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Response of banana cultivars to banana weevil attack

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Abstract

East African Highland Bananas (EAHB) (*Musa* AAA, 'Matooke' group) are a major staple food in the East African region. However, banana weevil (*Cosmopolites sordidus*) is a major production constraint to bananas and may cause damage levels of up to 100%. Pesticides can effectively control banana weevil but these are unaffordable by resource poor farmers, besides being environmentally unfriendly. The use of resistant cultivars therefore, may be a safer long-term intervention strategy for banana weevil control. An experiment was conducted to screen all the *Musa* germplasm found in Uganda for response to banana weevil, and evaluate levels of susceptibility. Weevil damage levels indicating both peripheral and inner damage were scored at harvest and used in two multivariate analyses. Cluster analysis grouped tbe cultivars into three significantly different gronps; resistant, intermediate and susceptible. Most of the East African Highland 'Matooke' cultivars were more homogenous in their response to banana weevil, with most of them falling into the intermediate group. One East African Highland cultivar Nalukira (a beer type) was grouped among the resistant cultivars while three, Nakawere, Namafura, and Ndiibwabalangira, were clustered as susceptible. Principal component analysis revealed almost similar results. Gonja (AAB-plantain) was the most susceptible, while Culcutta-4 (AA-wild type) was the most resistant. Culcutta-4 and FHIA-03 (AABB), which showed high resistance levels may be good sources of resistance genes for genetic improvement of land races for resistance to banana weevil.

Keywords: *MusaAAA, Banana weevil, response*

Introduction

The East African Highland banana (*Musa* AAA, 'Matooke' group) is one of the major food crops for millions of people in the Great Lakes Region in Eastern Africa. In recent years, there has been a decline in banana production in Uganda due to a range of biotic and abiotic factors, including banana weevil (Gold *et al.* 1994). Damage and yield losses by the pest are high in East Africa. Rukazambuga *et al.* (1998) similarly found yield losses of up to 44%, in a single cooking banana cultivar during an on-station trial in Uganda.

To sustain banana and plantain production a management strategy is required which can include the use of weevil resistant cultivars. Chemical control is effective but expensive to small holder farmers, contaminates the environment, and is poisonous to both humans and their domestic animals. A field screening trial was set up at International Institute of Tropical Agriculture, East and Southern Africa Regional Centre (IITA-ESARC) Sendusu Farm at Namulonge, Uganda to evaluate *Musa* host plant response to banana weevil.

Materials and Metbods

A trial was established in November 1996 at Namulonge to evaluate the host plant response of 45 *Musa* accessions to banana weevil. The germplasm included East Africa Highland bananas (*Musa* AAA, 'Matooke' group and 'Mbidde' group), plantains (*Musa* AAB), exotic cooking and brewing cultivars (*Musa* ABB), desert cultivars (*Musa* AAA), diploids (*Musa* AA and AB) and *Musa* hybrids. Namulonge is at 1128 m above sea level, has dark reddish brown loamy soil with a pH ranging from 5.5 to 6.2. The mean annual rainfall is approximately 1050 mm (IITA, 1992).

A randomized complete block design was used with twelve replicates. Sword suckers collected from the germplasm collection at Kawanda were used as planting material. Prior to planting, the suckers were pared and hot water treated and then planted in the field. At planting the holes at a spacing of 3m by 2.5m were half filled with farmyard manure. After eight months, adult weevils previously collected from farmers' fields and maintained in the laboratory, were released at the base of each mat at a ratio of 5 males to 5 females.

Banana weevil damage assessment was conducted at harvest. Data on percentage coefficient of infestation (PCI), (Mitchell, 1978) was collected by scoring presence/absence of damage in each of ten 18° sections, each from 0 to 5cm and from 5 to 10 cm below to the base of the pseudostem; thus PCI scores ranged from 0 to 20. Peripheral damage was also determined assessed by estimating the percentage of the corm periphery covered weevil galleries.

Cross sections were made at the base of the pseudostem and 5 cm below the base. For each cross section, weevil damage was determined for the natural inner (XI) and outer (XO) sections of the corm by estimating the percentage of corm area with larval galleries. The inner and outer sections refer the central cylinder and the cortex respectively.

Data analysis

Clustering was performed using the 'k-means clustering' procedure in STATISTICA (StatSoft, 1995). This method produces a preset number of clusters with the highest possible distinction using repeated analysis of variances.

Principal component analyses (PCA) was used on the three damage observations (PCI, XI and XO) of the 45 *Musa* accessions to determine patterns within the data matrix using SAS software (Anonymous, 1991). Principal component analysis Model I was used to estimate a Damage Index for each accession. First and second principal component (PC1 and PC2) axis values were plotted to enhance dispersion of the host response to banana weevil infection of the *Musa* accessions.

