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RESEARCH ARTICLE

Assessment of Biopotency of Fipronil 80 WG against Stem Borer and Leaf Folder in Paddy Ecosystem

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ABSTRACT

Two field experiments were conducted to assess the efficacy of fipronil 80 WG against stem borer and leaf folder in the paddy ecosystem at Tamil Nadu Agricultural University, Coimbatore. The results revealed that, the per cent reduction of leaf folder damage was recorded maximum in the plots treated with fipronil 80 WG at 100, 80 and 50 g a.i. ha^{-1} (77.96, 77.31 & 76.83 %, respectively over untreated control) and on par with standard check fipronil 5 SC @ 50 g a.i. ha^{-1} (76.37 %). Chlorpyriphos 20 EC @ 200 g a.i. ha^{-1} recorded 63.69 per cent reduction of leaf folder damage over untreated control. The stem borer damage was recorded minimum in fipronil 80 WG @ 100, 80 and 50 g a.i.ha^{-1} (3.43, 3.50 and 3.63 %, respectively over untreated check) followed by fipronil 5 SC @ 50 g a.i.ha^{-1} (3.76 %) and 40 g a.i.ha^{-1} (3.91 %) after two rounds of spraying. Whereas in untreated control stem borer damage recorded as 17.69 per cent. The grain yield was maximum in the plots treated with fipronil 80 WG @ 100 g a.i.ha^{-1} (4040 kg ha^{-1}) which was on par with fipronil 80 WG @ 80 g a.i.ha^{-1} (4028 kg ha^{-1}) and @ 50 g a.i.ha^{-1} (4017 kg ha^{-1}). Fipronil 80 WG @ 50 g a.i. ha^{-1} recorded the highest percent reduction of leaf folder and stem borer damage in paddy with significantly increased yield and registered on par with treatments of its higher dose. Hence, fipronil 80 WG @ 50 g a.i. ha^{-1} is recommended for the management of leaf folder and stem borer in paddy ecosystem.

Keywords: *Paddy; Stem borer; Leaf folder; Efficacy; Fipronil.*

INTRODUCTION

Rice (*Oryza sativa* L.) is the world's second most important cereal crop. At global level, it is a staple food crop of paramount importance to more than half of the population with regard to food value and is consumed by more than 60% of the world population. It provides 27 and 20 per cent of dietary energy and dietary protein in the developing world. In India, paddy is grown in 43.39 million ha. About 70% of our farmers are cultivating paddy and the production is about 104.32 million tonnes and productivity being 2404 kg/ha. The production of rice in India was 74.68 MTs in 1991-1992 increased to 124.1 MTs in 2022 - 2023 (Anonymous, 2022). Production of rice is facing various pest problems starting from seedling to maturity stage and cause 30 - 70 per cent yield loss. Rice is infested by more than 800 insect species and insects alone cause about 40 per cent yield loss in rice every year by attacking almost all the aerial parts of the crop plants as well as root system in soil (Behura *et al*. 2011). Among the various insect pests damaging the rice crop stem borer, gall midge, brown plant hopper and leaf folder is major pest in India. Yellow stem borer, *Scirpophaga incertulas* Wlk. and leaf folder *Cnaphalocrocis medinalis* (Guenée) are the widely distributed and dominant pests of paddy in the Indian subcontinent. The yield loss was recorded from 30-60 per cent due to leaf folder epidemic situation (Rani *et al.,* 2007). Hence, the present investigation is carried out to assess the effectiveness of new formulation fipronil 80 WG against *S. incertulas* and *C. medinalis* on paddy ecosystem

Materials and Methods

Two field experiments were conducted at Vellimalaipattinam (10°58'31.7"N 76°45'43.3"E), Coimbatore district to test the efficacy of different doses of fipronil 80 WG against *S. incertulas* and *C. medinalis* in rice. The experiments were conducted in Randomized Block Design (RBD) with nine treatments replicated three times with a plot size of 20 x 10 cm using the variety Paddy /White Ponni. The treatments were fipronil 80 WG @ 30, 40, 50, 80 & 100 g a.i.ha^{-1}, fipronil 5 SC @ 40 & 50 g a.i.ha^{-1} and chlorpyriphos 20 EC @ 200 g a.i.ha^{-1}. An untreated control was simultaneously maintained during the study. The treatments were imposed commencing from 30th day after transplanting in vegetative stage with pneumatic knapsack sprayer using 500 liters of spray fluid per hectare. The average temperature in the open field during the study period ranged between 27-31 °C with relative humidity ranging between 70 and 80 per cent and there was no rainfall during the periods of observation.

