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Collaborative Research on Special Constraints at the International Agricultural Research Centers

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10. Abstract (optional - 250 word limit)

USAID initiated a new program to support research to alleviate "bottleneck" problems at the International Agricultural Research Centers (IARCs) through collaborative research with U. S. scientists and institutions. Twenty-two research proposals have been funded in FY 1986, 1987, and 1988 with collaboration at AVRDC, CIAT, CIMMYT, CIP, ICRISAT, IFDC, IITA, ILCA, and IRRI and with 19 U. S. institutions. This report includes first-year progress reports from those projects initiating research in FY 1986.

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WORK SHEET

USDA/CSRS REPORT TO USAID/S&T/AGR

Project Title: Collaborative Research on Special Constraints at the International Agricultural Research Centers

Project Number: 936-4136

PASA Agreement: BST-4136-P-AG-5083-00

PASA Project Manager: Samuel C. Wiggans

AID Project Manager: Frank Mertens

For the Period: Winter/Spring 1985 through July 31, 1988

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USDA/CSRS REPORT TO USAID/S&T/AGR

Project Title:	Collaborative Research: IARCs
Project Number:	936-4136
PASA Agreement:	BST-4136-P-AG-5083-00
PASA Project Manager:	Samuel C. Wiggans
AID Project Manager:	Frank E. Mertens
For the Period:	August 1985 through July 31, 1988

The Collaborative Research on Special Constraints of the IARCs project was initiated in late 1985 to alleviate "bottleneck" problems at the International Agricultural Research Centers (IARCs) through collaborative research with U.S. scientists and institutions. The program was designed to allocate $4,200,000 over a 5-year period.

At the end of each year the AID project manager contacted the Director Generals at each of the IARCs to identify those research constraints which could not be readily alleviated or solved without assistance from U.S. scientists; over 100 "problem areas" were submitted. USAID personnel selected those 25 constraints which they believed to be the most critical.

The research contract to handle the day to day management was awarded to USDA/CSRS since this agency has excellent access to U.S. public and private sector agricultural research institutions, tested and established efficient granting mechanisms and low overhead rates.

SOLICITATION AND REVIEW OF PREPROPOSALS AND PROPOSALS

Beginning with the FY 1987 program, a standard procedure for solicitation and processing of proposals was implemented. The AID project manager in S&T/AGR solicits research constraints from all IARCs. The constraints are screened and ranked in AID and a reasonable number is being selected for further consideration. The list of constraints is forwarded to USDA/CSRS where the PASA project manager with the subcontractor, Wayne F. Keim, prepares the guidelines for submitting preproposals and then mails some 1200 copies to more than 400 laboratories, institutions, and individuals throughout the United States.

A copy of the FY 1988 Guidelines is included herein under Appendix B. The subcontractor locates and invites qualified peer reviewers who are specialists in the various research constraint subjects. A list of the peer reviewers is included in Appendix C.

Based on the reviews and recommendations of the U.S. peer scientists (at least four for each preproposal submitted) and on the rankings and recommendations of the IARC scientists collaboratively involved, a number of full proposals are requested from those submitting preproposals. A second intense review of the full proposals by the U.S. peer review team results in ranking of the proposals for possible funding. This list of recommended proposals is further evaluated by a panel of experts in Washington, D.C. including personnel from USDA/CSRS, AID, OICD, ARS, World Bank, Winrock International, National Science Foundation, and others. A final recommendation for allocation of funds is made by this group.

RESEARCH SUPPORTED IN FY 1986

The following 10 proposals were funded in the initial FY 1986:

1. Evaluation, Management, and Utilization of Maize Germplasm and Breeding Systems (cooperating with CIMMYT). C.O. Gardner, M. Thomas-Compton, and W.A. Compton, University of Nebraska. 36 months, $86,668.

2. Differentiating the Corn Stunt and Maize Bushy Stunt Disease of Latin America (cooperating with CIMMYT). D.T. Gordon, R.E. Gingery, and R.A. Simkins, Ohio State University and Ohio Agricultural Research and Development Center. 18 months, $55,432.

3. Evaluation of Wild Glycine Accessions for Resistance to *Phakopsora pachyrhizi* syd. (cooperating with AVRDC). T. Hymowitz and A.T. Tschanz, University of Illinois. 36 months, $50,000.

4. Removing Soil Structural Constraints to the Production of Maize and Legumes Following Rice (cooperating with IRRI). W.E. Larson and S.C. Gupta, University of Minnesota. 36 months, $110,000.

5. Monoclonal Antibodies and Cloned cDNA to Index for Sweet Potato and Yam Viruses (cooperating with IITA). R.H. Lawson, J. Hammond, and H. Hsu, USDA/ARS Florist and Nursery Crops Laboratory, Beltsville. 36 months, $143,610.

6. Reproductive Biology of *Striga hermonthica* (cooperating with ICRISAT). L.J. Musselman, Bharathalakshmi, and D.A. Knepper, Old Dominion University, Norfolk, VA. 36 months, $112,667.

7. Development of a Barley Yield Simulation Model (cooperating with ICARDA and IFDC). J.T. Ritchie and S. Otter-Nacke, Michigan State University. 36 months, $110,000.

8. Chemotherapy and Thermotherapy of In Vitro Potato and Sweet Potato Plantlets (cooperating with CIP). S.A. Slack, University of Wisconsin (now at Cornell University). 36 months, $86,000.

9. The Urgent Requirement by IITA for a Taxonomic Resolution of *Cylas* in Africa (cooperating with IITA). G.W. Wolfe, Rutgers University. 36 months, $49,852.

10. Development of a Maize Composite Resistant to Several Major Insect Pests (cooperating with CIMMYT). V.E. Gracen, F.M. Davis, W.P. Williams, and J.A. Mihm, Cornell University and USDA/ARS Entomology, Mississippi State. 12 months, $20,000.

A Summary and Description of the First-Year Research Progress Follows in Appendix A. Second-Year Reports Not Yet Available.

RESEARCH SUPPORTED IN FY 1987

1. Bacterial Leaf Blight of Rice: Seriological and Epidemiological Studies (cooperating with IRRI). A.M. Alvarez and A.A. Benedict, University of Hawaii. 36 months, $134,974.

2. Introduction of Chromosomes and Chromosome Segments from the D-Genome of Breadwheat into Hexaploid Triticale (cooperating with CIMMYT). J.P. Gustafson and A.J. Lukaszewski, University of Missouri. 36 months, $100,000.

3. Evaluation of African Clovers for Growth, Seed Production, and Nitrogen Fixation (cooperating with ILCA). C. Hagedorn and S.W. VanScoyoc, Virginia Polytechnic Institute and State University. 24 months, $80,000.

4. The Use of Plant Transformation Techniques to Modify the Protein Quality of Cassava (Manihot esculenta) (cooperating with CIAT). J.M. Jaynes, Louisiana State University. 36 months, $99,999.

5. Facilitating the Development of Resistance to the Sweet Potato Weevil (cooperating with IITA). S.J. Kays, S.K. Hahn, and R.F. Severson, University of Georgia. 24 months, $78,095.

6. Characterization of Barley Yellow Dwarf Viruses in Africa and Latin America (cooperating with CIMMYT). R.M. Lister, B.A. Larkins, and D.J. Asai, Purdue University. 24 months, $80,000.

7. Introduction of Pest Resistance into Mungbean (Vigna radiata) Via Unconventional Gene Transfer (cooperating with AVRDC). D.W.S. Mok and M.C. Mok, Oregon State University. 24 months, $101,584.

Research Progress Reports Not Yet Available for Projects Funded in FY 1987.

RESEARCH SUPPORTED IN FY 1988

1. Development of Methods for Mass Screening of Rice for Tolerance to Low Soil Zn and P (cooperating with IRRI). P.R. Bloom and D.L. Allan, University of Minnesota. 17 months, $40,589.

2. Development of Field-Useful Techniques for Identification and Enumeration of Inoculant Strains of Rhizobium for Chickpea and Pigeon Pea (cooperating with ICRISAT). G.H. Elkan, North Carolina State University. 36 months, $90,000.

3. Incorporation of Resistance to Pod Borer and Pod Bugs into Cowpeas (cooperating with IITA). P.M. Hasegawa, R.A. Bressan, and L.W. Kitch, Purdue University. 36 months, $90,000.

4. Identification, Characterization, and Detection of Sweet Potato Viruses (cooperating with CIP). J.W. Moyer, North Carolina State University. 24 months, $89,965.

5. Phenolic Compounds and Microbial Degradation of Stover from Diverse Sorghum Lines (cooperating with ILCA). J.A. Patterson, J.H. Cherney, and J.D. Axtell, Purdue University. 24 months, $86,271.

Research Progress Reports Not Yet Available for Projects Funded in FY 1988.

U.S. DEPARTMENT OF AGRICULTURE
RESEARCH WORK UNIT/PROJECT DESCRIPTION • PROGRESS REPORT
U.S. DEPT OF AGRICULTURE, STATE AGRICULTURAL EXPERIMENT STATIONS AND OTHER INSTITUTIONS

DATE (Day, Mo., Yr.) 13-OCT-87

1. ACCESSION NO.	2. AGENCY IDENTIFICATION NO.			5. WORK UNIT/PROJECT NO.	22-23. REGIONAL PROJECT NO.	TYPE/GRANT NO.
0099833	2 CSRS	3 NEB	4 0000	NEB-12-159		86-CRSR-2-2789

7. TITLE

EVALUATION, MANAGEMENT, AND UTILIZATION OF MAIZE GERMPLASM AND BREEDING SYSTEMS

8. PERFORMING ORGANIZATION

CIMMYT

AGRONOMY
AGRICULTURAL RESEARCH DIVISION
UNIVERSITY OF NEBRASKA
LINCOLN
NEBRASKA 68583

12. INVESTIGATOR NAME(S)

1. GARDNER C O
2. THOMAS-COMPTON M A
3. COMPTON W A
4.
5.
6.

9. STATUS TERMINATED	30. ESTIMATED TERMINATION DATE	34. PERIOD COVERED (Mo., Yr.) FROM THRU
E ☐	31 AUG 89	Jan 87 - Dec 87

35. PROGRESS REPORT

Initial emphasis was placed on analysis and interpretation of accumulated data in CIMMYT computer files and in classifying maize-growing environments where CIMMYT conducts their international testing trials. For stability analyses, Experimental Variety Trials which generally include 15 to 20 experimental varieties tested in 40 to 50 sites were used. Six trials from each of the 1) tropical full-season maize, 2) tropical intermediate and short-season maize, and 3) sub tropical short and intermediate-season maize, grown from 1979-83 were used. Most stabl. varieties were identified using the method of Westcott, which has some advantages over the regression method of Ebehart and Russell. From a breeders standpoint, the method of Eberhart and Russell provides much more useful breeding information when properly used on well designed and executed experiments. Several cycles of selection in each of populations undergoing selection for broad international adaptability during 1974 to 1984 were analyzed and components of variance were estimated. Although selection was for broad adaptability, there is little evidence of any reduction in genotype x environment interaction. Preliminary examination of components indicates that maximum yields cannot be achieved by selecting for broad adaptability and ignoring G x E interactions. Extensive data other than yield performance have been collected and cluster analysis has been used to group testing environments in Africa into similar groups. A similar approach is in progress for South America.

37. PUBLICATIONS

BRIDGES, W. C. JR., AND C. O. GARDNER, 1987. Foundation populations for adapted x exotic crosses. Crop Science 27:501-506.

CROSSA, J., C. O. GARDNER and R. F. MUMM, 1987. Heterosis among populations of maize (Zea mays L.) with different levels of exotic germplasm. Theoretical and Applied Genetics 73:445-450.

CROSSA, J. and C. O. GARDNER, 1987. Introgression of an exotic germplasm for improving an adapted maize population. Crop Science 27:187-190.

CROSSA, J., 1987. A comparison of two methods for assessing yield stability. (Submitted for publication)

CROSSA, J., B. WESTCOTT, AND C. GONZALES, 1987. The yield stability of maize genotypes across international environments. I. Full season tropical maize. (Submitted for publication)

CROSSA, J., B. WESTCOTT and C. GONZALES, 1987. The yield stability of maize genotypes across international environments. II. Tropical short and intermediate maize. (Submitted for publication)

CROSSA, J., B. WESTCOTT and C. GONZALES, 1987. The yield stability of maize genotypes across international environments. III. Subtropical short and intermediate maize. (Submitted for publication)

APPROVED (Signature)	TITLE	DATE
Lowell Nelson for	Director, Nebraska	

EVALUATION, MANAGEMENT AND UTILIZATION OF MAIZE GERMPLASM AND BREEDING SYSTEMS

Annual report of work accomplished under USAID/USDA/CSRS grant agreement No. 86-CSRS-2-2789 to support collaborative research between CIMMYT and the University of Nebraska with cooperators from other U.S. Universities.

C. O. Gardner, Foundation Professor
M. A. Thomas-Compton, Assistant Professor
W. A. Compton, Professor

A special report on this collaborative research from its initiation Sept. 1, 1986 to May 30, 1987 was submitted to Dr. S. C. Wiggans in June, 1987, so this annual report will repeat some of what was included in that report. To date considerable progress has been made in analyzing and utilizing data accumulated in CIMMYT files over the last decade. We have examined variance components, stability parameters, genotype x environment interactions, coefficients of variability, and other statistics from a vast amount of data. In addition, cooperator Dr. L. M. Pollak, Iowa State University, has worked with Dr. H. N. Pham, CIMMYT, in classifying maize growing regions in the tropics; and cooperator Dr. W. C. Bridges, Clemson University has continued work on development of methods for formulating foundation populations from adapted x exotic crosses.

Since the initiation of this collaborative research effort, Dr. C. O. Gardner has visited CIMMYT programs in Pakistan, Ecuador and Zimbabwe and Dr. W. A. Compton has visited maize programs in Bolivia accompanied by CIMMYT personnel. Both scientists presented seminars on the effective integration of population improvement systems with the development of a hybrid program. Population improvement programs need to be developed in such a way as to effectively produce improved superior varieties while at the same time providing material for an efficient hybrid program whenever and wherever this seems appropriate. We believe that these discussions have been beneficial to all concerned.

In February, 1987, Dr. M. A. Thomas Compton and Dr. W. A. Compton visited CIMMYT where they discussed operational procedures with personnel in charge of the various units. They also met with Dr. Ron Cantrell, Director of the Maize Program, and with Dr. R. L. Paliwal, Deputy Director, and discussed at length the maize program and plans for the future. We believe that very important and significant changes are being made such as greater flexibility in breeding systems, encouragement of national program staff to develop their own breeding structures to best fit their needs, encouragement of greater area specific breeding programs, and more efficient testing and evaluation.

In May, 1987, C. O. Gardner visited CIMMYT Headquarters to discuss progress being made on data analyses and to meet with a group of maize breeders to discuss extensive population diallel-cross testing results. He had previously made recommendations on the analysis of such data and the kind of information that should be extracted for use by maize breeders.

DATA ANALYSES

To adequately assess the effectiveness of the international maize improvement program based primarily on a single breeding system for population improvement prior to the arrival of Dr. R. P. Cantrell as Director, and to assess the effectiveness of the international testing program, a detailed analysis of data accumulated in CIMMYT files over the past decade was necessary. Data include: 1) the full-sib family trials conducted generally at six international locations at each cycle of selection in several populations, 2) the experimental variety trials (varieties formed from selected families within populations based on performance in specific sites or countries and across all testing sites) called ETV's, and the elite variety trials (ELTV's). The latter two are much more extensively tested. A massive amount of data has been collected over the years and has been used to make selections and identify superior varieties for use in national programs, but the critical information needed to make sound judgments concerning the international testing and evaluation program and to compare alternative breeding systems has not been available. Dr. Jose Crossa, a graduate of the Nebraska maize quantitative genetics and breeding program, has played a major role in locating the files and in getting various kinds of analyses run which are now being evaluated. Frequent visits to CIMMYT by collaborators and communication via telephone and correspondence have been important in promoting this collaborative research; however, we have now reached a point where longer and/or more frequent visits will be necessary to interpret results and make recommendations.