In both multivariate analyses the three variables were used together because they are highly correlated and important damage indicators. Cross section damage indices indicate how much the weevils can penetrate deep into the corm. Such damage would be important in nutrient and water uptake by the plant, thus affecting yield and eventually plantation life.

Results

Cluster analysis produced three significantly different ($P<0.005$) groups, here designated resistant, intermediate and susceptible. The mean peripheral damage for the groups was 6, 14 and 21% respectively (Table 1). Only one of the EAHB cultivar Nalukira, a beer type was grouped as resistant. Cavendish, FHIA-03 and Yamgambi-km5 are the other cultivars that showed resistance to banana weevil. Response of East African Highland Bananas was more homogeneous, most of them falling into the intermediate group.

The susceptible group included both plantain land-races, Gonja from East Africa and Obino l'Ewai from West Africa. Three EAHB, Nakawere, Namafura and Ndiibwabalangira were also grouped as susceptible (Table 1).

The correlation matrix between the three damage observations, revealed highly significant coefficients between them ($r>0.76$, $P<0.005$) (Table 2).

Table 1. Response of selected *Musa* cultivars for resistance to banana weevil

Resistant		Intermediate		Susceptible	
Mean PCI-PD 6.3 Mean XI 0.6 Mean XO 2.6		PCI-PD 14.6 XI 3.8 XO 6.1		PCI-PD 20.9 XI 7.5 XO 10.4	
Cultivar	**Use**	**Cultivar**	**Use**	**Cultivar**	**Use**
Cavendish (AAA)	Desert	Atwalira (AAA-EA)	Cooking	Gonja (AAB)	Roasting
Culcutta 4 (AA)	Wild banana	Bagandeseza ((AAA-EA)	Cooking	Nakawera	Cooking
FHIA-03 (AABB)	Multipurpose	Kivuvu-Blugoe (ABB)	Cooking	Namafura (AAA-EA)	Cooking
Yangambi-km5 (AAA)	Desert	Bukumu (AAA-EA)	Cooking	Ndiibwabalangira	Cooking
Nalikira (AAA-EA)	Brewing	Enshenyi (AAA-EA)	Cooking	Obino Lewai (AAB)	Roasting
		Kabula (AAA-EA)	Brewing		
		Mbwazirume (AAA-EA)	Cooking		
		Nakabululu (AAA-EA)	Cooking		
		Nakamali (AAA-EA)	Cooking		
		Nakitembe (AAA-EA)	Coking		
		Nakyetengu (AAA-EA)	Cooking		
		Namwezi (AAA-EA)	Cooking		
		Nandigobe (AAA-EA)	Dessert		
		Ndiizi (AB)	Brewing		
		Nsowe (AAA-EA)	Cooking		
		Siira (AAA-EA)	Cooking		
		Tereza (AAA-EA)	Cooking		

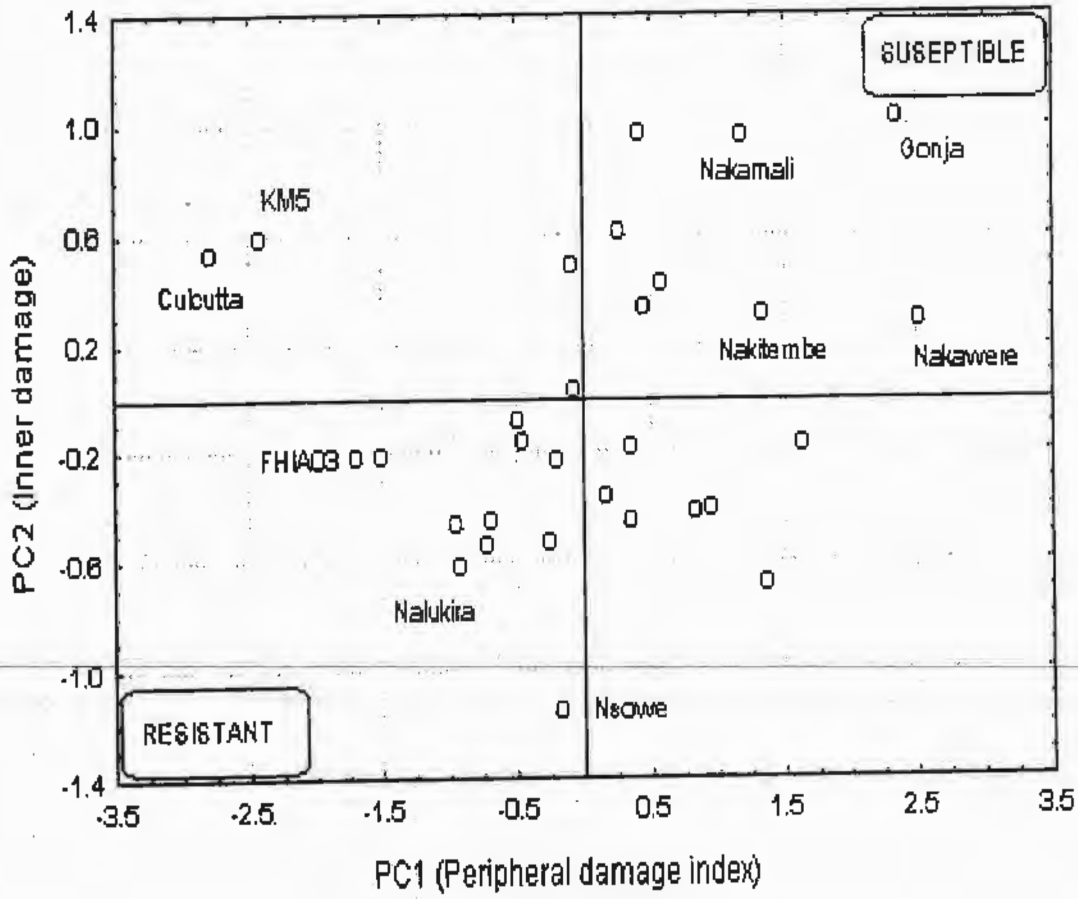
Table 2. Correlation coefficient between three weevil damage indices.

