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Efficacy of Ferterra 0.4% GR (chlorantraniliprole) against stem borers and leaffolder insect-pests of *basmati* rice

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Abstract

Field experiments were conducted during three *kharif* seasons from 2009 to 2011 at Sudhar village, Ludhiana and Rice Research Area of Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana. Four doses of Ferterra 0.4% GR (chlorantraniliprole) a new chemistry @ 20, 30, 40 and 50 g a.i. ha^{-1} and standard check Cartap hydrochloride 4 G @ 1000 g a.i. ha^{-1} was tested against stem borers and leaffolder infesting *basmati* rice. Over the years, dead heart in all the Ferterra doses and standard check (1.01-1.80 %) were at par 70 DAT, whereas, at 80 DAT doses @ 40, 50 and standard check were at par (1.04-1.13 %) but significantly better than lower doses and untreated control. Similarly, over the years, Ferterra doses @ 40 and 50 g a.i. ha^{-1} was significantly better than control in reducing white ear incidence, whereas, at 30 g a.i. ha^{-1} and standard check intermediately reduced the white ears incidence. Leaffolder infestation at all the Ferterra doses were at par with standard check 70 DAT (2.69-3.87 %), whereas, 80 DAT, Ferterra doses @ 30, 40, 50 and standard check were at par (2.95-3.49 %) but significantly better than lower dose and untreated control. Over the years the cost : benefit ratio was maximum (1 : 23.67) in the Ferterra @ 40 g a.i. ha^{-1} dose followed by 50 g a.i. ha^{-1} dose.

Key words

Basmati rice, Ferterra 0.4% GR, Insecticide, Leaffolder, Stem borers

Introduction

Rice is the most important food crop that has been improved since its domestication about 8000 years ago. It is the staple food of half of the world's population. India leads the world in rice area with 41.85 m ha with a production of 102 m tonnes, but productivity is only 75 % of the world average of 4.02 tonnes ha^{-1} (Anonymous, 2012). Rice being the major crop of the Punjab state, has been cultivated over on area of 2.80 million ha, with an annual production of 11.24 million tonnes, whereas *basmati* occupy 15 % area of rice area (Anonymous, 2012a).

Insect-pests are the major constraints in enhancing rice productivity, besides diseases and weeds (Behura *et al*., 2011). More than 100 species of insects are known as pests of this crop, out of which 20 are of major economic significance. The rice leaffolder (RLF), *Cnaphalocrocis medinalis* (Guenée) earlier considered as a minor pest has gained the status of major pest with the widespread of high-yielding rice varieties and the accompanying changes in cultural practices (Teng *et al.,* 1993). Larva fastens the edges of leaves together, fold them longitudinally and feed on green matter from inside the folded leaf. Damaged leaves produce white streaks, become membranous and ultimately reduces photosynthetic activity of the plant. It was most widely spread and damage caused due to this species ranged from 18.30 to 58.40 % (Ramasamy and Jaliecksono, 1996), depending on the stage of the crop at the time of infestation. The infested rice plants are also predisposed to bacterial and fungal infection, sheath rot, difficulty in heading and massive yield loss at the reproductive stage. Alvi *et al*. (2003) recorded that RLF caused 63 to 80 % yield loss in rice in Pakistan. Arshad *et al*. (2012) reported percentage of filled grains, 1000-grain weight and grain yield varied significantly with RLF infestation levels.

Among stemborers, the yellow stemborer (YSB), *Scirpophaga incertulas* (Walker) is the dominant species in India and rice plants are most prone to stemborer infestation at the

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tillering and flowering stages. YSB inflicted 18 to 40 % damage to the rice crop (Anonymous, 2006). Stem borer larvae after emerging from egg mass enter the tiller to feed inside it and damages the central whorl, that turn brownish and dries resulting in "dead hearts". The affected tillers do not grow further and dries up. At reproductive stage, the damage is characterized by whitish, erect and chaffy panicles called, "white ears". Muralidharan and Pasalu (2006) reported that due to 1 % dead heart or white ear, or due to both phases stem borer damage would be 2.5, 4.0, and 6.4 % yield loss, respectively. In general, yield loss due to insect pests of rice has been estimated at about 25 % (Dhaliwal *et al.,* 2010). Rice is essentially a crop of warm, humid environment which is conducive to survival and proliferation of lepidopteron insect-pests like stemborers and rice leaffolder. Farmers still consider application of insecticides as the key component of Integrated Pest Management. Hence, chlorantraniliprole a new chemical was evaluated for its bio-efficacy against the stemborers and leaffolder infesting *basmati* rice.

