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Bio-efficacy of new molecules chlorantraniliprole and emamectin benzoate against rice stem borers

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ABSTRACT

The bio-efficacy of two new molecules rynaxypyr 0.4 G and 18.5 SC (chlorantaniliprole) and emamectin benzoate 5 SG at different doses against rice stem borers were studied in comparison with fipronil, carbofuran and profenophos on rice variety "Swarna" (MTU-7029) at the Central Research Station Farm, Orissa University of Agriculture and Technology, Bhubaneswar during wet season, 2012 and dry season, 2013 with recommended agronomic package of practices. The results revealed that rynaxypyr 0.4 G @ 50 g a.i. ha $^{-1}$ to be the best treatment for the control of the pest by reducing the dead heart (80.21% and 87.48% during wet and dry seasons, respectively over control) and white ear head (72.56% and 86.16% reduction, respectively over control) with highest grain yield of 5.1 t ha^{-1} and 5.5 t ha^{-1} during wet season and dry season, respectively. Recommended insecticides like fipronil, profenophos and carbofuran were least effective in control of stem borer with lower grain yield. The highest C:B ratio (1:6.81) was due to rynaxypyr 0.4 G@ 40 g a.i. ha $^{-1}$ during dry season,2013 and second highest (1:5.80) during wet season, 2012.

Key words: *Bio-efficacy, chlorantraniliprole, emamectin benzoate, rice stem borer*

There are five species of stem borers distributed all over India. Among them, yellow stem borer, *Scirpophaga incertulas* (Walker) is the most predominant one causing serious damage in rice (Misra *et al.* 2005) giving a major economic loss of 25-30% (Senapati and Panda 1999). A large number of insecticides with different formulations were reported to be effective against this pest (Sontakke and Dash., 2000; Panda *et al.* 2002; Sahithi and Misra 2006; Sarao and Mahal 2008). But their indiscriminate use lead to 3R's i.e. resistance, resurgence and replacement of pests vis-à-vis environmental pollution and contamination of food. The present study was undertaken to study the efficacy of two new molecules *viz.*, rynaxypyr (chlorantraniliprole) belonging to anthranilic diamide group and emamectin benzoate belonging to avermectin group against rice stem borers.

Field experiments were conducted at Central Research Station Farm, Orissa University of Agriculture and Technology, Bhubaneswar in randomized block design with ten treatments replicated three times during wet season, 2012 and dry season, 2013. The treatments included rynaxypyr 0.4 G @ 40 and 50 g a.i. ha^{-1}, rynaxypyr 18.5 SC @ 30 and 40 g a.i. ha^{-1}, emamectin benzoate 5 SG @ 10 and 11.5 g a.i. ha^{-1}, fipronil 0.3 G @ 50 g a.i. ha^{-1}, profenophos 50 EC @ 500 g a.i. ha^{-1} and carbofuran 3G @ 750 g a.i. ha^{-1}. Rice variety "Swarna" (MTU-7029) was transplanted in plots of size 6m x 2.5m at a spacing of 20cm x 15cm. Chemical fertilizers and other agronomic practices were followed as per recommendations. The insecticides were applied at 30 and 50 days after planting (DAT) as spray and granular formulations, based on treatments. Observations were recorded on the 10 randomly selected plants of each plot on the incidence of stem borer causing dead heart (DH) and white ear head (WEH) at 3, 7 and 14 days after each application (DAA). The grain yield was recorded at harvest from each plot and the cost benefit ratio of each treatment is calculated.The per cent incidence of dead heart and white ears were calculated as follows:

$$\text{Per cent dead heart} = \frac{\text{Number of dead hearts/hill}}{\text{Total number of tillers/hill}} \text{x} 100$$

$$\text{Per cent white ears} = \frac{\text{Number of white ears/hill}}{\text{Total number of panicles/hill}} \text{x} 100$$

