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Evaluation of Newer Insecticides against Rice Earhead bug (*Leptocorisa acuta* Thunberg)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A study was conducted to evaluate the efficacy of newer insecticides in managing rice earhead bug, *Leptocorisa acuta* Thunberg during the Kharif season of 2020. The treatments included two sprays of Imidacloprid 17.8 SL @ 300 ml/ha, Thiamethoxam 25 WG @100 gm/ha, Dinotefuran 20 SG@200 gm/ha, Clothianidin 50 WDG @ 50 gm/ha, Acetamiprid 20 SP@ 50 gm/ha,

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Chloropyriphos 50 EC + Cypermethrin 5% EC @1200 ml/ha and untreated control. The presence of earhead bugs was observed from the tillering stage to the harvesting stage of the crop, with the highest population recorded at 16.50 bugs per hill during mid-October. Among the six insecticidal treatments tested Dinotefuran demonstrated the highest efficacy against earhead bugs and resulted in least panicle and grain damage during the 1st and 2nd spray applications, respectively. Dinotefuran 20SG can be considered a promising option for managing rice earhead bugs to mitigate potential yield losses.

Keywords: Insecticides; earhead bugs; modern agriculture; pest management.

1. INTRODUCTION

"Rice, *Oryza sativa* L. (Family: Poaceae) is the most important food crop for more than two-thirds population of India and more than fifty percent of the world population. Almost 90% of rice is produced and consumed in Asian countries like China, India, Japan, Korea Republic, Srilanka, Pakistan, Bangladesh", *etc.*, (Nadaf *et al.* 2016). India is the second-largest producer of rice in the world (Ghoghari et al., 2019; Panse et al., 2016; Rath et al., 2015).

"The United States Department of Agriculture estimates that the World Rice Production 2020-21 will be 503.17 million metric tons, around 1.97 million tons more than the previous month's projection" (Ashokappa et al., 2015; Baharally et al., 2014). "Rice Production last year was 496.40 million tons. This year's 503.17 estimated million tons could represent an increase of 6.77 million tons or 1.36% in rice production around the globe" (WorldAgricultural Production.com). "India's rice production is estimated at a record 102.36 million tonnes in the Kharif season of 2020-21 crop year on the back of good monsoon rains and acreage, according to government data" (Bloomberg | Quint).

In modern agriculture, high-yielding rice varieties are extensively grown with the use of fertilizers and manures (Bisen et al., 2019; Konchada et al., 2017). Such a cultivation pattern of rice accidentally or inadvertently offers infestation of a large number of insect pests, which results in severe loss in crop yields (Kumar et al., 2009; Pangtey, 1990). More than 100 species of insects have been recorded as a pest of rice, of which, *Scirpophaga incertulas* (Walker), *Nilaparvata lugens* (Stal), *Sogatella furcifera* (Horváth), *Cnaphalocrocis medinalis* (Guenée), *Nymphula depunctalis* (Guenée) *Orseolia oryzae* (Wood-Mason), and *Leptocorisa acuta* (Thunberg)are major pests (Gupta et al., 2019).

"The rice earhead bug, *L. acuta* also known as "gundhi bug" is one of the serious sap-sucking pests of paddy" (Hashmi *et al*. 1983; Kumari et al., 2020). "Both the nymphs and adults suck the sap from developing grains at the milky stage, rendering them fragmentary or entirely chaffy" (Horowitz et al., 2004). "The panicle is completely shattered and becomes white-colored under grievous infestation at the growing stage" (Israel & Rao, 1961; Kumbhar & Singh, 2020). "The pest appears on rice just before the flowering stage and continues until panicles ripen" (Roshan et al., 2016; Saeed et al., 2018). "Desapping of the peduncle, leaves, and stem causes shrivelled and chaffy grains, and the feeding site promotes the development of sooty mould resulting in a yield loss of up to 30%" (Tiwari *et al.,* 2014; Kencharaddi & Balikai, 2012). "Heavy infestation can result in 80% (Maharashtra) or total (Malaysia) loss of the crop" (Schaefer & Panizzi, 2000). "It is estimated that *L. oratorious* may damage 6.4 to 7.7 rice grains/day/adult when released in caged rice plants with the panicle at the flowering stage" (Schaefer & Panizzi, 2000; Kundoo et al., 2018). "Wild rice is an alternate host for earhead bugs. Rainfall is not only important for survival but also disposal of the insect population" (Sharma et al., 2019; Hossain et al., 2013).

