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Eco-friendly way of management of banana leaf and fruit scarring beetle, *Basilepta subcostata* (Jacoby) (Chrysomelidae: Coleoptera)

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Abstract
Leaf and fruit scarring beetle *Basilepta subcostata* (Jacoby) is a major pest of concern in case of banana. To address the issue a field experiment was carried out at the farmer's field of Samaguri, Nagaon during 2019-20 and 2020-21. Total six treatments were imposed *viz.*, - T_1: three spray of neem product (Azadiractin, 1500 ppm) @ 5 ml/lit; T_2: three-time filling of leaf axil with *Beauveria bassiana* (AAU Culture @ 10^8 spore), 5 ml /lit; T_3: three sprays of *Beauveria bassiana* (AAU Culture) @ 10^8 spore) 5 ml /lit; T_4: bunch covering with plastic bags (17 GSM polypropylene bag); T_5: sprays Cholropyrifos 20EC @ 2.5 ml/lit; and T_6: untreated control. The results revealed that the efficacy of *Beauveria bassiana* (filling of leaf axil with *B. bassiana* and spray of *B. bassiana*), Neem insecticides (Azadirachtin 1500 ppm), bunch covering with plastic bags and spray of chemical insecticides (chlorpyrifos 20 EC) were very much effective for reduction of the leaf scarring beetle per plant after third spray in comparison to untreated control plot. However, amongst the different treatments, bunch covering with plastic bag was the best treatment in suppressing the population of beetles i.e., 8.42 and 8.63 per plant followed by 9.42 and 9.72 numbers of beetle per plant in chlorpyrifos 20 EC @ 2.5 ml/lit treated plot during 2019-20 and 2020-21, respectively. Moreover, in case of entomopathogenic fungi, the treatments of filling of leaf axil with *B. bassiana* (AAU culture) @ 5ml/lit, spray of *B. bassiana* (AAU culture) @ 5 ml/lit and Neem product (Azadirachtin 1500) @ 5 ml/lit influenced insect population with 12.25, 12.67 and 13.42 beetles per plant during 2019-20; whereas 10.73, 11.60 and 11.37 beetles per plant recorded during 2020-21.

Keywords: Bio-efficacy, entomopathogens, azadiractin, *Beauveria bassiana*, banana fruit scarring beetle, *Basilepta Subcostata*, *Nodostoma subcostatum*, Chrysomelidae, Coleoptera, bunch covering

1. Introduction
Banana (*Musa* sp.) is one of the most preferred fruit crops of human being and grown globally in about 130 countries of the tropical and subtropical region. There are more than 200 numbers of pests species including insects have been associated with banana cultivation (Simmonds, 1966) [13]; Rhizome weevil *Cosmopolites sordidus*, banana aphid *Pentalonia nigronervosa*, fruit and leaf scarring beetle *Basilepta subcostata*, and banana pseudostem borer, *Odoiporus longicollis* are the key pests of banana; amongst all, banana leaf and fruit scarring beetle *Basilepta subcostata* (Jacoby) is one of the most notorious seasonal insect pests in many states of north, east, and north- eastern India, Bangladesh, and a few other countries of Southeast Asia (Bhagabati and Deka, 2016) [2]. Remarkably, Prathapan *et al*. (2019) [11] confirmed the banana fruit and leaf scarring beetle as *B. subcostata* instead of *Nodostoma subcostatum* with proper taxonomic and molecular studies on this particular insect. However, the incidence of *Basilepta subcostata* is generally observed during April and continued till the end of rainy season; however, the physical appearance of the peel of plantains and bananas is significantly influenced by scares produced by *Basilepta subcostata* which is also an important attribute in the highly competitive export market (Sharma and Saikia, 1967; Mishra *et al*., 2015) [12, 7]. According to Mukherjee, 2005 [8], - during rainy season around 30 per cent of banana bunches were affected by *Basilepta subcostata*.

