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IDENTIFICATION OF BANANA CORM WEEVIL *COSMOPOLITES SORDIDUS* GERMAR RESISTANCE IN *MUSA* GERMPLASM

B Padmanaban*, M Kannan, R Thangavelu, S Uma[1], S Backiyarani and K K Ashif**

Department of Crop Protection; [1]Department of Crop Improvement; ICAR-National Research Centre for Banana, Thayanur, Thogamalai Road, Tiruchirappalli- 620102, Tamil Nadu
* Email: bpadmanabannrcb@gmail.com (corresponding author)

ABSTRACT

In the present study, a field and *in vitro* screening approaches were followed to identify the resistant *Musa* accessions (n=310) against banana corm weevil attack (*Cosmopolites sordidus* (Germar). The corm was cross-sectioned and the tunnels (galleries) made by the grub were recorded. Based on the ratio of galleries of infestation, the % was calculated. The infestation level was categorized into resistant, less, moderate and highly susceptible. The results revealed three resistant accessions viz., Kanthali (ABB- Pisang awak), Sambalneyvannan (ABB- Pisang awak) and Bhimkol (BB- wild balbisiana). Around 44 accessions (AA:2, AAA:5, AAB:9, AB:4; BB:5; ABB:15, ABBB:2; Rhodochlayms:2) from different genomes were identified as less susceptible. These accessions may be popularized among the banana growing farmers after evaluation of other parameters like crop duration, yield and market value.

Key words: Musa germplasm, in vitro screening, cross-section method, grub damage**,** *Cosmopolites sordidus,* galleries, resistant accessions, less susceptible

Banana production has declined due to the banana corm weevil *Cosmopolites sordidus* Germar and it is considered as a major pest (Waterhouse and Norris 1987; Gold et al., 2001). This weevil was recorded as a native of the Indo-Malaysian region and later found worldwide and particularly in the banana growing countries like southern Asia, Africa, many Pacific islands, Australia, northern South America, most of Central America, Cuba, the West Indies, Mexico, Florida, and Hawaii (Gold et al., 2005; Yadav et al., 2017). This pest is a limiting factor in banana production in Uganda and Tanzania. It is nocturnally active and relatively sedentary (Gold et al., 1999). The female weevil lays the egg either in corm (outer part) or at the base of the pseudostem (Koppenhöfer, 1993). The larvae bore through the rhizome leading to the stunted growth, reduced fruit size and bunch weight, delayed maturation, disappearance of mats through grub feeding damage on the corm, and finally leads to death of plant under high infestations (Vuylsteke et al., 2010; Frison et al., 1998; Gold et al., 1999).

Once the weevil grub enters the plant, it is very difficult to manage by pesticides, and resistance to pesticides is also known (Collins et al., 1991). Even though, good cultivation practice such as use of clean planting material (hot water treatment), systematic trapping and field sanitation (periodically removing plant residue, as they act as breeding ground for weevil) contribute to weevil management, they require high labour input and materials which are often a limiting factor for adoption (Gold et al., 1998; Gold et al., 1999; Padmanaban, 2018; Fu et al., 2019).

Thus, ecofriendly approaches are required and some of these had been developed. These include exploration of natural enemies (predators, entomopathogenic fungi and nematode) (Koppenhöfer, 1993; Padmanaban et al., 2009; Lopes et al., 2013), use of botanicals (Musabyimana et al., 2009; Tinzaara et al., 2006); semiochemicals and kairomone-based trap (Tinzaara et al., 2005; Abagale et al., 2019). However, the biocontrol method has been hampered by lack of effective field delivery methods (Nankinga, 1999; Gold et al., 2001; Akello et al., 2008; Lopes et al., 2013) and only a limited number of weevils were trapped. In this context, the study of host plant resistance could be a possible approach with identification of weevil resistant *Musa* accessions (Fogain, 2001; Ortiz et al., 1995; Pavis and Lemaire, 1996; Abera et al., 2000; INIBAP, 2000; Kiggundu et al., 2003; Padmanaban et al., 2020).

