Indian Journal of Entomology 85(4): 1030-1034 (2023) DoI. No.: 10.55446/IJE.2021.348

FIELD EVALUATION OF BIOPESTICIDES AGAINST RICE INSECT PESTS UNDER ORGANIC FARMING

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ABSTRACT

Neem based commercial formulations Ecotin (azadirachtin 5%; 50,000 ppm) @ 150,175 and 200 ml ha^{-1}, and standard checks- Achook (azadirachtin 0.15%; 1500 ppm) @ 2500 ml ha^{-1} were applied at pest appearance for evaluating them for the management of rice stem borers Scirpophaga spp. and leaf folder *Cnaphalocrocis medinalis* (Guenee) on basmati and non-basmati rice under organic cultivation conditions. In basmati, the reduction of deadhearts due to stem borers was observed to be maximum with Ecotin @ 200 ml ha^{-1} as 55.79 and 56.84% at 5 and 10 DAS, respectively; while white ears were at 55.99% in 2019; and reduction of deadhearts was 50.45 and 45.75% at 5 and 10 DAS, respectively, while white ears reduced up to 50.71% in 2020. Similarly, reduction of damaged leaves due to leaf folder was 55.80 and 59.62% at 5 and 10 DAS, respectively; and in 2020, it was 50.45 and 45.75% at 5 and 10 DAS, respectively. Ecotin 5% @ 200 ml ha^{-1} gave maximum crop yield (31.29 q ha^{-1}). In non-basmati rice too the reduction of deadhearts was maximum with Ecotin @ 200 ml ha^{-1}, while white ears reduced by 50.47% in 2019, with similar trend in 2020; also results were of similar trend with leaf folder. The occurrence of spiders revealed a non-significant difference among the treatments. The biopesticides caused no residual or phytotoxic effects and were safe to the environment and predatory fauna.

Key words: Field evaluation, rice, Scirpophaga sp., *Cnaphalocrocis medinalis*, Ecotin, Achook, basmati, non-basmati, stem borers, deadhearts, damaged leaves, rice yield, organic farming

Rice is the important staple crop of India, and occupied 3.14 million ha in Punjab with total production of 18.92 million mt during 2019-20 (Anonymous, 2021). Due to biotic factors approximately 52% losses occur in rice production worldwide and about 21% of these are due to the insect pests (Sogawa et al., 2003). Rice crop is attacked by more than hundred insect pests, of which 20 are very serious. Under Punjab conditions, major lepidopteran insects pests on rice include *Scirpophaga incertulas* (Walker), *S. innotata* (Walker), *Sesamia inferens* (Walker) and leaf folder *Cnaphalocrocis medinalis* (Guenee). After cotton, rice cultivation is much dependent on insecticides due to serious pest damage, which causes resistance in insect pests and environmental pollution. The increasing demand of insecticide residue free products has resulted in farmer's acceptance of biopesticides in organic basmati and non-basmati rice. Keeping these in mind, this study on the field evaluation of some biopesticides against rice stem borers and leaf folder under organic conditions.

MATERIALS AND METHODS

The basmati and non-basmati rice crops were raised under organic conditions during kharif 2019 and 2020 at the Research Farm of School of Organic Farming following package of practices of Punjab Agricultural University, Ludhiana (PAU). The organic inputs viz. land, seed and organic manures were used as per PAU recommendations for organic farming. In the treatments, neem based commercial formulations, Ecotin (azadirachtin 5%; 50,000 ppm) @ 150, 175 and 200 ml ha^{-1}, standard checks- Achook 0.15% (azadirachtin 0.15%) @ 2500 ml ha^{-1} were evaluated along with untreated control. The trial was replicated thrice in randomized block design, and the pesticides were sprayed at pest appearance. The observations on stem borers' incidence as % deadhearts and leaf folder damage as % damaged leaves at vegetative stage were recorded one day before, and then 5 and 10 days after spray (DAS); and white ear incidence was observed about a week before harvest. Data on spider counts were also made. Crop yield data was observed at harvest, and the data analysed after arc sine transformation.