Damage index	1	2	3
1. Percentage coefficient of infestation	1.00	0.76	0.91
2. Inner cross section damage		1.00	0.78
3. Outer cross section damage			1.00

Table 3. Eigen vectors of Principal Components Analysis (PCA) using three weevil damage indices

Damage index	PC 1	PC 2
1. Percentage coefficient of infestation	0.59	-0.45
2. Inner cross section damage	0.56	0.83
3. Outer cross section damage	0.60	0.33
Percentage of total variation:	**88%**	**9%**
Eigen Value:	**2.63**	**0.27**

Figure 1. Plot of PC 2 (Inner damage index) against PC 1 (Peripheral damage index) for selected Musa cultivars.



PCA regrouped the original three damage observations to two major components that together accounted for 97% of the original variation (Table 3). The first and most important component, PC1, accounted for 88% of the total variability in the original data.

Principal component 1 which contributed 88% of the total variation was taken as a peripheral damage index (taking care of percentage coefficient of infestation and outer damage). It was then plotted with principal component 2 which highly correlated with inner cross section inner damage, and contributed 9% of the total variation (Table 3, Figure 1).

The plot of PC1 (peripheral damage index) against PC2 (inner damage) showed that Gonja was the most susceptible cultivar. Nakamali, Nakawere and Nakitembe were similarly very susceptible EAH bananas. Most of the EAHB, however, were intermediate, further confirming the results from the cluster analysis. Nalukira was the most resistant EAHB, while Culcutta-4, Yagambi-km5 and FHIA-03 were the most resistant in that order (Figure 1).

Discussion

In this study, plantains (*Musa,* AAB) showed the highest susceptibility compared to all other groups. Similar results have been reported from several other studies (Ittyepe, 1986; Speijer *et al.*, 1993; Sheshu Reddy & Lubega, 1993; Fogain & Price, 1994; Gold *et al.*, 1994; Ortiz et al., 1994). Most of the EAHB have consistently shown moderate resistance in this study.

Comparisons of weevil damage scores to site means (Z scores), from the Uganda nation-wide diagnostic survey (Gold *et al.*, 1993), suggested a wide range of variability but with most of the cultivars showing average susceptibility. This moderate resistance may be due to antibiosis, as several workers have already indicated (Pavis & Minost, 1993; Ortiz *et al*, 1995 and Abera, 1998). If this is true then, probably even with some of the present cultivars an effective IPM strategy can be devised that could go a long way in controlling banana weevil. The use of resistant cultivars in IPM centers around reducing the rates of population build up and this could be effectively achieved with moderate levels of host resistance, especially if they are antibiotic related (de Ponti, 1982; Pathak, 1991). Together with other cultural control measures like removal of post harvest residues and trapping, we should be able to keep banana plantations free of destructive levels of banana weevil. Gold *et al* (1997) have reported that moderate and intensive sanitation significantly lowered both weevil population and damage due to banana weevil. New pheromone traps (*Cosmo-lures*) that can trap many times more weevils compared to traditional pseudostem traps (Tinzaara *et al.* 1998) could be included in IPM strategies.

Cultivars Culcutta-4, Yangambi-km5 and FHIA-03 showed high levels of resistance to banana weevil and may be exploited as sources of resistance genes. Culcutta-4 a wild diploid has been reported resistant and has been used in conventional breeding successfully (Ortiz *et al* 1995). Yangambi-km5 was recently found resistant to banana weevil (Lemaire 1996). Yangambi-km5 and FHIA-03, have been reported to be totally sterile. However, since it known that fertility is influenced by climate and location, it may still be worth screening these cultivars for both male and female fertility.

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