Preliminary Analyses Of ETV's and ELTV's

A preliminary examination of analyses of several ETV's and ELTV's revealed a great deal about international testing sites and the reliability of data coming from many countries. Coefficients of variation greater than 50% were not uncommon. Obviously such data are of little value in making decisions; hence, much data collected had to be discarded. In the case of full-sib family recurrent selection programs, instead of actually having 6 testing sites with useful data, often only 2 or 3 could be used. This clearly emphasizes the importance of a greater degree of CIMMYT control over choice of testing sites used for recurrent selection programs in order to maximize progress in maize improvement.

Analysis of Recurrent Selection Data

Twelve populations undergoing improvement through full-sib family recurrent selection have now been analyzed. At each cycle, 250 full-sib families are tested at 6 international locations in replicated trials. Such data should provide excellent information not only for making selections for recombination but also for designing efficient testing programs, and, with some modifications could also provide information for comparing alternative breeding systems. Unfortunately, not all data are usable. Experiments with coefficients of variability greater than 25% are not sufficiently reliable to include in analyses. C.V.'s of 10 to 15% are desirable, but in developing countries, this may be a bit unrealistic. Some compromises have to be made. Also country politics and the relationship between CIMMYT and National programs have been factors in choice of testing sites. Often only 2 or 3 locations provide useful data, which is unfortunate because this reduces the precision on the estimates of components of variance, as well as on the family means used as the basis for

selection and recombination.

Although selection has been for broad adaptability over cycles, there is little evidence to indicate that the genotype x environment interaction is being reduced in improved CIMMYT populations. On the other hand, recent reports by Pandey et al. (1986, 1987) have indicated that progress has been made in improving yield, earlier maturity, lower ear height, reduced ear damage, and more ears per plant in some CIMMYT populations. As yet, we have not been able to compare expected progress with that reported.

Components of variance from a number of cycles of several populations are now available for detailed study and interpretation. A trip to CIMMYT in March, 1988, is planned to further study these data.

Stability Analyses

Stability analyses have been completed on some full-sib family evaluation programs and a number of ETV's. In the full-sib family testing and evaluation, we need to explore ways of using stability parameters along with other data in choosing those families to be recombined. In spite of the criticism of the Eberhart-Russell stability analysis, for recurrent selection programs it provides the most useful information. The mean, the response to improved environments, and the deviations from regression are useful data to any plant breeder. With 250 families, the influence of any one family on a specific environment mean is inconsequential. More needs to be done with these data and curvilinear responses need to be considered, but it should not be necessary to do regression analyses on all entries.

Stability analyses have been completed on 6 EVT's in each of three broad maize classifications: 1) full-season tropical maize, 2) short and intermediate-season tropical maize, and 3) short and intermediate season subtropical maize. The method of Westcott (1986) has been used to identify the most stable varieties in each set.

Some effort has been made to compare the Westcott model free method with the Eberhart-Russel model, but considerably more work will be necessary. Detailed study of data available on CIMMYT computer tapes will be required to more completely compare the two methods. Some computer simulation could also provide some insights. The response of a genotype does not have to be linear. In fact, a genotype that yields well over a range of poor environments but which also responds well to more favorable environments would be the ideal variety. In many developing countries, it is better for a farmer to grow a variety that provides him some food every year in contrast to one that has a higher mean and responds well in favorable environments but which might fail completely in some years. It is not clear that the Westcott Method is best to identify such stability.

Population Diallel Cross Analyses

Seeds from 8 different population diallel crosses including parents had been developed and distributed by CIMMYT personnel to several sites scattered throughout the world, including the USA. Parents used in each were either populations or pools developed in the CIMMYT program, but no information had been collected on how different or divergent these populations were genetically

or how they interacted when crossed. Data collected were analyzed using a method suggested by Lonnquist and Gardner (1961) in which the variation among parents and that among crosses were divided in the analysis of variance. Only the crosses were then used in estimating general and specific combining ability effects and variances as is done using Griffing's (1956) method 4. Heterosis was calculated as the superiority of the cross mean over the better parent and also over the mean of the two parents.

Results were presented to a group of maize breeders including C. O. Gardner and two cooperators on this project, Dr. L. M. Pollak and Dr. J. G. Coors. These results were discussed and recommendations were made to CIMMYT staff. Continued inbred line and hybrid development was endorsed both for training purposes and to provide materials to national programs where hybrids are appropriate. Heterosis in inter-population crosses was not great in any case suggesting the need to develop new populations that exhibit considerable heterosis when crossed and which also have the tolerances needed under biological and environmental stresses. The importance of continued population improvement was emphasized as was the need to have all programs from germplasm unit to backup units to advanced unit to hybrid unit fully integrated.

Determining Optimum Testing Procedures

Data available make possible the exploration of optimum testing schemes for evaluating full-sib families, experimental varieties and elite varieties. To date this has not been fully explored, but is included in our second year plans.

Evaluating Breeding Systems

In general, data available are inadequate to evaluate different breeding systems. This will be done in 1987-88, however, by making some assumptions about relative proportions of additive and non-additive genetic variances and examining realized heritabilities.

Progress From Selection

Predicting progress from selection and comparing realized responses to predictions and/or computing realized heritabilities will provide some insights into populations being used in the program and the efficiency of the evaluation program. This work is planned for the coming year.

DEVELOPING NEW POPULATIONS OR POOLS

Some discussions have been held among our group and with some CIMMYT personnel regarding the formation of new pools or populations made up of materials about which we have much information. Isozyme profiles, restriction fragment length polymorphisms (RFLP's), morphological traits, heterotic patterns, etc. of each component going into the pool would be known. If such a population could be maintained under natural selection and under directed selection for several generations, we could then develop a much clearer concept of what is happening in population improvement programs such as those conducted at CIMMYT and elsewhere.

In the development of new populations based on heterotic patterns to use in reciprocal recurrent selection programs to develop new superior source populations for inbred line and hybrid development, the use of genetic markers can also be used as an indication of genetic diversity.

Use of molecular markers to facilitate the transfer of single genes into populations is already underway. Dr. M. A. Thomas-Compton, HNL and Dr. M. Bjarnason, CIMMYT are using new sources of the dent sterile gene, Ga-s, combined with isozyme markers and protein probes to introduce a genetic isolation mechanism into CIMMYT's QPM material. Prior attempts at this have failed partly due to choice of Ga-s source material and lack of reliable screening techniques.

REFERENCES CITED

Eberhart, S. A. and W. A. Russell. 1966. Stability parameters for comparing cultivars. Crop Sci. 6:36-40.

Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing systems. Australian Jour. Biol. Sci. 9:463-493.

Lonnquist, J. H. and C. O. Gardner. 1961. Heterosis in intervarietal crosses in maize and its implication in breeding procedures. Crop Sci. 1:179-183.

Pandey, S., A. O. Diallo, T.M.T. Islam, and J. Deutsch. 1986. Progress from selection in eight tropical maize populations using international testing. Crop Sci. 26:879-884.

Pandey, S., A. O. Diallo, T.M.T. Islam and J. Deutsch. 1987. Response to full-sib selection in four medium maturity maize populations. Crop Sci. 27:617-622.

Westcott, B. 1987. A method of assessing the yield stability of crop genotypes. Jour. Agric. Sci. 108:267-274.

CLASSIFICATION OF MAIZE GROWING REGIONS IN THE TROPICS

L. M. Pollak, USDA-ARS, Iowa State University
H. N. Pham, CIMMYT

A useful project which would alleviate a special constraint in the CIMMYT maize program would be to obtain an accurate classification of maize testing sites used by CIMMYT. This would ultimately lead to identification of more efficient testing sites, more efficient breeding evaluations, a better measure of progress made by the maize program, and allow more accurate recommendations of populations to be used and requests for trials to be grown by national programs. These classifications will also allow CIMMYT to more easily set priorities and allocate breeding resources for meeting needs in developing countries.

The approach to classification that was decided on was to use environmental data collected from the cooperators at testing sites, information about particular countries sent back by CIMMYT staff in the field, and yield data from CIMMYT variety trials. Questionnaires were sent out to national cooperators and CIMMYT staff in the field in spring, 1986, requesting specific information concerning the climate, soil, stresses, and maize performance in their area.

Reports from national cooperators have presently been returned from 111 sites. In many cases, data were incomplete or obviously not correct. Much time was spent on data checking and revision, and some variables and reports had to be discarded. Some areas of particular importance to CIMMYT were not represented well, for example, only one report was received from Central America, and only seven from West Africa.

Only a portion of the experiment site data was selected for initial analysis to work out procedures and computer programs. Since CIMMYT is in the process of setting priorities for Africa, African data were as chosen for initial evaluation. Due to the limited number of reports returned from West Africa, a representative number of sites were added using published environmental data[1] for geographical locations corresponding to testing sites. After multivariate principal component, cluster, and canonical discrimination analysis, the African environmental data showed that West and East Africa were separate environments. West Africa could be separated into geographical environmental zones quite easily, but East Africa could not and was quite variable probably due to its mountainous terrain. The most important variables in discriminating among clusters were total rainfall and several months of average monthly rainfall and temperature. Geographical variables (latitude and longitude) and altitude were not important variables.

Analysis of world data was done in two ways. First, analysis of environmental data only was done similar to the African analysis. Second, data from the experiment site reports were analyzed. Membership in various clusters of particular locations was different between the two analyses in many cases,

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[1] 1984. Agroclimatological data. Food and Agriculture Organization of the United Nations. Rome.

even though the most important discriminating variables in the experiment site report analysis were again total rainfall and certain months of average monthly rainfall and temperature. World data analysis is still preliminary due to the lack of reports received from various important parts of the world. Reports from the CIMMYT staff in the field on a country basis were used to make a map of Africa incorporating zones of adaptation, disease and insect occurrence, and types of maize preference.

Future plans include trying to obtain more data both from station sites and environment. Preliminary maps and findings will be sent to field staff to make sure that they agree with their impressions and knowledge of the actual locations. Yield data will be analyzed to further refine environmental clusters. It was decided not to use yield data initially since results are not consistent from the same locations from year to year, and much data are unreliable. Much yield data arrive from experimental sites (especially Africa) with unacceptable CV's. Broad environmental clusters will also be refined using disease and insect resistance requirements, and any other variables considered important by CIMMYT staff or national programs.

MANUSCRIPTS AND REPORTS

Bridges, W. C. Jr., and C. O. Gardner. 1987. Foundation populations for adapted x exotic crosses. Crop Sci. 27:501-506.

Crossa, J., C. O. Gardner and R. F. Mumm. 1987. Heterosis among populations of maize (Zea mays L.) with different levels of exotic germplasm. Theoretical and Applied Genetics 73:445-450.

Crossa, J. and C. O. Gardner, 1987. Introgression of an exotic germplasm for improving an adapted maize population. Crop Science 27:187-190.

Crossa, J. 1987. A comparison of two methods for assessing yield stability. (Submitted for publication)

Crossa, J., B. Westcott, and C. Gonzales. 1987. The yield stability of maize genotypes across international environments. I. Full season tropical maize. (Submitted for publication)

Crossa, J., B. Westcott, and C. Gonzales. 1987. The yield stability of maize genotypes across international environments. II. Tropical short and intermediate maize. (Submitted for publication).

Crossa, J., B. Westcott, and C. Gonzales. 1987. The yield stability of maize genotypes across international environments. III. Subtropical short and intermediate maize. (Submitted for publication).

Pollak, L. M. and H. N. Pham. 1987. Classification of maize growing regions in the tropics. Proceedings NCR-2 Corn Breeders Conference.

Pollak, L. M. 1986. Report of classification of maize environments. Propose procedure for classifying maize growing environments in developing countries submitted to CIMMYT, and used for discussion purposes.

Gardner, C. O. 1986. Population improvement and its integration with hybrid development activities to produce superior maize cultivars for different maize growing areas of Pakistan. Printed and distributed by Pakistan Agricultural Research Center.

Gardner, C. O. 1986. Population improvement and its integration with hybrid development activities to develop superior cultivars for the tropics--some efficient and integrated schemes. Proc. XII Maize Research Conference for the Andean Region.

Gardner, C. O. 1987. Quantitative genetic theory and integrated breeding systems for maize improvement. Proc. Second Eastern, Central and Southern Africa Regional Maize Workshop.

Crossa, J. 1988. Estimation of variance components in CIMMYT's maize program. (Manuscript written).

TRAINING

Foreign students completing degrees in maize breeding in the past year:

Meshack Odhiambo, Kenya, Ph.D.

Foreign students working toward degrees in maize breeding:

Alfredo Leopoldo Pixley-Sinclair,	Costa Rica,	Ph.D.
Kiramat Khan,	Pakistan	Ph.D.
Haq Nawaz Malik,	Pakistan	Ph.D.
Enrique Navarro-Guerro,	Mexico	Ph.D.
Apolinar Mejia,	Mexico	Ph.D.
Lomas Tulsieram,	Guyana	Ph.D.
Sheng-Chung Huang,	Taiwan	Ph.D.

Visiting Scientists:

Dr. Mohammad Aslam)		
Dr. Muhammad Saleem)	Pakistan	-discussed breeding systems
Dr. Muhammad Afzal)		and cold tolerance

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RESEARCH WORK UNIT/PROJECT DESCRIPTION • PROGRESS REPORT

U.S. DEPT. OF AGRICULTURE, STATE AGRICULTURAL EXPERIMENT STATIONS AND OTHER INSTITUTIONS

1. ACCESSION NO.	AGENCY IDENTIFICATION NO.	5. WORK UNIT PROJECT NO.	22-23. REGIONAL PROJECT NO.	TYPE GRANT NO.
	2. 3. 4.			

7. TITLE

DIFFERENTIATING THE CORN STUNT AND MAIZE BUSHY STUNT DISEASE OF LATIN AMERICA

8. PERFORMING ORGANIZATION

Department of Plant Pathology
OSU/OARDC
Wooster, OH 44691

C/MMYT

12. INVESTIGATOR NAME(S)

1. D.T. Gordon
2. R.E. Gingery
3. R.A. Simkins
4.
5.
6.

6. STATUS TERMINATED	30. ESTIMATED TERMINATION DATE	84. PERIOD COVERED (Mo., Yr.) FROM	THRU:
E ☐	1-31-88	8-1-86	5-31-87

85. PROGRESS REPORT

Mice were immunized with preparations from maize bushy stunt mycoplasma (MBSM)-infected maize and/or MBSM-infected leafhoppers (Dalbulus maidis). Several hundred hybridomas arising from fusions of spleen cells from these mice and SP2/0 murine myeloma cells were screened for MBSM-specific monoclonal antibodies. None were found. We conclude that the isolated antibodies were all raised against normal maize constituents in the extracts used to immunize the mice. To obtain more highly purified MBSM, polyclonal MBSM antiserum was used to monitor MBSM purification. By this means, MBSM was purified by diatomaceous earth (Celite) clarification and centrifugation in a Percoll density gradient. A 25-kilodalton (kd) protein was discovered by use of this antiserum. This protein was associated with MBSM-infected preparations but not with healthy preparations. It reacted strongly with the MBSM antiserum. Mice have been immunized with the more purified MBSM preparations. They also will be immunized against the 25-kd protein. Hybridomas obtained using both of these preparations will be screened against plant and insect preparations as before and also against the 25-kd protein. For the purpose of obtaining pure CSS antigen for immunizing mice, several cultures of the corn stunt spiroplasma (CSS) were isolated from CSS-infected, greenhouse-maintained maize plants. Each culture became contaminated with fungi, forcing us to focus on solving this contamination problem. The problem appears solved and pure CSS antigen should be available soon. This antigen will be used to immunize the mice as the first step toward obtaining CSS monoclonal antibodies.

