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Bioefficacy of some botanical and chemical insecticides against yellow stem borer *Scirpophaga incertulas* (Walk.) In rice field at Jharkhand

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Abstract
Field experiments were conducted at Rice research farm of Birsa Agricultural University, RAC (Ranchi Agriculture College) Kanke, Ranchi to find effectiveness of different insecticides against stem borer in aromatic rice during *Kharif* season of 2016. Relative efficacy of four botanical insecticides *i.e.* NSKE 5% @25 kg/ha, Pongamia oil (@ 3 lit/ha, Nimbolin 0.15% Aza. (@ 3 lit/ha and Neembaan 0.15% Aza. (@ 3 lit/ha and one chemical control Acephate 75SP @ 650 g/ha were tested along with untreated control in rice. All the insecticidal treatments were significantly superior to untreated control. Acephate 75SP @ 650 g/ha was found most promising with minimum dead heart and white ear incidence. The data on dead heart and white ear incidence, grain yield showed that all the insecticides effectively control the stem borer on aromatic rice revealed that four foliar spray of acephate 75SP @ 650 g/ha applied at 25, 50, 75 and 100 DAT proved to be the most effective in causing maximum reduction in the incidence of stem borer, resulting in the highest grain yield of 37.80 q/ha with maximum net profit of Rs. 45,138/ha with BC ratio of 10.7:1.

Keywords: Bioefficacy, botanical, chemical insecticides, yellow stem borer, *Scirpophaga incertulas*

Introduction
Rice (*Oryza sativa* L.), is the most important cereal crop of the world, which occupies for most status in human food requirements. More than 90 per cent of the world's rice is grown and consumed in Asia, where 60 per cent of the earth's people live. India is the largest rice growing country of the world having 41.85 m ha area under this crop with 102 m tones production. In Punjab, rice is main crop, cultivated over 28.51 lakh ha area with annual grain production of 169.1 lakh tonnes, whereas basmati rice is cultivated in 20 per cent area under rice (Anonymous, 2015) [3]. The productivity of rice in India is quite low (3.01 tonnes ha^{-1}) as compared to world average of 4.02 tonnes ha^{-1} (Anonymous, 2012) [2]. Among the various factors, insect pests are the main causes of low yields of rice in India (Matteson, 2000 and Behura *et al*., 2011) [15, 4]. Rice crop is attacked by more than 100 species of insects, but 20 species are of economic importance (Kalode, 2005) [10]. The yield losses caused by insect pests in rice have been reported to the tune of 25 per cent (Dhaliwal *et al*., 2010) [7]. Among the insect pests, yellow stem borer (YSB), *Scirpophaga incertulas* (Walker) is the most destructive pest of rice, causing yield losses to the tune of 10-60 per cent every year (Panda *et al*., 1976, Mahar *et al*., 1985, Pasalu *et al*., 2005 and Anonymous, 2006) [17, 12, 18, 1]. Globally, yellow rice stem borer alone causes yield losses of 10 million tones and accounts for 50 per cent of all insecticides used in the rice field (Huesing and English, 2004) [8]. This insect attacks the crop from the seedling stage to the harvesting stage and thus causes complete loss of affected tillers. The larvae of rice stem borers, after hatching, bore into the stem of rice plant and cut out the food supply to the upper part of the affected stem. Dead hearts are produced when the insect attacks at vegetative stage while white ears occur when the stem borer attack at reproductive stage (Mahmood-ur-Rehman, *et al*., 2007, Chatterjee and Mondal, 2014) [13, 5]. Low percentage of dead hearts at early crop stage are compensated by rice plant, but 1-4 per cent loss of yield is expected for every per cent of white ear (Muralidharan and Pasalu, 2006) [16]

Materials and Methods
A field experiment was conducted at Rice Research Farm of Birsa Agricultural University, Kanke, Ranchi during *Kharif* season of 2016. Relative efficacy of four botanical insecticides i.e. NSKE 5% @25 kg/ha, Pongamia oil (@ 3 lit/ha, Nimbolin 0.15% Aza. (@ 3 lit/ha and

Neembaan 0.15% Aza. (@ 3 lit/ha and one chemical control acephate 75SP @ 650 g/ha were tested along with untreated control in rice. All the insecticidal treatments were significantly superior to untreated control. The field experiment was conducted with rice variety – Badsah Bhog (aromatic rice variety) for the purpose of evaluation of bio-efficacy of certain chemical and botanical insecticides against the incidence of major insect pests of aromatic rice. The experiment was conducted in the rice research farm of the university during *kharif* season 2016. The crop was transplanted in randomized block design in plot size of 5x4m^2 in three replications. Date of sowing and transplanting was 23rd July and 12th August of 2016, respectively