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Observations on the damage caused by leaf folders and stem borer were made on ten randomly selected hills per plot on a day before and 3, 7, 10 and 14 days after spray (DAS). Counts were taken on number of dead hearts/white ears and total number of tillers/panicle from 10 randomly selected hills. The per cent incidence (dead heart/ white ears) was calculated as follows.

$$\text{Per cent incidence} = \frac{\text{Number of dead heart/white ears}}{\text{Total number of tillers/panicles}} \times 100$$

The damaged leaves and total leaves from 10 randomly selected hills were observed in each plot to assess the leaf folder damage. The percentage of leaffolder damage was calculated as follows.

$$\text{Per cent incidence} = \frac{\text{Number of damaged leaves}}{\text{Total number of leaves}} \times 100$$

The observations on stem borer and leaf folder were recorded on 10 hills selected randomly and averaged to per hill basis. Observations were taken during the vegetative stage (tillering) percent dead heart was recorded. However during the reproductive stage the per cent white ears were recorded. The considerable level of leaf folder incidence that co-occurred during reproductive phase and hence observations were also recorded on leaf folder damage. The data thus obtained from all the observations were subjected to appropriate statistical analysis. The data on the percentage of damage were converted into corresponding angles (Arc sine percentage) for statistical interpretations and were analyzed in randomized block design (RBD) (Gomez and Gomez, 1984). The mean values were separated using Duncan's Multiple Range Test (DMRT) (Duncan, 1951).

To evaluate the phytotoxicity (if any) caused by fipronil 80 WG on rice; experiments were conducted simultaneously along with bioefficacy study. Three doses tested were fipronil 80 WG 50, 100 and 200 g a.i.ha^{-1}. Five plants were selected at random in each plot and the plants were examined for phytotoxic symptoms. To know the crop tolerance, the plants were observed on 1, 3, 7 ,10 and 14 days after spraying as per the protocol of Central Insecticide Board Registration Committee (C.I.B. and R.C) for the phytotoxic symptoms like leaf tip, wilting, necrosis, vein clearing, epinasty and hyponasty. The phytotoxicity symptoms, if any, were graded based on the per cent injured leaves as per the C.I.B and R.C). grade scale *viz.,* no phytotoxicity – grade 0; 1-10 % - grade 1; 11 - 20 % grade 2; 21 – 30 % grade 3; 31 - 40 % grade 4; 41 - 50 % grade 5; 51 - 60 % grade 6; 61 - 70 % grade 7; 71 – 80 % grade 8; 81 - 90 % grade 9 and 91 – 100 % grade 10. The per cent leaf injury was calculated using the following formula,

$$\text{Per cent leaf injury} = \frac{\text{Total grade points}}{\text{Maximum grade x Number of leaves observed}} \times 100$$

RESULTS AND DISCUSSION

Pretreatment count on damage due to leaf folder ranged from 10.32 to 10.77 per cent (Table 1). There was a significant reduction in damage after first round of application on 5 DAS. The lowest mean damage was recorded in fipronil 80 WG at 100, 80 and 50 g a.i. ha^{-1} (7.20, 7.34 and 7.43 %, respectively) followed by standard check fipronil 5 SC @ 50 g a.i. ha^{-1} (7.50 %). After first round of application, the highest per cent reduction was recorded in the plots treated with fipronil 80 WG @100, 80 and 50 g a.i. ha^{-1} (49.14, 48.19 and 47.55 %, respectively over untreated check) followed by standard check fipronil 5 SC @ 50 g a.i. ha^{-1} (47.08 %). Among the insecticidal treatments, the least reduction in damage was observed in plots treated with chlorpyriphos 20 EC @ 200 g a.i. ha^{-1} (37.73 %). After second round of application, the highest reduction was recorded in plots treated with fipronil 80 WG at 100, 80 and 50 g a.i. ha^{-1} (77.96, 77.31 & 76.83 %, respectively over untreated check) followed by standard check fipronil 5 SC @ 50 g a.i. ha^{-1} (76.37 %) . Among the insecticidal treatments, the least reduction in damage was observed in plots treated with chlorpyriphos 20 EC @ 200 g a.i. ha^{-1} (63.69 %) (Table 1 and Fig.1).

