Management of Sugarcane Rootstock Borer, *Emmalocera depressella* Swinhoe by Microorganisms in Bangladesh

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ABSTRACT

The experiments were conducted at Regional Sugarcrop Research Station farm, Thakurgaon during the cropping season of 2013-14, 2014-15 and 2015-16 with a view to find out the effective bio-insecticides against rootstock borer, *Emmalocera depressella* in sugarcane cultivation. The experiment was laid out in a Randomized Complete Block Design with three replications that comprised of seven treatments including one untreated (control) plots. Two different bio- insecticides *Metarhizium anisopliae* and *Beauveria bassiana* were tested against sugarcane rootstock borer. In cropping season 2013-14, the highest efficacy 42.08% was observed in *Beauveria bassiana* @ 5.0 kg ha^{-1} applied in Planting + March + May + July. In cropping season 2014-15, the highest efficacy 39.32% was observed in *Beauveria bassiana* @ 5.0 kg ha^{-1} applied in Planting + March + May + July. In cropping season 2015-16, the highest 30.60% efficacy was observed in *Metarhizium anisopliae* @ 5.0 kg ha^{-1} applied in Planting + March + May + July. The highest (31.66%) Brix% increase was found in *Metarhizium anisopliae* @ 5.0 kg ha^{-1} over control. The highest 53.88% yield increase was found in *Metarhizium anisopliae* @ 5.0 kg ha^{-1} applied in Planting + March + May + July.

Key words: Bio-insecticides, *Metarhizium anisopliae*, *Beauveria bassiana* and sugarcane rootstock borer

INTRODUCTION

Rootstock borer, *Emmalocera depressella* Swinhoe (Lepidoptera : Pyralidae) is one of the major insect pest of sugarcane causing significant losses of 8.55% (Miah *et al.*,1986). Rootstock borer is the serious pest causing damage to the underground portions of cane stalk. Infestation by rootstock borer in the early stages of cane was observed in reducing cane yield upto 68% (Miah *et al.*,1986). The larvae bore into the underground basal portion of the plant and feed there showing the dead heart symptom. The dead heart can not be easily pulled out and it does not give any offensive smell. The pest is active at high temperature and low humidity. Drying up $3^{rd}/4^{th}$ leaf is sometimes observed with yellowing of the whole plants attacked. In

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mature cane. the stock portion is badly damaged, tissues are macerated and food material can not be translocated. Leaf becomes pale-yellow resulting the death of the cane. Rootstock borer in its first brood affects cane by 52% of which produce no tiller, 30% produce only one tiller and 18% two tillers (Cheema,1953). During harvest, upto 10% yield decrease and reduction in sucrose in juice by about 0.3 unit have been observed by Gupta and Avasthy (1952). As the rootstock borer damages canes below the soil surface hence entomopathogenic fungus *Metarhizium anisopliae* and *Beauveria bassiana* can be thought an alternative control option for this type of pest. Among the several factors contributing for low productivity of sugarcane, the insect pests constitute the major. The losses estimated of sugarcane to be around 20% in cane yield and 15% in sugar recovery in every year.

Insect larvae pierce the rhizome, making plants weak and more susceptible to tipping and low productivity. In addition, the galleries built facilitate the entry of phytopathogens such as fungus like *Metarhizium anisopliae* and *Beauveria bassiana* that might be effective in controlling rootstock borer (Batista Filho *et al.*, 2002; Messiaen, 2002 and Mesquita, 2003). The control of this pest consists primarily of the application of chlorphyrifos-based insecticides in granular form for sugarcane, which attack and kill larval insects. However, due to the hinding properties of borer populations that may develope resistant to chemical insecticides (Suplicy Filho,1982; Raga and Oliveira, 1996). Therefore, it is necessary to search for alternatives of management and control, such as using traps containing aggregation pheromone, resistant varieties and biological control based on entomopathogenic fungi. (Gold *et al.*, 2001 and Leite, 2006).

Since the potential microbial insecticides like *Metarhizium anisopliae* and *Beauveria bassiana* to a particular insect depends on several factors and relationships involving the target insect, the entomopathogenic fungus specificity the pathogenicity and the environment, the search for more virulent species or isolates should be continued in pest control programs as well as additional studies about the interactive effects of pesticides on the performance of the selected pathogen. Therefore, this work aimed to evaluate new isolates of fungus that could provide better control against larvae of *E. depressella*.