87. PUBLICATIONS

APPROVED (Signature)	TITLE	DATE

(See reverse side for Instructions)

I. RESEARCH PROGRESS

Mice were immunized with preparations from maize bushy stunt mycoplasma (MBSM)-infected maize and/or MBSM-infected leafhoppers (Dalbulus maidis). Several hundred hybridomas arising from fusions of spleen cells from these mice and SP2/0 murine myeloma cells were screened for MBSM-specific monoclonal antibodies. None were found. We conclude that the isolated antibodies were all raised against normal maize constituents in the extracts used to immunize the mice.

To obtain more highly purified MBSM, polyclonal MBSM antiserum was used to monitor MBSM purification. By this means, MBSM was purified by diatomaceous earth (Celite) clarification and centrifugation in a Percoll density gradient. A 25-kilodalton (kd) protein was discovered by use of this antiserum. This protein was associated with MBSM-infected preparations but not with healthy preparations. It reacted strongly with the MBSM antiserum.

Mice have been immunized with the more purified MBSM preparations. They also will be immunized against the 25-kd protein. Hybridomas obtained using both of these preparations will be screened against plant and insect preparations as before and also against the 25-kd protein.

For the purpose of obtaining pure CSS antigen for immunizing mice, several cultures of the corn stunt spiroplasma (CSS) were isolated from CSS-infected, greenhouse-maintained maize plants. Each culture became contaminated with fungi, forcing us to focus on solving this contamination problem. The problem appears solved and pure CSS antigen should be available within the next three weeks. This antigen will be used to immunize the mice as the first step toward obtaining CSS monoclonal antibodies.

II. SIGNIFICANCE OF RESEARCH FINDINGS

In order to understand the significance of our research findings to date it is important to understand our approaches in relation to the results obtained. Our first approach was to immunize mice separately with preparations from MBSM-infected plants and MBSM-infected leafhoppers. Resulting hybridomas were screened against infected and healthy maize plant extracts and infected and healthy insect extracts. Screening against the host that was not used for immunization was done with the expectation that fewer monoclonal antibodies to the host would be detected, thereby enhancing the chances of detecting MBSM-specific monoclonal antibodies. Many months of work using this approach yielded no MBSM monoclonal antibodies and we concluded that this approach was not worth pursuing further.

As an alternate approach, we sought to find MBSM specific proteins with the aid of polyclonal antibodies produced in rabbits immunized with partially purified MBSM. This approach has permitted further purification of MBSM, but more importantly has resulted in the identification of a 25-kd putative MBSM protein that reacts with the rabbit polyclonal anti-MBSM serum. Incidentally, this antiserum, while apparently useful in detecting this 25-kd protein and monitoring MBSM purification, has not worked satisfactorily in attempts to detect MBSM in infected plant extracts because of unacceptably high background reactions. Thus, our second approach has yielded MBSM preparations of better purity which have already been used to immunize mice and the 25-kd protein which will also be used to immunize mice. Because an MBSM antigen exits

against which antibodies can be raised, at least in rabbits, we believe that this approach has a reasonably good chance of yielding monoclonal antibodies to MBSM. Such an antigen should elicit antibodies in mice which can be immortalized through hybridoma production.

III. IMPACT OF PROJECT ON THE IRAC AND ON THE OHIO STATE UNIVERSITY

The PI visited with CIMMYT maize scientists Drs. Renfro and Bajet at CIMMYT Headquarters from March 30 to April 3, 1987 detecting MBSM and CSS. At that time, polyclonal antisera to MBSM and CSS were provided to them for use. In addition, diseased maize samples were collected at the CIMMYT Poza Rica Station and subsamples tested at CIMMYT and at Wooster for these pathogens and maize viruses. A summary of the results of these joint assays is being prepared.

IV. TRAINING OF FOREIGN NATIONALS

No persons from foreign countries were trained in connection with this project for the reporting period. However, one person is scheduled for training in July,1987 at Wooster. The trainee will be Barbara Hernandez, B.S. degree, of the Colegio de Postgraduados, Montecellos, Mexico.

V. TRIPS

The trip by the PI to CIMMYT Headquarters was mentioned in item III above. The expenses of this trip were paid for from other grant funds.

Over a period of two weeks in January and February, 1987, one of the cooperators (RAS) visited the Virology Laboratory of the USDA in Beltsville, MD to learn spiroplasma culture techniques from Dr. Ing Ming Lee. This training covered the methodologies for extracting CSS from infected corn leaf and stem tissues; preparing both defined and undefined (serum-containing) medium; examining the differences in spiroplasma growth characteristics on both media; growing spiroplasma on agar-supported medium; and cloning primary cultures of CSS. The expenses of this trip were paid from other grand funds.

VI. CONTACT WITH USAID MISSION FOR PERMISSION TO MAKE THE TRIP TO MEXICO

Permission for the trip to Mexico was requested from the U.S. Embassay-Mexico and granted by Mr. Sam Taylor (see copy of Department of State telegram granting permission).

VII. FUTURE RESEARCH, TRAINING AND TRAVEL PLANS

The future research of the project was discussed in items I and II and future training in item IV. Plans for travel include a trip by the PI to CIMMYT Headquarters to work with maize scientists Drs. Renfro and Bajet on detecting CSS and MBSM in infected tissue using monoclonal antibodies to both. The date of this visit has not been set.

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RESEARCH WORK UNIT/PROJECT DESCRIPTION • PROGRESS REPORT
U.S. DEPT. OF AGRICULTURE, STATE AGRICULTURAL EXPERIMENT STATIONS AND OTHER INSTITUTIONS

13-OCT-87

1. ACCESSION NO.	AGENCY IDENTIFICATION NO.			5. WORK UNIT/PROJECT NO.	22-23. REGIONAL PROJECT NO.	TYPE/GRANT NO.
0130617	2. CSRS	3. ILLU	4. 0000	ILLU-15-0811		86-CRSR-2-2865

7. TITLE

EVALUATION OF WILD PERENNIAL GLYCINE ACCESSION FOR RESISTANCE TO PHAKOPSORA PACHYRHIZI SYD

8. PERFORMING ORGANIZATION

AVRDC

AGRONOMY
UNIVERSITY OF ILLINOIS
URBANA
ILLINOIS 61801

12. INVESTIGATOR NAME(S)

1. HYMOWITZ T
2. TSCHANZ A T
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5.
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6. STATUS TERMINATED	30. ESTIMATED TERMINATION DATE	84. PERIOD COVERED (Mo., Yr.) FROM	THRU:
E ☐	30 SEP 89	1086	0987

85. PROGRESS REPORT

Screening of wild perennial Glycine species to Phakopsora pachyrhizi, Taiwan.

Species	Total	Resistant	Moderately resistant	Susceptible
G. canescens[a]	12	0	0	12
G. clandestina-LP[b]	8	1	1	6
G. clandestina-IP	10	2	0	8
G. clandestina-?[c]	3	0	1	2
G. falcata	1	0	0	1
G. latifolia	7	4	0	3
G. microphylla	4	2	0	3
G. tabacina	8	0	2	6
G. tabacina (2n=80)	28	21	6	1
G. tabacina?[d]	6	2	0	4
G. tomentella	1	0	0	1
G. tomentella (2n=78)	8	2	3	3
G. tomentella (2n=80)	3	1	0	2

[a]Somatic chromosome number of accessions = 40 unless specifically noted. For the soybean 2n=40. [b]G. clandestina has two forms LP = long pod and IP = intermediate pod. [c]The forms have not been placed in either LP or IP categories. [d]The chromosome number of 6 accessions have not been determined.

87. PUBLICATIONS

APPROVED (Signature)	TITLE	DATE

(See reverse side for Instructions)

Form AD-421 (Revised 4/8

TITLE: Evaluation of Wild Perennial *Glycine* Accessions for Resistance to *Phakopsora pachyrhizi* Syd.

INVESTIGATORS: T. Hymowitz, Professor of Plant Genetics, Department of Agronomy, University of Illinois, Urbana, IL 61801.
A. T. Tschanz, Plant Pathologist, Asian Vegetable Research and Development Center (AVRDC), P.O. Box 42, Shanhua, Tainan 741, Taiwan.

DATE OF GRANT APPROVAL: 13 March 1986

DATE FUNDS RECEIVED: 27 October 1986

GRANT IDENTIFICATION: SG-86-CRSR-2-2865 (UI-1-5-25894)

OBJECTIVE: The major objective of the project is to screen and evaluate, at AVRDC, for resistance to *Phakopsora pachyrhizi* Syd., accessions from the wild perennial *Glycine* collection maintained at the University of Illinois.

RESEARCH FINDINGS AND PROGRESS: IN 1986, 100 *Glycine* accessions were sent from Illinois to Taiwan for screening studies. The results are shown in Table 1. Apparently, sources of resistance were located in *G. clandestina*, *G. latifolia*, *G. microphylla*, *G. tabacina* and *G. tomentella*. Those accessions which appeared to be resistant to *Phakopsora pachyrhizi* currently are undergoing a second screening. In addition, another set of 100 wild perennial *Glycine* accessions were sent from Illinois to Taiwan and these are undergoing a second screening.

TRAVEL: In either November, 1987 or March, 1988, Professor Hymowitz will visit AVRDC to observe the screening program.

GRADUATE STUDENT: A graduate student will enroll at the University of Illinois in February, 1988 or Summer, 1988.

GENERAL COMMENTS: The results of the first years screening were most interesting as sources of resistance to *P. pachyrhizi* were located in *G. clandestina* and *G. tomentella* accessions. We have been successful in hybridizing both of these species to the soybean.

Table 1. Screening results of wild perennial *Glycine* species to *Phakopsora pachyrhizi*, Taiwan, 1986.

Species	Total	Resistant	Moderately resistant	Susceptible
G. canescens[a]	12	0	0	12
G. clandestina-LP[b]	8	1	1	6
G. clandestina-IP	10	2	0	8
G. clandestina-?[c]	3	0	1	2
G. falcata	1	0	0	1
G. latifolia	7	4	0	3
G. microphylla	4	2	0	3
G. tabacina	8	0	2	6
G. tabacina (2*n*=80)	28	21	6	1
G. tabacina?[d]	6	2	0	4
G. tomentella	1	0	0	1
G. tomentella (2*n*=78)	8	2	3	3
G. tomentella (2*n*=80)	3	1	0	2

[a] Somatic chromosome number of accessions = 40 unless specifically noted. For the soybean 2*n* = 40.
[b] *G. clandestina* has two forms LP = long pod and IP = intermediate pod.
[c] The forms have not been placed in either LP or IP categories.
[d] The chromosome number of 6 accessions have not been determined.

Form AD 421 (6/79)

U.S. DEPARTMENT OF AGRICULTURE

RESEARCH WORK UNIT/PROJECT DESCRIPTION · PROGRESS REPORT

U.S. DEPT. OF AGRICULTURE, STATE AGRICULTURAL EXPERIMENT STATIONS AND OTHER INSTITUTIONS

DATE (Day, Mo., Yr.)

1. ACCESSION NO.	AGENCY IDENTIFICATION NO. 2.	3.	4.	5. WORK UNIT/PROJECT NO	6. STATUS TERMINATED [ ]	30. ESTIMATED TERMINATION DATE

7. TITLE

Removing soil structural constraints to the production of maize and legume following rice

8. PERFORMING ORGANIZATION

Department of Soil Science IRRI
University of Minnesota
St. Paul, MN 55108

12. INVESTIGATOR NAME(S)

1 W.E. Larson
2 S.C. Gupta
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84. PERIOD COVERED BY THIS REPORT (Month & year)

From July 1, 1986 Thru: June 30, 1987

85. PROGRESS REPORT

Puddling of rice soils results in the destruction of soil structure. Tillage during puddling also leads to the development of a compact layer at 30-35 cm from the soil surface. Both these conditions create physical and structural constraints to the establishment and growth of upland crops following rice. Growth chamber experiments were conducted to define soil physical conditions (soil temperature, soil water potential, and aggregate size distribution) that are conducive to the establishment of upland crops like mungbeans. Results showed no significant effect of matric potential or aggregate size distribution on time to mungbean emergence. However, instead of pushing straight up through the soil, mungbeans were emerging through the gap between soil and core. Thus, it is hypothesized that soil strength may be the major constraint to the establishment of mungbean and soybeans in rice soils. Plans are to test this hypothesis in the field next year.

Field trials (IRRI) were conducted to measure draft forces vs. soil disturbance at 3, 8, and 18 days after drainage (DAD) and at various depths of tillage. Specific resistance (draft force/disturbed area) of IRRI soil to winged tines increased with an increase in soil drying provided the depth of tillage was above the critical depth. If the depth of tillage was below the critical depth, specific resistance decreased slightly with an increase in soil drying. Also, the specific resistance was essentially constant in 0-30 cm depth at 18 DAD. It was concluded that simple methods are needed to define critical depth in order to optimize machinery and animal power for deep tillage of rice soils.

87. PUBLICATIONS

GUPTA, S.C., SCHNEIDER, E.C. and SWAN, J.B. 1987. Planting depth and tillage interactions on corn emergence. Soil Sci Soc. Amer. J. (submitted).

APPROVED (Signature)	TITLE	DATE
W.E. Larson	Prof + Head Soil Science	5-25-88

Annual (1986-87) Progress Report on USAID/USDA bottlenecks Project (Grant 86-CRSR-2899) "Removing soil structural constraints to the production of maize and legume following rice."

Significance of research finding and research progress

Research progress/findings are discussed by objectives listed in our proposal.

Objective 1. **To develop, for previously-puddled soils of various textures at various water contents, a methodology to use tensile strength measurements to predict the energy inputs, soil disturbance, and hence specific resistance for tillage operations (including zero tillage) that promote effective rooting and high yields of maize, mungbean, or soybean following rice.**

a) Field trials (IRRI) were conducted to measure draft forces vs. soil disturbance at 3, 8, and 18 days after drainage (DAD) and at various depth of tillage. Specific resistance (draft forces/soil disturbance)of IRRI soil to winged tines increases with an increase in soil drying provided the depth of tillage was above the critical depth. If the depth of tillage was below the critical depth, specific resistance decreases with an increase in soil drying. This points out the need for defining the critical depth in order to optimize machinery and animal power needed to till rice soils.

Since the available draft forces for deep tillage are limited in the developing countries and field trials to define critical depth are expensive, we are in the process of constructing a computer model that relates draft force to soil disturbance for various tine configurations. Output from this model will be used to develop guidelines on optimum water content at the time of tillage, type of implement (tine configuration) and the depth of tillage. Model development will be carried out in Minnesota and will be based on existing information in the literature. Future plans for the field trials at IRRI include planting of mungbeans in deep-tilled soils to evaluate the effects of deep tillage on root penetration, water availability, and yield.

b) Ridging trials in the field (IRRI) were not successful because when IRRI soil dried sufficiently to allow effective ridging, the soil was too dry for seed germination and seedling growth. Ridging experiments will not be pursued in the future.

c) Laboratory experiments included measurements of tensile strength by modulus of rupture on disturbed soil (0-10 cm) and by Brazilian test on undisturbed cores taken from IRRI Vertic Tropaquept soil at various times after drainage. As the soil dried, the soil strength increased at all depths. Data are being analyzed for relationships of soil strength to soil water content at various sampling depths. This methodology will be used to define soil water contents (days to drying) that are conducive for optimum tillage, both for seed establishment and deep penetration of roots by upland crops in rice soils.