Pretreatment count on dead hearts due to stem borer damage ranged from 10.52 to 10.79 per cent (Table 2). There was a significant reduction in damage after first round of application on 7 DAT. The lowest mean damage was recorded in fipronil 80 WG @ 100, 80 and 50 g a.i.ha^{-1} (6.45, 6.54 and 6.67 %, respectively over untreated check) followed by standard check fipronil 5 SC @ 50 g a.i.ha^{-1} (6.98 %). After first round of application, the highest reduction was recorded in plots treated with fipronil 80 WG @ 100, 80 and 50 g a.i. ha^{-1} (50.46, 49.77 and 48.71 % over untreated check, respectively) followed by standard check fipronil 5 SC @ 50 g a.i. ha^{-1} (46.35 %). Among the insecticidal treatments, the least reduction in dead hearts was observed in plots treated with chlorpyriphos 20 EC @ 200 g a.i. ha^{-1} (38.91%). After second round of application, the highest reduction was recorded in plots treated with fipronil 80 WG @100, 80 and 50 g a.i. ha^{-1} (80.63, 80.19 and 79.48 % over untreated check, respectively) followed by standard check fipronil 5 SC @ 50 g a.i. ha^{-1} (78.74 %). Among the insecticidal treatments, the least reduction in dead hearts was observed in plots treated with chlorpyriphos 20 EC @ 200 g a.i. ha^{-1} (67.19 %) (Table 2 and Fig.1).

Results of phytotoxicity study revealed that fipronil 80 WG did not show any kind of phytotoxicity symptom even at the dose of 200 g a.i. ha^{-1} (Table 3). Yield of paddy grains varied from 3370 kg ha^{-1} in untreated check to 4040 kg ha^{-1} in plot treated with fipronil 80 WG @ 100 g a.i.ha^{-1} which was on par with fipronil 80 WG@ 80 g a.i.ha^{-1} (4028 kg ha^{-1}) and @ 50 g a.i.ha^{-1} (4017 kg ha^{-1}). Standard check fipronil 5 SC @ 50 and 40 g a.i.ha^{-1} recorded a yield of 3951 and 3903 kg ha^{-1}, respectively (Fig.2).

Panda *et al.,* (2004), Singh and Singh (2005), Singh *et al.,* (2010), Dhaka *et al.,* (2011) and Dhaka *et al.,* (2012) have also reported fipronil 5SC as most effective insecticide to check the leaf folder incidence. Sontakke and Dash (2000) who substantiated that the application of chlorpyriphos, triazophos, carbofuran and fipronil at 50 DAT effectively controlled stem borer. Singh and Singh (2005) also reported about the effectiveness of fipronil, chlorpyriphos and cartap hydrochloride granules against stemborer. Mahal *et al.* (2008) observed that the tested dose of fipronil 80G significantly reduced the white ear damage in basmati rice. Kuttalam *et al*.(2008) reproted that among the evaluated doses of fipronil 80 WDG, a dose of 50 g a.i.ha^{-1} proved to be most effective in reduciton stem borer population (65.32 and 73.08 per cent reduciton over control of first and second season). Singh *et al.,* (2015), reported about the effectiveness of fipronil 5 SC in reducing the infestation of insect pests in rice.

Satyanarayana *et al.* (2014) also studied the efficacy of different granular insecticides against YSB in Varanasi (India) and reported that field performance of the treatments were in the order of fipronil 0.6 GR @ 60 g a.i./ha > fipronil 0.6 GR @ 40 g a.i./ha > cartap HCl 4 GR @ 750 g a.i./ha > fipronil 0.6 GR @ 50 g a.i./ha > fipronil 0.3 GR @ 60 g a.i./ha > carbofuran 3 GR @ 750 g a.i./ha.

Dhaka *et al.* (2009) has documented the effectiveness of fipronil against rice stem borer both as foliar application and granular application, due to its systemic activity and persistent toxicity. Sekh *et al*. (2007) revealed that fipronil 80 WG @ 40 & 50 g a.i./ha provided highly effective control of stem borer & leaf folder of rice. Sontakke and Dash (2000), who reported chlorpyriphos, ethoprophos, carbofuran, fipronil at 50 DAT afforded effective control of stem borer. Kamaljeet Singh Suri and Gurpreet Singh Makkar (2016) confirmed that fipronil 0.6% GR @ 50 and 60 g a.i/ha to be highly effective in providing outstanding control of the rice stem borers and rice leaffolder. Attributes including safety to natural enemies and no observable crop phytotoxicity even at the highest dosage of 60 g a.i/ha render it highly attractive tool for integrated pest management (IPM) in rice. Kulagod *et al*. (2011), who reported that cartap hydrochloride 50 SP @1 g/lit and fipronil 2.5 mL/lit recorded the lowest per cent of white ears and leaf damage, respectively.