2. Materials and Methods
Field experiment was carried out at the farmer's field of Samaguri, Nagaon during 2019-20 and 2020-21. Un-infested suckers of banana (cv. Jahaji) were planted during month of March by adopting all recommended practices as per package of practices (PoP's) of AAU, Jorhat (Anon., 2019) [1].

Altogether six treatments, - T1: three spray of neem product (Azadiractin, 1500 ppm) @ 5ml/lit; T2: three-time filling of leaf axil with *Beauveria bassiana* (AAU Culture @ 10^8 spore), 5 ml /lit; T3: three sprays of *Beauveria bassiana* (AAU Culture) @ 10^8 spore) 5 ml /lit; T4: bunch covering with plastic bags (17 GSM polypropylene bag); T5: sprays Cholropyrifos20EC @ 2.5 ml/lit; and T6: untreated control. The investigation was conducted in RBD with four replications and each sub plot comprised with total six numbers of banana plants planted at a spacing of 1.5m x 1.5 m.

Treatments were imposed as soon as the leaf scares were appeared on leaf and bunch of newly shooting banana was covered immediately with polypropylene bag. Three rounds of entomopathogenic fungi, neem products and chemical insecticides (Chlorpyriphios 20EC) were applied at 30 days interval. Observations on mean number of scarring beetle (beetles present on leaves and those hidden inside the crown) was recorded at 3, 7 and 10 days after application of treatments from 5 randomly selected plants of each treatment. Number of infested fingers per bunch was also recorded for per cent finger infestation.

3. Results and Discussions

The data recorded on mean number of beetles per plant (Table 1) revealed that the efficacy of *Beauveria bassiana* (filling of leaf axil with *B. bassiana* and spray of *B. bassiana*), Neem insecticides (Azadirachtin 1500 ppm), bunch covering with plastic bags and spray of chemical insecticides (chlorpyrifos 20 EC) were very much effective for reduction of the leaf scarring beetle per plant after third spray in comparison to untreated control plot. However, amongst the different treatments, bunch covering with plastic bag was the best treatment in suppressing the population of beetles i.e., 8.42 and 8.63 per plant followed by 9.42 and 9.72 numbers of beetle per plant in chlorpyrifos 20 EC @ 2.5 ml/lit treated plot during 2019-20 and 2020-21, respectively. The highest per cent reduction of 53.22 and 39.23 was also recorded in bunch covering with plastic bags treatment over untreated control plots followed by cholropyrifos 20 EC @ 2.5ml/lit with 47.67 and 31.55 during 2019-20 and 2020-21, respectively. This finding corroborates the results obtained by Mukherjee, 2005 [9]; Das and Baruah, 2018 [6].

Moreover, in case of entomopathogenic fungi, the treatments of filling of leaf axil with *B. bassiana* (AAU culture) @ 5 ml/lit, spray of *B. bassiana* (AAU culture) @ 5ml/lit and Neem product (Azadirachtin 1500) @ 5 ml/lit influenced insect population with 12.25, 12.67 and 13.42 beetles per plant during 2019-20; whereas 10.73, 11.60 and 11.37 beetles per plant recorded during 2020-21. However, highest number of beetles18.00 and 14.20 numbers per plant was registered in untreated control plot during 2019-20 and 2020-21, respectively. Moreover, the mean fruit infestation by scarring beetle varied significantly in different treatments and recorded 6.37 and 6.07 per cent fruit infestation in plastic bag treatment followed by 10.53 and 10.45 per cent in Cholropyrifos 20Ec @ 2.5 ml/l treated plot during 2019-20 and 2020-21, respectively. Nevertheless, maximum number of fruit infestation i.e., 20.52 and 19.73 per cent was recorded at untreated check during 2019-20 and 2020-21, respectively. Entomopathogenic fungi (EPF) could be a best option for management of banana pseudostem weevil, *Odoiporus longicollis* (Viswakethu *et al*., 2021) [14]; bhut jalakia (Borkakati *et al*., 2019) [4]; potato (Borkakati *et al*., 2020) [5] and mustard (Pradhan *et al*., 2020) [10]. In addition to this, application of eco-friendly pesticides can encourage the multiplication of natural enemies which may be a key component of natural farming (Borkakati *et al*., 2018) [3].

