Environment and Ecology 41 (3B) : 1680—1685, July—September 2023
Article DOI: https://doi.org/10.60151/envec/IGPS1731
ISSN 0970-0420

Organic Management Approaches of Stem Borer in Rice Ecosystem of Assam

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Received 20 March 2023, Accepted 25 May 2023, Published on 21August 2023

ABSTRACT

Stem borer is the only insect pest which attacks the rice plant starting from tillering upto maturity stage and is of great challenge to manage due to its cryptic behavior and nocturnal habit. The experiment was laid out in the experimental field of AAU-Assam Rice Research Institute, Assam Agricultural University, Titabar both in *kharif* and *rabi* season during 2019-2022 taking three popular rice varieties of Assam, Ranjit, Ranjit Sub-1 and Gitesh. Seeds were treated with a solution of *Pseudomonas florescense* (10 g/liter of water /kg of seed for 12 hrs in organic and with Chlorantraniliprole 18.5 SC @ 30 g/a.i in chemical treatment and without treating the seeds in farmers' practice plot and sown both in *kharif* season and *rabi* season. The foliar application of *Beauveria bassiana* (5gm/l/ha), *Pseudomonas florescense* (20g/l/ha) and neem product (5g/liter/ha) in organic plot and insecticide application with Chlorantraniliprole 18.5 SC @ 30 g/a.i. in the chemical plot was done at 45 days after transplanting (DAT) without application of any biopesticide or insecticide in farmers' practice plot. The dead heart incidence drastically reduced both in chemical (6.19%) and organic treatment (7.23%) without significant difference at 65 DAT in Ranjit. The benefit cost ratio was 2.32 and 2.06 in chemical and organic approach respectively, but it was 1.78 in farmers' practice. The use of *B. bassiana, P. florescense* and neem products were found to be safer to the predators as the spider and coccinellid beetle population in organic treatment (10.59 and 9.49 number/hill) was at par with farmers' practice (12.83 and 11.67 number/hill), respectively.

Keywords Dead heart, Organic management, Rice, Stem borer, White ear head.

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INTRODUCTION

Rice is the most important cereal crop for human nutrition and of crucial importance as a basic diet playing a major role in the national food and livelihood security. As the human population has been increased exponentially every year, it is a great challenge to feed the over growth population in the forth coming decades. Biotic stress as one of the

most important limiting factors of yield loss in rice. Rice crop is subjected to a considerable damage by nearly 300 species of insect pests, out of which only 23 species are serious pests of rice (Pasalu and Katti 2006). The rice stem borer, which infest the rice from seedling to maturity, act as a major constraint for the rice production which is difficult to manage due to its cryptic behavior and nocturnal habit by applying insecticides (Bora *et al.*1995). Excessive and irrational use of pesticides has become a major obstacle to sustainable agriculture and also threatens food safety and human health. As an alternative to chemical control, organic approaches have been gained momentum in managing insect pest in recent years which help in bio-ecological conservation of rice ecosystem. Since natural farming has been prioritized recently to sustain Indian Agricultural scenario as a whole, the present study was undertaken in the most prominent high yielding rice varieties of Assam to gather information on alternative management strategy against stem borer other than use of inorganic insecticides.

MATERIALS AND METHODS

The experiment was laid out in the rice field of AAU-Assam Rice Research Institute, Assam Agricultural University, Assam Agricultural University, Titabar both in *kharif* and *rabi* season during 2019-2022 taking three rice varieties of Assam, Ranjit, Ranjit Sub-1 and Gitesh. The seeds were sown both in *kharif* season and rabi season in three plots separately as organic, chemical and farmers' practice. The seeds for the organic plot were soaked in a solution of *Pseudomonas florescense* prepared by dissolving 10g in 1 liter of water per kg of seed for 12 hrs. The seeds of chemical plot were treated with the recommended insecticide, Chlorantraniliprole 18.5 SC @ 30 g/a.i and the seeds for the plot of farmers' practice were untreated. 7.5 kg of vermicompost (@500 g/sqm) and 1.5 kg of rice husk (@100 g/sqm) were mixed with soil at the time of nursery bed preparation of organic plot in 5m x 3m size for each variety. The recommended package of practice was followed in the preparation of nursery bed of chemical and farmers' practice plot. In the main field,10 kg vermicompost (@2 tonnes/ha) was applied in the organic plot along with half of 1.5 kg (0.75kg) neem cakes (@ 300 kg neem cakes /ha) as basal and remaining neem cakes (0.75kg) was applied as top dress at active tillering stage. The recommended doses of fertilizer were applied in the chemical and farmers' practice plot in each variety. The 30 days old seedlings were transplanted in the plot size of 5m x10 m with a rice bund of 50 m in between organic, chemical and farmers' practice. The plot size was 200 sqm for each of the three varieties. The design of experiment was Randomized Block Design. The foliar application of *Beauveria bassiana* (5gm/l/ha), *Pseudomonas florescense* (20 g/l/ha) and neem product (5g/liter/ha) were done at 45 DAT. Chlorantraniliprole 18.5 SC @ 30 g/a.i. was applied in the chemical plot at 45 DAT. No any biopesticide or insecticide was applied in the farmers' practice plot.