Neena Bharti *et al.* (2018), reported that during kharif season 2014 and 2015 insect pest under study, the minimum infestation of stem borer is (3.2%) and (3.4%) respectively were recorded in treatment with nursery management with carbofuran 3G + 2 spray of fipronil 5% SC at 30 and 50 DAT in both years. Devi and Singh (2017), reported that the percentage mean leaf damage recorded in the plots treated with fipronil 80 WG @ 40 g a.i. ha^{-1} (0.40% LD), fipronil 0.3 G @ 50 g a.i. ha^{-1} (0.51% LD) and thiocloprid 21.70 SC @ 120 g a.i. ha^{-1} (0.43% LD) had non-significant difference from each other. However, all the insecticidal treatments effectively restricted the infestation due to leaf folder compared with untreated control. The effectiveness of flubendiamide, thiamethoxam and fipronil 80 WG in controlling the leaf folder might be attributed to their systemic action and long residual toxicity against the pest. Atanu Seni and Bhima Sen Naik, (2017) found that fipronil 5 SC @ 75 g a.i/ha treated plot had lower number of silver shoot (2.6%) incidence and rynaxypyr 20 SC @ 30 g a.i/ha treated plot recorded highest yield of 46.10 Qt/ha (>34% yield increase over control) followed by fipronil 5 SC @ 75 g a.i/ha (31.86, Qt/ha). Vimalkumar and Sanjaykumar (2017) revealed that the treatment fipronil 5 SC @ 75 gm a.i./ha treated plots showed lowest infestation (3.08 and 3.48%) and gave higher grain yield (40.00 and 37.7q/ha). Amol Madhukar Kakde and Patel, (2019) found that average highest yield (59.04 q/ha) was obtained in fipronil 0.3 G followed by spinosad 45 SC (57.21 q/ha) and they were at par with each other. Fipronil 0.3 G against yellow stem borer, *Scirpophaga incertulas* was recorded at 7 DAS on first spray and showed significant results. The lowest dead hearts were found in plots of fipronil 0.3 G (3.21%), followed by spinosad 45 SC (3.46%).

Table 1. Effect of fipronil 80 WG against rice leaf folder (Pooled mean of two seasons)