Materials and Methods

Raising of Nursery Bed : Field experiments were conducted during *kharif* seasons at Sudhar village, Ludhiana in 2009 and Rice Research Area of Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana in 2010 and 2011. Rice variety, Pusa Basmati 1121 was sown in well prepared field in farmer's field on 26th June, 2009 while, at PAU Punjab Basmati 2 were sown in well prepared seed beds of 5 m x 0.5 m on 13th and 15th June during 2010 and 2011, respectively. The nursery was raised as per agronomic practices of PAU Package of Practices for *kharif* crops under unsprayed conditions (Anonymous, 2012).

Crop transplanting : The evaluation of insecticides was done in a randomized block design, with three replications. Two seedlings hill^{-1} of each variety was transplanted in a plot size of 5 x 5 m^2 on 28th, 13th and 15th July during 2009, 2010 and 2011, respectively. Row to row spacing was maintained at 0.20 m. Individual plots were separated by bunds and water channels to regulate water flow and prevent movement of water and insecticide from one plot to other. Urea was applied @ 0. 100 t ha^{-1}in two equal splits one at three and thereafter at 6 weeks, after transplantation.

Four doses of Ferterra 0.4% GR (chlorantraniliprole) at 20, 30, 40 and 50 g a.i. ha^{-1} was tested on *basmati* rice during 2009 to 2011 crop season. Cartap hydrochloride 4 G @ 1000 g a.i. ha^{-1} was used and kept as standard check. An untreated control was also kept for comparison purpose. All the application was done when the damage by stem borers exceeded 2 % deadheart in the plots. Stem borer damage was recorded at vegetative stage as deadheart (DH) and total tillers and per cent damage was worked. Similarly, white ear (WE) and panicle bearing tillers were recorded at harvest and per cent damage was worked out.

For assessing leaffolder damage, the leaf was considered to be damaged by the leaffolder if, at least one-third of its area was showing leaf damage symptoms. Leaf damage was recorded from 10 hills, selected at random in a replication from each plot. For this, total number of leaves per hill and damaged leaves were recorded and percent damage was worked out. The yield was also recorded on whole plot basis.

Benefit-cost ratio : This ratio was calculated by dividing the benefit in terms of increased crop value when a insecticide was used, by the cost of the insecticide treatment.

Statistical analysis : The data pertaining to the incidence of rice insect-pests, *viz*., stem borers and leaffolder were statistically analyzed with analysis of variance (ANOVA), using Minitab 15 software. The different treatment means were separated by least significant difference test (LSD) at p=0.05 (Gomez and Gomez, 1984).

Results and Discussion

The stem borer infestation was recorded on the basis of dead hearts and white ears. All the insecticides significantly reduced the dead hearts as compared to control. During 2009, in all the observations per cent dead hearts were significantly low in insecticide treated plots except at 20 g a.i. ha^{-1} dose of ferterra than control (Table 1). Ferterra doses @ 30, 40 and 50 g a.i. ha^{-1} were at par with standard check at 70 DAT. At 80 DAT, dead heart damage was significantly low in 50 g a.i. ha^{-1} and standard check, whereas, ferterra @ 30 and 40 g a.i. ha^{-1} intermediately control the dead heart damage (Table 1). During 2010, in all the observations, per cent dead hearts were significantly low in the insecticide treated plots than control (Table 2). Ferterra @ 30 and 40 g a.i. ha^{-1} were at par with standard at 70 DAT observations, whereas, ferterra @ 40 and 50 g a.i. ha^{-1} were at par with standard 80 DAT (Table 2). During 2011, ferterra doses @ 40 and 50 g a.i. ha^{-1} were at par with the standard 70 DAT, whereas, at 80 DAT all the insecticides were at par with each other and significantly better than the control (Table 3).

The average of dead heart damage during all the years, insecticide treatments were significantly better than control. All the Ferterra doses and standard check were at par at 70 DAT but significantly better than control ($F_{5,10}$ = 10.55, P=0.001) (Table 4). At 80 DAT, ferterra doses @ 40, 50 and the standard check were at par but significantly better than lower doses and untreated check ($F_{5,10}$ = 22.66, P=0.0001). These studies were corroborated by the studies of Wakil *et al*. (2001) who reported the efficacy of furadan, a granular insecticide against stem borer on *basmati* rice. Karthikeyan *et al*. (2008) also acknowledged that the phosphamidon granules were highly effective in managing *S. incertulas* in rice. Singh *et al*. (2009) proclaimed the efficacy of another granular insecticide, phorate against the stem borers. Similarly, Dhawan *et al*. (2010) also reported that dead heart incidence was significantly low in 500 g a.i. ha^{-1} dose of thiocyclam

hydrogen oxalate 4 G. Earlier also some scientists approved the efficacy of insecticides against stem borers (Sarao and Mahal, 2008; Gupta *et al*., 2008; Rath, 2012).