"Among the various methods, the application of insecticides is one of the most effective methods of pest control and it yields quick results, supporting its application in integrated pest management strategies" (Kilpatrick et al., 2005; Li et al., 2018). "However, the persistent use of the same insecticides or group of insecticides having the same mode of action will become less effective against insects because of developing possible resistance" (Sharma et al., 2019; Arbabtafti et al., 2014; Padhan & Raghuraman, 2018). Hence, the application of various neonicotinoid insecticidal formulations gives effective control of rice earhead bugs (Sangamithra et al., 2018; Singh et al., 2009). The present study was undertaken to evaluate a few of the newer insecticide combinations with a different novel mode of action against *L. acuta*.

2. MATERIALS AND METHODS

The work was carried out at College of Agriculture, Murjhad Farm, Waraseoni, Balaghat, Madhya Pradesh during kharif, 2020 in an irrigated transplanted rice ecosystem. The experiment was laid out in randomized block design (RBD) with 7 treatments, replicated thrice on the variety MTU-1010. A plot size of 5 x 3 m was maintained for each treatment with 15 cm plant-to-plant and 20 cm row-to-row spacing. All agronomical practices along with recommended dose fertilizers were followed for uniform crop raising.

All the liquid formulations were applied by spraying high-volume water-diluted spray with a knapsack sprayer. The pre-treatment observations on the number of adults and nymphs of earhead bugs, panicle, and hill damage were made on 10 tagged hills of every plot 24 hours before spray. The post-treatment observation was taken on these parameters on the 3rd, 5th, 7th, and 10th day after the first and second spraying and the mean population was expressed on a hill basis. At harvest, 15 panicles from each treatment were used for estimation of the total number of grains and the number of damaged grains.

The net profit was worked out by deducting the cost of treatment imposition from the value of additional income of yield. The cost-benefit ratio of each treatment was obtained as the net income divided by the cost of treatment. The observation was recorded 24 hours before the treatment's application, and there after 3, 5, 7 and 10 days after application. The data were subjected to transformation before statistical analysis. Analysis of variance was done by single factor RBD analysis with the software OPSTAT.

3. RESULTS AND DISCUSSION

All the insecticidal treatments were significantly effective in reducing the earhead bug population as compared to the control. Dinotefuran 20 SG@200 gm/ha (2.40 and 1.43 earhead bug/hill) was the most effective treatment against *L. acuta*. Neonicotinoids have earlier been reported to be effective against the earhead bug. Roshan and Raju, (2017) "demonstrated that a combination insecticide acetamiprid + fipronil was most effective against *L. acuta*". Zainab and Singh, (2016) "also found that a combination of chlorpyrifos 35% + fipronil 3.5% EC was most effective in reducing the rice earhead bug population". However, in the category of single insecticide, thiamethoxam and buprofezin were also found to be effective against rice earhead bug and these results corroborated with Girish and Balikai (2015) who reported the highest efficacy of thiamethoxam 25 WG @ (0.3 g/l) among all the treatments.

Efficacy of newer insecticides on hill damage by earhead bug: Statistical analysis of all the observation (3,5,7 and 10 DAS) of first and second spray indicated that all the insecticidal treatments were significantly more effective in reducing hill damage as compared to the control. Dinotefuran 20 SG@200 gm/ha (3.24% and 1.74 percent hill damage) was the most effective against earhead bug in 1st and 2nd spray, respectively. Similarly, Rothschild, (1970) reported that weight loss of attacked spikelets was 40-60%. The bug infestation varies from 10 to 30 percent grains in panicles in Assam (Sreenivas et al., 2015; Sudha & Praveen, 2019). In non-flooded fields of the rice crops in Indonesia, the bug becomes most destructive and, in some occasions, may cause 100 percent yield loss (Dresner, 1955). A loss of up to 70 percent has been reported by Verma et al. (1979) from India.