Treatments	First spray (Per cent leaf damage)*						Mean	PRC	Second spray (Per cent leaf damage)*					Mean	PRC
	PTC	3 DAT	5DAT	7 DAT	10DAT	15DAT			3 DAT	5DAT	7 DAT	10DAT	15DAT		
Fipronil 80 WG @ 30 g a.i. ha^{-1}	10.77	9.02^{c} (17.84)	8.19^{c} (16.63)	7.49^{c} (15.88)	8.02^{c} (16.45)	9.20^{c} (17.65)	8.78	38.00	8.38^{c} (16.83)	6.35^{d} (14.6)	5.45^{d} (13.50)	6.04^{d} (14.24)	7.04^{c} (165.39)	7.08	64.17
Fipronil 80 WG @ 40 g a.i. ha^{-1}	10.45	8.00^{ab} (16.43)	6.76^{ab} (15.06)	5.85^{ab} (13.99)	6.45^{b} (14.85)	7.55^{b} (15.95)	7.51	46.98	5.87^{ab} (14.02)	3.87^{bc} (11.34)	2.95^{bc} (9.89)	3.40^{bc} (10.63)	4.50^{ab} (12.25)	4.69	76.26
Fipronil 80 WG @ 50 g a.i. ha^{-1}	10.50	7.97^{ab} (16.4)	6.65^{ab} (14.94)	5.75^{ab} (13.87)	6.35^{ab} (14.59)	7.35^{ab} (15.73)	7.43	47.55	5.73^{ab} (13.85)	3.73^{abc} (7.8)	2.85^{abc} (9.71)	3.35^{abc} (10.55)	4.45^{ab} (12.18)	4.58	76.83
Fipronil 80 WG @ 80 g a.i. ha^{-1}	10.51	7.84^{ab} (16.26)	6.58^{ab} (14.86)	5.65^{ab} (13.75)	6.25^{ab} (14.47)	7.20^{ab} (15.56)	7.34	48.19	5.67^{ab} (13.77)	3.67^{ab} (11.04)	2.75^{ab} (9.60)	3.25^{ab} (10.39)	4.35^{ab} (12.04)	4.48	77.31
Fipronil 80 WG @ 100 g a.i. ha^{-1}	10.47	7.76^{a} (16.17)	6.49^{a} (14.76)	5.55^{a} (13.66)	6.00^{a} (4.18)	6.95^{a} (15.28)	7.20	49.14	5.56^{a} (13.64)	3.56^{a} (10.87)	2.65^{a} (9.37)	3.15^{a} (10.22)	4.25^{a} (11.90)	4.35	77.96
Fipronil 5 SC @ 40 g a.i. ha^{-1}	10.49	8.06^{b} (16.56)	6.90^{b} (15.17)	5.95^{b} (14.06)	6.55^{b} (14.82)	7.60^{b} (16.0)	7.59	46.40	5.92^{b} (14.08)	3.95^{c} (11.46)	3.00^{c} (9.97)	3.50^{c} (10.79)	4.60^{b} (12.38)	4.76	75.89
Fipronil 5 SC @ 50 g a.i. ha^{-1}	10.58	7.98^{ab} (16.42)	6.70^{b} (15.23)	5.76^{ab} (13.88)	6.45^{b} (14.71)	7.50^{b} (15.89)	7.50	47.08	5.80^{ab} (13.94)	3.85^{bc} (11.31)	2.90^{bc} (9.80)	3.45^{bc} (10.70)	4.50^{ab} (12.25)	4.67	76.37
Chlorpyriphos 20EC @ 200 g a.i. ha^{-1}	10.54	9.05c (17.51)	8.28^{c} (16.72)	7.53^{c} (15.93)	8.12^{c} (16.56)	9.40^{c} (17.85)	8.82	37.73	8.43^{c} (16.88	6.45^{d} (14.71)	5.53^{d} (13.60)	6.10^{d} (14.30)	7.11^{c} (15.47)	7.17	63.69
Untreated check	10.32	12.50^{d} (20.7)	13.50^{d} (21.56)	15.16^{d} (22.9)	16.00^{d} (23.58)	17.50^{d} (24.73)	14.16	-	18.11^{d} (25.19)	19.40^{e} (26.13)	20.50^{e} (26.92)	21.00^{e} (27.27)	22.00^{d} (27.97)	19.75	-

Table 2. Effect of fipronil 80 WG against rice stem borer (Pooled mean of two seasons)

