Session 11C

Tropical and Subtropical Crop Protection 2

Chairman:	Professor Terry Aveling *University of Pretoria, South Africa*
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Applications of information technology in IPM in the developing world

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Abstract
This project is structured around three aspects:
- a Global IPM Technology Database (IPM Technology Database hereafter);
- the application of IT in Regional Programs and other Global Themes (IT Applications hereafter);
- capacity building in IT for IPM.

The IPM Technology Database is tailored to the needs of developing countries, especially those where IPM CRSP programs are present.

The IPM Technology Database will serve as:
- a repository for IPM technology developed from IPM CRSP programs and other research, extension, education, and training programs around the world;
- a primary source for researchers, extensionists, educators, and other IPM stakeholders for information about IPM technology and outreach materials;
- an aid for training, pest identification, quarantine, and globalization/ regionalization of IPM technologies.

The IT Applications will serve to develop decision support tools, GIS applications, Web and database systems, data analysis, and other applications in collaboration with IPM CRSP Regional Programs and Global Themes.

Capacity building will
- train participants to develop and use IT systems and software tools;
- help Host Country (HC) institutions to build their information infrastructure;
- develop expertise in IT for IPM in developing countries.

Approaches and objectives
This project collaborates with IPM CRSP regional programs, US academic institutions, and a number of HC institutions.

IPM CRSP regional programs include:
- West Africa Regional IPM CRSP, lead by Virginia Tech;
- Southeast Asia Regional IPM CRSP, lead by Clemson University;
- Central Asia Regional IPM CRSP, lead by Michigan State University.

Regions or countries where this program collaborate include:
- The Caribbean/Jamaica;
- Southeast Asia;
- West Africa;
- Central Asia.

First year results
This is a four-year project. Achievements in year one are summarized as:

Objective 1
Develop Decision Support Tools (to organize, analyze, communicate and store IPM information.

- Global IPM Technology Database: Dedicated website has been developed (http://www.ipmnetwork.net/). User can preliminarily search online pest management information by using crop, pest name, and IPM technology.
- Developed the capacity for search online biocontrol materials. We might have the most comprehensive collections of online biological control materials in the world. It contains over 2,500 biological references after screening over 20,000 pest management online materials. We are working on the similar collections for other IPM technologies (e.g. chemical control, and cultural control).

Objective 2
Develop Decision Support Tools (to organize, analyze, communicate and store IPM information.

- Southeast Asia IPM Network and Pest Information Sharing
  - Training using IT for pest information sharing in Kuala Lumpur, Malaysia. Over 20 representatives from countries from the southeast Asia
  - Significant number of IPM materials were collected and searchable.
- West Africa IPM Network
  - Developing IT infrastructure for pest and pesticide information sharing
  - Component of West Africa Pesticide Education has been developed.

Objective 3
Analyze data, model interactions, and provide visualization and communication of results.

- A workshop was held with over 40 attendances from institutions in the region
- Survey instrument refined
- All extension staff trained in survey and protocol
- All sampling locations identified
- All trapping supplies procured (except Mcphail traps, lure, strainers)
- Information and feedback supplied to Jon Voortman to facilitate web database development.

Evaluation of different chemicals for weed control in wheat at different densities

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The green revolution of 1960s brought a major breakthrough in wheat production of Pakistan as it almost doubled with the extensive cultivation of short-stature, fertilizer responsive and high yielding varieties. During 2003-04, the area at national level under wheat cultivation was 8.2162 m ha, with a production of 19.499 m t. At provincial level in the North West Frontier Province (NWFP), the area under wheat cultivation was about 0.7416 m ha giving a total production of 1.0252 m tons at a yield of 1382 kg ha^{-1}. Farmers in high altitude areas most often grow wheat, although they do not get yield as high as in the plains. The low yield per acre beside many other factors could be attributed to serious weed infestation in the crop. Weed losses are up to 30% in wheat production. Weeds reduce crop yields, deteriorate quality of farm produce and hence decrease market value of wheat. Chemical control is being emphasized in modern agriculture. In Pakistan, annual losses in wheat crop amount to $466.7 m at national level and $33.3 m in the NWFP.