Ten hills were selected randomly for observation of stem borer incidence in organic, chemical and farmers' practice plot for each of the three varieties. The data on dead heart incidence was recorded before

Table 1. Details of the treatments of the field experiment under non- chemical approach management against stem borer.

Details	Non chemical block	Chemical block	Farmers' practice block
Seed	Seeds soaked in a a solution of *Pseudomonas florescense* prepared by dissolving 10 g in 1 liter of water per kg of at seed for 12 hrs	Seed treatment with Chlorantranil-iprole 20 SC @ 30 g/a.i	No seed treatment
Nursery	7.5 kg of vermicom-post (@500 g/sqm) and 1.5 kg of rice husk (@100 g/sqm) mixed with soil	Mixing of FYM soil in the ratio of 2:1.	Mixing of FYM in soil in the ratio of 2:1
Main field	a) 10 kg vermicompost (@2 tonnes/ha) + half 1.5 kg (0.75 kg) neem cakes (@300 kg neem cakes ha) as basal and remaining neem cakes (0.75 kg) applied as top dress at active tillering stage.	Recommended dose of fertilizer	Recommend-ed dose of fertilizer
	b) Foliar application of *Beauveria bassiana* (5gm/liter/ha), *Pseudomonas florescense* (20 g/liter/ha) and Neemazal 1% EC at 45 DAT	Application of Chlorantran-iliprole 18.5 SC @ 30 g/a.i. at 45 DAT	No applica-tion

Table 2. Mean damage incidence of stem borer after using non chemical products during *kharif* season 2019-2021.

Variety	Parameter	Dead heart % 45 DAT 1day before treatment	Dead heart % 45 DAT 7 days after treatment	Dead heart % 65 DAT	White ear head % (Pre-harvest)
Ranjit	Non chemical	15.43[a] (23.13)	12.56[ab] (20.76)	7.23[c] (15.60)	5.29[c] (13.30)
	Chemical	16.68[a] (24.11)	9.74[c] (18.19)	6.19[c] (14.41)	4.89[c] (12.78)
	Farmers' practice	15.84[a] (23.45)	16.65[a] (24.08)	14.68[a] (22.53)	15.56[a] (23.23)
	CD (p=0.05)	NS	2.39*	2.47*	2.19*
Ranjit Sub-1	Non chemical	16.76[a] (24.17)	11.73[ab] (20.03)	6.57[c] (14.85)	6.34[c] (14.58)
	Chemical	15.65[a] (23.30)	9.98[c] (18.42)	5.34[c] (13.36)	5.69[c] (13.80)
	Farmers' practice	16.75[a] (24.16)	18.83[a] (25.72)	15.17[a] (22.92)	14.27[a] (22.10)
	CD (p=0.05)	NS	3.76*	3.39*	2.56*
Gitesh	Non chemical	14.45[a] (22.34)	8.53[ab] (16.98)	5.27[c] (13.27)	5.30c (13.31)
	Chemical	14.39[a] (22.29)	7.62[c] (16.02)	4.35[c] (12.04)	4.45[c] (12.18)
	Farmers' practice	15.28[a] (23.01)	16.49[a] (23.96)	15.69[a] (23.33)	15.26[a] (22.99)
	CD (p=0.05)	NS	4.19*	3.43*	2.76*

Values arc sine transformed; both original and transformed values given; In a column mean followed by different letters significantly different at p = 0.05.

Table 3. Mean damage incidence of stem borer under non chemicals approaches during *rabi* season, 2019-2021.