A Pneumatic Fracture cell was installed at IRRI during April 1987. Work is under way to determine tensile strength of soils by a Pneumatic Fracture. The technique will be evaluated for its ease and

reproductibility of the data as compared to modulus of rupture and the Brazilian test.

Objective 2. **To relate, for previously-puddled soils at various water contents, input of tillage energy and pre-tillage topsoil friability to soil-structural characteristics of the resulting tilled seedbed, and to measure interactive effects of seedbed structure, water content, and temperature on emergence of maize, mungbean, and soybean.**

a) The first field experiment under this objective relates to the effects of tillage/delay in planting/soil oxidation status on the growth and yield of dry season mungbeans. Except for a slight increase in emergence at 5 days after drainage for tilled (T6) soils, emergence of mungbeans declined from about 90 percent to 50 percent as the delay in planting increased from 1 to 18 days. After 5 days, the decline in emergence was greater for tilled (T6) as compared to non-tilled soil. Early growth (plant height at 22 days after seeding) was also higher in tilled soils, when mungbeans were planted at 5 days after drainage. This indicated a need for some drying of tilled soil before planting. There was no dependence of plant height on days after drainage in a non-tilled soil. Also, presence/absence of a previous rice crop did not have a great influence on the emergence or early growth of mungbeans.

b) The second field experiment relates to the effects of variety/seeding method/reoxidation on the emergence, establishment, and growth of mungbeans. Both emergence and yield increased when mungbeans were planted with an inverted T seeder as compared to manual seeding. There was considerable reduction in emergence and thus yield of mungbeans when planted in reduced soil conditions. Differences in emergence and yield were minimal among three different varieties.

Data from both field experiments indicated a strong dependence of yield on emergence and establishment of mungbeans. Yield could be as high as 1.1 tons/ha provided soil conditions are favorable for 80 to 90 percent emergence. Average national mungbean grain yield varies from 0.6 to 0.8 tons/ha for the developing countries.

c) Growth chamber experiments were conducted in Minnesota to define the effects of soil temperature, soil water potential, and aggregate size distribution on mungbeans, soybeans, and corn emergence. Preliminary results of the experiment do not show a significant effect of matric potential or aggregate size distribution on time to mungbean, soybean, and maize emergence. However, some of the dicotyledon (mungbeans and soybeans) had great difficulty emerging from the soil. Percent emergence was much lower for dicotyledons as compared to maize. Also, instead of pushing straight up through the soil, the dicotyledons were more apt to take advantage of an easier route present (i.e., gaps between soil and core).

Since the hypocotyledonary arch of the mungbeans and soybeans appears to be more fragile than the maize growing point, soil strength may be a major constraint to the establishment of mungbean/soybean. This constraint may be even more important in rice soils because of their high clay content. Research is under way to relate legume emergence to soil strength as influenced by soil matric potential and aggregate size distribution. Additionally, an experiment was initiated to measure the strength of the

hypocotyledonary arch and the radicle of mungbeans and soybeans. This method will be used to identify varieties and seed sizes, within a given species, best suited for emergence in high soil strength conditions. Varieties under consideration are CES ID-21, Pagasa-3, M79-9-32, and M79-13-60, and the seed size corresponds to (a) 4:00 mm, (b) 3.25 mm, and(c)2.8 mm.

d) Calcium peroxide was not effective in growth-chamber trials of mungbean germination in chemically reduced soils. This experiment is discontinued.

TRAINING

Ms. Sabrina Phenice - U.S. citizen, master student at the University of Minnesota.

Thesis title: Influence of soil physical factors on crop emergence.

Ms. Susan Maghari - citizen of the Phlippines. Short-term training for 3 months.

Training topic: Laboratory and growth chamber techniques to study physical factors affecting crop emergence.

IMPACT

Impact on IRRI

Specialist training of Ms Susan Maghari in Minnesota has led to the adoption by IRRI of new methodology on crop emergence and tensile strength measurements by modulus of rupture and pneumatic fracture cells. Future IRRI plans include extending Schneider and Gupta's methodology to other upland crops such as wheat.

IRRI has access to specialized equipment, like pneumatic fracture apparatus and cone penetrometer, that are not currently available on the market. The equipment was manufactured at the University of Minnesota machine shop and made available to IRRI.

IRRI collaboration with Minnesota has been beneficial to IRRI in initiating cooperative projects with other developing countries on research-related to establishment of upland crops in rice soil. Since the start of our project, IRRI has initiated similar collaborative efforts with the Philippines, Korea, and China.

Impact on the University of Minnesota

Diversification of the cropping base and development of new products from existing crops are recognized as an important source of growth for the United States farm economy. Keeping with this objective, a center for Alternative Crops and Products (CACP) was established in 1987 at the University of Minnesota. The purpose of CACP is to 1) generate, receive, and evaluate new crops and product ideas, and 2) facilitate alternative crop research and development efforts. Soil physics related research generated under this project will provide expertise and a database that will be beneficial in evaluating grain legumes as alternative crops for the U.S. Corn Belt. IRRI collaboration with Minnesota has also been beneficial to our graduate students and faculty through increased contacts with international scientists and increased possibility of international employment.

TRIPS

U.S. Scientists

- Dr. W.E. Larson. February 1-7, 1987 to IRRI, Los Banos, Philippines.
To review and advise IRRI staff on laboratory growth chamber and field studies related to soil structural constraints on the establishment of upland crops in rice soils.
Costs: $1562.04 This travel is covered under the approved travel plan submitted with the original proposal. On December 12, 1986 a letter requesting permission was sent to Dr. Sam Wiggans.

- Dr. S. C. Gupta. April 7-14, 1987 to IRRI, Los Banos, Philippines.
To review and advise IRRI staff on laboratory, growth chamber, and field studies related to soil structural constraints on the establishment of upland crops in rice soils.
Costs: $1322.79. This travel is covered under the approval travel plan submitted with the original proposal. A letter requesting permission was sent to Dr. Sam Wiggans on February 17, 1987.

IRRI Scientists

- Dr. T. Woodhead. May 30-June 4, 1986 to the University of Minnesota, St. Paul, MN.
To define and agree on a workplan for our bottlenecks project.
Cost $1907.38 Dr. Swaminathan requested Dr. Woodhead travel from Mr. F. Martens.

- Ms Susan Maghari - September 28-December 18, 1986 to University of Minnesota, St. Paul, MN.
To learn new methodology on soil physical factors affecting crop emergence and tensile strength by modulus of rupture and pneumatic fracture.
Cost: $4044.61
Ms Maghari's travel was approved by Dr. Lloyd Frederick.

- Dr. T. Woodhead - June 21-24, 1987 to University of Minnesota, St. Paul, MN.
To discuss preparation of annual report to USDA and agree on workplan for 1987-1988.
Costs: Not known
Ms Lois Shapiro informed that we do not need travel approval for Dr. Woodhead if USDA has already approved a travel budget in a subcontract between the University of Minnesota and IRRI on our bottlenecks project.

FUTURE RESEARCH

The enclosed table outlines our research plans for the next two years. We are requesting the following modifications on research plans and budget from our original proposal:

- page 5, Objective 1, lines 4 and 10: Because of the time consuming and expansive nature of draft forces vs. soil disturbance measurements, we are requesting a reduction from 8 to 4 soils for these tests.
- Budget: We are requesting a shift of $10,000 ($7,000 from the IRRI

share of the budget plus $3,000 from the University of Minnesota share of the budget)from travel category to an assistantship. We feel research by a graduate student will be more effective in meeting our research objectives on the bottlenecks project.

FUTURE TRAVEL

- Dr. W. E. Larson travel to IRRI, January-February 1988
  To review and advise IRRI staff on ongoing laboratory and field experiments on this project.

- Dr. S.C. Gupta travel to Scotland to attend the 11th International Conference on "Tillage and Traffic in Crop Production" July 1988.

Table 1. Outline of research activities that were completed during the first year, and our plans on these activities over the second and third years of the project.

Year:	1		2		3	
Season:	wet	dry	wet	dry	wet	dry
Soil collection	x	x	x			
Aggregates mixing	x	x	x			
Equipment construction	x	x				
Friability tests	x		x			
Tensile strength		x	x		x	
Draft/energy trials		x		x		
Growth/yield trials		x		x		
Emergence (growth chamber)		x	x	x	x	x
Cotyledon and radical forces (lab)		x	x			
Program review	x	x		x		x
Analysis				x	x	x
Report writing					x	x

0140222 YR 86 PUB PG 1 MODE 1213-10-00 CWU 0101 21020-008-50

TITLE: MONOCLONL ANTIBODIES AND CLONED cDNA IN DIAGNOSIS SWEET POTATO AND YAM VIRUSES

PERIOD COVERED FROM 09/86 THRU 12/86

IITA

APPROVED: Roger H. Lawson 12/86

POSITION TITLE: Res. Leader, Florist/Nursery Crops Lab

PROGRESS REPORT

This project was initiated in cooperation with the International Institute of Tropical Agriculture in Nigeria, to produce reagents (monoclonal antibodies and cloned complementary DNA) for detection and identification of viruses infecting important vegetatively propagated crops. Most of the viruses of concern in sweet potato and yam are potyviruses; this work, therefore, relates well to our previous work with other potyviruses, and in particular the detection of and distinction between potyviruses by use of monoclonal antibodies and cDNA clones. We have shown that a previously prepared monoclonal antibody with apparently general reactivity to potyviruses also reacts with some of the sweet potato and yam viruses in simple tests in infected leaf tissue, as well as with purified virus. This antibody is of great potential value in detecting potyvirus infection, but not in identifying the particular virus. We have purified an isolate of sweet potato feathery mottle virus indigenous to the United States, and received purified preparations of two biologically distinct isolates from Nigeria. A mixture of these preparations has been used to immunize mice as the first step in preparing monoclonal antibodies capable of distinguishing these isolates. Ability to distinguish between strains of an individual virus would promote epidemiological studies to determine the sources of virus infection entering a healthy crop. Such reagents would also be of great value in facilitating enforcement of quarantine regulations.

PUBLICATIONS

(1)
(2)
(3)
(4)
(5)

CRIS Report for 1986

grant 86-CRCR-2-2866

ACCESSION 0140722 YR 87 TOBIGI MGPL 1215-10-00 CWU0901-21020-008-50

TITLE: MONOCLONL ANTIBODIES AND CLONED cDNA IN DIAGNOSIS OF SWEET POTATO AND YAM VIRUSES

PERIOD COVERED FROM 01/87 THRU 12/87

IITA

APPROVED: Roger H. Lawson 01/88

POSITION TITLE: RESEARCH LEADER, FNCL

PROGRESS REPORT

Distribution of sweet potato germplasm from international collections is limited because of concern about the presence of undetected pathogens, particularly viruses. Improved methods of detection and strain differentiation of sweet potato feathery mottle virus (SPFMV) will provide a greater movement of plant material internationally. One American (SPFMV-C) and one Nigerian (SPV-I) isolate of SPFMV were used to immunize mice and produce hybridoma cell lines. A hybridoma cell line was selected that secreted antibody reactive with SPV-I but not SPFMV-C. The antibody reacts with 5 of 9 SPFMV isolates from different parts of the world. RNA of SPV-I has been prepared for cDNA cloning. Purified samples of yam mosaic virus (YMV) and a potyvirus infecting legumes in Nigeria have also been examined. A monoclonal antibody reactive with all potyviruses previously tested reacted with these virus isolates and all isolates of SPFMV tested. This antibody is also being used in Nigeria for potyvirus detection. The YMV and legume potyvirus are being used to prepare monoclonal antibodies for detection and strain differentiation. Our cooperator from Nigeria visited Beltsville for training in aspects of monoclonal antibody production and use, and to coordinate future work. Development of a monoclonal antibody specific for a Nigerian strain of SPFMV provides a valuable reagent for establishing the international distribution of the virus and will aid in developing improved procedures for health certification.

PUBLICATIONS

(1)
(2)
(3)
(4)
(5)

CRIS Report for 1987

grant 86-CRCR-2-2866

Report June 1987 30.

Progress Report: Grant 86-CRCR-2-2866; Monoclonal Antibodies and Cloned cDNA to Index for Sweet Potato and Yam Viruses.

Summary.

A major objective of this project is to obtain monoclonal antibody reagents that will distinguish between and among virus isolates from sweet potato in Nigeria and other countries. A monoclonal antibody has been produced to a Nigerian isolate of sweet potato feathery mottle virus that distinguishes this isolate from some isolates from the USA and other countries. Reagents with this capability were not previously available.

The visit by Dr. Thottappilly provided an important opportunity to exchange reagents and information, and to discuss implementation of the next phase of the project.

The first experiments carried out were the testing of pre-existing monoclonal antibodies (raised and selected against other potyviruses) for activity against an isolate of sweet potato feathery mottle virus (SPFMV) indigenous to the United States. This isolate, SPFMV-C, has been propagated and purified successfully at Beltsville. None of eight monoclonal antibodies raised against tulip breaking virus, nor three raised against clover yellow vein virus, had significant reactivity against SPFMV-C in sap samples; under similar conditions most of these antibodies have differential cross-reactivities with a number of potyviruses other than the respective immunogens. A further panel of monoclonal antibodies prepared with an immunogen mix of several potyviruses (not including SPFMV) were also tested; of these, one antibody had been previously demonstrated to have reactivity with every definitive member of the potyvirus group tested. This antibody (PTY 1) was found to react with SPFMV-C (and later to all other isolates of SPFMV and related sweet potato potyviruses tested). Three further antibodies of this panel also react with both SPFMV-C and a Nigerian isolate (SPV-I), but none differentiate between these two isolates. Antibody PTY 1 reacts very well in indirect ELISA, and also on Dot-blots and Western blots on nitrocellulose or nylon membranes, but very poorly in double antibody sandwich forms of ELISA.

Partially purified preparations of a Nigerian isolate of sweet potato feathery mottle virus, SPV-I; of yam mosaic virus (YMV); and of two other potyvirus isolates from legumes were received from the International Institute of Tropical Agriculture (IITA). These preparations were assayed at Beltsville by SDS-polyacrylamide gel electrophoresis (SDS-PAGE), Western blotting, and probing of blots with polyclonal antibodies to SPFMV-C, and monoclonal antibody PTY 1. The YMV preparations were not found to have enough intact, undegraded virus present to be detectable by SDS-PAGE or by Western blotting. Preparations of the legume potyviruses were shown to contain significant levels of apparently undegraded virus by SDS-PAGE, and were detected by antibody PTY 1, but not by SPFMV-C polyclonal antibodies, on Western blots. The SPV-I preparations were found by SDS-PAGE to contain not only a protein of the size expected for SPFMV, but also a second protein of higher mobility which was in greater abundance. This protein did not react with either PTY 1 or polyclonal SPFMV-C antibodies on Western blots, and thus appeared to be a contaminant rather than a degradation product. Electron microscopy of the preparation revealed the presence of potyvirus particles, as

expected, but also a second class of particles resembling those of tobacco mosaic virus (TMV).

As a result these preparations were not of appropriate quality for generation and screening of monoclonal antibodies, because it would be difficult to distinguish between antibodies reactive with the contaminant and SPV-I. To overcome this problem we have propagated SPV-I at the Fort Detrick containment facility, after separating it from the contaminating virus by host passage, and have made several preparations of purified virus from the singly infected material. The contaminant was identified as a cowpea strain of TMV, believed to originate from Mucuna, a legume used in Nigeria as a green manure.

A mixture of the purified SPV-I prepared at Beltsville, a later preparation of SPV-I from IITA (without detectable contamination), and SPFMV-C purified at Beltsville was used as antigen to immunize mice. From the initial fusion, 494 hybridoma lines were screened against: a) healthy plant material of the hosts used for virus propagation; b) infected plant material; and c) a mixture of the purified viruses. In order to detect antibodies reactive against whole virus, and to differentiate those from antibodies against epitopes created by partial virus degradation, hybridoma supernatants were screened against virus trapped on SPFMV-C polyclonal antibody-coated plates, and separately on plates coated directly with virus antigens.