All the insecticides significantly reduced the white ears as compared to control during all the years of observations. During 2009 and 2010, in all the observations, per cent white ears were significantly low in the insecticide treated plots than control. All the insecticide doses were on a par with standard check (Table 1, 2). However, during 2011, ferterra doses @ 30 and 40 g a.i. ha^{-1} were at par with the standard check (Table 3).

The average of white ear damage in insecticide treatments during all the years was significantly less than untreated control ($F_{5,10}$=46.39, P=0.0001) (Table 4). Ferterra dose @ 40 and 50 g a.i. ha^{-1} was significantly better than control, whereas, 30 g a.i. ha^{-1} and the standard check intermediately reduced the white ears than other insecticides. These studies are in confirmation with the earlier studies of Sontakke and Dash (2000) who substantiated that application of chlorpyriphos, triazophos, ethoprophos, carbofuran and fipronil at 50 DAT effectively controlled stem borer. Singh *et al*. (2005) reported about the effectiveness of fipronil, chlorpyriphos and cartap hydrochloride granules against stem borer. Mahal *et al*. (2008) observed that the tested dose of fipronil 80 WG significantly reduced the white ear damage in *basmati* rice. Dhawan *et al.* (2010) reported that white ear incidence was significantly low in all the test doses of thiocyclam hydrogen oxalate 4 G. Similarly, Rath *et al*. (2010) also conceded the efficacy of different insecticides in controlling the incidence of stem borer.

All the insecticides significantly reduced the leaffolder damaged leaves as compared to control. During 2009, in the entire observations per cent leaffolder damaged leaves were significantly low in the insecticide treated plots than control. At 70 DAT, standard check and ferterra @ 50 g a.i. ha^{-1} gave better control (Table 1). However, at 80 DAT all the insecticide doses were at par with standard check in controlling leaffolder damage (Table 1). During 2010, the entire observations per cent leaffolder damaged leaves were significantly low in the insecticide treated plots than control. At 70 DAT, ferterra @ 30, 40 g a.i. ha^{-1} was at par with the standard check (Table 2). Whereas, at 80 DAT observations, ferterra @ 30, 40 and 50 g a.i. ha^{-1} was at par with standard check (Table 2). During 2011, all the insecticide treatments were at par but significantly better than control 70 DAT. At 80 DAT, ferterra doses @ 30, 40 and the standard check were at par in controlling leaffolder damage (Table 3).

Table 1: Efficacy of Ferterra 0.4% GR against stem borers and leaffolder insect-pests of *basmati* rice during *kharif* 2009

Insecticide	Dose (g a.i. ha^{-1})	Formulation (kg ha^{-1})	Dead heart damage (%)		Leaffolder damage (%)		White ear damage(%)	Yield (Q ha^{-1})
			70 DAT	80 DAT	70 DAT	80 DAT		
Ferterra 0.4% GR	20	5	1.78^{b}(7.65)	1.61^{c}(7.27)	1.62^{c}(7.29)	2.39^{a}(8.85)	1.19^{a}(6.16)	36.46^{b}
Ferterra 0.4% GR	30	7.5	1.63^{ab}(7.27)	1.46^{ab}(6.91)	1.59^{bc}(7.18)	1.80^{a}(7.70)	1.12^{a}(5.95)	36.25^{b}
Ferterra 0.4% GR	40	10	1.16^{a}(6.13)	1.04^{ab}(5.81)	1.29^{abc}(6.48)	1.79^{a}(7.65)	0.53^{a}(3.38)	46.87^{a}
Ferterra 0.4% GR	50	12.5	1.19^{a}(6.23)	0.89^{a}(5.32)	1.24^{ab}(6.37)	1.72^{a}(7.48)	0.82^{a}(5.09)	49.37^{a}
Cartap hydrochloride 4 G	1000	25	1.24^{a}(6.34)	0.96^{a}(5.53)	1.14^{a}(6.09)	1.70^{a}(7.44)	1.31^{a}(6.41)	47.92^{a}
Untreated control	-	-	2.48^{c}(9.04)	3.17^{d}(10.21)	4.29^{d}(11.94)	7.04^{b}(15.33)	4.38^{b}(12.06)	33.33^{b}
CD (p=0.05)			(1.15)	(1.63)	(0.86)	(1.75)	(3.31)	8.68