Variety	Parameter	Dead heart % 45 DAT 1day before treatment	Dead heart % 45 DAT 7 days after treatment	Dead heart % 65 DAT	WEH% (Pre harvest)
Ranjit	Non chemical	22.56[a] (28.36)	17.41[ab] (24.66)	7.54[c] (15.94)	5.78[c] (13.91)
	Chemical	24.73[a] (29.82)	12.65[c] (20.83)	5.34[c] (13.36)	4.65[c] (2.27)
	Farmers' practice	23.63[a] (29.09)	24.78[a] (29.85)	21.54[a] (27.65)	22.76[a] (28.49)
	CD (p=0.05)	NS	3.45*	2.78*	2.36*
Ranjit Sub-1	Non chemical	21.47[a] (27.60)	16.78[ab] (24.18)	7.83[c] (16.25)	6.86[c] (15.18)
	Chemical	22.65[a] (28.42)	11.65[c] (3.49)	6.34[c] (2.62)	5.37[c] (2.42)
	Farmers' practice	22.87[a] (28.52)	23.53[a] (4.90)	20.37[a] (4.57)	19.59[a] (4.48)
	CD (p=0.05)	NS	3.37*	3.42*	2.73*
Gitesh	Non chemical	15.59[a] (23.26)	10.48[ab] (18.89)	5.39[c] (13.42)	5.45[c] (13.50)
	Chemical	14.74[a] (22.58)	8.65[c] (17.10)	4.27[c] (11.93)	4.35[c] (12.04)
	Farmers' practice	15.83[a] (23.45)	16.64[a] (24.07)	14.87[a] (22.68)	14.59[a] (22.46)
	CD (p=0.05)	NS	2.28*	3.18*	2.13*

Values arc sine transformed; both original and transformed values given; In a column mean followed by different letters significantly different at p = 0.05.

one day and after seven days of application of bio-pesticides and chemical insecticide at 45 and again dead heart incidence was recorded at 65 DAT. The white ear head percentage was calculated by counting total number of panicle bearing tillers and white ear head at the time of harvesting. The grain yield was calculated in terms of tonnes/hectare and the benefit cost ratio was worked out in each of the three treatments in the better performed varieties both in *kharif* and *rabi* season. The population of two dominant predators viz., spider (No/hill) and coccinellid beetle (No/hill) were observed in both the season before one day and seven days after treatment in organic, chemical and farmers' practice plot both at 45 and 65 DAT (Table 1).

Data were transformed using square root transformation and analyzed by using IBM SPSS Statistics for factorial randomized block design and means were separated by critical difference (CD) value.

RESULTS AND DISCUSSION

Effect of use of organic products on stem borer damage

Incidence: The mean damage incidence of stem borer after the use of organic products in three better performed varieties, Ranjit, Ranjit Sub-1 and Gitesh is presented in Tables 2–3 during *kharif* and *rabi* season, 2019-2022 respectively.

In the rice variety Ranjit, dead heart incidence was recorded as 15.43%, 16.68% and 15.84% respectively before one day of organic treatment in organic, chemical and farmers' practice respectively at 45 days after transplanting of the crop without significant difference to each other. It was significantly reduced to 12.56% and 9.74% in organic and chemical treatment respectively seven days after treatment, whereas dead

Table 4. Grain yield and B: C ratio after using non chemical products in *kharif* season during 2019-2021.

Variety	Parameter	Yield (t/ha)	Benefit:Cost ratio
	Non chemical	4.45ac	2.06
Ranjit	Chemical	5.13ac	2.32
	Farmers' practice	2.81ad	1.78
	Non chemical	4.18ac	1.94
Ranjit Sub-1	Chemical	4.86ac	2.20
	Farmers' practice	2.85ad	1.81
	Non chemical	4.53ac	2.09
	Chemical	4.96ac	2.24
Gitesh	Farmers' practice	2.79ad	1.77
	CD (p=0.05)	1.76	
	CV%	8.89	

In a column mean followed by different letters significantly different at p = 0.05; Cost of cultivation: Rs 41000 (Non chemical), Rs 42000 (Chemical), Rs 30000 (Farmers' practice)
Price of rice grain=Rs1900/q.

Table 5. Grain yield and B: C ratio in non chemical approach in *rabi* season during 2019-2021.

Variety	Parameter	Yield (t/ha)	Benefit:Cost ratio
	Non chemical	4.67^{ac}	2.16
Ranjit	Chemical	5.25^{ac}	2.28
	Farmers' practice	2.78^{ad}	1.76
	Non chemical	4.34^{ac}	2.01
Ranjit Sub-1	Chemical	5.10^{ac}	2.31
	Farmers' practice	2.72^{ad}	1.72
	Non chemical	4.89^{ac}	2.27
	Chemical	5.07^{ac}	2.29
Gitesh	Farmers' practice	2.68^{ad}	1.70
	CD (p=0.05)	0.98	
	CV%	5.43	

