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ADVANCES IN SWEET POTATO AND POTATO RESEARCH AND DEVELOPMENT PROGRAMS IN CENTRAL AMERICA AND THE CARIBBEAN

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ABSTRACT

Considerable advances in sweet potato technology are apparent in several crop aspects which are relevant to the Region. Research results in genetic resource preservation, breeding for higher yields and non-sweet types, pathogen-tested cultivar availability and in vitro preservation through the collaborative efforts of the International Potato Center and National and Regional Programs and entities will be presented and discussed. For potatoes, research developments in breeding for adaptation to hot climates, seed production, true potato seed technology and virology will be discussed. Insect pests damaging potatoes and sweet potatoes in Tropical America will be identified and discussed. Insect pests like the potato tuber moth, Phthorimaea operculella (Zeller), and the sweet potato weevil, Cylas formicarius (Fabricius) have been known to cause yield losses of more than 40%. In an endeavour to address the challenging task of developing appropriate and sustainable pest management strategies, the International Potato Center (CIP) has followed, from its inception, an advanced multidisciplinary research and training approach on a collaborative basis. This approach has been intensified in the last ten years.

During this period, CIP's research efforts have yielded useful technology, the application of which promises to have definite impact on management of potato and sweet potato pests of economic importance in Tropical America. CIP's integrated pest management (IPM) program, over the last several years, has based its research effort on the use of host plant resistance (HPR) to insect pests, sex-pheromones, cultural practices and biological control of key insect pests. Status of research and development work on these control components and their use in national programs in Tropical America will be discussed.

INTRODUCTION

The International Potato Center (CIP) is one of the Research Centers of the Consultative Group for International Agricultural Research (CGIAR). Established in 1972 through an agreement with the Government of Peru, received funding and began its program in 1974. Its mandate is to develop and disseminate knowledge on potatoes and other root and tuber

crops, to increase their utilization as basic foods in developing countries. Until 1987, its research was concentrated on potatoes. Since then, its program has been expanded to include sweet potatoes. Its basic research is carried out through interdisciplinary programs, thrusts, covering major aspects of both crops: genetic resources; breeding and genetics; fungal, bacterial, viral and virus-like diseases; entomological problems and their control; physiological processes and agronomic techniques for distinct ecological zones; propagation material, including seed production schemes and innovative multiplication techniques; socioeconomic research on cropping and food systems in the developing world; post-harvest technology and prevention of food losses. All of these are complemented by human resources development and training. The dissemination of CIP's research results, suggested techniques and germplasm is carried out through its Regional Program in collaboration with National Agricultural Research Systems (NARS) in 8 agroecological zones comprising more than 75 developing countries. To accomplish this mandate, CIP utilizes special strategies which include collaborative research projects, contract research with developed and developing countries' Universities and Research Centers; placement of selected CIP research scientists in most regional offices for zones with comparative advantages and assistance in the development and continuity of Potato and Sweet Potato Regional Networks. Presently CIP is part of or assists networks in Latin America, Asia and Africa. Plans are in place to support a Network for sweet potatoes in the Caribbean in the near future.

Potatoes and sweet potatoes are considered the fourth and sixth most important crops in the world respectively, and vary in their relative economic importance as food and cash crops, on the developed and the developing world. Both are considered staple foods in many countries in Latin America and the Caribbean. This paper summarizes the major advances in technology for both crops attained by CIP and the NARS in the few years.

Genetic Resources

Most of the cultivated potato species collected since CIP's inception, which number more than 8000, are being preserved in vegetative form in at least 2 locations in Latin America and in in vitro collections in several other laboratories worldwide. Biochemical and botanical characterization to determine duplicates and to identify genetic traits useful to breeders is being carried out on most entries. A comprehensive description of the collection is being published. Similar programs are in place for the wild species.

Long-term preservation has been assured utilizing botanical seed, frozen with liquid nitrogen in seed reservoirs in the USA. By 1988, the program emphasis was shifted to sweet potato

germplasm collection and preservation. To date, more than 3000 entries of cultivated and wild Ipomoea species have been collected, mostly in Latin America, by CIP's researchers and received as donations from other International Research Centers, Universities' and NARS' collections. These are being preserved in Peru, with duplicates in each country of collection.

In Central America and the Caribbean, sweet potato germplasm collection expeditions have been carried out in Jamaica, Saint Vincent, Cuba, Mexico and Panama. Additional collections are planned in Honduras, Nicaragua and Mexico.