Plate 1: a) Experimental plot, b) Insect free bunch, c) Adult of *Basilepta subcostata*, and d) Fruit infested by the insect

Table 1: Bioefficacy of entomopathogen against *Nodostoma subcostatum* (Beetles/plant)

Treatments	Pr TC,2019-20	Post treatment count,2019-20 *					Pr TC, 2020-21	Post treatment count,2020-21*					Pooled MoTS	% Fruit damage, 2019-20	% Fruit damage, 2020-21
		Ist spray	IInd spray	IIIrd spray	MoTS, 2019-20	ROC		Ist spray	IInd spray	IIIrd spray	MoTS, 2020-21	ROC			
T1: Neem product (Azadiractin) @ 5ml/lit	16.25	16.75^{bc}	13.75^{b}	9.75^{b}	13.42^{d}	25.44	12.72	13.55^{c}	11.40^{bc}	9.15^{cd}	11.37^{d}	19.93	13.90	15.25^{c}	15.06^{c}
T2: Filling leaf axil with *Beauveria bassiana* (AAU Culture) @ 10^8 spore / ml	15.75	15.75^{b}	12.75^{b}	8.25^{b}	12.25^{c}	31.94	13.11	12.80^{b}	10.80^{b}	8.60^{c}	10.73^{c}	24.44	12.20	13.18^{c}	12.99^{c}
T3: Spray of *Beauveria bassiana* (AAU Culture) @ 10^8 spore / ml	16.25	16.00^{b}	13.00^{b}	9.00^{b}	12.67^{c}	29.61	12.86	13.40^{c}	12.40^{c}	9.00^{cd}	11.60^{d}	18.31	13.10	14.63^{c}	13.94^{c}
T4:Bunch covering with plastic bags	15.50	11.75^{a}	8.75^{a}	4.75^{a}	8.42^{a}	53.22	12.77	11.30^{a}	9.80^{a}	4.80^{a}	8.63^{a}	39.23	9.55	10.53^{b}	10.45^{b}
T5:Cholropyrifos20Ec @ 2.5 ml/l	15.75	12.75^{a}	9.75^{a}	5.75^{a}	9.42^{b}	47.67	13.01	11.80^{a}	10.55^{b}	6.80^{b}	9.72^{b}	31.55	7.53	6.37^{a}	6.07^{a}
T6:Untreated control	16.00	17.75^{c}	17.00^{c}	19.25^{c}	18.00^{e}	0	12.76	13.45^{c}	14.10^{d}	15.05^{e}	14.20^{e}		17.90	20.52^{d}	19.73^{d}
CD =0.05	-	1.71	1.78	1.66	2.54			3.17	4.04	5.62	2.83			2.61	2.34
CV %	NS	7.50	9.47	11.68	15.46		NS	0.61	0.70	0.75	0.47		NS	12.93	11.77

*Mean of three observations/ Means followed by the same letter in a column are not significantly different

* Pr TC: Pre-treatment count; MoTS: Mean of Three Sprays; ROC: Reduction over control

4. Conclusion

The study showed that lowest incidence of fruit and leaf scarring beetle *Basilepta subcostata*_was observed in the treatment with bunch covering by polypropylene bag. However, application of EPF and neem products are also an effective tool for pest management. Therefore, grower are need not to worry for organic alternative option of pest management.

Maximum yield (q/ha) and highest benefit (Rs./ha) achieved in IPM plots as compared to famers practice as well as untreated check. It can be concluded that IPM package proved as effective as chemical control on large scale for the management of insect pest of okra. Therefore, use of the IPM module may be an appropriate tool of wise application of synthetic chemical insecticides. Moreover, IPM may be recommended as a good substitute for the solely chemical dependent agriculture.

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