Schedules of insecticide application

1st application : 25 DAT (7th Sept., 2016)
2nd application : 50 DAT (2nd Oct., 2016)
3rd application : 75 DAT (27th Oct., 2016)
4th application : 100 DAT (21st Nov., 2016)

Four observations *viz*. at 4, 7, 10 and 14 DAA after 1st spray (at 25 DAT) and 2nd spray (at 50 DAT) were recorded on dead heart incidence. Observations on white ear head (WE) were recorded at dough stage and maturity stage of the crop.

Results

First round of insecticidal application

Results are presented in Table (1-a), (1-b). Experimental results recorded after 4, 7, 10 and 14 DAS (days after spraying) of 1st round of insecticidal application indicated that the minimum level of dead heart (DH%) to the tune of 2.08%, 1.96%, 3.13% and 4.66% dead heart (DH%) were registered in case of application of alternative spray of only acephate 75 SP @ 650 g/ha. However, 1st round of four foliar application of acephate 75SP @ 650 g/ha recorded the lowest dead heart (2.08% DH) which remained at par with foliar sprays applied with acephate 75SP @ 650 g/ha alternated with NSKE 5% (4.60% DH) and foliar sprays applied with acephate 75SP @ 650 g/ha alternated with Neembaan 0.15% aza. @ 3 l/ha (4.60% DH) followed by foliar application of acephate 75SP @ 650 g/ha alternated with Nimbolin 0.15% aza. @ 3 l/ha (4.80% DH), foliar sprays applied with acephate 75SP @ 650 g/ha alternated with pongamia oil @ 3 l/ha (6.30% DH) and foliar sprays applied with NSKE 5% (6.50% DH). Relatively lower dead heart (7.95%) was obtained foliar application of Neembaan 0.15% aza. @ 3 l/ha followed by foliar application of Nimbolin 0.15% aza. @ 3 l/ha (7.80% DH) and four foliar application of pongamia oil @ 3 l/ha (7.50% DH) at 4 days after spraying.

At 7 days after spray, four foliar sprays applied with acephate 75SP @ 650 g/ha was found most effective and resulted in lowest dead heart (DH%) (1.96%) followed by foliar sprays applied with acephate 75SP @ 650 g/ha alternated with NSKE 5% (2.80%), foliar sprays applied with acephate 75SP @ 650 g/ha alternated with Neembaan 0.15% aza. @ 3 l/ha (3.40%) and foliar sprays applied with acephate 75SP @ 650 g/ha alternated with Nimbolin 0.15% aza. @ 3 l/ha (3.90%).Four foliar application of Neembaan 0.15% aza. @ 3 l/ha resulted in highest dead heart (7.15%) followed by four foliar application of Nimbolin 0.15% aza. @ 3 l/ha (6.70%), four foliar application of pongamia oil @ 3 l/ha (6.30%), foliar sprays applied with acephate 75SP @ 650 g/ha alternated with pongamia oil @ 3 l/ha (5.80%) and four foliar application of NSKE 5% (5.06%) at 25 DAT.

At 10 days after spray, four foliar sprays applied with acephate 75SP @ 650 g/ha recorded the lowest dead heart (3.13% DH) followed by foliar sprays applied with acephate 75SP @ 650 g/ha alternated with Neembaan 0.15% aza. @ 3 l/ha (4.72% DH), foliar application of acephate 75SP @ 650 g/ha alternated with Nimbolin 0.15% aza. @ 3 l/ha (5.13% DH) and foliar application of acephate 75SP @ 650 g/ha alternated with NSKE 5% (5.40% DH). The highest dead heart (8.40% DH) was recorded in four foliar application of Neembaan 0.15% aza. @ 3 l/ha followed by foliar application of Nimbolin 0.15% aza. @ 3 l/ha (8.20% DH), foliar application of pongamia oil @ 3 l/ha (7.80% DH), foliar sprays applied with acephate 75SP @ 650 g/ha alternated with pongamia oil @ 3l/ha (6.80% DH) and four foliar application of NSKE 5% (6.77%).

