Farm yard manure and neem cake on feeding preference, ovipositional preference and developmental period of coffee berry borer, *Hypothenemus hampei*

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ABSTRACT

The impact of induced resistance acquired in coffee plants through organic sources of nutrition on berry infestation, feeding preference, ovipositional preference and developmental period of coffee berry borer was assessed. Among the various organic sources of nutrients / amendments tested, application of farm yard manure (FYM) (1.25 t/ha) + neem cake (0.75 t/ha) + azophos (25 kg/ha) followed by FYM + neem cake in two equal splits at four months interval was found to be consistently effective in reducing the infestation of coffee berry borer throughout the period of observations and also less preferred for feeding and oviposition by coffee berry borer and thus exhibited high inhibition for feeding (antifeedant) and ovipositional deterrency. The organics treated plots recorded significantly prolonged larval duration due to neem and it was maximum in FYM + neem cake + azophos (18.76 ± 3.14 days) as compared to 13.41 ± 2.25 in inorganic NPK. The growth index of berry borer was the least (4.24) in the treatment with FYM + neem cake + azophos as compared to 6.87 in inorganic NPK.

Key words : Coffee berry borer, *Hypothenemus hampei*, crop pest, organic amendments, induced resistance

INTRODUCTION

The mechanism of host plant resistance in insects is gaining the attention of the scientists in recent years. In the absence of natural heritable resistance, resistance can be induced by using alternate strategies. The organic sources of nutrients were found to induce systemic resistance in plants against pests by changing the chemical constituents of host plant. It has been established that chemical constituents of host plant influence the development and survival of phytophagus insects (Painter, 1951). Jayaraj (1967) reported that the nutrients content of a plant played an important role in determining its susceptibility or resistance to insect pests. Biochemical constituents of host plant have been reported to affect the survival, growth and reproduction of insects in various ways (Painter, 1958; Beck, 1965; Schoonhover, 1968). Variation in both basic nutrients and non-nutritional components (allelochemicals) in the food affects the amount and rate of food eaten, digested, assimilated and converted into the tissue for growth (Slansky, 1982). Various fungal entomopathogens have already been reported as endophytes (Vega *et al.,* 2008) and the various methods used to inoculate coffee plants with *B. bassiana* were partially effective (Posada *et al*., 2007), as recovery was confirmed but establishment was not long lasting. This lack of establishment was hypothesized to be due to the presence of other fungal endophytes that outcompeted *B. bassiana* (Posada *et al*., 2007 and Vega *et al.,* 2010).

The indiscriminate use of chemical fertilizers and insecticides has led to problems such as environmental pollution, reduction in yields, loss in soil fertility and resistance to insecticide. The present study has been carried out to evaluate the effect of organic sources of nutrition on infestation of berry borer, feeding preference, ovipositional preference and developmental period of coffee berry borer, *Hypothenemus hampei* Ferrari.

MATERIALS AND METHODS

Studies were carried out in both field and laboratory to assess the impact of induced resistance acquired in coffee plants through organic sources of nutrition on the biology of coffee berry borer, *H. hampei*. All the agronomic practices were adopted uniformly for all the treatments. The cultivar Sarchimor (S.4202) was adopted with the age of 8 years. Farm yard manure (FYM @ 2.5 tonnes/ha) and neem cake (NC @ 1.5 tonnes/ha) with computed half quantity were applied as first basal dose during February 2004 and 2005 after the harvest and remaining half was applied as second basal dose for the month of June 2004 and 2005. The biofertilizer *viz*., azophos @ 25 kg/ha was incorporated in the soil in the respective treatments.

Inorganic fertilizers in the form of urea, single super phosphate and muriate of potash with computed quantity (120 : 90 : 120 kg NPK / ha) were applied at recommended doses. Fifty per cent of total N, P and K were applied during February 2004 and 2005 and the rest of 50 per cent N, P and K was applied during June 2004 and 2005 as second top dressing at four months intervals. The treatments are T1-Farm yard manure (FYM) alone @ 2.5 tonnes/ha; T2- Neem cake (NC) alone @ 1.5 tonnes/ha; T3- FYM (50%) + NC (50%); T4- FYM (50%) + NPK (50%); T5 - NPK (50%) + NC (50%); T6 - FYM (50%) + NC (50%) + Azophos (25 kg/ha); T7- FYM (50%) + NPK (50%) + Azophos (25 kg/ha); T8-NPK (50%) + NC (50%) + Azophos (25 kg/ha); T9- NPK (recommended dose) alone @ 120 : 90 : 120 kg NPK/ha and T10- Untreated control.