Treatments	First spray (Per cent leaf damage)*						Mean	PRC	Second spray (Per cent leaf damage)*					Mean	PRC
	PTC	3 DAT	5DAT	7 DAT	10DAT	15DAT			3 DAT	5DAT	7 DAT	10DAT	15DAT		
Fipronil 80 WG @ 30 g a.i. ha^{-1}	10.68	8.52^{d} (16.97)	6.93^{c} (15.62)	6.15^{d} (14.35)	6.53^{c} (14.81)	7.98^{c} (16.41)	7.80	40.06	5.83^{c} (13.97)	4.86^{d} (12.71)	4.06^{d} (11.62)	5.25^{c} (13.25)	5.98^{d} (14.15)	5.66	68.00
Fipronil 80 WG @ 40 g a.i. ha^{-1}	10.52	7.00^{abc} (15.34)	5.55^{ab} (13.63)	5.07^{ab} (13.01)	5.74^{ab} (13.86)	6.71^{ab} (15.02)	6.77	48.00	4.03^{ab} (11.59)	2.90^{ab} (9.84)	1.96^{c} (8.87)	2.81b (9.64)	3.94^{b} (11.45)	3.73	78.94
Fipronil 80 WG @ 50 g a.i. ha^{-1}	10.57	6.96^{abc} (15.29)	5.41^{ab} (13.44)	4.84^{a} (12.71)	5.61^{ab} (13.71)	6.65^{ab} (14.94)	6.67	48.71	3.85^{ab} (11.31)	2.89^{ab} (9.78)	1.88^{b} (8.20)	2.68^{ab} (9.42)	3.82^{ab} (11.27)	3.63	79.48
Fipronil 80 WG @ 80 g a.i. ha^{-1}	10.68	6.77^{ab} (15.08)	5.15^{ab} (13.11)	4.68^{a} (12.49)	5.51^{a} (13.57)	6.42^{a} (14.68)	6.54	49.77	3.75^{ab} (11.16)	2.65^{ab} (9.37)	1.81^{b} (7.86)	2.60^{a} (9.29)	3.79^{ab} (11.23)	3.50	80.19
Fipronil 80 WG @ 100 g a.i. ha^{-1}	10.57	6.63^{a} (14.92)	4.98^{a} (12.88)	4.72^{a} (12.54)	5.40^{a} (13.43)	6.37^{a} (14.62)	6.45	50.46	3.69^{ab} (11.05)	2.51^{a} (9.12)	1.77^{a} (7.13)	2.56^{a} (9.21)	3.65^{a} (11.01)	3.43	80.63
Fipronil 5 SC @ 40 g a.i. ha^{-1}	10.79	7.58^{c} (15.97)	5.75^{b} (13.88)	5.56^{c} (13.63)	5.91^{b} (14.07)	6.95^{b} (15.17)	7.09	45.50	4.20^{b} (11.83)	3.24^{c} (10.36)	2.03^{c} (8.98)	2.77^{b} (9.58)	4.26^{c} (11.91)	3.91	77.90
Fipronil 5 SC @ 50 g a.i. ha^{-1}	10.72	7.42^{bc} (16.20)	5.66^{b} (13.76)	5.47^{bc} (13.51)	5.75^{ab} (13.87)	6.86^{b} (15.07)	6.98	46.35	4.14^{b} (11.75)	3.07^{bc} (10.10)	1.93^{c} (8.72)	2.60^{a} (9.29)	3.96^{b} (11.48)	3.76	78.74
Chlorpyriphos 20EC @ 200 g a.i. ha^{-1}	10.73	8.61^{d} (17.06)	7.15^{c} (15.51)	6.37^{d} (14.62)	6.78^{c} (15.10)	8.05^{c} (16.48)	7.95	38.91	6.07^{c} (14.26)	5.03^{d} (12.96)	4.11^{d} (11.69)	5.41^{c} (13.45)	6.14^{d} (14.35)	5.80	67.19
Untreated check	10.69	11.41^{e} (19.74)	12.37^{d} (20.59)	13.48^{e} (21.54)	14.74^{d} (22.58)	15.37^{d} (23.08)	13.01	-	16.07^{d} (23.64)	17.23^{e} (24.53)	18.22^{e} (25.27)	18.99^{d} (25.83)	20.23^{e} (26.73)	17.69	-

Table 3. Phytotoxic effect of fipronil 80 WG on paddy white ponni

S. No.	Treatments	Phytotoxicity rating *					
		Leaf tip injury	Wilting	Vein clearing	Necrosis	Epinasty	Hyponasty
1.	Fipronil 80 WG @ 50 g a.i. ha^{-1}	0	0	0	0	0	0
2.	Fipronil 80 WG @ 100 g a.i. ha^{-1}	0	0	0	0	0	0
3.	Fipronil 80 WG @ 200 g a.i. ha^{-1}	0	0	0	0	0	0
4.	Untreated check	0	0	0	0	0	0

* Observed at 1, 3, 5, 7, 10 and 14 days after each spraying and the data represent the mean of three replications.