RESULTS AND DISCUSSION

In basmati rice, deadhearts due to stem borers ranged from 1.73-1.81 and 1.93-2.07% in 2019 and

2020, respectively, in the treatments as pretreatment data with differences being non-significant (Table 1); all biopesticide treatments were significantly better than the untreated control after 5 and 10 DAS; Ecotin @ 200 ml ha^{-1} registered i.e. 1.07 and 1.23, against 1.67 and 1.98% deadhearts at 5 and 10 DAS in 2019 and 2020, respectively, which were significantly lower than its lower dosages (1.36-1.39 and 1.46-1.53%), standard check, Achook @ 1000 ml ha^{-1} (1.58 and 1.73%) and untreated control (2.42 and 2.85%). Mean white ears were lower i.e., 1.91 and 2.07% in Ecotin @ 200 ml ha^{-1} during 2019 and 2020, respectively, but were significantly higher than its lower dosages (2.74-2.79 and 2.80-3.00%), Achook (2.98 and 2.97%) and untreated control (4.34 and 2.97%). In 2019, Ecotin @ 200 ml ha^{-1} at vegetative stage registered more reduction of deadhearts (55.79 and 56.84 at 5 and 10 DAS, respectively), than its lower dosages (42.56-43.80 and 46.32-48.77%) and Achook (34.71 and 39.30%). About white ears, it was 55.99% reduction at harvest stage. In 2020, also similar trend was noticed with regard to deadhearts and white ears. Similarly, the leaf folder damaged leaves ranged from 3.07- 3.21 and 2.80- 4.30% in pretreatment, with differences being non-significant; Ecotin @ 200 ml ha^{-1} registered 2.21 and 2.54%, and 2.18 and 2.72% reduction in damaged leaves at 5 and 10 DAS during 2019, respectively, which were significantly less than its lower dosages (3.00-3.15 and 3.22-3.48%). Thus, Ecotin @ 200 ha^{-1} led to 55.80 and 59.62% reduction in damage at 5 and 10 DAS, respectively; in 2020 too similar trend was observed. The data on the occurrence of spiders revealed non-significant differences in all the treatments at pretreatment level, at pre-spray, 5 DAS and 10 DAS. Crop yield was significantly more with Ecotin 5% @ 200 ml ha^{-1} (31.29 q ha^{-1}) than its lower dosages (29.56-30.17 q ha^{-1}), Achook (29.27 q ha^{-1}) and the untreated control (27.63 q ha^{-1}) during 2019. Similar trend was observed in kharif 2020.

In non-basmati rice, incidence of stem borers varied from 3.83-4.29 and 4.19-4.80% during 2019 and 2020, respectively at the pretreatment level, with differences being non-significant (Table 2). All biopesticide treatments were significantly superior after 5 and 10 DAS; Ecotin @ 200 ml ha^{-1} recorded lower i.e. 3.13 and 3.28, and 2.52 and 2.90% deadhearts at 5 and 10 DAS in 2019 and 2020, respectively, but were significantly lower than its lower dosages (3.44-3.49 to 3.64-3.70 and 2.83-3.27 to 3.10-3.57 %), Achook (3.63 to 3.78 and 3.13 to 3.55%) and untreated control (5.90 to 6.71 and 4.43 to 4.75%. Similarly, Ecotin @ 200 ml ha^{-1} recorded 3.69 and 3.43 % white ears in 2019 and 2020, respectively, which were significantly more compared to its lower dosages (4.09-4.13 and 4.03-4.30 %), Achook (4.95 and 4.57 %) and untreated control (7.45 and 5.63 %). In 2019, Ecotin @ 200 ml ha^{-1} at vegetative crop stage gave maximum reduction in deadhearts and white ears. Similar trend was observed in 2020. With leaf folder, in terms of % damaged leaves Ecotin @ 200 ml ha^{-1} was superior (3.06 and 3.21, and 2.33 and 2.95 at 5 and 10 DAS in 2019 and 2020, respectively), registering significant reductions. The counts of spiders revealed on-significant differences prior to treatment and at 5 and 10 DAS. Crop yield was significantly more with Ecotin 5% @ 200 ml ha^{-1} (68.53 q ha^{-1}) than its lower dosages (64.80-66.40 q ha^{-1}), Achook (64.53 q ha^{-1}) and the untreated control (62.27 q ha^{-1}) in 2019. A similar yield trend was observed during kharif 2020.