Hölscher et al. (2016) identified the weevil resistance compound namely "2-methoxy-4-phenylphenalen-1-one" from the corm of *Musa* accession Bluggoe. Padmanaban et al. (2000) evaluated the *Musa* germplasm of various genomic accessions at the field gene bank of National Bureau of Plant Genetic

Resource (NBPGR) Thrissur, Kerala. The observations concluded that further studies are needed at laboratory level with identified resistant clones by studying weevil physiology and reproduction. Field data was recorded for all the *Musa* accessions but the data on the level of infestation were unreliable due to various factors like climatic change, adaptation of the host, migration of weevil and also long time taken to complete the observation. Moreover, in vitro screening reports are lacking or very limited (Sadik et al., 2010). Identification of potential resistant *Musa* accessions againt banana corm weevil might be part of an IPM approach (Seshu Reddy and Lubega, 1993). The present investigation was carried out to determine the response of *Musa* accessions to the *C. sordidus* through field and in vitro screening approach.

MATERIALS AND METHODS

Field evaluation of *Musa* accessions (n=310) against banana corm weevil were performed at the ICAR-NRCB farm. *Musa* accession numbers were provided based on NRCB *Musa* germplasm log book. The sucker from core collection of accessions were also planted in sick plot (farmers field) where *C. sordidus* population is high (>20 %) in Theni (district), Tamil Nadu for screening study. The standard cultivation practices were followed during the observation period from 2016-2019. Approximately, 10 month old plants were selected and uprooted from the field. As suggested by Kiggundu et al. (2003), the uprooted plant corms were cross cross-sectioned and the level of infestation was recorded based on the galleries produced by grubs because damage on the central cylinder of corm is the best predictor of susceptibility. The field data was categorized into three categories such as less, moderate and highly susceptible.

Banana weevils were reared in the ICAR-NRCB Entomology laboratory, in perforated plastic containers at 22±2 °C and 60% RH. The weevils required were collected using banana corm trap (Fig. 1) or manually collected from the infested plants from field. The weevils were introduced into the rearing container with supply of fresh corm of Karpuravalli (ABB-Pisang awak) and Poovan (AAB-Mysore). Once in a month, the weevils were harvested from damaged corm and replaced with new corm to avoid building up of rotting corm material. All the weevils were separated based on their sex and used for artificial infestation.

Field-resistant and less susceptible *Musa* accessions were futher screened using in vitro screening approach by planting the suckers in plastic pots (10 L) in

Fig. 1. Weevil collection using cross-sectioned corm trap

the Entomology screen house at the ICAR-NRCB, Tiruchirappalli. Each plastic pot containing accessions was nurtured without weevil and other insect pest attack with application of fertilizer and sufficient irrigation. Three pairs of adult weevils were released at the base of plant. Each pot containing plant was covered using tailored cotton cloth (width: 40 cm x height: 70 cm) after release of weevils. After 50 days of weevil's release, the weevil infestation was recorded and computed in %. Corm damage was estimated using galleries produced by the grub on central cylinder of the corm as reported by Gold et al. (2005) and Twesigye et al. (2018). Triplicates for each accession were evaluated as described above. Even though peripheral damage has been noted on the *Musa* accessions, it is concluded that it is a susceptible genome but the cross section score is more important because the peripheral damage does not explore the extent of the internal damage (Ortiz et al., 1995). In the present study, the level of infestation was catagorized into categories such as resistant, less moderate and highly susceptible. Each accession was screened in triplicates. The % infestation data was analyzed statistically using SAS Institute Inc.