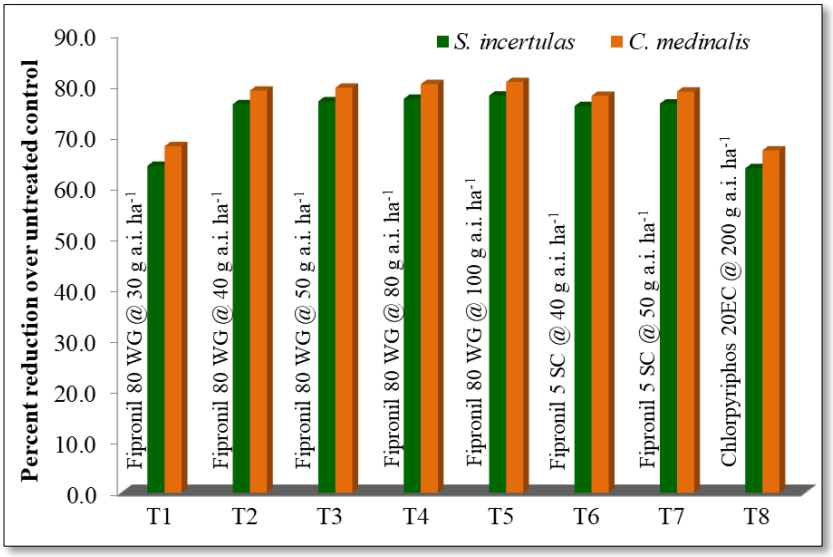

Fig.1. Effect of fipronil 80 WG against leaf folder and rice stem borer

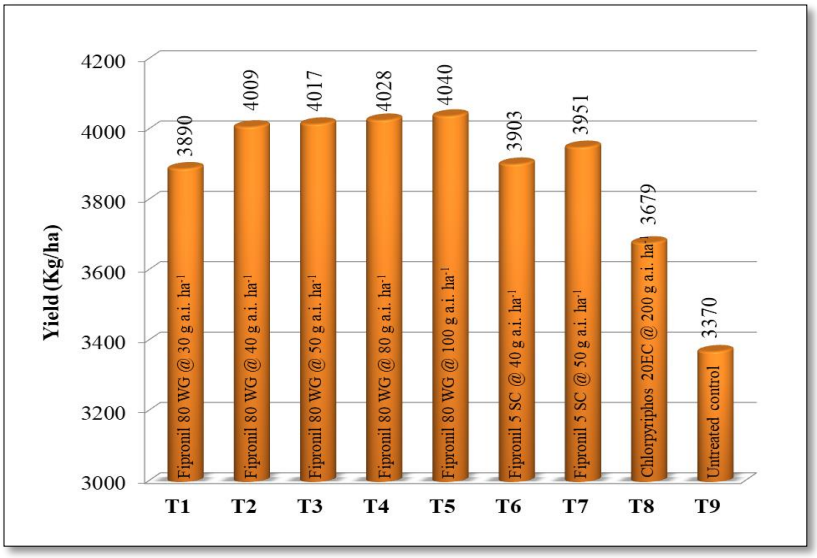

Fig 2. Impact of Insecticides on yield of paddy

CONCLUSION

Fipronil 80 WG @ 50 g a.i. ha^{-1} recorded the highest percent reduction of leaf folder and stem borer in paddy with significantly increased yield and registered on par with treatments of its higher dose. Hence, fipronil 80 WG @ 50 g a.i. ha^{-1} is recommended for the management of leaf folder and stem borer in paddy ecosystem.

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Ethics statement

No specific permits were required for the described field studies because no human or animal subjects were involved in this research.

Originality and plagiarism

The authors assure that the contents were written by us and were not plagiarized.

Consent for publication

All the authors agreed to publish the content.

Competing interests

There were no conflict of interest in the publication of this content

Data availability

All the data of this manuscript are included in the MS. No separate external data source is required. If anything is required from the MS, certainly, this will be extended by communicating with the corresponding author through corresponding official mail.

Author contributions

Idea conceptualization – BVK; Experiments – PK,VM, PT; Guidance - BVK, Writing original draft - PK,VM, PT; Writing - reviewing & editing – BVK, PK.

REFERENCES

Amol Madhukar Kakde and K.G. Patel. 2019. Yield performance of different insecticides against rice yellow stem borer, *Scirpophaga incertulas* WLK. *Rice Res.*, **7**: 203. doi:10.4172/2375-4338.1000203

Anonymous, 2022. Commodity Intelligence Report. International Production Assessment Division, Global Market Analysis, Foreign Agricultural Service, United States Department of Agriculture. Web: https://ipad.fas.usda.gov.

Atanu Seni and Bhima Sen Naik, 2017. Efficacy of some insecticides against major insect pests of rice, *Oryza sativa* L. *J. Entomol. Zool. Stud.,* **5(4)**: 1381-1385.

Behura, N., Sen, P. and Meera Kar. 2011. Introgression of yellow stem borer (*Scirpophaga incertulus*) resistance genes into cultivated rice (*Oryza sp.*) from wild species. *Indian J. Agric. Sci.*, **81(4)**: 359-362. https://epubs.icar.org.in/index.php/IJAgS/article/view/5375

Devi, P.R. and K.L. Singh. 2017. Efficacy of new molecules, spinosad and monocrotophos on the incidence of *Cnaphalocrocis medinalis* guenee under *kharif* rice crop ecosystem of manipur valley. *Int. J. Agric. Sci. Res.,* **6(1)**: 7-14.

Dhaka, S.S., Sachan, S. K., Prajapati, C. R., Ali, N. and R. Singh. 2009. Efficacy of novel insecticides against yellow rice stem borer, *Scirpophaga incertulus* (Walk.) and predators in rice. *Ann. Entomol.,* **27(1-2)**: 71-76.

Dhaka, S. S., Prajapati, C. R., Singh, D. V. and R. Singh. 2011. Field evaluation of insecticides and bio-pesticides against rice leaf folder, *Cnaphalocrocis medinalis* (Guenee). *Ann. Plant Prot. Sci.,* **19(2):** 324-326.

