SYMPOSIUM 1.4: INCREASING THE QUALITY AND USEFULNESS OF IPM RESEARCH

ABSTRACTS

INCREASING THE QUALITY AND USEFULNESS OF INTEGRATED PEST MANAGEMENT RESEARCH: AN OVERVIEW

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In 1992, the 'Earth Summit' recognized that attempts to raise living standards through conventional development approaches were only having a limited impact on hunger and poverty in developing countries, and that inappropriate development strategies were destroying the planet's ecological life support systems. In the 'Agenda 21' action plan of the Summit, integrated pest management (IPM) was identified as a key part of the solution to this problem, as it allows more food to be produced with minimal damage to agricultural and natural ecosystems. In 1996, as part of its response to Agenda 21, the CGIAR launched the Systemwide Program on Integrated Pest Management (SP-IPM). The SP-IPM is an inter-institutional partnership program which harnesses complementary strengths of international agricultural research centers and their partners to enable IPM make decisive contributions in sustainable agricultural development at national and community levels. The SP-IPM encourages researchers to increasingly focus on seeking better understanding of farmers' perceived needs and on participatory approaches to elucidate the biological, ecological, and sociological processes that underpin major and previously intractable pest problems arising when these processes are disrupted, and using this understanding to solve the problems. Through strategic alliances between researchers and pertinent stakeholder groups, the SP-IPM promotes technical, communication, policy and investment environment required in IPM for farmers to achieve greater food security and raise their incomes within a healthier environment. This symposium highlights some of the achievements of the SP-IPM in these areas.

WHITEFLIES (HOMOPTERA: ALEYRODIDAE) AS VIRUS VECTORS

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Although there are over 1200 species of whiteflies (Homoptera: Aleyrodidae), some of which are major pests of cultivated plant species, there are few whitefly species known to transmit plant viruses. Of the known virus vectors, *Bemisia tabaci* is by far the most ubiquitous and important whitefly species, with more than 110 plant viruses reportedly being transmitted by this vector. Over 90% of the viruses transmitted by *B. tabaci* belong to the genus *Begomovirus*. These are single-stranded DNA viruses that replicate in the nucleus of plant cells, causing severe physiological disorders in susceptible plant species. *B. tabaci* is also a vector of about fourteen single-stranded RNA plant viruses belonging to the genera *Crinivirus, Carlavirus, Ipomovirus* and probably other unclassified genera. *B. tabaci* is a major pest in the tropical and subtropical lowlands and mid-altitude valleys of the world. In temperate countries and in the highlands of the Tropics, the whitefly *Trialeurodes vaporariorum* replaces *B. tabaci* as both a pest and virus vector. *T. vaporariorum* transmits a few single-stranded RNA viruses in the family *Closteroviridae*. These viruses can cause significant yield losses, and their range can overlap with that of some *B. tabaci*-transmitted viruses in subtropical regions. Other *Bemisia* and *Trialeurodes* species, such as *B. afer* and *T. abutilonea* have also been implicated or shown to be virus vectors. The diversification and intensification of cropping systems around the world, are blamed for the continuous outbreaks and emergence of new whitefly-transmitted viruses, but pesticide abuse and climate change have also played a major role in the epidemiology of these plant viruses.

RECENT ADVANCES IN WHITEFLY (*ALEUROTRA- CHELUS SOCIALIS* BONDAR; HOMOPTERA: ALEYRODIDAE) RESISTANCE IN CASSAVA (*MANIHOT ESCULENTA* CRANTZ)

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A complex of whitefly species cause considerable yield loss to the cassava crop in Latin America, Africa and Asia as direct feeding pests and virus vectors. The most economically important species in northern South America is *Aleurotrachelus socialis*. Direct feeding damage and lower photosynthetic rate can reduce yields by as much as 79% when prolonged attacks occur. The cassava clone MEcu 72 has consistently expressed the highest levels of resistance to *A. socialis*. *A. socialis* feeding on this resistant clone had less oviposition, longer development periods, reduced size

and higher mortality than those feeding on a susceptible clone. A cross between MEcu 72 and MBra 12 resulted in numerous whitefly resistant, high yielding progeny. The genotype CG 489-31 was selected for release to farmers by the Colombian Institute of Agronomy during 2003. In order to understand and characterize the genetics of resistance expressed in the MEcu 72 genotype, a cross was made between MEcu 72 (Resistant) x MCol 2246 (Susceptible). Segregation of the F1 population of this cross was evaluated using molecular markers such as micro satellites and AFLPs. The use of micro satellite markers showed an association between molecular markers and resistance.