RESULTS AND DISCUSSION

In the current work, a total of 310 *Musa* accessions belonging to different genomic groups were screened against the corm weevil *C. sordidus* in the field. The genomic groups AAB and ABB were more among the accessions; the distribution is as follows: AA- 26; AAA- 28; AAB- 99; AB- 23; ABB- 99; ABBB- 8; BB- 25; and Rhodo-2. The field evaluation at ICAR-NRCB farm at Thiruchirappalli and farmers field in Theni (Dt) revealed that about 51.56% (160 *Musa* accessions) fall under less susceptible whereas 40.64 and 7.74% fall under the category of moderate and highly susceptible, respectively (Fig. 2A). Particularly, the genome AA,

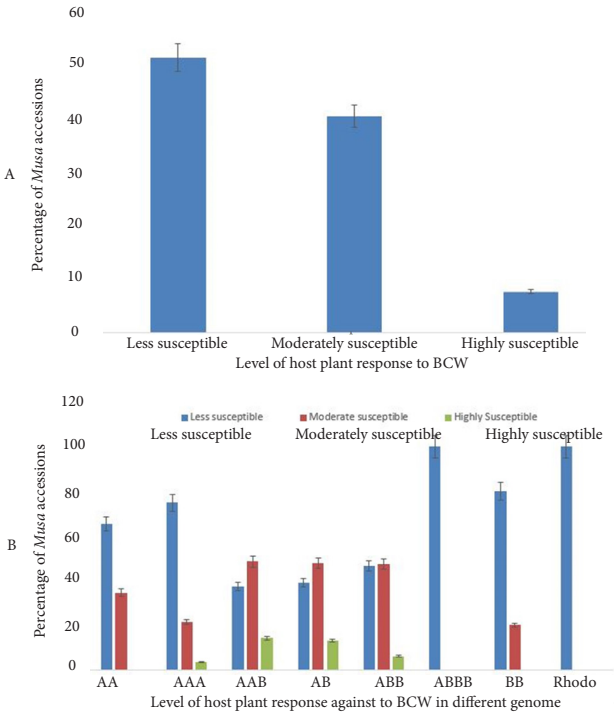

Fig. 2. Field evaulation of Musa germplasm against C. sordidus- A. Response of accessions; B. Analysis of

AAA, ABBB, BB and *Rhodochlayms* (about 50 % of *Musa* accessions from each genomic groups) were found to be less susceptible and AAB, ABB and AB (about 40% from each genomic groups) were found to be moderately susceptible. Similarly, Prasad and Reddy, (2000) recorded the susceptibility of ABB and ABB genomes to banana corm weevil followed by AAA genome. However, very less i.e. 3.57, 13.04 and 6.06% to AAA, AAB and ABB, respectively were identified as highly susceptible (Fig. 2B). The results of the present study derive support from those of Kiggundu et al. (2003a) where they reported that AAA dessert banana have ranged from resistant to susceptible assesions.

The less susceptible *Musa* accessions (160 no's) from the field study were further studied through in vitro screening. The corms were cross-sectioned after 50 days of artificial infestation and the difference in the corm damage was shown in Fig. 3. Similalry, Sadik et al. (2010) and Twesigye et al. (2018) also recommended that 60 days is better for screening of weevil resistance and susceptibility in in vitro trials after weevil release. The in vitro screening results revealed that about 1.87, 27.5, 53.1 and 17.5% of plants fall under resistant, less, moderate and highly susceptible, respectively (Fig. 4A; Table 1). Most of the accessions from each genome except rhodo fell under moderately susceptible groups (Fig. 4B). Similarly, Oliveira et al. (2017) reported that AAB and ABB based accessions were less susceptible while BRS tropical hybrids (AAAB, AAAA) were highly susceptible. The comparative analysis of field and in vitro screening (78 *Musa* accessions) revealed that both screening approaches have higher probability (60.25%) to determine the susceptibility/ resistance.