MATERIALS AND METHODS

The field experiment was conducted at the experimental farm of Regional Sugarcrop Research Station (RSRS), Thakurgaon during the cropping seasons of 2013-14, 2014-15 and 2015-16. The experiment consisted of seven treatments in cropping season of 2013-16 including one control. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. The individual plot size was 6m x 6m. Block to Block distance was 2m apart with a border of 1.5 m. The variety Isd 37 was used as planting material and planting was done through conventional sett placement In the trenches. The test insecticides were entomopathogenic fungus *Metarhizium anisopliae* and *Beauveria bassiana* as bio-control agent. The application schedules of bio-insecticides were such that in all cases it was planting, March, May and July. Bio-insecticides application at each time was followed by irrigation. Before irrigation, soil ridges were made surrounding

individual plots to protect the flow of water from one plot to another. The fertilizer application, weeding, mulching and earthing up were done as normal cultural practices. For application of bio-insecticides furrows were made on both sides of cane rows and then insecticides were applied at base of the plants with spraying and in the space between furrows and mixed with soils followed by irrigation and then covered with soils. The experiment was located in Old Himalayan Piedmont Plain Soil under Agro-ecological Zone^{-1} with high land of typical sandy loam soil having 4.5 to 5.5 pH.

The experiment was comprised of seven treatments and those were:
T_1: *Metarhizium anisopliae*@ 3.0 kg ha^{-1} applied at Planting + March + May + July
T_2: *Metarhizium anisopliae*@ 4.0 kg ha^{-1} applied at Planting + March + May + July
T_3: *Metarhizium anisopliae*@ 5.0 kg ha^{-1} applied at Planting + March + May + July
T_4: *Beauveria bassiana*@ 3.0 kg ha^{-1} applied at Planting + March + May + July
T_5: *Beauveria bassiana*@ 4.0 kg ha^{-1} applied at Planting + March + May + July
T_6: *Beauveria bassiana*@ 5.0 kg ha^{-1} applied at Planting + March + May + July
T_0: Control (untreated)

The experimental plot was prepared with plowing thoroughly because sugarcane being deep-rooted crops requires a good tilth of soil free from clods for its proper growth. At the time of final land preparation whole of TSP, Gypsum, Zinc sulphate, Boron and ⅓ Urea and ⅓ MOP were applied and rest amount of Urea and MOP were applied in two installments at March and June. *Metarhizium anisopliae* and *Beauveria bassiana* are slow growing fungus. It was used as a solution made of powder with water in the sugarcane field. Sugarcane field must be in moist condition when sprayed this solution. For counting the population of rootstock borer, data were taken from 5 randomly selected clumps per plot. An area of 60 cm x 60 cm was dug up from a depth of 40 cm with spade. Population of rootstock borer larvae and adult (if any) was counted in roots and in soils of these pits. Data were taken thrice, 40 days after each application. Total weight of cane was taken from each plot and statistically analyzed with the help of Statistic-10 program with LSD test at 5% level of significance (Gomez and Gomez, 1984) to adjust the yield (t ha^{-1}) during harvest.

RESULTS AND DISCUSSION

From the Table 1 it is revealed that data collected in April and June during the cropping season 2013-14, all the treatments showed reduction in rootstock borer infestation which are statistically significant over control plot. Pool data shows, the highest (42.08%) efficacy of reduction in *Beauveria bassiana* @ 5.0 kg ha^{-1} followed by *Metarhizium anisopliae* @ 5.0 kg ha^{-1} (40.55%) applied in Planting + March + May + July and the lowest (26.61%) efficacy against rootstock borer infestation was found in *Beauveria bassiana* @ 3.0 kg ha^{-1} in Planting + March + May + July over control. Pool data (Table 1) shows the efficacy ranged from 26.61 to 42.08% against rootstock borer infestation. From the presented data in Table-1 it shows that *Beauveria bassiana* and *Metarhizium anisopliae* has some positive effect in controlling rootstock borer infestation. The present findings partially agrees with Rasmann *et al.* (2005) who stated that bio-insecticidal effects of entomopathogenic fungus *Metarhizium anisopliae* could be reduced the infestation of sugarcane cultivation in Bangladesh.