BEMISIA BIOLOGY, ECONOMIC IMPACT AND MANAGEMENT IN AFRICA

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Whiteflies are globally one of the most damaging groups of insect pests, and *Bemisia tabaci* is the most economically important species in this group. *B. tabaci* has been recognized as a virus vector and physical pest of African crops for more than 80 years, but problems have been exacerbated during this time by a number of factors including: excessive pesticide use leading to resurgence, the appearance of synergistic interactions with host plants and vectored viruses and the emergence of novel biotypes. Greatest problems have been experienced in the cotton, tomato, sweetpotato and cassava systems, although virtually all of the non- graminaceous crops have been affected to some degree, primarily through the transmission by *B. tabaci* of begomoviruses. Recent research focusing on cassava, arguably Africa's most important staple food crop, has provided important insights into the genetic characteristics and variability of African *B. tabaci* populations, virus and host interactions, the role of beneficial insects in limiting population development and management strategies for both *B. tabaci* and the viruses it transmits. In this paper, we provide a broad review of these facets of whitefly research in Africa. We conclude that whilst resources targeting support for whitefly research in Africa continue to be grossly inadequate, a number of factors, both biological and socio-economic, are working to increase the threat that this pest poses to African agricultural systems, a situation that needs to be urgently addressed if the promise of agricultural development in the African continent is to be realized.

VIRUS DISEASES OF CASSAVA IN AFRICA

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Cassava is one of the major food staples in sub-Saharan Africa and is vital to the livelihoods of more than 300 million people. Virus diseases represent some of the most important constraints to the sustained production of the crop, and two in particular continue to have a major impact. Cassava mosaic disease (CMD), caused by cassava mosaic geminiviruses (CMGs) and transmitted by the whitefly vector, *Bemisia tabaci*, occurs in all countries where cassava is grown and affects more than half of all cassava plants. Recent experimental evidence has shown this group of viruses to have a remarkable capacity to adapt, change and overcome host plant defenses through recombination, pseudorecombination and interaction with sub-genomic satellite molecules. All of these features seem to be critical factors in the expansion of a pandemic of unusually severe CMD which now affects nine countries in East/Central Africa. Cassava brown streak disease (CBSD), caused by *Cassava brown streak virus*, occurs primarily in coastal East Africa, but is particularly devastating through causing dry root rot leading to large-scale crop spoilage. Recent evidence suggests that CBSD may be more widespread than previously thought, but progress in addressing the problem is hindered by inadequate current understanding of the virus and the failure to date to identify the putative vector. In this paper we review recent progress made in understanding these two virus diseases and the development of IPM strategies to manage them.

GENETIC ENGINEERING AS A COMPONENT OF IPM FOR MAIZE STEM BORER CONTROL IN AFRICA

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Considerable debate has taken place on the use of genetic engineering (GE) to increase the quantity and quality of food