From the 494 actively growing hybridoma cell lines derived from the first fusion, 56 were found to react in a virus-specific manner. Of these, 53 reacted with both types of viral antigens, and 3 with polyclonal antibody-trapped (="whole") virus. None reacted only on the antigen-coated plates ("dissociated" virus). The numbers of cell lines maintaining positive reactions over subsequent tests declined substantially; this is normal experience during the course of cell line stabilization. Only one cell line was ultimately found to stably secrete virus-specific antibodies. This cell line, FMV 7H8, has been sub-cloned, and ascites fluid produced. The antibody is reactive with SPV-I, (the Nigerian isolate) but not with SPFMV-C. The reactivity and usefulness of this antibody will be discussed in more detail below.

For the second fusion, we decided to further bias the odds in favour of antibodies reactive to external epitopes on whole virus (which from previous experience, and results in other labs, are more likely to be isolate specific). To achieve this, preparations of SPV-I and SPFMV-C were fixed by incubation with glutaraldehyde for the final immunizations preceding the fusion. Again, a large number of cell lines were produced, but only 9 of 335 were initially found to have virus-specific reactions. In this instance one cell line secreted antibodies reactive with antigen-coated plates ("dissociated" virus) but not with virus trapped by polyclonal antibodies, and again three lines secreted antibodies recognizing only virus trapped by polyclonal antibodies ("whole" virus). None of the hybridomas from the second fusion continued to secrete specific antibodies after the second or third screening.

Before proceding with a third fusion we are awaiting preparations from IITA of isolates that do not react with antibody 7H8, in order to increase the range of antigens that could potentially be detected and differentiated. We are also awaiting further material of YMV, as the initial material was not of suitable quality for use as either antigen or for screening.

As sufficient quantities of SPFMV-C and SPV-I were available for monoclonal antibody production and screening, further virus was prepared for RNA production for cDNA cloning. As the yield of SPV-I (from Nicotiana benthamiana) were far superior to those of SPFMV-C (from Morning Glory, as SPFMV-C does not infect N. benthamiana), we have decided to prepare cDNA to the SPV-I isolate instead of the SPFMV-C isolate. To this end, viral RNA of SPV-I has been extracted from purified virus, and cDNA preparation and cloning will follow.

Visit of Dr. George Thottappilly to Beltsville.

Our principal contact and cooperator at IITA, Dr. George Thottappilly, spent from April 12 - April 30 at Beltsville. This visit was approved in advance through the offices of Dr. Wiggans and Terry Pacovsky, with notification to Dr. Mertens. The visit was supported in part by IITA, with expenses within the United States being covered from the grant to the extent of $1447. During the time he was in the USA, Dr. Thottappilly also visited the laboratory of Dr. James Moyer at North Carolina State University. Dr. Moyer's lab. is also concerned with sweet potato viruses, and we are informally cooperating to exchange reagents and compare results.

The purposes of Dr. Thottappilly's visit were several, and benefit to both parties was obtained in all areas. Communication by letter and cable between Beltsville and IITA is slow and limited; one primary benefit of the visit was in-depth discussion of the problems to be overcome in the remainder of the grant period, and of the approaches that are likely to be successful. To this end we demonstrated to Dr. Thottappilly the efficacy of several techniques for partial purification of virus gene products, including a method for SDS-PAGE identification of virus-infected plants from the presence of the viral cytoplasmic inclusion protein; and electroelution of the cytoplasmic inclusion protein of SPV-I from a preparative gel for use to prepare a polyclonal antiserum.

Dr. Thottappilly participated in the screening of the second fusion for SPFMV monoclonal antibodies, in order to gain insight into the procedures and understand the advantages and the limitations of monoclonal antibody production. He also participated in the initial characterization of antibody 7H8 (obtained from the initial fusion). We have shown that this antibody recognizes SPV-I, but not SPFMV-C, in a variety of test protocols, using either culture supernatants or ascitic fluid. The antibody appears to react with whole, undissociated virus, as it reacts with SPV-I trapped on polyclonal (SPFMV-C) serum, as well as with SPV-I directly coated onto ELISA plates. The antibody can also be used as a trapping antibody, as purified SPV-I, but not SPFMV-C, was detected by SPFMV-C polyclonal antibody and goat anti-rabbit conjugate on plates precoated with antibody 7H8. A conjugate produced by glutaraldehyde coupling of 7H8 and alkaline phosphatase was not of significant value when tested with sap or purified virus samples trapped on either polyclonal SPFMV-C or monoclonal 7H8 trapping antibodies. Our conclusion is that the conjugation affected the antibody's reactive site, possibly due to sub-optimal ratios of antibody, enzyme and coupling reagent. A new conjugate will be prepared to assess whether the antibody can indeed be used in this type of double antibody sandwich assay.

The antibody was shown to have the same specificity for SPV-I in Dot-blots and Western blots, on nitrocellulose and nylon membranes. Dot-blots and indirect (antigen-coated) ELISA assays were used to show

that SPV-I could be detected in infected N. benthamiana sap diluted with healthy sap up to at least 1:19 ratios, and that healthy sweet potato sap was not inhibitory to the reaction.

As a result of exchanging Dot-blot membranes with Dr. Moyer of NCSU, we have demonsrated that antibody 7H8 reacts with SPFMV-RC as well as with a Nigerian isolate similar to SPV-I, but not with SPFMV-C or two isolates from Costa Rica and the Caribbean. Our previously produced antibody PTY 1, in contrast, reacted with all five isolates. Dr. Moyer has since shown that 7H8 reacts with two additional isolates.

In order to facilitate this kind of comparison with a large number of samples, we will use Dot-blots to compare field isolates, in particular to identify Nigerian isolates that do not react with 7H8, (and thus differ at least in this respect from SPV-I), to broaden the base of antigens used as immunogen, thus enabling Dr. Thottappilly to select appropriate isolates, conserve materials, and identify variants other than by host range and symptomatology. We have therefore purchased a 96-well manifold system, and nitrocellulose membranes to be sent to Dr. Thottappilly for his use, and have also supplied him with a minigel apparatus for polyacrylamide gel electrophoresis. He took back to IITA with him ascitic fluid of cell line FMV 7H8, and also ascitic fluid of antibody PTY 1 for evaluation against potyvirus isolates in various crops other than sweet potato.

Additional travel funds ($231) were used for the attendance of Dr. Hammond at the American Society for Virology Annual Meeting, in Chapel Hill, North Carolina, and a subsequent visit to the laboratory of Dr. Moyer at North Carolina State University in Raleigh, North Carolina. This visit was primarily related to cooperation in aspects of sweet potato virus diseases and exchange of reagents and materials.

Future research plans are essentially as laid out in the proposal. Future travel plans are for one of the USDA researchers to visit IITA in mid-1988, to hand-carry further reagents and help to apply them to the field situation. Such a visit would also allow on-site evaluation of the problems involved with some of the viruses.

☆U.S.GPO:1981-0-344-862/1275

Form AD 421 (6/79)

U.S. DEPARTMENT OF AGRICULTURE

RESEARCH WORK UNIT/PROJECT DESCRIPTION - PROGRESS REPORT

U.S. DEPT. OF AGRICULTURE, STATE AGRICULTURAL EXPERIMENT STATIONS AND OTHER INSTITUTIONS

1. ACCESSION NO.	AGENCY IDENTIFICATION NO. 2.	3.	4.	5. WORK UNIT/PROJECT NO.	6. STATUS TERMINATED E ☐	DATE (Day, Mo., Yr.) / 30. ESTIMATED TERMINATION DATE

7. TITLE

REPRODUCTIVE BIOLOGY OF STRIGA HERMONTHICA

8. PERFORMING ORGANIZATION

ICRISAT

DEPARTMENT OF BIOLOGICAL SCIENCES
OLD DOMINION UNIVERSITY
NORFOLK, VA 23529-0266

12. INVESTIGATOR NAME(S)

1 L.J. MUSSELMAN
2 BHARATHALAKSHMI
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4
5
6

84. PERIOD COVERED BY THIS REPORT (Month & year)

From: 1 JULY 1986 Thru: 30 JUNE 1987

85. PROGRESS REPORT

This project was not actually funded until September 1986 after the growing season. The fall was largely given to set up of experimental techniques in Norfolk and collaboration with the USDA Striga laboratory. Preliminary runs of allozymes of Striga asiatica were conducted. In December of 1986, David Knepper traveled to the ICRISAT research station in Zimbabwe to study Striga resistance. Principal findings of the above efforts are: (1) establishment of an electrophoresis lab; (2) seed and ovule development in several species of Striga; (3) discovery of pseudo-heterostyly in Striga forbesii; (4) evaluation of maize and sorghum lines to Striga forbesii resistance.

87. PUBLICATIONS

Research Summary

December 1986 to June 1987

I. DISTRIBUTION OF *Striga forbesii* IN ZIMBABWE:

A. ZIMBABWE:

To get an idea of the damage caused by witchweeds on a national scale, questionnaires were sent out to all Agricultural, Technical, and Extension Services (AGRITEX) offices; the Farmer's Unions; and the Department of Research and Specialist Services (R&SS) of Zimbabwe.

According to the survey *S. asiatica* is the most widespread species, but is rarely considered to be an agricultural problem. Although not as abundant, *S. forbesii* is a major problem in localized areas where crop losses have been reported to be as high as 90%.

Based on the questionnaires and the holdings of the National Herbarium, *S. forbesii* is found in all natural regions of Zimbabwe. It has been reported as a solitary plant in native grasslands and as large infestations in cultivated fields.

B. HUNTER'S ROAD DISTRICT, KWEKWE, ZIMBABWE:

To assess the extent of the *S. forbesii* infestation in the Hunter's Road District, detailed questionnaires were sent out to area farmers. All farms reported large infestations of the giant mealie witchweed that severely restricted crop selection and production. Although many control measures had been previously employed, none were found to be effective and so were discontinued.

II. *Striga* OBSERVATION NURSERY:

An observation nursery is a preliminary field-screening stage whereby large numbers of sorghum cultivars are evaluated for witchweed resistance in unreplicated, single-row plots. At Kingswood farm 440 sorghum lines from the SADCC region germplasm collection were evaluated for their reaction to *S. forbesii*. Number of emerged witchweed and sorghum plant stand were used as indices of resistance. Unfortunately susceptible control plots were not included in the trial so results can only be used to finger highly susceptible sorghum lines. Only 12 cultivars were found to be witchweed-free, however, these must be subjected to more rigorous screening techniques to determine their degree of "resistance."

III. ADVANCED *Striga* NURSERY:

In the advanced nursery *Striga asiatica*-Resistant (SAR) lines, RADAR, FRAMIDA, and local sorghum varieties were grown in fields known to be infested with *S. forbesii* to see if they possessed broad-based resistance to witchweeds in general. Each test entry (consisting of 3 row plots) was surrounded on all four sides by a susceptible control plot (Marupantse). Using this field-design the number of emerged witchweed in the test entry can be expressed as a percentage of the mean infestation in the surrounding control plots.

Evaluation of test entry performance was obscured by poor and variable host emergence, however, general trends were evident. Cultivars supporting no or very little emerged witchweed included SAR 29, SAR 33, and SAR 19. RADAR, PMC, RED SWAZI, and SAR 26 were found to be quite susceptible. Information on yield was not recorded due to extensive

:ow and bird damage.

The fact that SAR lines show promising levels of resistance to ;. forbesii indicates the possibility of broad-based resistance to ›roblem witchweeds.

V. GERMINATION REQUIREMENTS OF S. forbesii:

A. GERMINATION STIMULANTS:

Seeds of S. forbesii (collected 16 April 86 from maize) were tested to see whether they require host-root exudates for germination. Seeds were preconditioned for 8-18 days at 23 C before germination stimulants were applied. Root exudates of maize and sorghum (Marupantse) were collected by the Pasteur-pipette technique; a water control and the germination stimulant GR-24 were included for comparison. Petri dishes were placed in an incubator at 23 C for germination. Unfortunately many of the petri dishes dried, making quantitative analysis impossible. Both sorghum and maize root exudates triggered low levels of germination, but noticeably higher levels were achieved using GR-24. No germination occured in the water checks. Although not proven, it appears as if stimulants are required for S. forbesii seed germination.

B. SCARIFICATION:

Seeds (from the same seed-set as above) were scarified by 3 different methods:

1. Abrasion with fine sandpaper
2. Treatment with sulfuric acid
3. Treatment with a 3:1 bleach solution

The seeds were not preconditioned in any way before scarification. For each method half of the seeds were placed in petri dishes with distilled water as a control and the other half were treated with the artificial stimulant GR-24. After 7 days no germination was observed, therefore, it appears as if this species may require a "pretreatment" period as is true of S. asiatica and S. hermonthica.

C. AFTER-RIPENING:

Three different seed collections were used to determine if S. forbesii requires an after-ripening period for germination:

S. forbesii from maize, Long Valley, 16 April 1986
S. forbesii from sorghum, Long Valley, 16 April 1986
S. forbesii from sorghum, Long Valley, 4 June 1987

Seeds were preconditioned at 23 C for 8-18 days after which GR-24 was added to stimulate germination. Percent germination ranged from 10-45% for seeds which were 14 months old, however, none of the freshly-collected seeds germinated. Likewise no germination occured in the water control. This study indicates S. forbesii seeds require an after-ripening period before high germination levels are reached.

V. HOST SPECIFICITY:

At the Henderson Research Station, Zimbabwe, the following commercially important crops and local weeds were screened as potential hosts for *S. forbesii* and *S. asiatica*.

1. *Dactylotenium aegyptium* "Crowsfoot Grass"
2. *Eleusine indica* "Goose Grass"
3. *Setaria verticillata* "Bur Grass"
4. *Rottboellia exaltata* "Shamva Grass"
5. *Triticum vulgare* "Wheat"
6. *Urochloa panicoides* "Kuri Millet"
7. *Sorghum arundinaceum* "Common Wild Sorghum"
8. *Sorghum bicolor* "Sorghum" (Marupantse)

The following seedsets of *Striga* were tested:

A. *S. forbesii* 16 April 86 HOST: Maize
B. *S. forbesii* 16 April 86 HOST: Sorghum
C. *S. asiatica* 17 April 86 HOST: Maize
D. *S. asiatica* 17 April 86 HOST: Millet

There were 3 replicate pots of each host-parasite combination. The number of emerged witchweed was scored after hosts had matured. No unemerged witchweed was evident when the soil was washed from the roots. The results are in the process of being analyzed.

Dr. Bharathalakshmi's Progress Report

Summary of work conducted during the period September, 86 to July, 87 on Floral biology of Striga asiatica.

Objectives :

I. Developmental biology in Striga asiatica : To describe the different stages in seed development - Microsporogenesis, Megasporogenesis and embryogenesis.

II. Reproductive biology of Striga asiatica : To analyse the factors involved seed production - determination of pollen/ovule ratio; pollen load; and seeds/capsule.

III. Breeding behaviour in Striga asiatica : To determine the pollen load in flowers allowed for either self and cross pollination.

I(1) : Flowers, buds and capsules of yellow-flowered Striga asiatica attacking wild grasses were collected at the Bangalore University Campus, Bangalore, India in September, 86. The material was fixed in FAA and brought to ODU, Norfolk, Va.

I(2) : Striga material from scarlet-flowered plants attacking sorghum in the green house at Witchweed Methods Development Laboratory, Whiteville, NC, was collected ; fixed in FAA; and brought to ODU, Norfolk, Va, in October, 86.

I(3) : Both the American and Indian Striga material were prepared for microtechnique and sectioned longitudinally. Sections were stained with safranine and fast green; and the slides were made permanent.