Table 1. Efficacy of entomopathogenic fungi *Metarhizium anisopliae* and *Beauveria bassiana* on sugarcane rootstock borer, RSRS, Thakurgaon, 2013-14

Teatments	% Rootstock borer infestation Mean (5 clumps uprooted/plot)		Pool data
	April' 14	June'14	
T_1 - *Metarhizium anisopliae* @ 3.0 kg ha^{-1} at Planting + March + May + July	32.48ab (34.57)	69.10cde (23.76)	50.79 (29.16)
T_2 - *Metarhizium anisopliae* @ 4.0 kg ha^{-1} at Planting + March + May + July	24.23b (51.19)	69.11cde (23.74)	46.67 (37.46)
T_3 - *Metarhizium anisopliae* @ 5.0 kg ha^{-1} at Planting + March + May + July	28.36ab (42.86)	55.97bcde (38.24)	42.17 (40.55)
T_4 - *Beauveria bassiana* @ 3.0 kg ha^{-1} at Planting + March + May + July	27.64ab (44.32)	82.56ab (8.90)	55.10 (26.61)
T_5 - *Beauveria bassiana* @ 4.0 kg ha^{-1} at Planting + March + May + July	26.65b (46.31)	62.50e (31.04)	44.57 (38.67)
T_6 - *Beauveria bassiana* @ 5.0 kg ha^{-1} at Planting + March + May + July	20.71b (58.28)	67.17de (25.89)	43.94 (42.08)
T_0 : Control (untreated)	49.64a	90.63a	70.14
LSD (0.05)	14.899	12.948	-

From Table 2 it is observed that all the treatments showed insignificant result in reducing rootstock borer infestation in May, June and November data collection. But in August data all the treated plots showed significant differences over control plot in lowering the rootstock borer infestation, where *Beauveria bassiana* @ 5.0 kg ha^{-1} showed 37.12% reduction followed by *Metarhizium anisopliae* @ 5.0 kg ha^{-1} 35.09%. Pooled data shows the similar effect as in August data where *B. bassiana* gave the highest 39.32% efficacy @ 5.0 kg ha^{-1} followed by *M. anisopliae* @ 5.0 kg ha^{-1} 37.20% efficacy in rootstock borer reduction applied in Planting + March + May + July over control. Lowest (9.33%) reduction was observed in *Beauveria bassiana* @ 3.0 kg ha^{-1} applied in Planting + March + May + July. Laznik *et al.* (2012) reported that bio-insecticidal effects of entomopathogenic fungus *Metarhizium anisopliae* as a potential bio-control agent on sugarcane rootstock borer which reduced the infestation of sugarcane borers in commercial cultivation of sugarcane growing areas of Bangladesh.

Table 2. Efficacy of entomopathogenic fungi *Metarhizium anisopliae* and *Beauveria bassiana* on sugarcane rootstock borer, RSRS, Thakurgaon, 2014-15

Treatments	% Rootstock borer infestation (5 clumps uprooted/plot) Mean				Pool Data
	May'15	Jun'15	Aug'15	Nov'15	
T_1 - *Metarhizium anisopliae* @ 3.0 kg ha^{-1} at Planting + March + May + July	16.99 (6.13)	29.98 (16.97)	53.10 abc (12.27)	58.18 (2.41)	40.18 (9.44)
T_2 - *Metarhizium anisopliae* @ 4.0 kg ha^{-1} at Planting + March + May + July	15.88 (12.26)	30.91 (14.40)	47.20 abc (22.02)	54.37 (8.81)	37.09 (14.37)
T_3 - *Metarhizium anisopliae*@ 5.0 kg ha^{-1} at Planting + March + May + July	11.49 (36.52)	22.63 (37.33)	39.29 bc (35.09)	35.85 (39.87)	27.32 (37.20)
T_4 - *Beauveria bassiana*@ 3.0 kg ha^{-1} at planting+March + May+July	16.20 (10.49)	34.63 (4.09)	53.71 abc (11.27)	52.78 (11.47)	41.04 (9.33)
T_5 - *Beauveria bassiana*@ 4.0 kg ha^{-1} at Planting + March + May + July	15.08 (16.68)	34.74 (3.79)	45.77 abc (24.38)	49.95 (16.21)	36.39 (15.27)
T_6 - *Beauveria bassiana*@ 5.0 kg ha^{-1} at Planting + March + May + July	10.49 (42.04)	21.76 (39.74)	38.06 bc (37.12)	36.73 (38.39)	26.76 (39.32)
T_0 - Control (untreated)	18.10	36.11	60.53 a	59.62	41.89
LSD (0.05)	NS	NS	15.529	NS	