The reduction in the pest incidence might be due to repellency, oviposition deterrence and antifeedant effects of azadirachtin. Ho et al. (1983) observed that neem oil can control borer menace at vegetative stage. Dhaliwal et al. (1998) also reported that neem based insecticides are effective against insect pests of cabbage. Nanda et al. (1996) and Murugabharathi and Balasubramanian (1999) suggested the application of 3% neem oil to suppress rice borers. Bora et al. (2004) found neem products as effective to control yellow rice stem borer. Ponnusamy (2003) reported a quantum jump in yield with neem formulations. Kaul et al. (1999) also observed positive impact of neem products on rice. Longkumer et al. (2017) observed less leaf damage due to leaf-folder with Achook (azadirachtin 1500 ppm). Mohapatra and Nayak (2015) reported that the foliar application of neemazal @1.0 ml l^{-1} at 60 and 70 DAS and foliar spraying of buprofezin 25SC @ 1.5 ml l^{-1} at 85DAS at ETL afford excellent control of major insect pests of rice like leaf folder and green leafhopper. Saikal and Parameswaran (2003) reported the EC formulations of neem and pungam oil combination proved to be highly effective against *Cnaphalocrocis medinalis* under laboratory conditions. Nigam et al. (2010) also studied the efficacy of neem oil @ 5% against leaf folder in basmati rice, and showed reduction in leaf damage and increased grain yield. The present results also corroborate with those of Sharma and Aggarwal (2014) on stem borer with neem azal 1% (1250 ml ha^{-1}).

ACKNOWLEDGEMENTS

Authors thank the field coordinators- Mr Jagwinder Singh and Mr Surinder Singh, School of Organic Farming, PAU, Ludhiana for their assistance in all the farm operations.

Table 1. Efficacy of neem based biopesticides against insect pests of *basmati* rice under organic conditions

Treatment	Dosage (ml ha^{-1})	% deadhearts due to stemborers*					% white ears		% damaged leaves due to leaf-folder					Spider population (nos./ hill)			Yield (q ha^{-1})
		Pre-spray	5 DAS		10 DAS		Mean	PROC	Pre-spray	5 DAS		10 DAS		Pre-spray	5DAS	10DAS	
			Mean	PROC	Mean	PROC				Mean	PROC	Mean	PROC				
2019																	
Ecotin (azadirachtin 5%)	150	1.73	1.39 (6.77)	42.56	1.53 (7.11)	46.32	2.79 (9.61)	35.71	3.21	3.15 (10.22)	37.00	3.48 (10.74)	44.67	0.23	0.20	0.23	29.56
Ecotin (azadirachtin 5%)	175	1.74	1.36 (6.70)	43.80	1.46 (6.94)	48.77	2.74 (9.52)	36.87	3.07	3.00 (9.96)	40.00	3.22 (10.31)	48.81	0.27	0.20	0.23	30.17
Ecotin (azadirachtin 5%)	200	1.78	1.07 (5.94)	55.79	1.23 (6.36)	56.84	1.91 (7.92)	55.99	3.09	2.21 (8.55)	55.80	2.54 (9.17)	59.62	0.23	0.17	0.20	31.29
Achook (azadirachtin 0.15%)	2500	1.81	1.58 (7.21)	34.71	1.73 (7.56)	39.30	2.98 (9.93)	31.34	3.13	3.58 (10.90)	28.40	3.93 (11.43)	37.52	0.23	0.17	0.20	29.27
Untreated control	-	1.80	2.42 (8.94)	-	2.85 (9.70)	-	4.34 (12.01)	-	3.18	5.00 (12.89)	-	6.29 (14.48)	-	0.23	0.27	0.27	27.63
CSD (p=5%)		NS	(0.14)	-	(0.41)	-	(1.34)	-	NS	(0.98)	-	(1.20)	-	NS	NS	NS	0.44
2020																	
Ecotin (azadirachtin 5%)	150	2.00	2.01 (8.16)	40.36	2.45 (8.91)	32.88	3.00 (9.95)	28.57	3.20	2.85 (9.71)	29.10	3.47 (10.73)	23.74	0.10	0.17	0.13	30.07
Ecotin (azadirachtin 5%)	175	2.00	1.88 (7.88)	44.21	2.35 (8.81)	35.62	2.80 (9.43)	33.33	3.00	2.62 (9.29)	34.83	3.25 (10.37)	28.57	0.20	0.20	0.20	30.30
Ecotin (azadirachtin 5%)	200	1.93	1.67 (7.41)	50.45	1.98 (8.08)	45.75	2.07 (8.17)	50.71	4.30	2.18 (8.49)	45.77	2.72 (9.48)	40.22	0.13	0.17	0.20	30.70
Achook (azadirachtin 0.15%)	2500	2.00	2.02 (8.16)	40.06	2.43 (8.95)	33.42	2.97 (9.73)	29.29	2.80	2.73 (9.50)	32.09	3.32 (10.49)	27.03	0.13	0.10	0.17	29.10
Untreated control	-	2.07	3.37 (10.55)	-	3.65 (10.97)	-	4.20 (11.68)	-	3.20	4.02 (11.55)	-	4.55 (12.31)		0.13	0.17	0.17	28.00
CSD (p=5%)		NS	(0.78)	-	(1.17)	-	(0.48)	-	NS	(0.24)	-	(0.37)		NS	NS	NS	0.22