Dhaka, S.S., Singh, G., Yadav, A., Ali, N. and D. V. Singh. 2012. Evaluation of some novel insecticides against rice leaf folder, *Cnaphalocrocis medinalis* (Guenee). *Progress. Agric.,* **12(2)**: 360-364.

Duncan, D.B. 1951. A Significance test for differences between ranked treatments means in an analysis of variance. *Va. J. Sci.*, **2**: 171-189.

Gomez, K.A. and A.A. Gomez. 1984. Statistical Procedures for Agricultural Research, 2nd edition. John Wiley and Sons Inc, New York, USA. 704 pp.

Kamaljeet Singh Suri and Gurpreet Singh Makkar. 2016. Efficacy assessment of fipronil 0.6% GR against rice stem borers and leaffolder. *J. Exp. Zool.,* **19(2)**: 857-861.

Kulgagod, S D., Hegade. M., Nayak. G. V., Vastrad. A. S., Hugar, P. S and K. Basavanagoud. 2011. Evaluation of insecticides and biorationales against yellow stem borer and leaf folder in rice crop. *Karnataka J. Agric. Sci.,* **24(2)**: 244-246.

Kuttalam, S., Kumaran, N., Boomathi, N. and B. Vinothkumar. 2008. Bioefficacy of fipronil 80 WDG against rice stem borer *Scirpophaga incertulas* Walker. *Pestology*, **32(6)**: 28-31.

Mahal, M.S., Sarao, P.S. and M.L. Singla. 2008. Bioefficacy of Fipronil 80 WG for the control of stem borer and leaf folder in Basmati rice. *Indian J. Plant Prot.,* **36**: 260-262.

Neena Bharti, Uday Kumar Singh, Vinay Kumar and Anil Kumar. 2018. Evaluation of insecticides and biopesticides against rice stem borer (*Scirpophaga incertulas)* and Leaf Folder (*Cnaphalocrosis medinalis*) in Kharif rice under farmers' field condition. *Int. J. Curr. Microbiol. Appl. Sci.,* Special Issue - **7**: 3436 - 3441.

Panda, S.K., Nayak, S.K. and U.K. Behera. 2004. Field efficacy of some insecticides against the rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) and whorl maggot, *Hydrellia philippina* (Ferino). *Pest Mgt.& Eco. Zoo.,* **7(1)**: 55-59.

Rani, W.B., Amutha, R., Muthulakshmi, S., Indira, K. and P. Mareeswari. 2007. Diversity of rice leaf folders and their natural enemies. *Res. J. Agric. Bio. Sci.,* **3(5)**: 394-397.

Satyanarayana, P., Raghuraman, M. and Santeshwari. 2014. Evaluation of phenyl pyrazole for the management of yellow stem borer *Scirpophaga incertulas* Walker, in rice. *Int. J. Pl. Prot.,* **7(2)**: 360 - 363.

Sekh, K., Nair, N., Chakraborty, S. and A. K. Somchoudhury. 2007. Efficacy of fipronil 80% against stem borer and leaf folder. *Pestology*. **31(1)**: 39 - 41.

Singh, P., Singh, R., Dhaka, S.S., Kumar, D., Kumar, H. and N. Kumari. 2015. Bioefficacy of insecticides and bio-pesticides against yellow stem borer, *Scirpophaga incertulus* (walk.) and their effect on spiders in rice crop. *South Asian J. Food Sci. Technol.,* **1(2)**:179-183.

Singh, A.K. and R.N. Singh. 2005. Screening of rice (*Oryza sativa* L.) germplasm resistant to leaf folder (*Cnaphalocrocis medinalis* Guen). *J. App. Biol.,* **11(1/2)**:10-13.

Singh, D., Bhatnagar, P., Om, H. and R. S. Sheokhand., 2010. Efficacy of insecticides against stem borer and leaf hopper. *Environ. Ecol.*, **20(2)**: 884-886.

Sontakke, B.K. and A.N. Dash. 2000. Field efficacy of some new granular insecticides against major pests of rice. *Ind. J. Entomol.,* **62:** 353-357.

Vimal Kumar and Sanjay Kumar. 2019. Evaluation of Novel Groups of Insecticides against Leaf Folder, *Cnaphalcrocis medinalis* (*Guenee*) in Rice Crop. *Int. J. Curr. Microbiol. Appl. Sci.,* **6(9)**: 442 – 448.