Detailed protocols for the description of the germplasm, which include botanical and physiological characteristics were developed for use by CIP and the NARS, establishing a uniform system to facilitate the comparison of entries, eliminate duplicates and classify the germplasm for the benefit of breeders.

Breeding

Through population breeding, recurrent selection and progeny testing, a large number of tuber families, clones and true (botanical) seeds of specific hybrids were produced and distributed to breeding programs in developing countries for further selection and possible varietal release. To date, more than 60 varieties and advanced clones have been released or named in various regions of the world, with tolerance or resistance to foliar diseases, especially Late Blight (Phytophthora infestans); nematodes; and abiotic stresses with adaptation to tropical conditions, either cold and high or warm and low tropics. Concurrently, NARS collaborators have been offered the opportunity to select 2 or 3 of the best clones to be included in CIP's worldwide collection of cultivars and advanced clones for preservation and further distribution.

In order to overcome the restrictions on the international movement of germplasm, strict export quarantine procedures have been developed, including new techniques of virus and virus-like structures detection and elimination. Consequently, a pathogen-tested collection has been obtained. Seed tubers, in vitro propagules and botanical seed from this collection have been sent (upon request) to almost all developing countries. This has resulted in the release of new varieties in several continents from entries developed in other programs and continents. The pathogen tested collection of worldwide cultivars and clones includes more than 150 entries.

The same strategy is being applied to sweet potato breeding and selection, utilizing the growing availability at CIP of cultivated and wild species of Ipomoea; the research contracts awarded to Universities to provide clones with specific traits in regard to yield, skin and flesh color, and food value (degree

of sweetness); and the collection and redistribution of advanced clones and cultivars from many breeding programs in the world. At this stage, approximately 50 entries are being tested for pathogens, and it is expected that these will be pathogen-free in the near future. The NARS can select 1 to 3 of their best cultivars and incorporate them to this process for themselves or for other programs.

Progress in the area of host-plant resistance to a major limiting factor in sweet potato cultivation, sweet potato weevil, has been slow. No cultivars with high levels of resistance are available, despite past research programs utilizing conventional breeding techniques. Many of the species of Ipomoea and primitive cultivars maintained at CIP's world collection need to be evaluated for levels of resistance.

Similar considerations apply to breeding for resistance to diseases, particularly viruses. The complexity of their nature and the limited research being undertaken on the subject, reduces the potential for success in detecting resistance. Substantial efforts by CIP and collaborators are directed to address the problem.

Disease Control

Potato diseases are the most important factor affecting potato productivity. The virus content of the seed, the soil fungi, the bacterial wilts and the foliar diseases such as Late Blight and Alternaria sp., individually or in combination, are limiting factors affecting the crop's yields and productivity. CIP's scientists and collaborators developed virus detection techniques, such as monoclonal antibodies for utilization in serological tests; Elisa kits for potato viruses X, Y, S, Leaf Roll and other Andean latent viruses; and special tests for the Spindle-tuber Viroid (PSTV). The latter is extremely important for seed programs and for export of germplasm.

Through population breeding and recurrent selection, CIP breeders have been able to select numerous clones with resistance to Late Blight, for testing in several locations worldwide. This resistance is of great importance wherever potatoes are grown. During a 10-year program, efforts were concentrated on identifying and selecting clones and families with "horizontal" or "field" resistance. This trait assures a long-lasting stand against the disease, as opposed to inmunity, which is overcome by the constant recombination of the fungus. The former is based on the selection of "minor" genes, limited plant infection by the organism and expression of yield despite the fungal invasion. The latter is easily broken by the adaptation of the fungal races to the "major" genes in the population. After six cycles of selection at locations where the disease is endemic and where all forms of the fungus are present (Toluca Valley, Mexico), CIP breeders have selected 168 clones for distribution to NARS.

Separate populations with resistances to the Cyst nematodes (Globodera sp.), to virus PVY and PLRV and to bacterial wilt (Pseudomonas solanacearum) are also available.

A specific program was set up to identify the most important viruses affecting sweet potato. The problem justified considerable research in the past. In spite of this, little progress has been achieved in virus control due to lack of precise symptomatology and complications in the preparation of purified antisera for their detection.

Biochemical and bioengineering techniques are used to isolate the different viruses and possible components of complex viral mixtures and to prepare antisera to each individual virus or component of the mixture. The antisera will be utilized, in combination with other methods to start freeing the sweet potato worldwide collection from pathogens, and thus, to allow a safe distribution of genetic material.