From the Table 3 it is found that in May, June and August of the cropping season 2015-16, statistically significant difference was observed among the treatments in lowering the infestation over control plot from bio-insecticidal treatments in May and August month. But no significant differences among the treatments was observed in June. From pool data (Table 3), the highest (30.60%) efficacy was observed in *Metarhizium anisopliae* @ 5.0 kg ha^{-1} followed by *Beauveria bassiana* @ 5.0 kg ha^{-1} (25.53%) applied in Planting + March + May + July in reducing the infestation and the lowest (7.77%) efficacy was found in *Beauveria bassiana* @ 3.0 kg ha^{-1} in Planting + March + May + July over control. Costa *et al.* (2007) found that bio-insecticidal effects of entomopathogenic fungus *Metarhizium anisopliae* as a potential agent of integrated control on sugarcane rootstock borer, *Emmalocera depressella* which was reduced the infestation of sugarcane borers in commercial cultivation in Bangladesh.

Table 3. Efficacy of Entomopathogenic fungi *Metarhizium anisopliae* and *Beauveria bassiana* on sugarcane rootstock borer, RSRS Thakurgaon, 2015-2016

Treatments	% Rootstock borer infestation Mean (5 clumps uprooted/plot)			Pool data
	May'16	Jun'16	Aug'16	
T_1 - *Metarhizium anisopliae*@ 3.0 kg ha^{-1} at Planting + March + May + July	10.90a (1.98)	28.53 (6.89)	59.01bcd (22.92)	32.81 (10.60)
T_2 - *Metarhizium anisopliae*@ 4.0 kg ha^{-1} at Planting + March + May + July	8.65bc (22.21)	28.97 (5.68)	53.26d (30.34)	30.29 (19.41)
T_3 - *Metarhizium anisopliae*@ 5.0 kg ha^{-1} at Planting + March + May + July	7.42c (33.27)	22.78 (25.65)	51.39d (32.88)	27.20 (30.60)
T_4 - *Beauveria bassiana*@ 3.0 kg ha^{-1} at Planting+March + May+July	10.87a (2.25)	27.30 (10.90)	68.79ab (10.15)	35.65 (7.77)
T_5 - *Beauveria bassiana*@ 4.0 kg ha^{-1} at Planting + March + May + July	10.53ab (5.31)	22.73 (25.82)	65.00abc (15.10)	32.75 (15.41)
T_6 - *Beauveria bassiana* @ 5.0 kg ha^{-1} at Planting + March + May + July	7.63c (31.38)	25.97 (15.24)	53.61cd (29.98)	29.07 (25.53)
T_0- Control (untreated)	11.12a (-)	30.64 (-)	76.56a (-)	-
LSD (0.05)	1.98	NS	15.529	

From the Figure 1 it is observed that Brix% (pool/mean data) of the three cropping season 2013-16, the highest Brix 19.42% was observed in *Metarhizium anisopliae* @ 5.0 kg ha^{-1} followed by *Beauveria bassiana* @ 5.0 kg ha^{-1} (18.65%) applied in Planting + March + May + July and the lowest 14.75% Brix was found in control plot. Incase of Brix% increase over control, the highest (31.66%) Brix increase over control was found in *Metarhizium anisopliae* @ 5.0 kg ha^{-1} followed by *Beauveria bassiana* @ 5.0 kg ha^{-1} 26.45% applied in Planting + March + May + July and the lowest (19.79%) Brix increase over control was found in *Beauveria bassiana* @ 3.0 kg ha^{-1} treated plot applied in Planting + March + May + July. Bio-insecticidal effects of entomopathogenic fungus *Metarhizium anisopliae* as a potential agent of integrated control on sugarcane rootstock borer, *Emmalocera depressella* which reduced the infestation of sugarcane borers in commercial cultivation of sugarcane growing areas of Bangladesh.