Infestation of coffee berry borer

The total number of uninfested berries and number of berries showing bore hole at naval region were recorded from five tagged plants in each replication (sub plot) and in each plant, three secondary branches were examined (one top, one middle and one bottom) and the percentage of berry borer infestation after each period was calculated. The above observations were recorded at fortnightly intervals from 120 days (endosperm hardening stage) after treatment (DAT) (when the bean attaining maturity) to 300 DAT, during both 2004 and 2005 seasons.

Biological traits of coffee berry borer in in-vitro condition

One hundred and twenty days after imposing the treatment (endosperm hardening stages), healthy beans collected from each treatment were taken in plastic boxes, which were covered with muslin cloth. Hundred pre-starved (24h) beetles were released into each box. After a day of infestation, the infested beans were dissected out periodically in the laboratory to determine the different stages of the coffee berry borer. The parameters observed were egg, larval, and pupal periods, per cent pupation and per cent emergence of normal adults. Per cent adult emergence was used to find out, the growth index (Howe, 1971) was computed as follows:

$$\text{Growth index} = \frac{\text{Log adult emergence (\%)}}{\text{Average developmental period (days)}}$$

The same procedure was followed (making infestation) as described under developmental period. The observations were recorded on number of bored beans showing bore hole at naval region of bean of each replication on 3 and 5 days after adult released, and the per cent bean damage was worked out.

The following procedure was followed (making infestation) as described under developmental period. After a day of infestation the infested beans were dissected out daily in the laboratory to examine (under stereo microscope) the coffee berry borer eggs and larval populations, and calculated the percentage of egg hatched.

Statistical Analysis

The data collected in various field and laboratory experiments were statistically analysed using randomized and completely randomized block designs. The percentage values were subjected to angular or *arc - sine* transformation. Square root transformation was followed for converting the population / numbers. The treatment means were compared with Duncan's multiple range test (DMRT) for their significance (Gomez and Gomez, 1985).

RESULTS AND DISCUSSION

The results of the field experiments on the impact of organic sources of nutrients on berry borer infestation is given in Table 1 and the effect of various organic form of nutrition on feeding preference, ovipositional preference and developmental period were given in Table 2, 3 and 4.

Infestation of coffee berry borer

In the present investigation, the plots treated with FYM + neem cake + azophos and FYM + neem cake application in two splits showed significant reduction in berry borer infestation than other treatments with NPK as inorganic form throughout the period of observations in coffee. This may be attributed to the high repellent and deterrency effect of neem cake on berry borer for feeding and oviposition. This is in close agreement with the findings of Rajendran and Chandramani (2002) who reported the efficacy of FYM along with neem cake and biofertilizers in reducing the incidence of aphid (*Myzus persicae*) and thrips (*Scirtothrips dorsalis*) in chillies.

Further, Krishnamoorthy *et al.* (2001) revealed that the soil application of neem cake significantly reduced the ash weevil grub, thrips and shoot and fruit borer and this may be due to the high repellent effect of neem cake for feeding and oviposition. This was again in consonance with the earlier observation that the less incidence of sweet potato weevil, *Cylas formicarius* due to rational release of nitrogen when FYM applied to the soil (Singh *et al.*, 1992). Kavitha (2004) also observed less incidence of shoot and fruit borer infestation in bhendi with FYM + biofertilizers + neem cake and poultry manure + biofertilizers + neem cake application than that of NPK as straight fertilizer. It has been further opined that the inorganic form of nutrients increases the plant growth by providing the nutrients to the plants in large quantity for shorter period. Thereby the plants are endowed with

Table 1. Effect of organic nutrients / amendments on the infestation of coffee berry borer (field experiment)