Figures in bracket are arc sine transformed values; Variety: Pusa Basmati 1121

Table 2 : Efficacy of Ferterra 0.4% GR against stem borers and leaffolder insect-pests of *basmati* rice during *kharif* 2010

Insecticide	Dose (g a.i. ha^{-1})	Formulation (kg ha^{-1})	Dead heart damage (%)		Leaffolder damage (%)		White ear damage(%)	Yield (Q ha^{-1})
			70 DAT	80 DAT	70 DAT	80 DAT		
Ferterra 0.4% GR	20	5	2.01^{b}(8.09)	2.33^{b}(8.72)	6.17^{b}(14.34)	6.81^{b}(15.11)	1.93^{a}(7.97)	33.55^{c}
Ferterra 0.4% GR	30	7.5	0.92^{a}(5.39)	1.97^{b}(8.04)	3.58^{a}(10.87)	3.69^{a}(11.06)	1.86^{a}(7.65)	36.06^{b}
Ferterra 0.4% GR	40	10	1.03^{a}(5.73)	1.09^{a}(5.92)	4.11^{a}(11.60)	3.25^{a}(10.34)	1.46^{a}(6.93)	44.44^{a}
Ferterra 0.4% GR	50	12.5	1.37^{ab}(6.39)	1.11^{a}(5.97)	4.66^{ab}(12.41)	3.31^{a}(10.45)	1.45^{a}(6.92)	44.99^{a}
Cartap hydrochloride 4 G	1000	25	0.74^{a}(4.94)	0.87^{a}(5.34)	3.36^{a}(10.46)	2.67^{a}(9.39)	1.22^{a}(6.25)	42.92^{a}
Untreated control	-	-	3.58^{c}(10.88)	3.62^{c}(10.85)	10.35^{c}(18.74)	15.15^{c}(22.88)	4.62^{b}(12.36)	31.37^{d}
CD (p=0.05)			(2.28)	(1.95)	(2.23)	(1.79)	(2.44)	2.50

Figures in bracket are arc sine transformed values; Variety: Punjab Basmati 2

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Table 3 : Efficacy of Ferterra 0.4% GR against stem borers and leaffolder insect-pests of *basmati* rice during *kharif* 2011

Insecticide	Dose (g a.i. ha^{-1})	Formulation (kg ha^{-1})	Dead heart damage (%)		Leaffolder damage (%)		White ear damage(%)	Yield (Q ha^{-1})
			70 DAT	80 DAT	70 DAT	80 DAT		
Ferterra 0.4% GR	20	5	1.60^{ab}(7.21)	1.89^{a}(7.88)	3.83^{a}(11.27)	5.60^{b}(13.66)	2.08^{b}(8.29)	36.93^{b}
Ferterra 0.4% GR	30	7.5	1.69^{b}(7.37)	1.57^{a}(7.10)	3.97^{a}(11.45)	4.97^{ab}(12.82)	1.76^{ab}(7.57)	38.79^{ab}
Ferterra 0.4% GR	40	10	1.04^{a}(5.86)	1.25^{a}(6.35)	3.72^{a}(11.06)	4.56^{ab}(12.29)	1.47^{ab}(6.91)	40.23^{a}
Ferterra 0.4% GR	50	12.5	1.03^{a}(5.81)	1.33^{a}(6.52)	3.43^{a}(10.66)	3.82^{a}(11.18)	1.14^{a}(6.13)	40.53^{a}
Cartap hydrochloride 4 G	1000	25	1.05^{a}(5.88)	1.29^{a}(6.42)	3.57^{a}(10.85)	4.67^{ab}(12.45)	1.44^{ab}(6.82)	39.20^{a}
Untreated control	-	-	4.98^{c}(12.89)	5.76^{b}(13.87)	17.19^{b}(24.48)	16.83^{c}(24.20)	5.77^{c}(13.88)	28.39^{c}
CD (p=0.05)			(1.44)	(1.88)	(1.85)	(2.28)	(1.54)	1.90

Figures in bracket are arc sine transformed values; Variety: Punjab Basmati 2

Table 4 : Mean of all the years regarding efficacy of Ferterra 0.4% GR against stem borers and leaffolder insect-pest of *basmati* rice

