TO RESEARCH CONTRACT AID/TA/C-1294 PRIOR TO 1983

Name	Rank/Title	Department	FTE
Minor, H. C.	Asst. Professor	Agronomy (to 4/17/78)	.75
Nelson, A. I.	Professor	Food Science (8/21/77 to 6/20/78)	.25
Nyuyen, Q. N.	Asst. Professor	Agronomy (from 11/13/78 to 3/16/80)	1.00
Oard, J. H.	Asst. Agronomist	Agronomy (from 9/12/78 to 8/10/79)	1.00
Rodda E. D.	Professor	Ag Engineering (to 8/20/77)	.25
Santas, J. W.	Asst. Professor	Ag Communications (9/17/78 to 3/31/79)	.50
Shock, Theresa L.	Asst. Plant Pathologist	Plant Pathology (from 9/7/76 50 8/20/79)	1.00
Smith, R. Stewart	Asst. Professor	Agronomy (from 6/13/77 to 12/31/79)	1.00
Thompson, W. N.	Director	INTSOY Administration (.25 to 9/21/78 to 12/20/81)	.40
Whigham, D. K.	Asst. Professor	Agronomy (to 4/11/77)	.75
Support Staff			
Allison, Elizabeth (Schaefer)	Res. Assistant	Ag. Entomology (6/7/76-8/11/78)	1.00
Anderson, Debra	Res. Assistant	Agronomy (5/21/77-8/20/78)	1.00
Appleman, J. D.	Res. Assistant	Food Science (to 11/23/76)	1.00
Baer, K. D.	Res. Assistant	Food Science (to 8/20/78)	1.00

APPENDIX IV: INTSOY PROJECT STAFF ASSIGNED TO RESEARCH CONTRACT AID/TA/C-1294 PRIOR TO 1983

Name	Rank/Title	Department	FTE
Bowers, G. R., Jr.	Res. Assistant	Plant Pathology (from 5/21/76 to 8/20/80)	.50
Brinkman, G. S.	Res. Assistant	Plant Pathology (from 5/21/76 to 5/20/79)	.50
Burnsmier, Helen	Clerk III	Agronomy (to 9/30/78)	1.00
Eckenbeck, Susan L.	Res. Assistant	Agronomy (from 7/21/76 to 10/31/77)	.50
Elmore, R. W.	Res. Assistant	Agronomy (from 8/21/78 to 8/20/81)	.50
Endsley, Margaret R.	Clerk-Typist III	Agronomy (to 9/27/77)	1.00
Foor, S. R.	Res. Assistant	Plant Pathology (4/1/77-7/20/77)	.50
Halbert, Susan E.	Res. Assistant	Ag. Entomology (5/21/76-12/20/78 & 9/21/79-11/20/79)	.50
Kanthamani, S.	Res. Assistant	Food Science (to 11/23/76)	.25
King, Phyllis	Clerk Typist III	Plant Pathology (from 10/19/83)	.50
Kogan, Jenny	Res. Associate	Ag. Entomology (from 1/21/77)	.75
McBroom, R. L.	Res. Assistant	Agronomy (from 8/21/78 to 8/20/80)	.50
McClary, Richard D.	Res. Assistant	Plant Pathology (9/21/77-12/20/78)	1.00
McCune, T. D.	Res. Assistant	Food Science (to 8/20/76)	1.00

APPENDIX IV: INTSOY PROJECT STAFF ASSIGNED TO RESEARCH CONTRACT AID/TA/C-1294 PRIOR TO 1983

Name	Rank/Title	Department	FTE
Medina-Lopez, F.	Res. Assistant	Ag. Economics (from 7/1/78 to 11/30/79)	.50
Newell, Christine A.	Res. Assistant	Agronomy (to 8/20/77)	1.00
Orf, J. H.	Res. Assistant	Food Science (from 8/17/78-3/1/79)	.50
Orlowski, Janet	Res. Assistant	Food Science (from 8/21/78 to 7/21/79)	1.00
Primmer, R. R.	Assistant I	Ag. Engineering (to 4/29/77)	.50
Quarles, D. B.	Res. Assistant	Agronomy (from 6/1/78 to 5/7/81)	.50
Rokke, Douglas L.	Staff Assistant	Ag. Engineering (8/8/77-8/20/78)	.25
Schneider, Barbara L.	Res. Assistant	Agronomy (from 2/1/78 to 8/20/80)	1.00
Spitz, Martha	Clerk-Typist	Agronomy (from 1/121/79 to 2/6/81)	1.00
Taeger, Deanna	Secretary	INTSOY Administration (from 12/6/81 to 8/28/82)	.75
Thongmeearkom, P.	Res. Assistant	Plant Pathology (to 8/20/78)	.75
Tucker, Margaret E.	Clerk-Typist III	Food Science (to 5/16/81)	.50
Weger, Laura	Clerk-Typist III	Agronomy (10/5/77 to 12/16/78)	1.00
Yeh, C. C.	Res. Assistant	Plant Pathology (from 1/21/78)	.50