A field trail was conducted at Agriculture Research Station, Chitral (NWFP-Pakistan) during 2004-05. Three seed rates; 100, 125 and 150 kg ha^{-1} and four post-emergence herbicides. The effect was studied on weed control efficiency (WCE), weed biomass (WB) and grain yield (GY). The experiment was laid out in Randomized Complete Block design with split plot arrangement keeping three replications. The seed rates (Factor A) were arranged in the main plots and herbicides (Factor B) in the subplots with a size of 5m x 1.8m consisting of 6 rows each 30 cm apart with the row length of 5m. *Main plots:* Factor A, Seed Rates; 100 kg ha^{-1}, 125 kg ha^{-1} and 150 kg ha^{-1}. *Sub-plots*: Factor B, Herbicides; Buctril super 60 EC (bromoxynil+MCPA) @ 0.45 kg, Topik 15 WP (clodinafop-propargyl) @ 0.04 kg, Puma super 75 EW (fenoxaprop-p-ethyl) @ 0.75 kg, and Isoproturon 50 WP (isoproturon) @ 1.0 kg a.i. ha^{-1} and a weedy check. The data were recorded on weed control efficiency (%), weed biomass (kg ha^{-1}), number of tillers m^{-2}, 1000-grain weight (g), biological yield (kg ha^{-1}) and gain yield (kg ha^{-1}). The data recorded for each parameter was individually subjected to the ANOVA technique by using MSTATC and means were separated by using LSD test.

The differences among the seed rates and herbicides were significant in Weed Control Efficiency (WCE). Maximum WCE (79 %) was recorded in Buctril super 60EC (Table 1). Similarly the highest WCE (52.2 %) was recorded in seed rate 125 kg ha^{-1}. Weed biomass (WB)was significantly affected by seed rates and herbicides (Table 2). Maximum WB (3770 kg ha^{-1}) was recorded in weedy check and minimum (1086) in Buctril super 60EC which is statistically similar to Isoproturon 50WP (1157 kg ha^{-1}). Moreover the highest WB (2199) was recorded in seed rate 100 kg ha^{-1}. Grain yield (GY) was also significantly affected by herbicides and seed rates (Table 3). Maximum (2504 kg ha^{-1}) GY was recorded in Buctril super 60EC and minimum (1406) was recorded in weedy check (Table 3). Maximum GY (2053) was recorded in 125 kg ha^{-1} seed rate. Increase in grain yield in the herbicide treated plots was probably due to the efficient weed control and thus the crop efficiently utilized all the available resources.

Table 1. Weed control efficiency (%) as affected by different herbicides and crop densities

Herbicides	Wheat densities			Herbicide means*
	100 kg ha^{-1}	125 kg ha^{-1}	150 kg ha^{-1}	
Buctril super 60 EC	73.8	82.8	80.3	79.0 a
Topik 15 WP	57.9	62.5	60.5	60.3 b
Puma super 75EW	44.7	51.0	48.3	48.0 b
Isoproturon 50 WP	71.5	81.4	78.4	77.1 a
Weedy check	0.0	0.0	0.0	0.0
Density means	49.5	55.4	53.5	

$LSD_{0.05}$ for herbicides = 15.1

*Means sharing a letter in common do not differ significantly by LSD Test at 5% level of probability

Table 2.Weed biomass (kg ha^{-1}) as affected by different herbicides and crop densities

Herbicides	Wheat densities			Herbicide means*
	100 kg ha^{-1}	125 kg ha^{-1}	150 kg ha^{-1}	
Buctril super 60 EC	1225	941	1091	1086 c
Topik 15 WP	1918	1833	1900	1884 b
Puma super 75EW	2200	2061	2091	2118 b
Isoproturon 50 WP	1258	1036	1175	1157 c
Weedy check	4006	3776	3526	3770 a
Density means	2121	1992	1956	

$LSD_{0.05}$ for herbicides = 624

*Means sharing a letter in common do not differ significantly by LSD Test at 5% level of probability

Table 3. Grain yield (kg ha^{-1}) as affected by different herbicides and crop densities

Herbicides	Wheat densities			Herbicide means*
	100 kg ha^{-1}	125 kg ha^{-1}	150 kg ha^{-1}	
Buctril super 60 EC	2206	2846	2460	2504 a
Topik 15 WP	1926	2066	2006	1999 b
Puma super 75EW	1833	1900	1886	1873 b
Isoproturon 50 WP	2100	2473	2300	2291 a
Weedy check	1340	1420	1460	1406 c
Density means	1881	2141	2022	

$LSD_{0.05}$ for herbicides = 321

*Means sharing a letter in common do not differ significantly by LSD Test at 5% level of probability

Buctril super 60EC @ 0.45 kg a.i. ha^{-1} proved the best in weed control which was closely followed by Isoproturon 50 WP @ 1.0 kg ha^{-1}. Grain yield was the highest in 125 kg ha^{-1} seed rate. The interaction of Buctril super 60EC with 125 kg ha^{-1} seed rate was desirable in all the weed and crop parameters. The authors are highly indebted to Pakistan Science Foundation, Islamabad for sponsoring the research envisaged in this article. The research was funded by PSF Project on 'Management of Weeds in wheat in NWFP'.