production in both developed and developing countries. Maize and cotton were among the first commercial products which contained modified genes expressing δ-endotoxins from *Bacillus thuringiensis* (Bt). Rapid adoption of these varieties has created a sense of urgency to assess the compatibility of this technology with existing control strategies and to assess their environmental impact so as to provide scientific information for policy makers, researchers and the general public to objectively assess GE technology. The Insect Resistant Maize for Africa (IRMA) project based in Kenya has conducted research in areas to address issues that impact on the utilization of Bt-maize for stem borer control. Economic analysis revealed that Kenyan farmers lose more than US$ 72 million in maize production due to stem borers, with highest percent (25%) losses occurring in marginal areas. The project developed and characterized several Bt maize events against the major stem borer species (*Chilo partellus*, *Chilo orichalcocliiliellus*, *Busseola fusca*, *Eldana saccharina*, and *Sesamia calamistis*) and found *cry1Ab*, *cry1Ac* and *cry1Ba* to be effective against *Chilo spp.* but none of the events provided adequate control for *B. fusca*. Base-line surveys of arthropod diversity in the major maize production zones identified similar levels of arthropod diversity across different ecologies, with the most abundant families being Gryllidae (11%) and Formicidae (35%). A digital data-base has been developed to assist researchers to identify insect specimens and to determine the most appropriate trap and sampling time to monitor different arthropod families. The data-base will be used to monitoring any shifts in arthropod abundance following the release of Bt maize in Kenya. Surveys of 500 farm families that represent the different maize agroecologies enabled alternate hosts of maize stem borers to be mapped to estimate the refugia available for resistance management. All district, except for Makueni district, have an adequate refugia (>20%) within the existing the October to January cropping season but five districts require a structured refugia during the March to August cropping season. Gene flow was monitored by using yellow endosperm, a dominant trait, to estimate gene flow in maize. Percent contamination in three locations was predicted using the equation 13/d where “d” is the distance in meters from the pollen source. This paper will highlight the lessons learnt from the IRMA project for the responsible use of GE technology for maize improvement within Africa.

ADDRESSING TAXONOMIC IMPEDIMENTS FOR IPM DEVELOPMENT: THE ROLE OF BIONET AND ITS LOOPS

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BioNET INTERNATIONAL, the Global Network for Taxonomy, adopts a sub-regional approach to capacity-building in taxonomy for sustainable development. These regional LOOPS are government-endorsed permanent structures, made up of member institutions that participate in regional and national programmes. This model of regional cooperation offers the advantages of expanded capabilities and increased cost effectiveness, and encourages the pooling of resources to address common issues and realistic goals. Taxonomy is fundamental to sustainable development and IPM. There are elegant examples of the important role that taxonomy plays in pest management, monitoring and incursion management of invasive alien species and the identification of biological control agents and other beneficial species. Activities of the ten established LOOPs contributing directly, or indirectly, to capacity building for sustainable development include: a global strategy and action plan for the GTI, the International Pollinators Initiative, training workshops on the identification of major pest groups and biological control agents, development of taxonomic training materials and databases, needs assessment surveys on plant health capacity, etc. Many of these activities have been implemented with existing like-minded regional and global initiatives; a large number of these activities have been made possible through funding support from relevant international aid agencies.
BioNET INTERNATIONAL has positioned itself to contribute directly to the Program of Work of the Global Taxonomy Initiative, especially with respect to needs assessments, awareness raising, regional cooperation and the coordination and implementation of capacity building programs.

IMPORTANT INVASIVE ALIEN SPECIES IN AGRICULTURAL SYSTEMS: OPPORTUNITIES FOR BIOLOGICAL CONTROL

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Invasive alien species (IAS) are often agriculturally important arthropod pests, diseases or weeds. Combating IAS starts with prevention and interception, which in the tropics is particularly difficult, because of conducive climatic conditions (e.g. absence of rigid winter), but also logistic and structural problems (e.g. porous borders and extensive, uncontrollable trading of agricultural produce, seeds and planting material), and. Once IAS become established, it is often too late to implement a successful eradication campaign. Among the remaining pest control options, biological control has shown to have a great potential for the management of IAS. Four case studies from Subsaharan Africa are presented to illustrate the different degrees of amenability to biocontrol during the various steps of its implementation:

determining the origin of the pest, finding efficient natural enemies, establishing them in different agro-ecosystems, and ensuring their competitiveness and impact under a range of socio-economic profiles. Case 1) the cassava mealybug *Phenacoccus manihoti,* a showcase example of planning and implementation of one of the most successful biological control projects at continental scale; case 2) the water hyacinth *Eichhornia crassipes*, a beautiful invader from South America which is now under satisfactory control on many waterways; case 3) the weed *Chromolaena odorata*, a controversial exotic invasive species for which a biological control solution has been demonstrated; and case 4) the cowpea podborer *Maruca vitrata*, a possible IAS in search of a new identity.