* Figures in parentheses % arc sine transformed values; PROC: % reduction over control

Table 2. Efficacy of neem based biopesticides against insect pests of non-basmati rice under organic conditions

Treatment	Dosage (ml ha^{-1})	% deadhearts due to stemborers*					% white ears		% damaged leaves due to leaf-folder					Spider population (nos./ hill)			Yield (q ha^{-1})
		Pre-spray	5 DAS		10 DAS		Mean	PROC	Pre-spray	5 DAS		10 DAS		Pre-spray	5DAS	10DAS	
			Mean	PROC	Mean	PROC				Mean	PROC	Mean	PROC				
2019																	
Ecotin (azadirachtin 5%)	150	4.05	3.49 (10.76)	40.85	3.70 (11.08)	44.86	4.13 (11.72)	44.56	4.07	3.80 (11.23)	43.87	4.02 (11.55)	44.48	0.30	0.27	0.33	64.80
Ecotin (azadirachtin 5%)	175	4.06	3.44 (10.68)	41.69	3.64 (11.00)	45.75	4.09 (11.66)	45.10	4.74	3.66 (11.01)	45.94	3.88 (11.35)	46.41	0.26	0.23	0.30	66.40
Ecotin (azadirachtin 5%)	200	3.83	3.13 (10.19)	46.95	3.28 (10.43)	51.12	3.69 (11.07)	50.47	4.93	3.06 (10.06)	54.80	3.21 (10.31)	55.66	0.33	0.30	0.36	68.53
Achook (azadirachtin 0.15%)	2500	3.89	3.63 (10.98)	38.47	3.78 (11.21)	43.67	4.95 (12.85)	33.56	4.10	4.19 (11.81)	38.11	4.88 (12.75)	32.60	0.27	0.23	0.30	64.53
Untreated control	-	4.29	5.90 (14.06)	-	6.71 (15.00)	-	7.45 (15.82)	-	4.86	6.77 (15.08)	-	7.24 (15.60)	-	0.30	0.33	0.40	62.27
CSD (p=0.05)		NS	(0.15)	-	(0.38)	-	(0.52)	-	NS	(0.91)	-	(0.98)	-	NS	NS	NS	1.59
2020																	
Ecotin (azadirachtin 5%)	150	4.33	3.27 (10.39)	26.19	3.57 (10.86)	24.84	4.30 (11.96)	23.62	4.10	3.10 (10.14)	30.02	3.70 (11.08)	31.48	0.20	0.10	0.13	63.37
Ecotin (azadirachtin 5%)	175	4.45	2.83 (9.68)	36.12	3.10 (10.11)	34.74	4.03 (11.57)	28.42	4.37	2.70 (9.45)	39.05	3.38 (10.59)	37.41	0.23	0.27	0.20	63.90
Ecotin (azadirachtin 5%)	200	4.19	2.52 (9.11)	43.12	2.90 (9.78)	38.95	3.43 (10.67)	39.08	6.03	2.33 (8.78)	47.40	2.95 (9.87)	45.37	0.17	0.20	0.20	64.63
Achook (azadirachtin 0.15%)	2500	4.46	3.13 (10.17)	29.35	3.55 (10.83)	25.26	4.57 (11.95)	18.83	4.07	2.85 (9.71)	35.67	3.43 (10.67)	36.48	0.10	0.17	0.17	62.97
Untreated control	-	4.80	4.43 (12.13)	-	4.75 (12.55)	-	5.63 (13.72)	-	4.03	4.43 (12.15)	-	5.40 (13.42)	-	0.17	0.17	0.17	60.46
CSD (p=0.05)		NS	(0.37)	-	(0.39)	-	(0.70)	-	NS	(0.55)	-	(0.48)	-	NS	NS	NS	0.72

*Figures in parentheses % arc sine transformed values; PROC: % reduction over control

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(Manuscript Received: May, 2021; Revised: November, 2021;
Accepted: December, 2021; Online Published: March, 2022)
Online First in www.entosocindia.org and indianentomology.org Ref. No. e21131