The results revealed that the yellow stem borer attacked rice both at tillering stage causing dead heart and heading stage causing white ear heads. It was observed that the per cent dead heart and white ear head were significantly low in all the insecticidal treatments as compared to untreated control at 3, 7 and 14 DAA during wet season, 2012 and dry season, 2013. During wet season, 2012 among all the nine insecticidal treatments, rynaxypyr 0.4 G @ 50 g a.i. ha^{-1} was significantly superior to other insecticides in reducing DH (80.21% over control) as well as WEH (72.56% over control) at 14 DAA. Rynaxypyr 0.4 G @ 40 g a.i. ha^{-1} also recorded highest reduction of dead heart (76.61%) over control and was followed by rynaxypyr 18.5 SC @ 40 g a.i. ha^{-1}, rynaxypyr 18.5 SC @ 30 g a.i. ha^{-1}, emamectin benzoate 5 SG @ 11.5 g a.i. ha^{-1} and emamectin benzoate 5 SG @ 10 g a.i. ha^{-1}. Fipronil 0.3 G @ 50 g a.i. ha^{-1}, carbofuran 3 G @ 750 g a.i. ha^{-1} and profenophos 50 EC @ 500 g a.i. ha^{-1} recorded comparatively higher incidence of DH. The second highest per cent reduction in WEH was recorded in the treatment rynaxypyr 0.4 G @ 40 g a.i. ha^{-1} followed by rynaxypyr 18.5 SC @ 40 g a.i. ha^{-1}, emamectin benzoate 5 SG @ 11.5 g a.i. ha^{-1}, rynaxypyr 18.5 SC @ 30 g a.i. ha^{-1} and emamectin benzoate 5 SG @ 10 g a.i. ha^{-1}. The other treatments that recorded lower per cent reduction over control are fipronil – 57.36%, carbofuran – 50.18% and profenophos – 46.64%.

During dry season 2013, rynaxypyr 0.4 G @ 50 g a.i. ha^{-1} also proved to be the best treatment against rice stem borer causing DH and WEH giving 87.48% and 86.16% reduction over control, respectively. The trend of efficacy of the insecticides against DH formation was similar with that of wet season, 2012. The second best treatment was rynaxypyr 0.4 G @ 40 g a.i. ha^{-1} recording 86.23% reduction over control followed by rynaxypyr 18.5 SC @ 40 g a.i. ha^{-1}, rynaxypyr 18.5 SC @ 30 g a.i. ha^{-1}, emamectin benzoate 5 SG @ 11.5 g a.i. ha^{-1} and emamectin benzoate 5 SG @ 10 g a.i. ha^{-1}. Fipronil 0.3 G @ 50 g a.i. ha^{-1}, carbofuran 3 G @ 750 g a.i. ha^{-1} and profenophos 50 EC @ 500 g a.i. ha^{-1} also recorded higher reduction over control but comparatively higher incidence of DH as compared to the test insecticides. Regarding WEH incidence, the second best treatment was rynaxypyr 0.4 G @ 40 g a.i. ha^{-1} (84.13% reduction over control) which was followed by rynaxypyr 18.5 SC @ 40 g a.i. ha^{-1}, rynaxypyr 18.5 SC @ 30 g a.i. ha^{-1}, emamectin benzoate 5 SG @ 11.5 g a.i. ha^{-1} and emamectin benzoate 5 SG @ 10 g a.i. ha^{-1}.

Based on the results of the present investigation it may be concluded that two applications of rynaxypyr in both granular and sprayable formulation as well as emamectin benzoate in both the doses recorded least incidence of stem borer causing both DH and WEH than that of fipronil 0.3G, carbofuran 3G and profenophos 50 EC. Effective control of rice stem borer by the application of carbofuran and fipronil have been reported by various authors (Sontakke and Das. 2000; Saljoqi *et al.* 2002; Khan *et al.* 2005; Firake *et al.* 2010 and Rath *et al* 2012). Based on the present studies, it can be inferred that the two new molecules tested are more efficacious than fipronil and carbofuran against stem borer of rice. Suri (2011) and Suri and Brar (2012) compared chlorantraniliprole at different doses with thiocyclam hydrogen oxalate @ 400 g a.i. ha^{-1} and cartap hydrochloride @ 1000 g a.i. ha^{-1} and reported that chlorantraniliprole in both the formulations are significantly superior to thiocyclam hydrogen oxalate and cartap hydrochloride in controlling DH and WEH effectively. PengJei *et al.* 2011 reported that 2.2% emamectin benzoate ME effectively controlled rice stem borers for long duration and recommended its spray at 15-30 g a.i ha^{-1} for controlling during peak incidences of adult borers.

In both the seasons, the highest grain yield (5.1 t ha^{-1} and 5.5 t ha^{-1} respectively) was recorded with two applications of rynaxypyr 0.4 G @ 50 g a.i. ha^{-1} at 30 and 50 DAT due to superior control of stem borer. This was followed by the same insecticides @ 40 g a.i. ha^{-1}, rynaxypyr 18.5 SC @ 40 g a.i. ha^{-1} where yield increase over control ranged from 65.42 to 66.10 per cent and 72.16 to 76.08 per cent, respectively. Rynaxypyr 18.5 SC @ 30 g a.i. ha^{-1} and emamectin benzoate 5 SG @ 11.5 g a.i. ha^{-1} also recorded higher yield because of their effectiveness in controlling the pest. In the treatment of fipronil 0.3G, carbofuran 3G and profenophos 50 EC, the grain yield ranged from 4.12 to 4.54 t ha^{-1} and 4.34 to 4.72 t ha^{-1}, respectively. Many workers (Chakraborty 2011 and Kulagod *et al*