Treatments	Season 2004 - 05		Season 2005 - 06		Pooled mean	
	Mean per cent infestation *	Per cent reduction over NPK *	Mean per cent infestation *	Per cent reduction over NPK *	per cent infestation	Per cent reduction over NPK
T1	12.27 (19.94)[d]	13.46[f]	12.00 (20.26)[f]	11.89[f]	12.14 (20.16)[d]	12.68[f]
T2	7.59 (15.08)[b]	46.76[c]	7.37 (15.40)[c]	46.90[c]	7.48 (15.24)[b]	46.83[c]
T3	3.51 (10.99)[a]	75.24[b]	3.55 (11.48)[b]	75.62[b]	3.53 (11.24)[a]	75.43[b]
T4	13.45 (21.04)[e]	6.21[g]	12.89 (21.44)[g]	5.69[g]	13.17 (21.24)[e]	5.95[g]
T5	9.18 (17.03)[c]	35.26[d]	8.95 (17.40)[d]	36.25[d]	9.07 (17.22)[c]	35.76[d]
T6	2.84 (9.61)[a]	79.97[a]	2.62 (9.06)[a]	82.35[a]	2.73 (9.34)[a]	81.16[a]
T7	11.77 (19.39)[d]	16.99[e]	11.57 (19.88)[e]	17.09[e]	11.67 (19.64)[d]	17.04[e]
T8	7.95 (15.84)[b]	43.93[c]	7.52 (15.28)[c]	45.58[c]	7.74 (15.56)[b]	44.76[c]
T9	13.94 (20.66)[e]	4.65[g]	12.81 (20.42)[h]	7.58[g]	13.38 (20.54)[e]	6.12[g]
T10	14.62 (22.88)[f]	-	13.86 (21.73)[i]	-	14.24 (22.31)[f]	-

* Each value in the mean of three replications
Figures in parentheses are arc sine transformed values
In a column, means followed by a common letter (s) are not significantly different by DMRT (P = 0.05)
T1 = Farm yard manure alone (FYM), T2 = Neem cake (NC) alone, T3 = FYM + NC, T4 = FYM + NPK, T5 = NPK + NC, T6 = FYM + NC + Azophos, T7 = FYM + NPK + Azophos, T8 = NPK + NC + Azophos, T9 = Untreated check, T10 = NPK alone

Table 2. Impact of organic nutrients on the biology of coffee berry borer

Treatments	Egg	Larval	Pupal	Total development	Per cent larvae pupated +	Per cent adult emergence+	Growth index #
T1	6.09 ± 2.12	16.88 ± 2.81	6.91 ± 1.69	29.88 ± 5.15	85.27(65.09)[e]	86.75(66.19)[e]	5.14(2.27)[c]
T2	7.66 ± 2.21	18.16 ± 3.41	8.59 ± 2.01	34.41 ± 5.26	81.92(64.36)[c]	83.33(64.30)[c]	4.59(2.14)[ab]
T3	7.83 ± 2.32	18.76 ± 3.14	8.89 ± 1.98	35.48 ± 6.31	78.25(64.83)[a]	79.57(65.11)[a]	4.24(2.06)[a]
T4	7.22 ± 1.89	17.19 ± 2.89	7.25 ± 1.88	31.66 ± 5.71	80.14(63.71)[b]	81.36(64.10)[b]	4.73(2.18)[b]
T5	6.93 ± 1.93	14.76 ± 2.16	6.81 ± 1.51	28.50 ± 4.16	83.36(64.41)[d]	85.14(65.00)[d]	5.77(2.40)[d]
T6	6.38 ± 2.03	13.96 ± 2.41	6.26 ± 1.56	26.60 ± 4.23	84.11(64.15)[d]	85.93(65.11)[de]	6.16(2.48)[e]
T7	6.42 ± 1.80	13.41 ± 2.25	6.15 ± 1.71	25.98 ± 3.71	90.13(70.15)[g]	92.16(72.54)[g]	6.87(2.62)[f]
T8	6.73 ± 1.87	16.16 ± 2.72	7.49 ± 2.11	30.38 ± 6.13	87.16(67.17)[f]	88.98(68.71)[f]	5.51(2.35)[cd]

* Each value in the mean of three replications
\# Figure in parentheses are square root transformed values
\+ Figure in parentheses are arc sine transformed values
In a column, means followed by a same letter (s) are not significantly different by DMRT (P=0.05)
T1 = Farm yard manure alone (FYM), T2 = Neem cake (NC) alone, T3 = FYM + NC, T4 = FYM + NPK, T5 = NPK + NC, T6 = FYM + NC + Azophos, T7 = FYM + NPK + Azophos, T8 = NPK + NC + Azophos, T9 = Untreated check, T10 = NPK alone

Table 3. Influence of organic sources of nutrients on the ovipositional preference of coffee berry borer.