Possible effects of global warming on coffee diseases in Kenya

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Introduction

The cultivars of coffee (*Coffea arabica* L.) grown in Kenya are susceptible to a number of diseases: Coffee Berry Disease (CBD) caused by *Colletotrichum kahawae* and Coffee Leaf Rust (CLR) caused by *Hemileia vastatrix* are the most important. The CBD is characterized by dark necrotic lesions on green berries which are either shed prematurely or are mummified on branches. The disease is favoured by wet, cool weather and can cause up to 80% crop loss (Baker, 1972). The CLR occurs on the lower surface of leaves as round, scattered, orange pustules. Affected leaves are shed prematurely. The disease is favoured by wet, warm weather conditions. In recent years the incidence of CBD has decreased even in the prevalent higher altitude plantations while that of CLR has increased. A critical analysis of data was therefore conducted to determine the relationship between the incidence and distribution of CBD, CLR and meteorological conditions, particularly, rainfall and temperature in the last ten years (1997-2006).

Materials and methods

Data on the incidence of coffee berry disease and leaf rust was obtained from the archives of the Coffee Research Foundation covering the period 1997 to 2006. The data was originally obtained from fungicide evaluation trials designed using randomized complete blocks with four or more replications. Altitude was considered in the comparison of disease incidence between sites which were distributed across the three coffee agro-ecological zones: Upper Median 1, 2 & 3, representing altitudes >1700m; 1600-1700m & <1600m, respectively. The rainfall and temperature data for the period 1997-2006 was collated from the Coffee Research Station. Rainfall data was considered only for April and May in each year as this is the critical infection period for CBD and CLR.

Results

The long-term mean rainfall total for April-May period is about 450mm. Therefore seven out of the ten years received more rainfall than the long-term total for the period. Peak incidence of CBD was on decline from a high of 52.79% in 1997 to a low of <3.51% in subsequent years. This trend was neither consistent with rainfall amounts nor the number of rainy days. or instance, in 2003 more rain was received in 35 rainy days than in 1997 but CBD failed to develop. Temperature-range was not limiting between the two years.

The incidence of CLR was relatively low in years with a high incidence of CBD (1997 and 1999) and relatively high in years with a low incidence of CBD (1998, 2001, 2006). Most striking was the weather and disease data for 1998. The year had the highest number of rainy days out of the seven years with >450 mm rainfall during the April-May period. This resulted in a high incidence of CLR but was of no significance to the development of CBD.
At different altitudes ranging from 1515m to 1935m the incidence of CBD was low and did not increase at higher altitudes as expected during the period 2001 to 2006. In contrast, the incidence of CLR was higher than that of CBD in most sites at ≥1600m. The incidence of CLR increased at the upper-most coffee growing zone (>1700m) in 2001 and 2002. In the past CLR was not an important disease in this zone

Discussion and conclusion

Declining incidence of CBD and upsurge of CLR particularly in the higher altitude plantations occurred for the first time, after the heavy but warm rains of 1998 described as *el-Niño*. Germination of *C. kahawae* conidia require a water film for a continuous period of at least five hours at a temperature range of 17 to 28°C with an optimum of 22°C (Nutman & Roberts, 1960). Germination does not take place in the absence of a water film even when atmospheric humidity is close to 100% (Woodhead, 1968). Under field conditions, a water film is expected to be maintained on susceptible coffee berries for at least five hours if the rain fell at night. The *el-Niño* rains fell during the day and mostly in alternation with sunny periods. Consequently, a water film could not be maintained for long enough in favour of development of CBD.

On the other hand, germination of *H. vastatrix* uredospores takes place in darkness in the presence of a water film for at least one to three hours and a temperature range of 20- 25°C (optimum, 23°C). Free water on the under surface of leaves is necessary for germination of spores and appressorium formation. High humidity alone (even at 98%) is not sufficient to stimulate germination (Rayner, 1960). These temperature limits are of importance since spore germination occurs at night. However, it has been established that wetness at temperatures above 22°C rarely occurs for durations of at least five hours in coffee growing areas in Kenya but prolonged wetness does occur at temperatures below 17°C (Waller, 1971). Thus, the observed upsurge of CLR in the higher, cooler agro-ecological zones where it was not of economic importance in the past is an indicator of occurrence of warmer temperatures (>20°C), at least in the early hours of the night accompanied by short durations of wetness (≤ 3 hours), a situation that is unfavourable to the development of CBD. Coffee leaf rust had been known for many years to be more severe in the lower and warmer districts than it is at about 1902 m (5800ft) (Nutman & Roberts, 1972).