Similarly at 14 days after spray, four foliar sprays applied with acephate 75SP @ 650 g/ha recorded lowest dead heart (4.66% DH) followed by foliar application of acephate 75SP @ 650 g/ha alternated with Neembaan 0.15% aza. (5.46% DH) and foliar application of acephate 75SP @ 650 g/ha alternated with Nimbolin 0.15% aza. (5.80% DH).The highest dead heart (9.20% DH) was recorded in foliar application of Neembaan 0.15% aza. followedby foliar application of Nimbolin 0.15% aza. (8.86% DH), foliar application of pongamia oil (8.30% DH), foliar application of NSKE 5% (7.48% DH), foliar sprays applied with acephate 75SP @ 650 g/ha alternated with pongamia oil (7.20% DH) and foliar application of acephate 75SP @ 650 g/ha alternated with NSKE 5% (6.70% DH).

Overall mean results of the four observations also followed almost similar trends in terms of reduction of dead heart (DH) caused by the respective test insecticides in the present experimentation.

Second round of insecticidal application

The observations recorded on dead heart incidence, due to YSB recorded at 4, 7, 10 and 14 DAA (days after application of insecticides) after 2nd application of the test insecticide alsofollowed almost similar trend to that of the 1st application of insecticides Table (1-a) and (1-b).

Efficacy of the test insecticides on the incidence of yellow stem borer.YSB, at the reproductive stage of the crop. The lowest level of DH% (2.80%) in foliar application of acephate 75SP @ 650 g/ha at par with foliar application of acephate 75SP @ 650 g/ha alternated with NSKE 5% (2.90% DH), foliar application of acephate 75SP @ 650 g/ha alternated with Neembaan 0.15% aza. (3.40% DH) and foliar sprays applied with acephate 75SP @ 650 g/ha alternated with Nimbolin 0.15% aza. (3.60% DH). The highest dead heart (6.50% DH) was recorded in four foliar sprays applied with Neembaan 0.15% aza. followed by four foliar application of Nimboloin 0.15% aza. (5.80% DH), four foliar application of pongamia oil (5.60% DH), four foliar application of NSKE 5% (4.80% DH) and foliar sprays applied with acephate 75SP @ 650 g/ha alternated with pongamia oil (4.60% DH) respectively were recorded at 4 DAS.

At 7 days after spray, four foliar sprays applied with acephate 75SP @ 650 g/ha at 50 DAA was found most effective and resulted in lowest dead heart (1.86% DH) followed by foliar sprays applied with acephate 75SP @ 650 g/ha alternated with NSKE 5% (2.40% DH) and foliar sprays applied with acephate 75SP @ 650 g/ha alternated with Neembaan 0.15% aza. (3.20% DH). The highest incidence of dead heart (5.30% DH) was recorded in case of four foliar application of

Neembaan 0.15% aza. followed by four foliar application of Nimbolin 0.15% aza. (5.00% DH), four foliar application of pongamia oil (4.80% DH), four foliar application of NSKE 5% (4.30% DH), foliar sprays applied with acephate 75SP @ 650 g/ha alternated with pongamia oil (3.80% DH) and foliar sprays applied with acephate 75SP @ 650 g/ha alternated with Nimbolin 0.15% aza. @ 3 l/ha (3.45% DH).

At 10 days after spray, the lowest level of pest incidence of (2.88% DH) was registered when four foliar sprays applied with acephate 75SP @ 650 g/ha applied followed by foliar spray of acephate 75SP @ 650 g/ha alternated with Neembaan 0.15% aza. @ 3 l/ha (3.40% DH), four foliar sprays applied with acephate 75SP @ 650 g/ha alternated with Nimbolin 0.15% (3.75% DH), foliar sprays applied with acephate 75SP @ 650 g/ha alternated with NSKE 5% (3.80% DH), foliar application of acephate 75SP @ 650 g/ha alternated with pongamia oil (4.12% DH) and four foliar application of NSKE 5% (4.87% DH). The highest incidence of dead heart (6.20% DH) was recorded in case of four foliar application of Neembaan 0.15% aza. @ 3 l/ha followed by four foliar application of Nimbolin 0.15% aza. @ 3 l/ha (5.69% DH) and four foliar application of pongamia oil @ 3 l/ha (5.20% DH) at 50 DAT (days after transplanting).