The less susceptible accessions from genome AA were recorded with 7.69% frequency but the genome BB recorded with 20% frequency through in vitro screening revealed that the genome AA was more prone as compared to BB (Table 1). Even though, the accession *Musa accuminata* have fibrous corm, it was recorded as susceptible. Similarly, Mesquita et al. (1984) reported that the AA genome *M. accuminata* is more susceptible to weevil attack than the BB genotypes, *Musa balbasiana.* Morevoer, *Musa* accessions such as YKM-5, Pisang linin, Culcutta-4 and Bluggoe are moderate to highly resistant (Ortiz et al., 1995 ; Sadik et al., 2010; Kiggundu et al., 2003b). The present result is thus in contrast to the report of Ortiz et al. (1995) who stated that there is a significant dosage effect of the susceptibility gene in plantain hybrids, all of which are tetraploid falling under highly susceptible category- in the present study both field and in vitro screening results revealed that ABBB based accession was less to moderately susceptible.

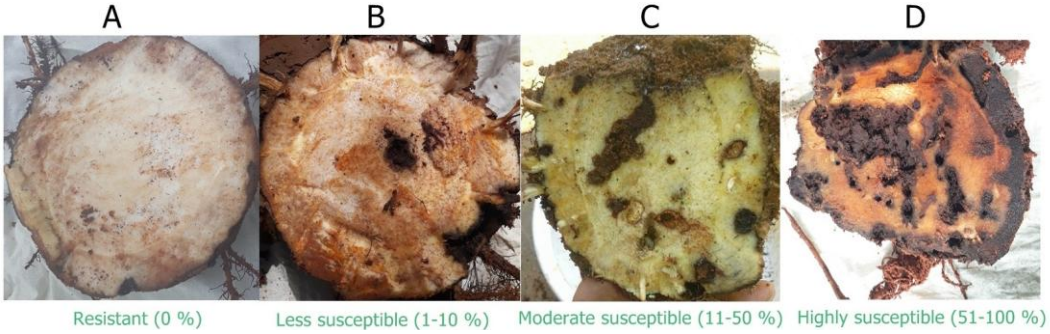

Fig. 3. Cross-section assessment- corm damage due to tunnelling by grub vs. plant response (after 50 days of artificial infestation)

Table 1. *Musa* accessions less susceptible to *C. sordidus* (1-10 % damage)

S. No	Accession No.	Name	Genome
1.	1030	Chendwat	AA
2.	0640	PisangJariBuaya	AA
3.	0012	Jahaji	AAA
4.	0081	Harichal	AAA
5.	1065	Pachakappa	AAA
6.	0009	Borjahaji	AAA
7.	0632	GCTCV-119	AAA
8.	0240	Ladan small	AAB
9.	0241	Ladanpointed	AAB
10.	0445	Baidichinia	AAB
11.	0637	Pisangnanga	AAB
12.	0215	K. Chakarakeli	AAB
13.	0619	Mysorebale	AAB
14.	0048	Dasaman	AAB
15.	0043	Garomoina	AAB
16.	0700	Thozhuvan	AAB
17.	0178	Kunnan	AB
18.	186	Nattupoovan	AB
19.	0364	Gragricsarpara	AB
20.	0234	Valiyakunnan	AB
21.	0050	Karthobiumthom	ABB
22.	0193	Peyan	ABB
23.	0102	Pagar banana	ABB
24.	0157	Bhurkel	ABB
25.	0333	Bluggoe	ABB
26.	0442	Poompidiyan	ABB
27.	0525	Chirapunji	ABB
28.	0552	Boothibale	ABB
29.	0636	Saba	ABB
30.	0799	Dinamalakol	ABB
31.	0803	GP 24	ABB
32.	0068	Kaitshenging	ABB
33.	0088	Batisa local	ABB
34.	0634	Bluggoe	ABB
35.	0130	Lamby	ABB
36.	0075	Bhat manokar	ABBB
37.	0253	Klueteparod	ABBB
38.	0067	Bhimkol	BB
39.	0446	Bachariamalbhog	BB
40.	1914	Beejikela	BB
41.	2028	Attikol	BB
42.	0018	Borkalbaista	BB
43.	1260	*Musa ornata*	Rhodo
44.	1376	*Musa laterita*	Rhodo