In a column mean followed by different letters significantly different at p = 0.05
Cost of cultivation: Rs 41000 (Non chemical)
Rs 42000 (Chemical)
Rs. 30000 (Farmers' practice)
Price of rice grain=Rs.1900/q.

heart percentage increased to 16.65% in the farmers' practice. The dead heart incidence drastically reduced both in chemical and organic treatment and there was no significant difference between the dead heart incidence 6.19% and 7.23% in chemical and organic treatment respectively at the age of 65 days after transplanting. Lower incidence of white ear head was recorded in chemical treatment (4.89%) as compared to organic treatment (5.29%), whereas higher white ear head incidence (15.59%) was recorded in farmers' practice. Similar trend of dead heart and white ear head incidence were followed in case of other two rice varieties, Ranjit Sub-1 and Gitesh that stem borer incidence was found to be lower in chemical treatment that was not significantly different with that of organic treatment, whereas it was higher in farmers' practice. Similar kind of observation was recorded in case of dead heart and white ear head incidence during rabi season as the dead heart incidence was 22.56% and 24.73% in organic and chemical treatment plot one day before application respectively that was not significantly different with that of 23.63% in farmers' practice plot. The stem borer incidence reduced to 17.41% and 12.65% in organic and chemical plot after seven days of application, but it increased slightly in case of farmers' practice (24.78%). The dead heart incidence was 5.34% and 7.54% in organic and chemical treatment that was not significantly different, whereas it was higher in farmers' practice (21.54%) at 65 days after transplanting. White ear head incidence was 4.65% and 5.78 % that were lower as compared to farmers' practice (22.76%).

Effect of use of organic products on grain yield:

The grain yield and benefit cost ratio after the use of organic products in three better performed varieties, Ranjit , Ranjit Sub-1 and Gitesh is presented in Tables 4–5 during *kharif* and *rabi* season, 2019-22 respectively.

During *kharif* season, the recorded grain yields were 5.13 t/ha and 4.45 t/ha in chemical and non chemical treatment respectively but the farmers' practice recorded lower grain yield 2.81t/ha in the rice variety, Ranjit. The benefit cost ratio was 2.32 and 2.06 in chemical and non chemical approaches respectively, but it was 1.78 in farmers' practice. Similar trend of the grain yield and benefit cost ratio were found in case of Ranjit Sub-1 and Gitesh as higher grain yield and benefit cost ratio were recorded in chemical treatment followed by organic treatment (Table 4). Similar observation was made in case of grain yield and benefit cost ratio during *rabi* season that the grain yield and benefit cost ratio were higher in case of chemical treatment (5.25 t/ha and 2.28) as compared to organic treatment (4.67 t/ha and 2.16), but lower grain yield and benefit cost ratio were

Table 6. Mean population of natural enemies under non chemical approaches during 2019-2021.

Variety	Parameter	Spider (No/hill) 45 DAT			Coccinellid beetle (No/hill) 45 DAT		
		1 day before treatment	7 days after treatment	65 DAT	1 day before	7 days after 45 DAT	65 DAT
kharif	Non chemical	12.62[a] (20.81)	11.73[a] (20.03)	10.59[a] (18.99)	11.89[a] (20.17)	10.57[a] (18.97)	9.49[a] (17.94)
	Chemical	12.59[a] (20.78)	8.45[b] (16.90)	5.67[c] (13.78)	10.78[a] (19.17)	7.85[b] (16.27)	5.56[c] (13.64)
	Farmers' practice	12.50[a] (20.70)	13.79[a] (21.80)	12.83[a] (20.99)	11.98[a] (20.25)	12.69[a] (20.87)	11.67[a] (19.98)
	CD (p=0.05)	NS	0.89	1.03	NS	0.93	0.79
rabi	Non chemical	12.78[a] (20.95)	11.65[a] (19.96)	10.73[a] (19.12)	14.75[a] (22.59)	13.49[a] (21.55)	12.56[a] (20.76)
	Chemical	13.67[a] (21.70)	7.56[b] (15.96)	5.45[c] (13.50)	14.86[a] (22.67)	8.36[b] (16.81)	5.45[c] (13.50)
	Farmers' practice	13.43[a] (21.50)	13.79[a] (21.80)	12.85[a] (21.01)	14.68[a] (22.53)	15.58[a] (23.25)	14.69[a] (22.54)
	CD (p=0.05)	NS	0.87	0.98	NS	0.85	0.88

*Significant at 0.05 level, No of replications=10, Figure in parentheses is arc sine transformed value, DAT: Days after transplanting.

recorded 2.78 t/ha and 1.76 in farmers' practice plot in the variety Ranjit. Similar trend of the grain yield and benefit cost ratio were recorded in case of Ranjit Sub-1 and Gitesh also.