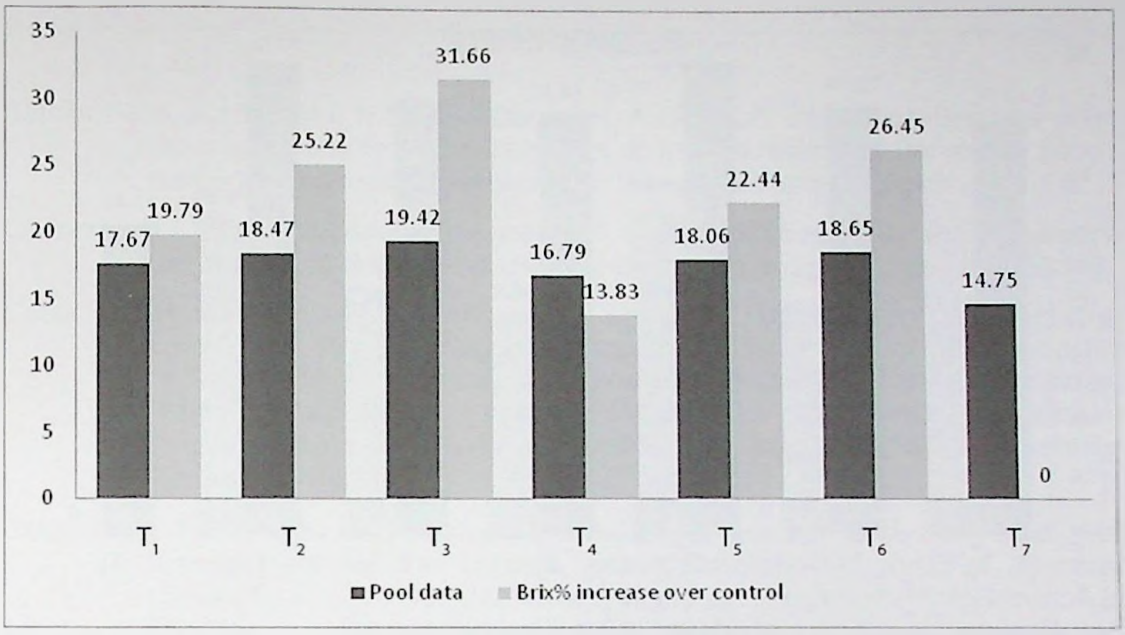

Figure 1. Effects of entomopathogenic fungi *Metarhizium anisopliae* and *Beauveria bassiana* on Brix% of sugarcane against rootstock borer, RSRS, Thakurgaon, 2013-16

T_1: *Metarhizium anisopliae* @ 3.0 kg ha^{-1}, **T_2:** *Metarhizium anisopliae*@ 4.0 kg ha^{-1}, **T_3:** *Metarhizium anisopliae*@ 5.0 kg ha^{-1}, **T_4:** *Beauveria bassiana*@ 3.0 kg ha^{-1}, **T_5:** *Beauveria bassiana* @ 4.0 kg ha^{-1}, **T_6:** *Beauveria bassiana*@ 5.0 kg ha^{-1} and **T_0** - Control (untreated)

The result presented through Figure 2 reaveled thar yield tha^{-1} (pool/mean data) of the three cropping season 2013-16, the highest yield (79.19 tha^{-1}) was observed in *Metarhizium anisopliae* @ 5.0 kg ha^{-1} followed by *Beauveria bassiana* @ 5.0 kg ha^{-1} which was (78.56 tha^{-1}) applied in Planting + March + May + July and the lowest (51.46 tha^{-1}) yield was found in control plot. Incase of yield increase over control, the highest (53.88%) yield increase over control was found in *Metarhizium anisopliae* @ 5.0 kg ha^{-1} followed by *Beauveria bassiana* @ 5.0 kg ha^{-1} which was 52.66% applied in Planting + March + May + July and the lowest (35.17%) yield increase over control was found in *Metarhizium anisopliae* @ 3.0 kg ha^{-1} treated plot applied in Planting + March + May + July. Woodring and Kaya (1998) stated that effects of entomopathogenic fungus *Metarhizium anisopliae* as a potential bio-agent of sugarcane rootstock borer, *Emmalocera depressella* control which was reduced the infestation of sugarcane borers in commercial cultivation of sugarcane growing North-western regions of Bangladesh.