Pests

A major component in CIP's approach to pest control is the development of an integrated approach, which could result, if correctly applied by farmers, in a reduction in the use of insecticides. For potatoes in Latin America, concentration has been placed on two tuber moths, Phthorimala operculella and Scrobipalposis solanivora. The control strategy includes the application of agronomic practices in the field and in storage, the identification of resistance in CIP's germplasm collection, the identification of beneficial insects which parasitize the moths, and the isolation of other parasites like viruses. Of special interest is the utilization of (chemically synthesized) pheromones which resemble that naturally produced by the female moth, to mass trap or disorient the male population and disrupt the life cycle of the pest. Considerable progress has been achieved in the preparation of pheromones, testing of traps and utilization of the pheromones in farmers' fields in several South and Central American countries and Mexico. Recently, a spreadable compound containing a baculovirus, isolated from affected moths, was made available to researchers to evaluate its effect as a natural insecticide for the pest.

In sweet potatoes, several weevil species are reported as important in terms of damage: Cylas formicarius elegantulus is a major pest in Cuba, Dominican Republic, Haiti, Jamaica, Puerto Rico and St. Kitts. Euscepes postfasciatus has been reported of major concern in Grenada, Guadaloupe, St. Lucia, St. Vincent and Martinique. CIP has placed some emphasis in field surveys to confirm the reports and to assess the real damage the pest produces.

National programs have been encouraged to prepare collaborative research projects to develop IPM strategies for

managing the sweet potato weevil complex. Two International Workshops were organized by CIP and NARS and in cooperation with U.S. Universities in 1988 and 1989, where the status of the current knowledge worldwide was assessed and research needs were determined. The IPM components which were determined as potentially most useful were:

a) Utilization of Sex Pheromones

A sex pheromone, (Z)-3-dodecen-1-01 (E)-2-butenoate, has been identified as highly attractive to Cylas formicarius males. CIP and researchers from the University of Florida are cooperating to develop a pheromone trap monitoring program for the sweet potato weevil in the Dominican Republic and Jamaica. Protocols for testing trap designs and pheromone doses have been developed. In the proposed study at least three trap designs will be compared. Trap-type selection will be based on costs of construction and/or purchase and local availability of materials. Trap efficiency and weevil escape for all the trap designs will also be assessed. Work in the southern U.S. indicates that a single system can be developed for the entire U.S. It is important to test this technology in key countries in the Caribbean to see if the system is applicable to most of the region. The purpose is to assess the chances for monitoring the pest, mass trapping and mating disruption techniques.

b) Biological Control

Entomopathogenic nematodes, Neoplectana carpocapsae and Heterorhabditis heliothidis, have been effective in controlling C. formicarius elegantulus in the Southern U.S. In Peru, the entomopathogenic fungus Beauveria bassiana has been found promising for E. postfasciatus control. A research program on the use of indigenous and exotic pathogens and nematodes for control of these tuber feeding weevils has been developed. The Dominican Republic and Puerto Rico will be the lead countries to develop this technology. In Cuba, studies of sweet potato fields at risk of attack by C. formicarius elegantulus have showed that yields were higher from fields protected by a predacious ant Pheidole megacephala either occurring naturally or introduced, than those in which recommended chemical treatments were applied. Both CIP and the University of Florida are involved in assisting the national research programs in the design and implementation of studies related to biological control.

c) Agronomic Practices/Use of Clean Planting Materials

Countries such as Jamaica and the Dominican Republic have placed emphasis on a) producing and distributing clean planting materials, b) conducting adaptive on-farm trials to diffuse proper agronomic practices, and c) developing post harvest practices to reduce weevil damage. Emphasis is on transferring

local experience through on-farm trials with strong involvement by farmers. Through this experience a technological package would be eventually developed for testing in other countries of Caribbean.

d) On-farm Interviews

CIP in the Dominican Republic and CIP and the Caribbean Agricultural Research Development Institute (CARDI), through its representative in Jamaica, are conducting on-farm interviews on the sweet potato weevil problem and its control in these islands. The results of these surveys will be extremely useful in identifying promising control measures which could be incorporated in the final development of a total IPM program for sweet potato weevil management in Caribbean.

The total program approach as described above is being complemented by an Institutional and Human Resources Development Assistance Program which included training plans through courses and In-service training; Potato and Sweet Potato Networks' activities support in Central America (PRECODEPA) and the Caribbean; project development and funding procurement and specific contract research given to Universities and National Research Institutes to investigate specific problems of interest to all. The detailed description of these programs exceeds the scope of this report and is available upon request.