Treatments	Mean ± SD (Eggs / ♀ / berry) *	Oviposition (%)
T1	6.69 ± 2.81^{d}	10.38
T2	5.83 ± 2.11^{c}	9.04
T3	4.35 ± 1.78^{a}	6.75
T4	4.93 ± 1.98^{b}	7.65
T5	7.86 ± 2.21^{e}	12.19
T6	8.92 ± 2.35^{f}	13.84
T7	15.76 ± 3.89^{h}	24.45
T8	10.13 ± 2.93^{g}	15.71

* Each value in the mean of three replications
In a column, means followed by a same letter (s) are not significantly different by DMRT (P=0.05)
T1 = Farm yard manure alone (FYM), T2 = Neem cake (NC) alone, T3 = FYM + NC, T4 = FYM + NPK, T5 = NPK + NC, T6 = FYM + NC + Azophos, T7 = FYM + NPK + Azophos, T8 =NPK + NC + Azophos, T9 = Untreated check, T10 = NPK alone

luxuriant growth and that may offer adequate and highly preferred food to the insects leading to heavy infestation (Surekha and Arjuna Rao, 2000; Kavitha, 2004).

In the present investigation, the berry borer infestation was high in NPK as inorganic form treated plants than organically treated ones. This is in line with the earlier findings revealed that the application of nitrogen at higher doses induced the succulency and rendered them susceptible to fruit and shoot borer in brinjal (Mehto and Lall, 1981) and to rice stem borer (Hirano, 1964; Shim, 1965).

Biological traits of coffee berry borer in in-vitro condition
The results indicated that the feeding preference of coffee berry borer significantly increased towards the increased levels of nitrogenous fertilization. The borer infestation was more on berries treated with NPK as in inorganic form. The organic treatments harboured berry borer comparatively much less in the combination of FYM + neem cake + azophos. Similarly, Kavitha (2004) revealed that the feeding area of *Epilachna* beetle was less in the combination of FYM + neem cake + biofertilizers. The increase in the feeding preference of brinjal leaf hopper with increased fertilization is again in agreement with the

Table 4. Influence of organic sources of nutrients on the feeding potential of coffee berry borer.

Treatments	Mean per cent of berry infestation *			Per cent reduction over NPK
	Days after release			
	3	5	Mean	
T1	19.14	33.13	26.22	57.83^{d}
	$(25.94)^{bc}$	$(35.14)^{b}$	$(30.80)^{d}$	
T2	16.17	28.19	22.18	
	$(23.71)^{bc}$	$(32.07)^{b}$	$(28.09)^{c}$	64.34^{c}
T3	3.26	16.28	9.77	
	$(10.40)^{a}$	$(23.79)^{a}$	$(18.21)^{a}$	84.29^{a}
T4	13.80	25.92	19.86	
	$(21.80)^{b}$	$(30.60)^{ab}$	$(26.46)^{b}$	68.07^{b}
T5	32.13	49.25	40.69	
	$(34.53)^{d}$	$(44.57)^{c}$	$(39.63)^{e}$	34.57^{e}
T6	39.10	51.34	45.22	
	$(38.70)^{e}$	$(45.76)^{c}$	$(42.25)^{f}$	27.29^{f}
T7	42.74	73.18	57.96	
	$(40.82)^{ef}$	$(58.81)^{d}$	$(49.58)^{g}$	6.80^{g}
T8	44.66	79.72	62.19	
	$(41.93)^{f}$	$(63.23)^{d}$	$(52.05)^{h}$	-

* Each value in the mean of three replications
Figure in parentheses are arc sine transformed values
In a column, means followed by a same letter (s) are not significantly different by DMRT (P = 0.05)

findings of Godase and Patel (2001) and Chandramani (2003) in rice.

Prolonged larval and pupal durations of coffee berry borer was observed with the application of FYM + neem cake + azophos as compared to faster due to the presence of higher levels of nitrogen in NPK as inorganic form. The similar trend was observed by Kavitha (2004) who reported the prolonged larval and pupal durations of brinjal shoot and fruit borer was observed with the application of organic manures and amendments. Further, Purohit and Deshpande (1991) who reported that with increased application of nitrogen, the average number of days required to complete larval stage of *Helicoverpa armigera* on sunflower was less.

The ovipositional preference of coffee berry borer beetle was less with the treatments FYM + neem cake + azophos and FYM + neem cake as compared to NPK as inorganic form. The present investigation revealed that the lower ovipositional preference was associated with the plants containing low level of nitrogen which is in agreement with the findings of Waghray and Shivraj Singh (1965). This is in corroboration with the findings of Kavitha (2004)reported the ovipositional preference of *Epilachna* beetle was less with the treatments FYM + biofertilizers + neem cake and FYM + biofertilizers + mahua cake as compared to NPK as inorganic form.

The present investigation revealed that the low growth index of coffee berry borer was observed with the application of organic manures and amendments and high in NPK as inorganic form are in consonance with finding of Kavitha (2004) who observed that the low growth index of hadda beetle associated with organics treatments.

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