I(4) : Slides were observed carefully under light microscope and drawings were prepared using camara lucida. Using these the different stages in the development of seeds were described.

Features like bud pollination; occurrence of sterile ovules and immature pollen; production of large number of ovules; sterile seeds; rudimentary cotyledons; single layer of endosperm in seeds; and thick seed coat could be attributed to the parasitic habit of this autogamous species.

II(1) : Striga material collected at Bangalore and Whiteville were used for this study and atleast 30 readings were taken for each parameter. The data were analysed using t-test.

II(2) : Number of pollen grains per flower - Anthers from buds, prior to dehiscence were dissected and placed in a drop of water on either side of a hemocytometer. Pollen grains were released by crushing the anthers by a fine needle point. Anther walls were removed and the number of mature as well as immature pollen grains was counted under a light microscope.

II(3) : Number of ovules per ovary - Ovaries from buds used in (2) were dissected; ovules were separated and counted as above.

II(4) : Pollen/ovule ratio - This was calculated using the results obtained in the previous experiments.

II(5) : Pollen load per stigma - Stigmas from flowers and buds were collected and the number of pollen grains deposited on each stigma was counted either directly after staining with aniline blue or by follwing the procedure of Beattie (1971). In this procedure the buds were fixed in 70% alcohol. Later, each stigma was taken on a slide along with glycerine jelly containing basic fuchsin; and this was heated and lightly crushed after placing a cover slip; pollen grains adhering to the stigma were counted using a light microscope.

II(6) : Number of seeds per capsule - Seeds from each capsule were sand-

witched between two layers of cellophane paper; and the number of seeds were counted under a dissecting microscope.

The number of pollen grains per flower was not significantly different in the two populations of Striga. However, the American Striga produced a significantly large number of ovules per flower than Indian Striga. Therefore, the American population has a higher pollen /ovule ratio than its Indian counterpart. The magnitude of pollen/ovule ratio is in conformance with that for autogamous species. In accordance with the number of ovules per flower, the American Striga produced significantly higher number of seeds per capsule than the Indian Striga The capsules were also smaller in the latter population. In both the populations, the seed production was lower than the actual capability as seen by the difference between the ovules per flower and seeds per capsule. This could partly be due to sterility.

III(1) This experiment was conducted in the green house at the Witchweed Methods Development Center, Whiteville, N.C.

III(2) Buds prior to dehiscence were selected and allowed to (i) self : buds were enclosed loosely within small plastic pouches , (ii) cross : buds were emasculated prior to anther dehiscence, and (iii) : control : buds were left without any treatment.

III(3) Pollen load per stigmas from the buds of i,ii, and iii sets were determined after 24,48 and 72 h using Beattie's method.

Significantly higher pollination was observed when the buds were allowed to self than to cross; in fact, the pollen load on stigmas of the buds allowed to cross pollinate, was negligible. However, the control set showed the highest pollen load.

U.S. DEPARTMENT OF AGRICULTURE

RESEARCH WORK UNIT/PROJECT DESCRIPTION • PROGRESS REPORT

U.S. DEPT. OF AGRICULTURE, STATE AGRICULTURAL EXPERIMENT STATIONS AND OTHER INSTITUTIONS

DATE (Day, Mo., Yr.) 13-OCT-87

41

1. ACCESSION NO.	AGENCY IDENTIFICATION NO.			5. WORK UNIT/PROJECT NO.	22-23. REGIONAL PROJECT NO.	TYPE/GRANT NO.
0130747	2. CSRS	3. MICL	4. 0000	MICL07534		86-CRSR-2-2367

7. TITLE

DEVELOPMENT OF A BARLEY YIELD SIMULATION MODEL

8. PERFORMING ORGANIZATION

ICARDA + IFDC

INTERNATIONAL AGRICULTURE
MICHIGAN STATE UNIV
EAST LANSING
MICHIGAN 48824

12. INVESTIGATOR NAME(S)

1. RITCHIE J,
2. Otter-Nacke S.
3.
4.
5.
6.

6. STATUS TERMINATED	30. ESTIMATED TERMINATION DATE	84. PERIOD COVERED (Mo., Yr.) FROM	THRU:
E ☐	31 AUG 89	1/87	12/87

85. PROGRESS REPORT

A management oriented computer model is being developed based on the CERES-Wheat model which simulates the growth and development of barley in the contrasting environments where barley can be grown with emphasis on duration of growth phases, and water and nutrient deficits. The strategy for this research is to receive a complete picture of barley physiology with emphasis on differences between barley and wheat.

A portable computer was installed at an office in West Germany and the basic structure of the barley model was created. First, phenology related subroutines were adapted to barley based on the following findings: base temperature set to 0 degree C; shorter phyllochron than in wheat, thus barley develops faster; definition and quantification of phases shorter in barley than in wheat (e.g., emergence, ear growth phase, grain filling); maximum number of primordia indicating the end of the primordia initiation phase, because barley does not develop a terminal spikelet; recognition of ear emergence rather than anthesis, because anthesis in barley is hard to determine. Barley is self-pollinating and anthesis may occur before, during or after ear emergence. The effects of all these facts were quantified with the available data and were incorporated into the source code to create a preliminary model.

Approximately 40 data sets were assembled, complete with climatic data, and used for trial runs to discover whether performed changes could generally be accepted. Test runs showed other areas in which additional work was necessary were the tillering process and the differing tillering patterns of 2-row and 6-row genetic specific parameters.

We have also learned that barley has a stronger stomata control of transpiration than wheat and that it will be important to include photosynthesis of the ear and leaf sheaths in barley into the model. Because barley is grown in drier regions, we are incorporating features of the plant's survival ability into the model.

87. PUBLICATIONS

Otter-Nacke, S., D.C. Godwin and J.T. Ritchie. 1987. Testing and validating the CERES-Wheat model in diverse environments. AgRISTARS Publication No. YM-15-00407.

Ritchie, J.T., L.F. Ratliff and D.K. Cassel. 1987. Soil survey laboratory data, field descriptions and field measured soil water limits for some soils in the United States. ARS Technical Bulletin.

APPROVED (Signature)	TITLE	DATE

"Development of a Barley Yield Simulation Model"
86-CRSR-2-2867
31 Aug 87
J.T. Ritchie and S. Otter-Nacke

Report of activities (Oct. 1986 - May 1987)

The project entitled "Development of a Barley Yield Simulation Model," which is funded through a USAID/CSRS grant, started on October 1, 1986. The goal is to develop a management oriented computer model on the basis of the CERES-Wheat model which simulates the growth and development of barley in the contrasting environments where barley can be grown with emphasis on duration of growth phases,and water and nutrient deficits.

The strategy is to receive a complete picture of barley physiology with emphasis on differences between barley and wheat from literature study and discussions with experts in various countries. Much expertise is in Western Europe, particularly England, with English scientists being involved in physiological studies conducted in Syria (ICARDA). Other good studies have been performed in Canada, North Dakota, Scotland and Cyprus.

After an initiation session in October, 1986 at Michigan State University, a portable computer was installed at an office in West Germany and the basic structure of the model, based on the CERES-Wheat model, was created. First, phenology related subroutines were adapted to barley based on the following findings:

- Base temperature set to 0 degree C.
- Shorter phyllochron than in wheat, thus barley develops faster.
- Definition and quantification of phases shorter in barley than in wheat (e.g.: emergence, ear growth phase, grain filling).
- Maximum number of primordia indicating the end of the primordia initiation phase, because barley does not develop a terminal spikelet.
- Recognition of ear emergence rather than anthesis, because anthesis in barley is hard to determine. Barley is self-pollinating and anthesis may occur before, during, or after ear emergence.

The effects of the above mentioned facts had to be quantified as well as possible with the available data material. Subsequently these relations were incorporated into the source code to create a preliminary barley model.

Approximately 40 data sets were assembled, completed with climatic data, and used for trial runs in order to find out whether performed changes could generally be accepted. Also, other areas in which additional work was necessary could be defined from the test runs such as the tillering process, the differing tillering patterns of 2-row and 6-row barley varieties, which can be reflected by different ranges in two genetic specific parameters.

On several occasions crop data were sampled from a farmer's field near Goettingen and at the Westphalian Research Station at Haus Duesse, West Germany. Plant and tiller numbers were counted and dry weights of plant parts measured to create additional test data sets. Researchers at the agricultural facilities in Giessen and Weihenstephan in West Germany were encouraged to collect barley data in the same fashion.

Trips

1. October, 1987: S. Otter-Nacke to Michigan State University. Project initiation. Cost: $1,421.00.

2. February, 1987: S. Otter-Nacke to International Centre for Agricultural Research in Dry Areas (ICARDA), Aleppo, Syria. Coordination of project goals with ICARDA expectations; discussion of special problems related to growing barley in semi-arid environment. Cost: $1,624.00.

3. May, 1987: S. Otter-Nacke to International Fertilizer Development Center, Muscle Shoals, Alabama; Northern Great Plains Research Station, Mandan, North Dakota; and Michigan State University, East Lansing, Michigan. Discussion of special physiology related topics; evaluation of progress; planning future collaboration. Cost: Approximately $1,700.00

Future Research and Travel Plans

June, 1987:	Discussion session at Reading University with scientists from England and Syria. Results to date will be discussed with ICARDA and European researchers for their comments and suggestions.
July-Sept., 1987	Modeling of tillering routines and growth of barley; do many test runs on a preliminary version of CERES-Barley.
September, 1987:	Meeting of S. Otter-Nacke and J. Ritchie with ICARDA staff to discuss progress and receive additional inputs.
October, 1987:	Meeting at IFDC with D.C. Godwin to incorporate nitrogen subroutines from the wheat model into the barley model.
Jan.-March, 1988:	Final development and testing.
March-May, 1988:	Documentation for ICARDA staff.
June, 1988:	Hold workshop for ICARDA staff to train them regarding model use.

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Form AD 421 (6/79) U.S. DEPARTMENT OF AGRICULTURE

RESEARCH WORK UNIT/PROJECT DESCRIPTION - PROGRESS REPORT

U.S. DEPT. OF AGRICULTURE, STATE AGRICULTURAL EXPERIMENT STATIONS AND OTHER INSTITUTIONS

DATE (Day, Mo., Yr.): 31/05/88

1. ACCESSION NO.:
AGENCY IDENTIFICATION NO.: 2. 3. 4.
5. WORK UNIT/PROJECT NO: 86-CRSR-2-2800
6. STATUS TERMINATED: E [ ]
30. ESTIMATED TERMINATION DATE:

7. TITLE

CHEMOTHERAPY AND THERMOTHERAPY OF IN VITRO POTATO AND SWEET POTATO PLANTLETS

8. PERFORMING ORGANIZATION

Department of Plant Pathology
University of Wisconsin-Madison
Madison, WI 53706

C/P

12. INVESTIGATOR NAME(S)

1 Steven A. Slack
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84. PERIOD COVERED BY THIS REPORT (Month & year)

From: 10/1/86 Thru: 9/30/87

85. PROGRESS REPORT

Objective 1 has been completed as desired, i.e., heat chambers (six) for thermotherapy experiments were designed and built, and the potato and sweet potato germplasm for tests were acquired. In addition to group Tuberosum potato germplasm, 52 genotypes representing seven species of particular importance (principally group Andigena germplasm) to the International Potato Center (CIP) were acquired through Dr. John Dodds, CIP. Dr. Dodds visited in July 1987, which permitted experiments and goals to be outlined. Two sweet potato cultivars, Jewel and Georgia Red, infected with and free from feathery mottle virus were obtained from Dr. Jim Moyer, North Carolina State University. Excellent progress has been made on Objective 2 (thermotherapy experiments) and on Objective 3 (chemotherapy experiments). Both sweet potato and potato will tolerate our standard protocol of a 4-hour alternating 35°C light/31°C dark regime for 4 weeks. Under more stringent conditions, most potato cultivars will not tolerate temperatures >35°C for more than 10 days and sweet potatoes seemed to tolerate 40°C (some death occurred) but not 45°C. Ribavirin effects on the potato cultivar Desiree and potato virus S (PVS) have been studied most extensively. At low ribavirin concentrations (e.g., 5 mg/l), an interaction was observed for ribavirin + heat treatment; but, at higher ribavirin concentrations (e.g., 20 mg/l), no interaction was detected. In the latter case, PVS was reduced below detectable levels for >70% of the plantlets tested in enzyme-linked immunosorbent assays (ELISA). About 50% of the ELISA-negative plantlets produced virus-free plants from nodal cuttings on media free from ribavirin. Experiments have just been completed to evaluate this result for several potato genotypes and potato viruses. Data suggest genotype and virus differences in response to treatments. All combinations tested respond to treatments, but some combinations do not respond as unequivocally.

87. PUBLICATIONS

SLACK, STEVEN A., PETERSON, MICHAEL D., ROTT, MARC and QUINONES, SARAH H. 1987. Effect of heat and chemical therapy treatments on potato virus S elimination in Desiree. Am. Potato J. 64:447.

APPROVED (Signature) | TITLE | DATE

CHEMOTHERAPY AND THERMOTHERAPY OF IN VITRO POTATO AND SWEET POTATO PLANTLETS

Grant No. 86-CRSR-2-2800
Annual Progress Report for Year Ending September 30, 1987

Steven A. Slack

The first complete project year was completed on the grant. The timetable outlined in the original proposal is on target. Objective 1 has been completed as desired, i.e., that heat chambers (six) for thermotherapy experiments were designed and built, and the potato and sweet potato germplasm for tests were acquired. In addition to group Tuberosum potato germplasm, 52 genotypes representing seven species of particular importance (principally group Andigena germplasm) to the International Potato Center (CIP) were acquired through Dr. John Dodds, CIP. Dr. Dodds was able to visit our laboratory in July, 1987, and this visit permitted us to review the project and to outline experiments and goals. Two sweet potato cultivars, Jewel and Georgia Red, were obtained from Dr. Jim Moyer at North Carolina State University. We have clones that are virus-free and infected with feathery mottle virus. The virus status has been verified via dot-blot assays utilizing antisera and a test protocol supplied by Dr. Moyer. A great deal of time has been spent evaluating sweet potato growth media for <u>in vitro</u> studies. A medium used at CIP appears to be best for our test regimes. We feel that we now have the sweet potato plant materials and test protocols in-hand and are ready for the thermotherapy and chemotherapy experiments. Significantly, Dr. Helen Griffiths joined the project in April, 1987, and her presence has enabled the thermotherapy and chemotherapy experiments on both potato and sweet potato to be initiated in earnest.

Excellent progress has been made on Objective 2 (thermotherapy experiments) and on Objective 3 (chemotherapy experiments). Both sweet potato and potato will tolerate our standard protocol of a 4-hour alternating 35°C light/31°C dark regime for 4 weeks. We have been evaluating more stringent conditions and have found that most potato cultivars will not tolerate temperatures >35°C for more than 10 days. A preliminary test on the sweet potato cultivars suggested that 40°C might be tolerated (some death occurred) and that 45°C was not tolerated. More extensive evaluations will be performed in the upcoming year. Data suggest that plantlets can be exposed to heat stress as soon as rootlets have been established. We are using 23°C to establish plantlets and a 72-hr conditioning period at 31°C immediately prior to placing plants into regimes where temperatures exceed 35°C to reduce plantlet shock. Chemotherapy experiments have only been performed on potato plantlets thus far, but results have been very interesting. Ribavirin has been used in experiments thus far, but additional chemicals for evaluation have already been obtained. The potato cultivar Desiree and potato virus S (PVS) have been studied most extensively. At low ribavirin concentrations (e.g., 5 mg/l), an interaction was observed for ribavirin + heat treatment; but, at higher ribavirin concentrations (e.g., 20 mg/l), no interaction could be detected. In the latter case, PVS was reduced below detectable levels for >70% of the plantlets tested in enzyme-linked immunosorbent assays (ELISA). Interestingly, about 50% of the ELISA-negative plantlets produced virus-free plants when new plantlets were propagated via nodal cuttings on media free from ribavirin. Experiments have just been completed to evaluate

this result for several potato genotypes and potato viruses (PVA, PVS, PVX, PVM, PVY, and leaf roll). Preliminary evaluation of data suggest genotype and virus differences in response to treatments. All combinations tested do respond to treatments, but some combinations do not respond as clearly, e.g., PVY and leaf roll concentrations are reduced an order of magnitude in plantlets, but virus is still detectable by ELISA and nodal cuttings generate virus-infected plantlets.