Effect of use of organic products on population of natural enemies: The effect of use of bio-products on the mean population of the most abundant predators in rice ecosystem, spider and coccinellid beetle during *kharif* and *rabi* was depicted in Table 6.

During *kharif* season, spider population was 12.62, 12.59 and 12.50 numbers/hill in organic, chemical and farmers' practice respectively before one day of treatment at 45 days after transplanting. It was drastically reduced to 8.45 numbers/ hill in chemical treatment, but a slight reduction (11.73 numbers /hill) was observed in organic treatment and it increased to 13.79 numbers/hill in farmers' practice after seven days of treatment at 45 DAT. The spider population followed the similar trend at 65 DAT as in case of 45 DAT that it reduced to 5.67 numbers/ hill in chemical treatment which was significantly lower with that of organic treatment (10.59 numbers/hill). The population of coccinellid beetle also reduced significantly in chemical treatment in comparison with that of organic treatment and farmers' practice.

During *rabi* season, the abundance of spider and coccinellid beetle was higher in organic treatment plot (11.65 and 13.49 numbers/ hill) as compared to chemical treatment (7.56 and 8.36 numbers/hill) and farmers' practice (13.79 and 15.58 numbers/ hill) respectively at seven days after treatment at 45 DAT. The population of both the predator reduced significantly in chemical treatment as compared to organic treatment and farmers' practice at 65 DAT.

The present findings revealed that bio-pesticides can be used as alternative keeping in mind of reducing the use of chemical insecticides against stem borer as because there was no significant difference in dead heart and white ear head incidence after application of chemical as well as bio products in both the seasons. The present results are in close conformity with the findings of application of Nimbecidine 0.03 EC @ 3 ml and *B. bassiana* reduced rice stem borer and leaf folder incidence drastically (Karthiba *et al.* 2010). Though the use of chemicals provide quick result in managing stem borer damage, the foliar application of the entomopathogenic fungi, *B. bassiana* reduced the stem borer damages very effectively in rice that rice leaf hopper was effectively managed by using these biopesticides (Abdullah *et al.* 2020). Rice stem borer can be managed by using myco in-

secticide, *B. bassiana* and *P. fluorescens* along with neem products applied separately in tillering stage in an effective way. The present results are in close conformity with the result of the combination of *P. fluorescens* strains and *B. bassiana* isolate effectively reduced the incidence of rice leaf folder (Karthiba *et al.* 2010). The results revealed that there was no significant difference in grain yield and benefit cost ratio between organic and chemical management of stem borer both in *kharif* and *rabi* season (Saravanakumar *et al.* 2008). Higher grain yield was recorded in chemical treatment than that in the application of organic products including neem without significant difference reported by Ravichandra *et al.* (2014). The results are in close conformity with the findings that application of Nimbecidine 0.03 EC @ 3 ml and *B. bassiana* recorded the average yield after managing stem borer and leaf folder (Kalitha *et al.* 2009). The use of chemical insecticides can be replaced by using organic products to manage insect pests in rice for the sake of environmental protection, food safety and human health. Similar kind of result was reported which stated that various organic treatments including neem were safer to natural enemies reported by Anitha and Parimala (2014). The application of *P. fluorescens* was safer to natural enemies as well as enhanced their population at the same time (Anitha and Parimala 2014). *B. bassiana* treated plots were found safer to natural enemies viz., spiders and coccinellids in rice leaf folder as compared to chemical insecticide (Bajya and Rajnith 2018).

CONCLUSION

The present findings revealed that the use of organic products was safer to natural enemies as compared to chemical treatment as because the application of chemical insecticide reduced the population of predator drastically. As the reduction in stem borer incidence after application of the organic products that was at par with that of chemical treatment and there was no significant difference between the grain yield and benefit cost ratio of chemical and organic approaches, the farmers can apply bio-pesticides as better alternative to chemical insecticides against stem borer considering the issues of the ill effects of chemical insecticides on environment as well as food security. This will definitely substantiate a better alternative for partial replacement of chemicals to reduce the irrational use of chemicals for the sake of environmental protection and human health and to achieve sustainability of agriculture for future generation.

ACKNOWLEDGMENT

The authors extends their heartfelt gratitude to AAU-Assam Rice Research Institute, Assam Agricultural University, Titabar, Assam for conducting field works and Department of Entomology, Assam Agricultural University, Jorhat, Assam, India for the financial support and constant suggestions to carry out the research works.

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