This study revealed a wide range of host plant response to *C. sordidus* between the genome groups and among the accessions within the groups. The present study implied that resistant groups can be used as reference genotypes for weevil resistance. Moreover, this study provided a quick screening method to analyze the weevil resistance as compared to the field screening experiment that takes more than three years as reported by Sadik et al. (2010). They suggested that further study needs to be carried out to determine the resistance

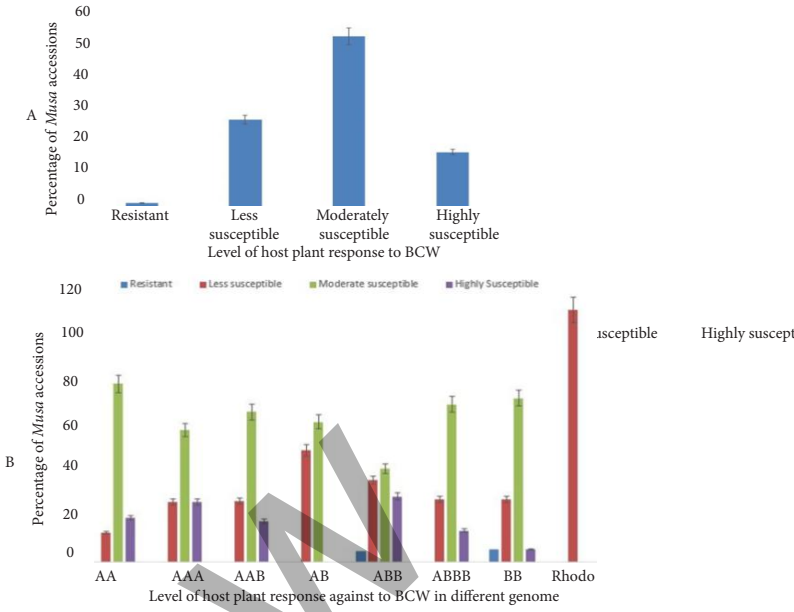

Fig. 4. In vitro screening of *Musa* germplasm against *C. sordidus* A. Response of accessions; B. Analysis of genomic groups

mechanisms based on either presence or absence of essential nutrients/ components which inhibits weevil development. Similarly, Kiggundu et al. (2007) also reported that methanol extracts from kayinja (resistant cultivars) inhibited the larval development on the corms of susceptible cultivars in the laboratory assay. They further studied the deleterious effect of plant cystatins on the growth of *C. sordidus* (Kiggundu et al., 2010). Even though, in vitro screening approach takes short duration to identify the resistant or susceptible *Musa* accession, field evaluation is also an important component in this study because the weevil population is rich in the field due to their several ratoon cycle of host plants (Ocan et al., 2008).

Most resistant cultivars are not cooking types and this presents a problem to breeder as cooking types are the staple food as well as consumer's preference (Night et al., 2011). Improving the resistance of cooking type remains a challenge that indicates the attempts to find a lasting solution through plant breeding. This also implies that banana weevil still posseses a challenge with respect to food security and income to banana growing community. In addition, the banana corm weevil also affects the macropropagation technology which is a cost-effective method for mass production of banana seedlings from the corm (Njau et al., 2011). Surivival and adaptation of banana weevil involves finding host plants, host plant acceptance (oviposition) or antixenosis or antibiosis (larval survival, developmental rate amd fitness) or physiochemical factors (phytochemical

which are non-nutrients produced by *Musa* plant that affect the behaviour, health and ecology of weevil) are important in insect- plant interactions (Kiggundu et al., 2007). Host plant resistance affecting any of those above processes in the insect system, could pave a way for weevil management in an ecofriendly approach. Therefore, the present study shows great interest to identify the weevil resistant *Musa* accessions from germplasm for weevil management.

Thus, it can be concluded that the difference in corm damage is clearly revealed in the susceptible accessions from resistant groups of *Musa* accessions and this information can be useful for breeding of resistant and less susceptible cultivars against *C. sordidus*. Further work needs to be done at both molecular and biochemical level to find out the factors like phytoalexins that play a major role in weevil resistance in *Musa* accessions as they could be useful to develop a novel screening method.

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