Our data suggest that virus reduction in plantlets during treatment is a significant indicator of the potential to obtain virus-free plants following meristem-tip excision and plantlet regeneration or following plantlet transfer via nodal cuttings. We consider the ability to obtain virus-free plantlets from nodal cuttings to be very significant because new plantlets can be obtained in 2-3 weeks rather than 2-3 months and the technical skill required to obtain consistent meristem-tips is eliminated.

Since these data suggest a protocol of considerable importance to CIP and others utilizing potato germplasm, considerable effort is now being directed toward this phenomenon for the upcoming year. The potato data will be used as a guideline for the sweet potato chemotherapy experiments.

PUBLICATIONS

Slack, Steven A., Peterson, Michael D., Rott, Marc, and Quinones, Sarah H. 1987. Effect of heat and chemical therapy treatments on potato virus S elimination in Desiree. Am. Potato J. 64:447.

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RESEARCH WORK UNIT/PROJECT DESCRIPTION • PROGRESS REPORT
U.S. DEPT. OF AGRICULTURE, STATE AGRICULTURAL EXPERIMENT STATIONS AND OTHER INSTITUTIONS

1. ACCESSION NO	AGENCY IDENTIFICATION NO 2	3	4	5. WORK UNIT/PROJECT NO	22-23. REGIONAL PROJECT NO	TYPE/GRANT NO.
8600620					08516	AID

7. TITLE

The Urgent Requirement by IITA for a Taxonomic Resolution of Cylas in Africa

8. PERFORMING ORGANIZATION

International Ag. and Food Prog. IITA
Cook College
P.O. Box 231
Rutgers University
New Brunswick, NJ 08903

12. INVESTIGATOR NAME(S)

1. G.W. Wolfe
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4.
5.
6.

6. STATUS TERMINATED	30. ESTIMATED TERMINATION DATE	84. PERIOD COVERED (Mo., Yr.) FROM	THRU:
E ☐	31 May 89	7/86	7/87

85. PROGRESS REPORT

During 1986-1987 most research centered on acquiring, curatin, sorting, and identifying specimens of Cylas. About 10,000 specimens from 25 museums around the world were obtained for study. Field work was conducted in Rwanda, Burundi and Kenya. As a result of the field work immature stages of three African pest species (C. brunneus, C. puncticollis, and C. puncticallis form 1) were associated with adult stages.

Computerization of locality data for each specimen was initiated.

87. PUBLICATIONS

APPROVED (Signature) G.W. Wolfe | TITLE Asst. Prof. | DATE

(See reverse side for Instructions)

Form AD-421 (Revised 4/84)

Annual Report (July 1986 - 30 June 1987)
"The Urgent Requirement by IITA for a Taxonomic Resolution of Cylas in Africa."

Overall Objectives

The lone term objective of this research is to resolve taxonomic problems of the larval, pupal, and adult, life stages of pest species of Cylas in Africa. Resolution of taxonomic problems will allow plant breeders to more optimally target and evaluate their breeding programs. Solving the taxonomic problems will involve accurate determination of the geographic distribution, host plants, and geographic variation for each pest. The thorough taxonomic field studies that I have proposed also will allow discovery of parasites associated with pest species.

Accomplishments

During 1986-1987 most research centered on acquiring, curatin, sorting, and identifying specimens of Cylas. About 10,000 specimens from 25 museums around the world were obtained for study. Field work was conducted in Rwanda, Burundi and Kenya. As a result of the field work immature stages of three African pest species (C. brunneus, C. puncticollis, and C. puncticollis form 1 1) were associated with adult stages.

Computerization of locality data for each specimen was initiated.

Travel

In 1986, I traveled to Rwanda, Kenya, and Burundi to, 1) present a paper on Cylas at the Symposium on Tropical Entomology, 2) collect specimens of Cylas and 3) consult with IITA plant

breeders (especially Dr. M. Alvarez) and scientists at Rwanda and Burundi National Research Centers. Funding for this trip was not from my IARC grant but the objectives of the trip were completely consistent with grant objectives and the results from the trip will directly benefit grant research.

Results

Submitted Papers:

Wolfe, G. William. 1984. Cylas, how many pest species? Annual Sweet Potato Collaborators Conference, Nashville, Tennessee.

Invited Papers:

Wolfe, G. William. Sept. 1986. The requirement by sweet potato breeders for taxonomic information on sweet potato weevils. Presented at the International Symposium on Sweet Potato Weevil Management, convened at the International Conference on Tropical Entomology, Nairobi, Kenya. PARTICIPATION Funded by AID (Airfare/per diem) - $3,575.

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RESEARCH WORK UNIT/PROJECT DESCRIPTION • PROGRESS REPORT

U.S. DEPT. OF AGRICULTURE, STATE AGRICULTURAL EXPERIMENT STATIONS AND OTHER INSTITUTIONS

1. ACCESSION NO.	AGENCY IDENTIFICATION NO. 2	3	4	5. WORK UNIT/PROJECT NO.	22-23. REGIONAL PROJECT NO.	TYPE/GRANT NO.

7. TITLE

Development of a Maize Composite Resistant to Several Major Insect Pests

8. PERFORMING ORGANIZATION

Department of Plant Breeding
Cornell University, Ithaca, NY and
ARS Entomology
Mississippi State University
State College, MS

CIMMYT

12. INVESTIGATOR NAME(S)

1. V.E. Gracen
2. F.M. Davis
3. W.P. Williams
4. J.A. Mihm
5.
6.

6. STATUS TERMINATED	30. ESTIMATED TERMINATION DATE	84. PERIOD COVERED (Mo., Yr.) FROM	THRU:
E ☐	7/87	7/86	7/87

85. PROGRESS REPORT

See following pages

87. PUBLICATIONS

APPROVED (Signature)	TITLE	DATE

(See reverse side for Instructions)

Form AD-421 (Revised 4/84)

1985-86

Progress in 1986-87

In 1984-86 three maize composites were made up including sources of resistance to each of the 3 stalk boring insects (SWB, SCB, and ECB). From these some 390 S1 families were developed, and recombined, and grown in Mexico in the winter of ~~1986-87~~. In the summer of 1986, 200 recombinant families were selected as being the most resistant and having acceptable agronomic quality. These were tested as follows:

1) For ECB resistance, at Aurora, NY and Newark, Delaware.
2) For SWCB resistance, at Tlaltizapan, Mexico, and State College, Miss.
3) For SCB resistance, at Poza Rica, Mexico.
4) For FAW resistance, at State College, MIss., Tifton, Ga. and Poza Rica.

At each site the best lines were selfed, and the seed harvested. These were planted at both CIMMYT sites (Tlaltizapan and Poza Rica) in Mexico in the winter of 1986-87, and again evaluated for insect resistance.

Results from both the summer (1986) and winter (1986-87) tests showed that all selected families had resistance to 3-5 major insects.

The same populations were screened at IITA in Nigeria for resistance to Eldana spp. and Sessamia spp. and at ICIPE in Kenya, for Chilo spp. Results showed that many of the borer resistant lines also carried resistance to these insects.

At Aurora, New York, plants from some of the more resistant families were sampled at leaf feeding and after flowering to study the mechanisms of resistance involved. Several lines carried the DIMBOA chemical resistance to ECB leaf feeding. However lines high in DIMBOA were not resistant to SCB or SWCB. Several resistant families had high stalk content of silica, lignin, and/or fiber, all linked to insect resistance in earlier studies. However unknown mechanisms also appeared to be involved, since known mechanisms were not sufficient to explain the resistance observed in some families. Identification of these additional mechanisms should be a goal for further research.

In preparation for continuing work on this project, recombinations were made among the most resistant lines for testing during the 1987-88 seasons. Also, highly resistant S1 lines were advanced to S2's for further testing. And, in a move ahead of the projected schedule, high-resistance synthetic varieties were developed for testing for adaptation in specific insect stressed environment.

In sum, all of the activities projected for 1986-87 were carried out. In addition, due to the success in identifying multiple resistant families, the researchers moved ahead into the next stages of the program, in developing synthetic varieties that may have use in CIMMYT and national breeding programs, and, possibly, directly as varieties for farmer use.

JUN 25 1987

Progress Report: "Development of a Maize Composite Resistant to Several Major Insect Pests", funded for one year under the USDA/CSRS Collaborative Research on Special Constraints at the International Agricultural Research Centers.

P.I. Vernon E. Gracen, Formerly Professor of Plant Breeding, Cornell University, now Adjunct Professor of Plant Breeding, Cornell.

Cooperators: B. R. Wiseman, ARS, Tifton, GA
F. M. Davis, ARS, Dept. of Entomology, Miss. State Univ.
W. P. Williams, ARS, Crop Science Res. Lab., Miss. State Univ.
J. A. Mihm, Entomologist, CIMMYT

The objectives of this project were to build maize populations with multiple resistance to several major insect pests that are widespread problems in world maize production. Such populations would be of broad benefit to CIMMYT as sources for maize lines to help meet the needs of the many national programs that CIMMYT serves. Lacking such multiple resistant populations, CIMMYT breeders must now seek individual lines, with specific resistance to each problem insect, adapted to each area that they serve. CIMMYT listed the need for populations with multiple insect resistance as their top priority "Special Constraint".

Multiple resistant populations were to be formed by incorporating diverse sources of biochemical, physical and genetic mechanisms of resistance. Resistance would be actively sought for:

Southwestern corn borer, Diatraea grandiosella (~~SCB~~ SWCB)
Sugarcane borer, D. saccharalis (SCB)
European corn borer, Ostrina nubilalis (ECB)

In addition, observations would evaluate potential for resistance to the:

Corn earworm, Heliothus zeae (CEW)
Fall armyworm, Spodoptera frugiperda (FAW)
Spotted stem borer, Chilo partellus (SSB)
African sugarcane borer, Eldana saccharine (AFSCB)
Pink stem borer, Busseola fusca (MSB)
Maize stalk borer, Busseola fusca (MSB)
Asian stalk borer, Ostrinia furnicalis (ASB)

Populations formed were to be evaluated for performance directly, and in combination with elite testers. Specific populations would be tested under insect pressures at Tlaltizapan and Poza Rica, Mexico; State College, Mississippi; Tifton, Georgia; Newark, Delaware; and Aurora, New York. Later, test sites were added at IITA, Nigeria, and ICIPE in Kenya.

Earlier studies had indicated that multiple resistance was possible. Also, individual corn populations had been identified with resistance to one or another of the above insects. The object in this project was to develop populations containing multiple resistance to at least three of the borer insects, (SWB, SCB, and ECB) and as many of the others as could be obtained.

Significance of this research

Progress to date has demonstrated that maize lines with resistance to individual insect pests can be combined to develop multiple insect resistant maize populations. Testing at widely diverse sites in the world make rapid screening possible under insect pressures that do not exist at any one site. The project brought together appropriate expertise from three U.S. state research stations, three international centers (CIMMYT, IITA, and ICIPE), and the USDA-ARS. The substantial progress demonstrates that such a cooperative project can move rapidly in producing useful maize germplasm.

The project also developed and identified superior maize families, with multiple resistance to the three target borer insects, and found associated resistance to other maize insect pests. Through its progress, a beginning was made to improve and use these multiple resistant families as sources for improving maize resistance to many insects. The resulting populations may have value to breeders in many maize growing areas of the world.

Unfortunately the project was funded for only one year. Unless further funding is identified so that this work can be continued, the resistant populations identified are likely to have little impact on world maize production. Not only has the research impact been thwarted by the lack of continued funding, but the entire funding and review process has dissillioned and discourage both the U.S. and CIMMYT participants.

Impact of this project on CIMMYT programs - The CIMMYT collaborators rate the impact very high in helping them begin to relieve this "Special Constraint". They are pleased with the project's progress, both in demonstrating that multiple insect resistance is a possible goal in maize breeding, and in developing a series of maize families with functioning multiple resistance for further breeding and for variety development. They are deeply disappointed that, after such a strong beginning, this project lost its funding, and are deeply concerned that much of its potential impact may not be realized.

Impact of this project on the U.S. state programs - We are pleased to help demonstrate that maize lines with multiple insect resistance are achievable. We expect to be able to use some of these lines in our own programs. We also learned some of the essential features needed to successfully organize a program involving this many stations and people. Some logistical and communications problems exist, but once these are overcome, such cooperation has tremendous power for moving forward a program rapidly, in many environments and against multiple pests.

However, the investigators and cooperators put much time and effort into this project. For the time involved in project preparation and revision, and in the organization of the task group above, and with the frustrations involved, we are not sure it was worth it. We doubt that we would do it this way again, particularly if we anticipated in advance that the funding was for only one year.

Training: Norma Ruiz, an associate breeder at CIMMYT, received training through participation on this project. It is likely that she will continue her education as a graduate student in Plant Breeding at Cornell.

Trips: The four U.S. participants (Gracen, Wiseman, Davis, and Williams) each travelled to CIMMYT once, to view maize materials at that site, and to plan further steps in this program. Costs ran about $800 each, for a total travel cost of about $2400. Travel funds for this purpose were in the budget mailed from Cornell 7/12/85. Since the funding was approved, the investigators assumed that the travel was approved.

Future Research, etc: Since funding for this project was terminated we assume that its direct activities will cease. Both CIMMYT and Cornell, and probably some of the other investigators will continue their interest in similar objectives, and seek funds through other routes. We believe that important progress has been made in helping CIMMYT with this "Special Constraint" and that useful information and breeding lines have been made available to other breeders. We will try to keep this research advancing.

APPENDIX B

GUIDELINES FOR GRANT PREPARATION FOR COLLABORATIVE RESEARCH ON SPECIAL CONSTRAINTS AT THE INTERNATIONAL AGRICULTURAL RESEARCH CENTERS

The Cooperative State Research Service (CSRS) plans to make a limited number of grants to U.S. investigators for Collaborative Research on Special Constraints at the International Agricultural Research Centers (IARCs) in fiscal year 1988 with funds provided by the Agency for International Development (AID).

Preproposals are invited on each of the special constraints identified at the IARCs--Appendix I, attached. Addresses of the IARCs are listed in Appendix II, attached. The preproposal should address the special constraint at the IARC--see Appendices III to V, attached.

The name, address and telephone number of the U.S. principal investigator should be included in the event additional details are required.

Grant preproposals should identify any presently existing cooperative research with specific scientists at the IARC. If no such linkage currently exists, the preproposal should identify the person or persons, if known, to be working in the specific area of research. It is expected that the IARC will participate fully in this activity. The preproposals will be reviewed simultaneously by a panel in the U.S. and by personnel at the appropriate IARC. Input from the two different evaluations will provide information as to which preproposals are most likely to succeed in solving the specific special constraint.

The budget should not exceed $90,000. None of the funds will go to the IARC. No part of the principal investigator's salary can be included as a part of the proposed project budget. Nonexpendable equipment costs should not exceed $1,000. The maximum length of time a proposal can be funded is three years. It is anticipated that the average grant awarded will be approximately $75,000 to $80,000, with most grants being of two to three years duration. Funds from other sources, however, may be used to help fund the proposed research. Indirect costs in the total budget must be identified.