At 14 days after spray, similarly four foliar sprays applied with acephate 75SP @ 650 g/ha was found most effective and resulted in lowest dead heart (DH%) (3.60%) followed by foliar sprays applied with acephate 75SP @ 650 g/ha alternated with Nimbolin 0.15% aza. (4.60% DH), foliar application of acephate 75SP @ 650 g/ha alternated with NSKE 5% (5.00% DH), foliar application of acephate 75SP @ 650 g/ha alternated with Neembaan 0.15% aza. (5.20% DH) and four foliar application of NSKE 5% (5.30% DH). The highest incidence of dead heart (8.80% DH) was recorded in case of four foliar application of pongamia oil followed by four foliar application of Nimbolin 0.15% aza. (6.80% DH), four foliar application of Neembaan 0.15% aza. (6.40% DH) and foliar sprays applied with acephate 75SP @ 650 g/ha alternated with pongamia oil (6.30% DH).

Overall mean results of four observations noticed at 4, 7, 10 and 14 DAS of YSB also followed almost similar trends in minimizing the incidence of dead heart in the present studies.

The overall mean results of the present experiment indicating the overall superiority of acephate 75SP @ 650 g/ha applied thrice at 25 days interval, in the vegetative stage of rice (Var. Badsah Bhog) in reducing the incidence of dead heart (DH) over all the test botanical insecticides *viz*. NSKE, Neembaan, Nimbolin and pongamia oil was found almost in the lone of the finding of the earlier workers (Singh, 1996 [20], Rath 1999 [19], Dhaliwal *et al*., 2002 [6], Mahal *et al*., 2008 [11], Islam *et al*., 2013 [9] and Majlish *et al*., 2015 [14]).

Table 1(a): Effect of botanical and chemical insecticides on the incidence of yellow stem borer (*Scirpophaga incertulas* Walker) infesting aromatic rice crop (Var. Badsah Bhog)

Tr. No.	Treatments (Alternate spray of 'A' & 'B' and so on …..on need based basis)*		Percentage of DH caused by yellow stem borer at DAS after 1st spray or application				
	'A'	'B'	4 DAA	7 DAA	10 DAA	14 DAA	Overall mean
T_1	Acephate 75SP (@ 650 g/ha)	NSKE 5% (@ 25 kg NSKP/ha)	4.60(12.18)	2.80(9.52)	5.40(13.40)	6.70(14.96)	4.88(12.52)
T_2	Acephate 75SP (@ 650 g/ha)	Pongamia oil (@ 3 lit/ha)	6.30(14.41)	5.80(13.74)	6.80(15.08)	7.20(15.53)	6.53(14.69)
T_3	Acephate 75SP (@ 650 g/ha)	Nimbolin 0.15% Aza. (@ 3 lit/ha)	4.80(12.50)	3.90(10.13)	5.13(12.93)	5.80(13.88)	4.91(12.36)
T_4	Acephate 75SP (@ 650 g/ha)	Neembaan 0.15% Aza. (@ 3 lit/ha)	4.60(12.23)	3.40(10.44)	4.72(12.39)	5.46(13.48)	4.55(12.14)
T_5	NSKE 5% (@ 25 kg NSKP/ha)	NSKE 5% (@ 25 kg NSKP/ha)	6.50(14.66)	5.06(12.82)	6.77(14.97)	7.48(15.83)	6.45(14.57)
T_6	Pongamia oil (@ 3 lit/ha)	Pongamia oil (@ 3 lit/ha)	7.50(15.80)	6.30(14.50)	7.80(16.19)	8.30(16.72)	7.48(15.80)
T_7	Nimbolin 0.15% Aza. (@ 3 lit/ha)	Nimbolin 0.15% Aza. (@ 3 lit/ha)	7.80(16.12)	6.70(14.88)	8.20(16.61)	8.86(17.28)	7.89(16.22)
T_8	Neembaan 0.15% Aza. (@ 3 lit/ha)	Neembaan 0.15% Aza. (@ 3 lit/ha)	7.95(16.29)	7.15(15.42)	8.40(16.83)	9.20(17.59)	8.18(16.53)
T_9	Acephate 75SP (@ 650 g/ha)	Acephate 75SP (@ 650 g/ha)	2.08(8.11)	1.96(7.94)	3.13(9.89)	4.66(12.40)	2.96(9.59)
T_{10}	Untreated check/water spray		11.40 (19.67)	12.60 (20.76)	12.80 (20.92)	12.90 (21.02)	12.43 (20.59
	S.Em (±)		(1.40)	(1.36)	(1.12)	(0.80)	(1.17)
	CD (P=0.05)		(4.20)	(4.08)	(3.36)	(2.39)	(3.51)
	CV (%)		(17.13)	(18.12)	(13.02)	(8.69)	(14.24)