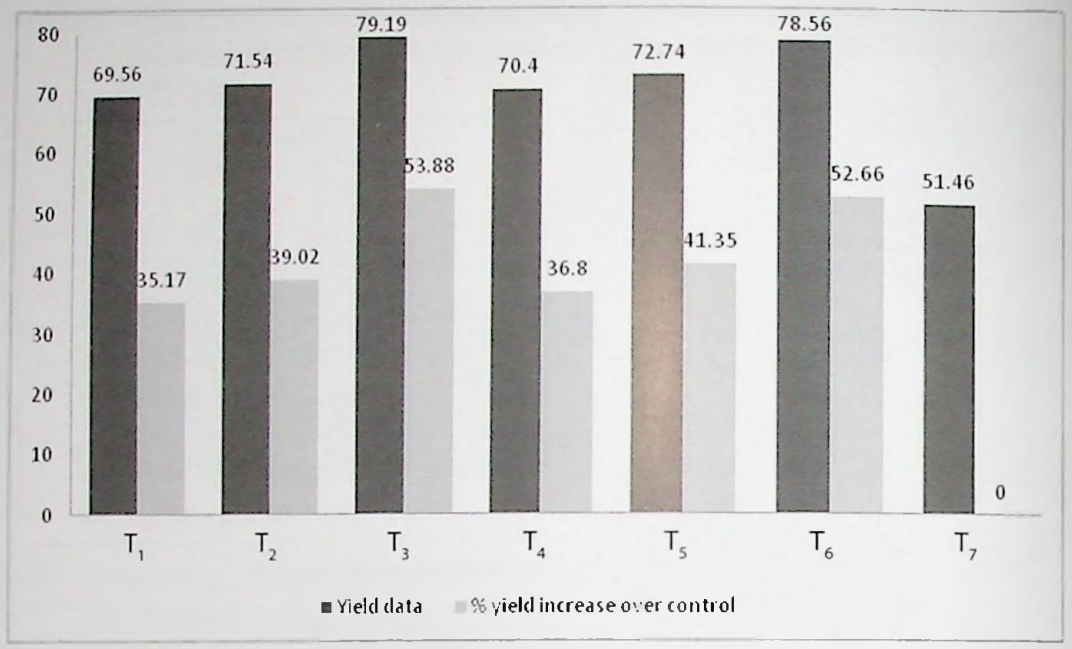

Figure 2. Effects of entomopathogenic fungi *Metarhizium anisopliae* and *Beauveria bassiana* on yield of sugarcane against rootstock borer, RSRS, Thakurgaon, 2013-16

T_1: *Metarhizium anisopliae*@ 3.0 kg ha^{-1}, **T_2:** *Metarhizium anisopliae*@ 4.0 kg ha^{-1}, **T_3:** *Metarhizium anisopliae*@ 5.0 kg ha^{-1}, **T_4:** *Beauveria bassiana*@ 3.0 kg ha^{-1}, **T_5:** *Beauveria bassiana* @ 4.0 kg ha^{-1}, **T_6:** *Beauveria bassiana*@ 5.0 kg ha^{-1} and **T_0** - Control (untreated)

Therefore, from the present study which is continued for three consecutive years (2013-2016), it is revealed that the two bio-pesticides likes *Metarhizium anisopliae* and *Beauveria bassiana* might be used alternatively to chemical control as an environmental friendly component which might reduce the use of chemical insecticides against sugarcane rootstock borer in minimizing the cost and ensure environmental safety. Among the treatments of tested two bio-pesticides viz., *Metarhizium anisopliae* and *Beauveria bassiana* @ 5.0 kg ha^{-1} gave satisfactory effective control upto 42.08% against sugarcane rootstock borer in commercial cultivation of sugarcane growing North-Western regions of Bangladesh. Further investigation might be carried out to fit the use of Bio-pesticides in IPM system of sugar crops in the country.