THE FPR-IPM PROJECT: EXCHANGING EXPERIENCES ON PARTICIPATORY IPM RESEARCH AND LEARNING PROGRAMS

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After four years of preparation and fund raising, a project was conducted from February to October 2001 aiming to formulate strategies for incorporating the most effective and appropriate forms of farmer participatory research and learning into IPM programs, based on a critical, first-hand analysis of the best approaches currently available. The methodology to come to this analysis included mentored 'study tour' exchanges among projects that apply different models of farmer participation for IPM research and training, followed by a 'learning workshop' where study tour and other interested participants distilled collective lessons from these experiences based on a common analytical framework. Six IPM projects paired in three teams, i.e. Honduras and Vietnam, Bolivia and the Philippines, and Kenya and Indonesia, participated in the study tour exchange and spent 7-10 days together at each of the project sites. The learning workshop allowed for an in-depth analysis of the strengths, weaknesses and complementarities of the various approaches applied in the six participating projects, and provided input to each project for possible adjustments based on tour/workshop learning. It also established a mutual support mechanism for on-going inter-project exchange. The project was evaluated with varying levels of appreciation. A concrete product generated by the projects consisted of a two-volume CD containing documentation on the project case studies, exchange visits and workshop experiences and synthesis of learning, and a reflection on the learning process.

OROBANCHE IPM IN CEREAL-LEGUME SYSTEMS IN NORTH AFRICA

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Parasitic weeds *Orobanche* spp cause very high levels of crop damage in terms of both yield and quality of crops in the cereal-legume cropping systems in North Africa. Estimates of yield losses range from 5 to 100% depending on the level of *Orobanche* infestation and environmental conditions. In the search for sustainable options to increase food security, sound knowledge-base on cropping systems and crop and land management practices that increase food production while repressing the parasitic weed were and are being established. Integrated *Orobanche* management makes key contributions to increase productivity and minimize threats to human health and environmental quality in the production systems. In fact, improved crop production packages that comprise improved cultivars and optimal levels of inputs such as fertilizers, irrigation, weed control and selective use of pesticides have been developed for individual crop commodities. However, successful parasitic weed management depends on development of integrated control systems and their careful application by farmers in targeted agroecological zones. As part of IPM implementation strategy, pilot sites are being established to introduce farmers to a range of integrated pest management of the cereal / food legume cropping system, assist participating organizations to gain experience in developing effective farmer-scientist-extension partnerships, and increase understanding, dissemination and adoption of the technology options. Some of the farmer-proven technologies need adaptation and immediate dissemination, whilst others need optimization and validation by farmers in location specific conditions. IPM options to control Orobanche in cereal-legume systems in North Africa and implementation strategies are discussed in this contribution.

FARMER-PARTICIPATORY ON-FARM EVALUATION OF *STRIGA HERMONTHICA* MANAGEMENT OPTIONS IN THE NIGERIAN NORTHERN GUINEA SAVANNA PILOT SITE OF THE SP-IPM.

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The Systemwide Program on Integrated Pest Management initiated in 2000 IPM pilot sites in range of cereal-legume production systems in Africa to place promising technologies into the hands of farmers. In Nigeria the pilot site is in northern Guinea savanna and the stakeholder groups are farmers and farmer groups, local government extension services Sasakawa Global 2000; the Institute for Agricultural Research, Ahmadu Bello University, Zaria, and the International Institute of Tropical Agriculture. Through participatory approaches in each of three villages, the participants prioritize crops, production systems and constraints, farmers' coping strategies against the constraints and perception of IPM options. Together researchers and downstream partners then agree on "best bet" options for farmer led trials. The farmers agreed on their need to experiment on *Striga hermonthica* management in maize and sorghum, and on soil fertility enhancement in the legume-cereal production system. The farmers' experimented on (i) comparison of two *S. hermonthica* tolerant maize varieties with farmers' own varieties; (ii) strip cropping comprising two rows of Acr.97TZLComp.1-W and four rows of soybean (TGX-1448-2E), cowpea (IT93K-452-1 followed by IT81D-994, in the same season), or groundnut (RMP12), compared with sole crop of farmers' own maize varieties; (iii) legume trap crop-cereal rotation compared with growing two successive crops of Striga tolerant maize variety; and (iv) double cropping of 60-day cowpea (IT-93K-452-1) followed by extra-early maize (95 TZEE-W) compared with a double crop of 95 TZEE-W, or natural fallow followed by 95 TZEE-W in same season. The results and lessons learnt are presented and discussed.