Listed below are the criteria which will be used to evaluate the preproposals/proposals:

1. The merit of the research idea and the feasibility of the proposed investigation(s) being able to solve the problem.

2. The capability of the U.S. institutions conducting the proposed research, especially the capability of the U.S. scientists undertaking the research.

3. The extent to which the proposed research is feasible within the time and budget proposed.

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4. The extent to which the proposed activity will interface with research already underway at the IARCs, in U.S. research institutions, in other developed countries, or LDCs.

5. The commitment of the proposing U.S. institutions to do research in international agricultural development.

Since the research needs of the sponsoring agency (AID) are highly specific and the funds are limited, final details of the grants may be negotiated.

Peer scientists, representing the SAES, USDA/CSRS, USDA/ARS, AID and other organizations will review all preproposals.

Preproposals (10 pages or less) should be submitted as follows:

1. The original signature copy plus two (2) photocopies and a letter of transmittal should be sent to the Program Manager:

   Dr. Samuel C. Wiggans
   USDA/CSRS
   Rm. 217, J. S. Morrill Bldg.
   Washington, D.C. 20251-2200

2. Seven (7) copies and a copy of the letter of transmittal should be sent to the Program Coordinator:

   Dr. Wayne F. Keim
   Department of Agronomy
   Colorado State University
   Fort Collins, Colorado 80523

ALL PREPROPOSALS MUST BE RECEIVED NO LATER THAN AUGUST 10, 1987

Following review of the preproposals, fully developed proposals will be requested from a limited number of investigators. In the fully developed proposal, details of the cooperative research, and statements of collaboration with the IARC scientist(s) and the Director General or his Deputy at the IARC will be required.

Scientists having questions on the technical aspects of the proposed grants should call Dr. S. C. Wiggans, Program Manager, (202) 447-4202, or Dr. W. F. Keim, Program Coordinator, (303) 491-6985.

APPENDIX I

SPECIAL CONSTRAINTS (SUMMARIES)

CIMMYT

Barley Yellow Dwarf Virus in Africa and Latin America:

The research objectives are to obtain isolates of barley yellow dwarf virus from Africa and Latin America through CIMMYT, to characterize the various viruses and develop methods for diagnosis for use in CIMMYT's breeding program.

CIP

Identification, Characterization and Detection of Sweet Potato Viruses:

CIP is developing an extensive sweet potato program based on the utilization of a large germplasm collection. The Center must be able to distribute to national programs, and use in its own research, pathogen-tested sweet potato germplasm in accordance with international quarantine regulations. In the South American center of origin, sweet potato viruses need both identification and the development of detection methods that could be used in an efficient indexing system. Therefore, complete identification and characterization of sweet potato viruses is required prior to germplasm distribution and other research activities.

ICRISAT

Development of Field-useful Techniques for Identification and Enumeration of Inoculant Strains of Rhizobium for Chick-pea and Pigeon Pea

ICRISAT has identified efficient Rhizobium inoculant strains. Identifying and verifying their usefulness and survival under field conditions have been frustrated by low antigen titre and cross reactions with native rhizobia. Research on the cause of low antigenic titre and ways to improve the serological or other identification of the unmodified strains is desired.

IFDC

Enhancement of Fertilizer Efficiency by Use of Guanylurea Salts

Losses of nitrogen from fertilizers are a major economic loss to farmers, especially in flooded crops. It is known that guanylurea sulfate can be used more efficiently than deep-placed urea, sulfur-coated urea, or split applications of urea. In order to determine the critical loss-reduction locations in breakdown and uptake pathways of guanylurea, the synthesis of ^{15}N-labeled guanylurea is needed. IFDC expects that use of the labeled material may provide information leading to increased efficiency in nitrogen-fertilizer use.

IITA

Cowpea Host Plant Resistance to the Pod Borer, Maruca testualis, and to Coreid Bugs

These are major pests of cowpea flowers and pods in the tropics, and a major constraint to cowpea production in Africa. Several insecticides control them, but their use is not a practical solution in African peasant agriculture. Host plant resistance has been studied for several years at IITA, but high levels of resistance have not been identified. A number of pubescent wild cowpeas appear to be resistant. Incorporation of hairiness and other resistance mechanisms from related wild species in cultivated forms holds much promise.

ILCA

Factors Limiting Microbial Digestion of Cell Wall Carbohydrates in the Crop Residue from Sorghum

The objective of this proposed research is to determine the anatomical and chemical characteristics of the crop residue from sorghum that limit digestibility by rumen microorganisms in order to identify specific factors for possible inclusion in sorghum research breeding programs for improved nutritive value of crop residue and for grain yield. New methodologies in rumen microbiology, electron microscopy, and high-performance liquid chromatography are available to determine factors that limit microbial metabolism of cell wall carbohydrates. Although ILCA has a well equipped animal nutrition laboratory and good feeding facilities, it lacks the necessary instrumentation and expertise in the area ot rumen microbiology and plant histology.

ILRAD

Analysis of Genetic Basis of Antigenic Variation in Salivarian Trypanosomes

Antigenic variation in salivarian trypanosomes is the process by which trypanosomes evade the protective immune responses of the mammalian host; hence an understanding of the genetic basis of this process may lead to means of immunization or new chemotherapeutic attack. ILRAD does not have the manpower to devote to an exhaustive analysis of the phenomenon, whereas there are laboratories in the U.S. currently studying this process. ILRAD's emphasis is now being turned to genetic control of trypanosome differentiation, which is little studied by other groups, and is directly relevant to induction of immunity and studies of genetic resistance of animals. ILRAD will make available relevant parasite materials, reagents, facilities, and available techniques.

IRRI

Development of Methodologies for Mass Screening of Rice Breeding Lines for Tolerance to Low Soil Zn and P

Aside from nitrogen deficiency, zinc and phosphorus deficiencies are the most widespread nutrient deficiencies in flooded soils. Tolerance to both low Zn and P is critical in establishing tolerance of rice varieties to multiple stresses in adverse soils. Current screening methods only allow for a limited number of entries per year and do not allow for screening under conditions that realistically reflect the wide range of rooting environments in low P and low Zn soils. Highly reliable methods for the repeatable screening of several thousand entries per year under greenhouse/laboratory conditions are needed. These methods must be able to maintain soluble nutrient contents in the rooting environment at a constant level without constant monitoring.

APPENDIX II

DIRECTOR GENERALS AND ADDRESSES OF THE INTERNATIONAL AGRICULTURAL RESEARCH CENTERS

CIMMYT

Dr. Donald L. Winkelmann
Director General
Centro Internacional de
Mejoramiento de Maiz y Trigo
P.O. Box 6-641
Londres 40
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595-42100
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Cable: CENCIMMYT

CIP

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la Papa
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ICRISAT

Dr. Leslie D. Swindale
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TDS IBA NG 20311 (Box 015)
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APPENDIX III

APPLICATION PROCEDURES

1. Eligible Institutions

Grants may be made to U.S. institutions only, including Land-Grant Colleges and Universities, Schools of Veterinary Medicine, State Agricultural Experiment Stations, and to other institutions and organizations having a demonstrable capacity for food and agricultural research.

2. Preproposal Submission

A. In order to be considered for award, preproposals must not exceed a total of ten (10) pages in length including the research proposal and supporting materials. The title page should be Form S&E-661, which is the same as Appendix V in these guidelines. The preproposal must be received by August 10, 1987.

B. Preproposals should address in a condensed style the items listed in Format for Research Proposal, Appendix IV. Items 2 (Objectives), 3 (Procedures), 4 (Justification), 9 (Personnel Support), and 10 (Financial Support) should receive emphasis. An extensive literature review is not required for preproposals.

C. All preproposals from an institution must be signed by a person authorized to act on behalf of the institution. The signature of the authorized person indicates that:

1. The institution is committed to pursue the research activities described in the preproposal and in the proposal if selected for funding.

2. The institution will commit all funds shown in the proposal budget to the research if the proposal is selected for funding.

D. Research projects will be considered for funding only if they conform to the subject-matter guidelines.

E. Submit preproposals as follows:

1. The original signature copy, two (2) copies, and a letter of transmittal should be sent to Dr. S. C. Wiggans, Program Manager, Room 217, J. S. Morrill Building, Cooperative State Research Service, USDA, Washington, D.C. 20251-2200

2. Seven (7) copies and a carbon copy of the letter of transmittal should be sent to Dr. W. F. Keim, Program Coordinator, Department of Agronomy, Colorado State University, Fort Collins, CO 80523.

F. All preproposals will be evaluated by peer scientists. Based on their recommendations, a limited number of fully developed proposals will be requested later. One copy of the preproposals will be retained in the CSRS office for one year.

G. Fully developed proposals will be evaluated by peer scientists and by a Final Evaluation Committee. Recommendations for funding will be made to the Administrator, USDA/CSRS, and to the Director, S&T/AGR, AID.

H. After grants are awarded, one copy of each fully developed proposal which is not funded will be retained by CSRS for one year.

3. Budget and Reporting Requirements

The following items apply only to those proposals selected for funding:

A. The grant will be awarded on the basis of scientific merit and funding availability.

B. An annual financial report (Standard Form 269) will be required.

C. An annual progress report not to exceed five pages will be required in addition to a shorter summary for insertion into a computerized research information service. Annual reports will be organized around the objectives and research timetable as specified in the project proposal.

D. Quarterly trip reports will be required.

E. A comprehensive (performance and financial) final report must be submitted to CSRS within 90 days after the termination date of the grant.

4. Terms and Conditions

The Uniform Federal Assistance Regulations (7CFR Part 3015) applies to these grants. This document is available upon request to this office. Where applicable, this document can be obtained from Agricultural Experiment Station Directors.

APPENDIX IV

FORMAT FOR RESEARCH PREPROPOSAL

1. TITLE PAGE (Form S&E-661)

   A. Title: A brief, clear, specific designation of the subject of the research. Do not include such terms as "A Study of" or "A Detailed Analysis of".

   B. Approved signatures of appropriate officials: All proposals from a University, College, or Institution must be signed by the same authorized official(s).

2. OBJECTIVES: Clear, concise, complete statements of the specific aims of the research.

3. PROCEDURES: Statements of the essential working plans and methods to be used in attaining each of the listed objectives. Procedures should correspond to the objectives and follow the same order.

4. JUSTIFICATION: A brief description of the importance of the problem to the needs of developing countries, including estimates of the magnitude of the problem and reasons for the work being performed by your particular institution.

5. LITERATURE REVIEW: A summary of pertinent publications with emphasis on their relationship to the research.

6. CURRENT RESEARCH: Describe the relevancy of the proposed research to ongoing research conducted by you and others. This section may be combined with Literature Review, if convenient to do so.

7. FACILITIES AND EQUIPMENT: The locations of the work and the facilities and equipment needed and available should be clearly indicated. This section may be combined with Procedures, but the combination must clearly show needed and available facilities and equipment.

8. RESEARCH TIMETABLE: Show all important research phases as a function of time.

9. PERSONNEL SUPPORT: Identify clearly all personnel who will be involved in the research. For each scientist involved include:(1) an estimate of the time commitments; (2) a statement of his/her training and research experience (3) vitae of all research personnel who will be involved in the proposed project.

10. FINANCIAL SUPPORT: Show estimated annual costs by source of funds (grant and other sources) in conventional budget categories. Include indirect overhead costs where appropriate. (See Appendix V)

11. INSTITUTIONAL UNITS INVOLVED: List each unit of the institution contributing essential services or facilities to the proposes research. The responsibilities of each should be clearly shown. If there is an advisory, or coordinating committee, for the project, list members by name, title, and affiliation.

12. IMPACTS: Estimate the magnitude of the scientific and/or socioeconomic benefits expected from the new knowledge or technology generated. Describe the users of the research results, how the results could be used, their potential impact on the problem defined in the project justification statement, the beneficiaries of the research results and the nature of the benefits received.

If you are asked to submit a fully developed proposal, the USDA Research Grant Application Kit should be used and the appropriate forms in the kit should be completed and submitted with the proposal.

APPENDIX C

PROPOSAL REVIEWERS

FY 1986

Baenziger, P. Stephen, Department of Agronomy, University of Nebraska, Lincoln, NE 68583

Barnes. Robert F., Executive Vice President, American Society of Agronomy, 677 South Segoe Road, Madison, WI 53711

Brewbaker, J.L., Department of Horticulture, 3190 Maile Way, University of Hawaii, Honolulu, HI 96822

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Hooker, Arthur L., 39W749 Deerhaven Trail, St. Charles, IL 60115

Larson, William E., Head, Department of Soils, University of Minnesota, St. Paul, MN 55108

Lechtenburg, Victor L., Associate Director, Indiana Agricultural Experiment Station, Purdue University, W. Lafayette, IN 47907

MacCollom, G. B., Department of Plant and Soil Science, Hills Building, University of Vermont, Burlington, VT 05405

McIntyre, Gary I., Head, Department of Plant Pathology and Weed Science, Colorado State University, Fort Collins, CO 80523

Moss, Dale N., Department of Crop Science, Oregon State University, Corvallis, OR 97331

Pesek, John T., Head, Department of Agronomy, Iowa State University, Ames, IA 50011

Peterson, Gary A., Department of Agronomy, Colorado State University, Fort Collins, CO 80523

Phillips, Ronald L., Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, MN 55108

Schalk, James M., U.S. Vegetable Laboratory, 2875 Savannah Highway, Charleston, SC 29407

PROPOSAL REVIEWERS

FY 1987

Dr. Robert F. Barnes, Executive Vice President, American Society of Agronomy, 677 South Segoe Road, Madison, WI 53711-1086, (Crop Physiology)

Dr. Stephen Baenziger, Department of Agronomy, University of Nebraska, Lincoln, NE 68583, (Crop Breeding, Molecular Plant Genetics)

Dr. Richard A. Bowen, Department of Physiology and Biophysics, College of Veterinary Medicine, Colorado State Univeristy, Fort Collins, CO 80523, (Monoclonal antibodies)

Dr. Francis A. Haskins, Department of Agronomy, University of Nebraska, Lincoln, NE 68583, (Molecular Plant Genetics, Crop Physiology)

Dr. H. Charles Hines, Department of Dairy Science, Ohio State Univeristy, Columbus, OH 43210, (Immunogenetics, Monoclonal Antibodies)

Dr. Donald A. Holt, Director, Illinois Agricultural Experiment Station, University of Illinois, Urbana, IL 61801, (Crop Physiology)

Dr. Arthur L. Hooker, 39W749 Deerhaven Trail, St. Charles, IL 60115, (Crop Breeding, Plant Pathology)

Dr. Daniel P. Knievel, Department of Agronomy, Pennsylvania State University, University Park, PA 16802, (Crop Physiology)

Dr. Paul Lalor, Department of Genetics, Stanford Univeristy, Stanford, CA 94305, (Monoclonal Antibodies)

Dr. William E. Larson, Head, Department of Soils, University of Minnesota, St. Paul, MN 55108, (Soils)

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Dr. John T. Pesek, Head, Department of Agronomy, Iowa State University, Ames, IA 50011, (Soils)

Dr. Gary A. Peterson, Department of Agronomy, Colorado State University, Fort Collins, CO 80523 (Soils)

Dr. Ronald L. Phillips, Department of Agronomy and Plant Genetics, University of Minnesota, St. Paul, MN 55108, (Molecular Plant Genetics, Cytogenetics, Crop Breeding)

Dr. James M. Schalk, U.S. Vegetable Laboratory, 2875 Savannah Highway, Charleston, SC 29407 (Entomology)

Dr. Michael Stear, USDA Meat Animal Research Center, Clay Center, NE 68933, (Monoclonal Antibodies)

PROPOSAL REVIEWERS
FY 1988

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