REFERENCES

Batista Filho, A.; Takada, H.M. and Carvalho, A.G. 2002. Brocas da Bananeira. In: Reuniao itinerante de fitossanidade do instituto biologico-Banan, 6., São Bento do Sapucaí, SP. *Anais.* São Paulo: Instituto Biológico,. pp.1-16.

Cheema, P.S. 1953. Nature and extent of damaged caused by the sugarcane rootstock borer, *Emmalocera depressella* Swinhoe. *Indian, J. Ento.*, **15** : 139-145.

Costa, J.C.R.; Dias, R.J.P. and Morenz, M.J.F. 2007. Determining the adaptation potential of ntomopathogenic nematode multiplication of *Heterorhabditis riobravus* and *Steinernema carpocapsae*(Rhabditida: Heterorhabditidae, Steinernematidae) in larvae of *Alphitobius diaperinus* (Coleoptera: Tenebrionidae) and *Galleria mellonella* (Lepidoptera: Pyralidae). *Parasitology Research*, **102**:139-144.

Gold, C.S.; Pena, J.E. and Karmura, E.B. 2001. Biology and integrated pest management for the banana weevil, *Cosmopolites sordidus* (Germar) (Coleoptera: Curculionidae). *Integrated Pest Management Reviews*, **6**(2) :79-155.

Gomez, K. A. and Gomez. A. A. 1984. Statistical Procedure for Agricultural Research, John Willey and Sons. New York, Brisbane. Singapore. pp. 1-240.

Gupta, B.D. and Avasthy. P.N. 1952. Biology of sugarcane rootstock borer *Emmalocera depressella* Swinhoe. *J. Agric. Anim. Husb.*, **2**: 19-25.

Laznik, Z.; Vidrih, M. and Trdan, S. 2012. The Effects of Different Fungicides on the Viability of Entomopathogenic Nematodes *Steinernema feltiae* (Filipjev), *S. carpocapsae* Weiser, and *Heterorhabditis downesi* Stock, Griffin & Burnell (Nematoda: Rhabditida) under Laboratory Conditions. *Chilean Journal of Agricultural Research*, **72** (1): 62-67.

Leite, L.G. 2006. Nematóides entomopatogênicos. In:*Controle biolygico de insetose ácaros.* São Paulo: *Instituto Biolygico.*, pp. 42-51.

Mesquita, A.L.M. 2003. Importância e Métodos de Controle do Moleque ou Broca-do-Rizoma-da-Bananeira. Fortaleza: EMBRAPA *Agroindústria Tropical*, pp.1-5.

Messiaen, S. 2002. Componentes de una estrategia para el manejo integrado del picudo negro del banano *Cosmopolites Sordidus*(Germar) (Coleoptera: Curculionidae). *Infomusa*, **12** (1): 52-53.

Miah, M. A. H.; Kundu, R.; Mannan, A. and Abdullah, M. 1986. Assessment of cane damage caused by Root stock borer, *Emmalocera depressella* Swinhoe and effects of pesticides on the pest. *Bangladesh J. of Sugarcane*, **8**: 1-4.

Raga, A. and Oliveira, J. A. 1996. Ação de inseticida sobre a Broca-da-bananeira (*Cosmopolites sordidus*)(Coleoptera: Curculionidae) no Vale do Ribeira, SP. *Arquivos do Instituto Biolygico*, São Paulo, **63** (1): 81-84.

Rasmann, S.; Kollner, T. G.; Degenhardt, J.; Hiltpold, I.; Toepfer, S.; Kuhimann, U.; Gershenzon, J. and Turlings, T. C. J. 2005. Recruitment of entom pathogenic nematodes by insect-damaged maize roots. *Nature*, **434**:732-737.

Suplicy Filho, N. and Sampio, A. S. 1982. Pragas da bana-neira. *Biolygico*. São Paulo, **48** (7):169-182.

Woodring, J. L. and Kaya, H. K. 1998. *Sternematidae and a Heterorhabditidae nematodes*: a handbook of biology and techniques. Nemathode Subcommittee on the Southern Regional Project S135 - *Entomopathogens for use in Pest Management Systems, Arkansas:Southern Cooperative*, (Series Bulletin, n. 331).