Figures under the parentheses corresponds to arc sin values

DAS-Days after spraying, DH- Dead heart

* Four foliar sprays with the respective treatment combination(s) were applied on need based basis starting 1st spray at 25 DAT (days after transplanting) followed by 2nd, 3rd and 4th at 50, 75 and 100 DAT. As such, altogether 2 sprays of the each material contained in 'A' and 'B' were provided alternatively during the whole cropping season for protecting the crop against the major prevailing insect pests

Table 1(b): Effect of botanical and chemical insecticides on the incidence of yellow stem borer (*Scirpophaga incertulas* Walker) infesting aromatic rice crop (Var. Badsah Bhog)

Tr. No.	Treatments (Alternate spray of 'A' & 'B' and so on …..on need based basis)*		Percentage of DH caused by yellow stem borer at DAS after 2nd spray or application				
	'A'	'B'	4 DAA	7 DAA	10 DAA	14 DAA	Overall mean
T_1	Acephate 75SP (@ 650 g/ha)	NSKE 5% (@ 25 kg NSKP/ha)	2.90(9.80)	2.40(8.72)	3.80(11.20)	5.00(12.89)	3.52(10.65)
T_2	Acephate 75SP (@ 650 g/ha)	Pongamia oil (@ 3 lit/ha)	4.60(12.27)	3.80(11.10)	4.12(11.66)	6.30(14.49)	4.71(12.38)
T_3	Acephate 75SP (@ 650 g/ha)	Nimbolin 0.15% Aza. (@ 3 lit/ha)	3.60(10.85)	3.45(10.65)	3.75(11.09)	4.60(12.32)	3.85(11.23)
T_4	Acephate 75SP (@ 650 g/ha)	Neembaan 0.15% Aza. (@ 3 lit/ha)	3.40(10.55)	3.20(10.19)	3.40(10.37)	5.20(13.10)	3.80(11.05)
T_5	NSKE 5% (@ 25 kg NSKP/ha)	NSKE 5% (@ 25 kg NSKP/ha)	4.80(12.56)	4.30(11.93)	4.87(12.56)	5.30(13.23)	4.82(12.57)
T_6	Pongamia oil (@ 3 lit/ha)	Pongamia oil (@ 3 lit/ha)	5.60(13.66)	4.80(12.62)	5.20(13.12)	8.80(17.23)	6.10(14.16)
T_7	Nimbolin 0.15% Aza. (@ 3 lit/ha)	Nimbolin 0.15% Aza. (@ 3 lit/ha)	5.80(13.89)	5.00(12.86)	5.69(13.77)	6.80(15.09)	5.82(13.90)
T_8	Neembaan 0.15% Aza. (@ 3 lit/ha)	Neembaan 0.15% Aza. (@ 3 lit/ha)	6.50(14.75)	5.30(13.28)	6.20(14.36)	6.40(14.62)	6.10(14.25)
T_9	Acephate 75SP (@ 650 g/ha)	Acephate 75SP (@ 650 g/ha)	2.80(9.58)	1.86(7.77)	2.88(9.75)	3.60(10.80)	2.78(9.47)
T_{10}	Untreated check/water spray		13.40 (21.45)	14.50 (22.36)	14.90 (22.69)	15.80 (23.41)	14.65 (22.48)
	S.Em (±)		(0.81)	(0.90)	(1.01)	(0.84)	(0.89)

	CD (P=0.05)	(2.42)	(2.69)	(3.03)	(2.51)	(2.66)
	CV (%)	(10.84)	(12.83)	(13.41)	(9.87)	(11.74)

Figures under the parentheses corresponds to arc sin values
DAA- Days after application of insecticides
DH- dead heart
* Four foliar sprays with the respective treatment combination(s) were applied on need based basis starting 1st spray at 25 DAT (days after transplanting) followed by 2nd, 3rd and 4th at 50, 75 and 100 DAT. As such, altogether 2 sprays of the each material contained in 'A' and 'B' were provided alternatively during the whole cropping season for protecting the crop against the major prevailing insect pests.

Conclusion

The management of pest using, four foliar spray of acephate 75SP @ 650 g/ha applied at 25, 50, 75 and 100 DAT (T_9) proved to be the most effective in causing maximum reduction in the incidence of yellow stem borer in the Ranchi region of Jharkhand resulting in the highest grain yield of 37.80 q/ha with maximum net profit of Rs. 45,138/ha with BC ratio of 10.7:1.

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