Table 1. Efficacy of different chemicals against rice stem borer, grain yield and cost benefit ratio during wet season, 2012

Insecticides	Doseg a.i. ha^{-1}	Dead heart incidence (%) 1st spray 3DAA	7DAA	14DAA	% reduction over control	White earhead % 2nd spray 14DAA	% reduction over control	Yield (t ha^{-1})	Increase in yield over control (%)	Cost benefit ratio
Rynaxypyr 0.4G	40	4.43(2.22)^{bc}	4.52 (2.24)^{b}	4.87 (2.32)^{b}	76.61	5.03(2.35)^{bc}	70.38	4.90^{ab}	66.10	1 : 5.80
Rynaxypyr 0.4G	50	3.79 (2.07)^{a}	3.98 (2.12)^{a}	4.12 (2.15)^{a}	80.21	4.66(2.27)^{a}	72.56	5.10^{a}	72.88	1 : 5.24
Rynaxypyr 18.5SC	30	4.78 (2.30)^{bcde}	4.97 (2.34)^{c}	5.27 (2.40)^{bcd}	74.69	5.68(2.49)^{d}	66.55	4.67^{bcd}	58.31	1 : 4.02
Rynaxypyr 18.5SC	40	4.37 (2.21)^{b}	4.50 (2.24)^{b}	4.98 (2.34)^{bc}	76.08	4.92(2.33)^{ab}	71.02	4.88^{abc}	65.42	1 : 3.57
Emamectin benzoate 5SG	10	5.22 (2.39)^{efgh}	5.53 (2.46)^{d}	5.98 (2.55)^{e}	71.28	6.72(2.69)^{e}	60.42	4.44^{de}	50.51	1 : 4.24
Emamectin benzoate5SG	11.5	4.91 (2.33)^{def}	5.01 (2.35)^{c}	5.33 (2.41)^{bcd}	74.40	5.23(2.39)^{bc}	69.20	4.56^{cd}	54.58	1 : 4.13
Fipronil 0.3G	50	5.02 (2.35)^{efg}	5.61 (2.47)^{d}	6.00 (2.55)^{e}	71.18	7.24(2.78)^{f}	57.36	4.54^{d}	53.90	1 : 5.94
Profenophos 50EC	500	5.52 (2.45)^{gh}	7.27 (2.79)^{f}	8.56 (3.01)^{g}	58.89	9.06(3.09)^{h}	46.64	4.12^{e}	39.66	1 : 5.76
Carbofuran 3G	750	4.51 (2.24)^{bcd}	6.32 (2.61)^{e}	7.08 (2.75)^{f}	65.99	8.46(2.99)^{g}	50.18	4.49^{de}	52.20	1 : 4.48
Control	-	8.04 (2.92)^{i}	16.98 (4.18)^{g}	20.82 (4.62)^{h}	-	16.98(4.18)^{i}	-	2.95^{f}	-	-
SE(m) $\pm$	-	0.03	0.03	0.04	-	0.02	-	0.11	-	-
CD (P<0.05)	-	0.10	0.09	0.11	-	0.06	-	3.24	-	-

Figures in parenthesis are $\sqrt{x + 0.5}$ transformed values ; Figures followed by similar alphabets are not significant at P = 0.05

DAA = Days after application (Insecticides applied at 30 days and 50 days after planting)

Ferterra (Rynaxypyr 0.4G) Rs. 195/ kg; Coragen (Rynaxypyr 18.5SC) Rs. 400/ 30ml; Megaclaim (Emamectin benzoate 5SG) Rs. 418/ 50g; Ratnagent (Fipronil 0.3G) Rs. 90/ kg; Profix (Profenophos 50EC) Rs. 70/ 100ml; Ratnafuran (Carbofuran 3G) Rs. 80/ kg.

*Labour charge = Rs. 126/day (5 labourers/ha for spraying and 2 labourers/ha for granule broadcasting);

Cost of minimum support price of paddy calculated @ Rs. 1310/quintal

Table 2. Efficacy of different chemicals against rice stem borer, grain yield and cost benefit ratio during dry season, 2013