Based on past and present findings, it is inferred that changes in weather conditions associated with global warming could be responsible for the declining incidence of CBD and upsurge of CLR:

a) The rise in global temperatures has resulted in shifting precipitation patterns. For instance, wet periods alternating with sunny, hot periods;

b) Lack of cloud cover especially after rains in the evening has resulted in rapid disappearance of a water film on susceptible targets thus curtailing infection of the slower germinating *C. kahawae* conidia in favour of the faster germinating *H. vastatrix* uredospores.

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Yield losses due to brown rust (*Puccinia melanocephala*) in sugarcane

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Introduction

Brown rust, also known as common rust, caused by the fungus, *Puccinia melanocephala* H. & P. Syd.), (Ryan & Egan, 1989) is a major disease in sugarcane (*Saccharum* interspecific hybrids) in many areas of the world. Yield losses have been estimated at 10-20 % under good growing conditions and up to 50 % where growing conditions were poor or the disease was unusually severe (Esquivel, 1980). In Louisiana, USA, brown rust was first detected in 1970's and could be found annually at varying levels of severity. It was not until 2000 that the disease was considered serious and yield limiting.

Materials and methods

Losses due to brown rust had not been measured therefore yield loss field studies were implemented to determine the impact of common rust on the local sugarcane crop. The studies were conducted in four locations over three years, 2004 through 2006, where natural epidemics occurred. Field experiments with 4-row, 21.4 meter plots of the variety LCP 85-384 replicated four times were used. Commercially available fungicides containing azoxystrobin, propiconazole and tebuconazole were used in combination to manage common rust as a 'disease-free' check that was then compared to varying levels of the disease accomplished by delayed fungicide applications and a non-treated control.

Applications of the fungicides were made in April, May and June of each year in the study. The number and time of fungicide treatments varied from early rust development (April), early-mid (April, May), mid (May), mid-late (May-June), late (June) and across the rust development period (April through June) in 2004 and 2006. Treatment times in 2005 were May only, May-June and June only due to late development of rust. Yield data collected included counts of millable stalks, stalk weight, cane sucrose content, cane tonnage, and total sucrose produced per hectare. Disease was assessed by image analysis (Lamari, 2002) of detached leaves.

Results and conclusions

Fungicide treatments controlled brown rust each year of the three-year study. Table 1 shows the percentage of rust on leaves measured each year for different treatments. Multiple treatment applications reduced rust development more than single applications most years. In 2004, rust development was reduced by 93 % as compared to no fungicide applications. Similarly, in 2005 and 2006, rust development reductions were 89 and 88 %.

Cane tonnage and tons of sucrose produced per hectare were reduced by brown rust (Table 2). The mean effects of brown rust on yield were compared for years 2004 and 2006 only in Table 2. Data from 2005 were not presented because of different application times due to the later development of rust that year compared to the other two. The amount of yield loss was affected by the time of occurrence and duration of the epidemic. Significant yield losses were demonstrated when rust was controlled throughout the epidemic period or during mid- and late-epidemic. Yield losses relative to the 'disease-free' check over the three-year study were 17% in cane tonnage and 18% in sucrose production. Yield reduction was due to a decrease in stalk weight and a slight decrease in stalk population.

Table 1. Brown rust infection % for different fungicide treatment times, 2004-2006.

Treatment time	2004 rust %[1]	2005 rust %[1]	2006 rust %[1]
No fungicide	22.0 a	38.1 a	10.4ab
April only	24.4 a		8.3 b
April-May	9.6 b		1.4 c
April-June	1.5 c		1.2 c
May only		45.1 a	1.4 c
May-June	1.2 c	4.1 b	1.3 c
June only	3.0 c	4.0 b	13.0 a

[1]Means not followed by the same letter (within columns) differ at the 0.05 level.

Table 2. Mean effect of brown rust on yield of LCP 85-384, 2004 and 2006

Treatment time	Tons cane/ha	Tons sugar/ha	% increase sugar over untrt.
No fungicide	72.7 b	8.5 d	–
April only	76.8 b	8.7 cd	2.4
April-May	77.0 b	9.2 c	8.2
April-June	87.6 a	10.4 a	22.4
May-June	86.2 a	10.0 ab	17.6
June only	75.2 b	9.5 bc	11.8

[1]Means not followed by the same letter (within columns) differ at the 0.05 level.

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