Insecticide	Dose (g a.i. ha^{-1})	Formulation (kg ha^{-1})	Dead heart damage (%)		Leaffolder damage (%)		White ear damage(%)	Yield (Q ha^{-1})
			70 DAT	80 DAT	70 DAT	80 DAT		
Ferterra 0.4% GR	20	5	1.80^{ab}(7.69)	1.94^{b}(7.99)	3.87^{a}(10.99)	4.93^{b}(12.56)	1.73^{b}(7.51)	35.65^{d}
Ferterra 0.4% GR	30	7.5	1.41^{ab}(6.77)	1.67^{bc}(7.40)	3.05^{a}(9.88)	3.49^{ab}(10.55)	1.58^{ab}(7.18)	37.03^{c}
Ferterra 0.4% GR	40	10	1.08^{ab}(5.95)	1.13^{ab}(6.08)	3.04^{a}(9.77)	3.20^{a}(10.13)	1.15^{a}(6.02)	43.85^{ab}
Ferterra 0.4% GR	50	12.5	1.20^{ab}(6.27)	1.11^{ab}(6.02)	3.11^{a}(9.84)	2.95^{a}(9.76)	1.14^{a}(6.08)	44.96^{a}
Cartap hydrochloride 4 G	1000	25	1.01^{a}(5.73)	1.04^{a}(5.83)	2.69^{a}(9.19)	3.01^{a}(9.79)	1.32^{ab}(6.60)	43.35^{b}
Untreated control	-	-	3.68^{c}(10.95)	4.18^{d}(11.70)	10.61^{b}(18.40)	13.00^{c}(20.83)	4.92^{c}(12.79)	31.03^{e}
CD (p=0.05)			(1.89)	(1.47)	(3.50)	(2.40)	(1.18)	0.17

Figures in bracket are arc sine transformed values

The average of folded leaf damage during all the years, the insecticide treatments were significantly better than control. All the ferterra doses were at par with standard check 70 DAT, but significantly better than control ($F_{5,10}$ = 9.44, P=0.0012) (Table 4). At 80 DAT, ferterra doses @ 30, 40, 50 and the standard check were at par but significantly better than lower dose and control ($F_{5,10}$ = 32.24, P=0.0001). These observations were corroborated by the findings of Prasad *et al*. (1995) who reported the efficacy of cartap hydrochloride in reducing the leaffolder damage. Zhu *et al*. (2002) reported that 5% SC formulation of fipronil @ 5 ml mu^{-1} controlled the early instar larvae of leaffolder. Karthikeyan *et al*. (2008) reported that the phosphamidon granules were highly effective in managing *C. medinalis* in rice. The findings were also endorsed by Mahal *et al*. (2008) who submitted that the tested dose of fipronil 80 WG significantly reduced the leaffolder damage in *basmati* rice. Bhutto and Soomro (2009) reported the efficacy of different granular insecticide of 4G formulation against yellow stem borer under field conditions. Dhawan *et al.* (2010) found that leaffolder incidence was significantly low at all the doses of thiocyclam hydrogen oxalate 4 G. Similarly, Kumar *et al*. (2010) demonstrated the efficacy of controlled release formulations of cartap hydrochloride against leaffolder. Several other scientists (Sarao and Mahal, 2008; Chander and Palta, 2008; Dash, 2007; Zafar, 1991) also conceded the efficacy of insecticides against leaffolder.

During the year 2009, 2010 and 2011 the yield in ferterra doses @ 40 and 50 g a.i. ha^{-1} was at par with the standard check (Table 1, 2, 3). Over the years, yield differed significantly ($F_{5,10}$ = 14.37, P=0.0003) and was highest at 50 g a.i. ha^{-1} followed by 40 g a.i. ha^{-1} and check insecticide (Table 4). Wakil *et al.* (2001) also observed highest yield in case of furadan application on *basmati* rice. Mahal *et al*. (2008) proclaimed that all the tested doses of fipronil 80 WG gave significantly better yield than control. Bhutto and Soomro (2009) reported that the application of granular insecticide of 4G formulation increased the paddy yield. Dhawan *et al.* (2010) reported that yield was at par with different doses of thiocyclam hydrogen oxalate 4 G and check insecticide. Over the years, C : B ratio was maximum (1 : 23.67) in ferterra @ 40 g a.i. ha^{-1} (i.e. 10 kg ha^{-1}) dose followed by 50 g a.i. ha^{-1} dose.

The new molecule Ferterra 0.4% GR (chlorantraniliprole) @ 40 g a.i. ha^{-1} was effective in the management of rice stem borers and leaffolder on *basmati* rice and gave highest cost : benefit ratio. It will enhance the choice of farmers in selecting chemicals from different groups.

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