Insecticides	Doseg a.i. ha^{-1}	Dead heart incidence (%) 1st spray 3DAA	7DAA	14DAA	% reduction over control	White earhead % 2nd spray 14DAA	% reduction over control	Yield (t ha^{-1})	Increase in yield over control (%)	Cost benefit ratio
Rynaxypyr0.4G	40	3.00(1.87)^{ab}	3.18(1.92)^{ab}	3.30(1.95)^{ab}	86.23	3.28(1.94)	84.13	5.30^{ab}	76.08	1: 6.81
Rynaxypyr0.4G	50	2.82(1.82)^{a}	2.91(1.84)^{a}	3.00(1.87)^{a}	87.48	2.86(1.83)	86.16	5.50^{a}	82.72	1: 6.06
Rynaxypyr18.5SC	30	3.45(1.99)^{abcd}	3.60(2.02)^{cd}	3.81(2.08)^{bcd}	84.10	3.62(2.03)	82.49	4.97^{bcd}	65.12	1: 4.58
Rynaxypyr18.5SC	40	3.31(1.95)^{abc}	3.49(1.99)^{abc}	3.70(2.05)^{bc}	84.56	3.34(1.96)	83.84	5.18^{bc}	72.16	1: 4.04
Emamectin benzoate5SG	10	4.00(2.12)^{cdef}	4.18(2.16)^{cdef}	4.53(2.24)^{ef}	81.10	4.64(2.27)	77.55	4.68^{cde}	55.48	1: 4.75
Emamectin benzoate 5SG	11.5	3.87(2.09)^{cde}	3.96(2.11)^{cde}	4.28(2.18)^{cde}	82.14	4.32(2.19)	79.10	4.86^{bcde}	61.46	1: 4.74
Fipronil0.3G	50	4.10(2.14)^{cdefg}	4.78(2.30)^{fg}	5.03(2.35)^{fg}	79.01	5.98(2.54)	71.07	4.72^{cde}	56.81	1: 6.39
Profenophos50EC	500	5.28(2.40)^{h}	5.99(2.55)^{h}	7.08(2.75)^{h}	70.46	7.06(2.75)	65.84	4.34^{e}	44.19	1: 6.55
Carbofuran3G	750	4.30(2.19)^{efg}	5.00(2.34)^{g}	5.32(2.41)^{g}	77.80	6.84(2.71)	66.91	4.63^{de}	53.82	1: 4.71
Control	-	9.07(3.09)^{i}	20.06(4.53)^{i}	23.97(4.95)^{i}	-	20.67(4.60)	-	3.01^{f}	-	-
SE(m) ±	-	0.06	0.06	0.05	-	0.05	-	1.78	-	-
CD (P<0.05)	-	0.19	0.17	0.15	-	0.16	-	5.29	-	-

Figures in parenthesis are $\sqrt{x+0.5}$ transformed values ; Figures followed by similar alphabets are not significant at P = 0.05

DAA = Days after application (Insecticides applied at 30 days and 50 days after planting)

Ferterra (Rynaxypyr 0.4G) Rs. 195/ kg; Coragen (Rynaxypyr 18.5SC) Rs. 400/ 30ml; Megaclaim (Emamectin benzoate 5SG) Rs. 418/ 50g; Ratnagent (Fipronil 0.3G) Rs. 90/ kg; Profix (Profenophos 50EC) Rs. 70/ 100ml; Ratnafuran (Carbofuran 3G) Rs. 80/ kg.

*Labour charge = Rs. 126/day (5 labourers/ha for spraying and 2 labourers/ha for granule broadcasting);

Cost of minimum support price of paddy calculated @ Rs. 1310/quintal

2011) recorded comparatively higher grain yield of rice and effective control of stem borer in rice due to the application of carbofuran, fipronil and profenophos. However, in the present studies, new insecticide, rynaxypyr and emamectin benzoate out yielded the recommended insecticides.With respect to cost benefit ratio, fipronil 0.3G @ 50 g a.i. ha^{-1} was found to be the best (1: 5.94) and most economical insecticide followed by rynaxypyr 0.4G @ 40 g a.i. ha^{-1} (1: 5.80) and profenophos 50 EC @ 500 g a.i. ha^{-1} (1: 5.76) during wet season, 2012. During dry season, 2013 the cost benefit ratio was highest in rynaxypyr 0.4G @ 40 g a.i. ha^{-1}(1: 6.81) followed by profenophos 50 EC @ 500 g a.i. ha^{-1} (1: 6.55) and fipronil 0.3G @ 50 g a.i. ha^{-1} (1: 6.39) as per cent reduction over control and yield was much higher in rynaxypyr 0.4G @ 40 g a.i. ha^{-1} in comparison to profenophos and fipronil.

The results of the present studies led to the conclusion that new molecule rynaxypyr (chlorantraniliprole) 0.4G @ 40 g a.i./ha is the best treatment for the control of the pest and getting higher yield with higher monitary benefits. This chemical, in sprayable formulation, in different doses and in higher dose of granular formulation though equally effective against the pests are not cost effective. Another new molecule, emamectin benzoate was found to be effective but with low monitary benefits due to its high cost.

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