Efficacy of insecticides on panicle damage by earhead bug: Statistical analysis of all the observations (3,5,7 and 10 DAS) of first and second spray indicated that all the insecticidal treatments were found to be significantly effective in reducing further panicle damage as compared to control. Dinotefuran 20 SG@200 gm/ha (15.21% and 14.17 per cent panicle damage) was found the most effective against earhead bug in 1st and 2nd sprays, respectively. Earhead bug has been reported to cause damage to as many as 90 percent of rice grains and make them remain unfilled in Papua New Guinea (Sands, 1977). Pathak, (1968) reported that a 10% yield reduction occurs depending on the degree of infestation. The loss of crop yield generally varies from 5 to 30% but up to 44% damage has been reported in some rice varieties (Nair, 1995; Rai et al., 1990).

Impact of insecticides on grain damage by earhead bug and grain yield: Two sprays of the six tested insecticides namely, Imidacloprid 17.8 SL @ 300 ml/ha, Thiamethoxam 25 WG @100 gm/ha, Dinotefuran 20 SG@200 gm/ha, Clothianidin 50 WDG @ 50 gm/ha, Acetamiprid 20 SP@ 50 gm/ha, Chloropyriphos 50 EC + Cypermethrin 5% EC 1200 ml/ha proved to be effective in reducing grain damage as compared to control (16.90 percent grain damage). Dinotefuran 20 SG@200 gm/ha (7.64 percent grain damage) was found the most effective against earhead bug in 1st and 2nd spray.

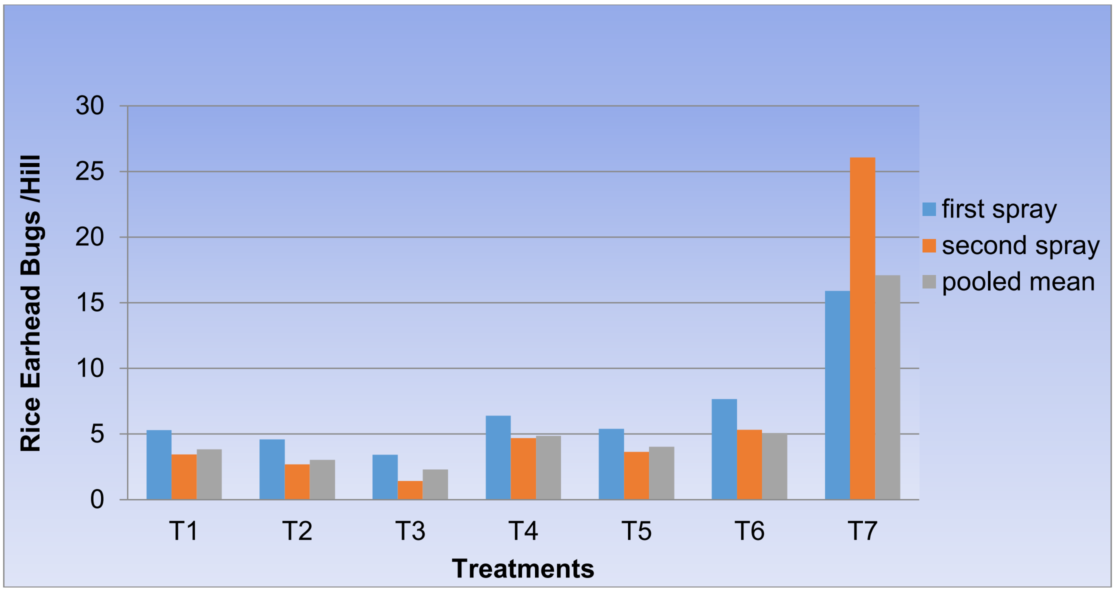

Fig. 1. Bio-efficacy of newer insecticides against rice earhead bug

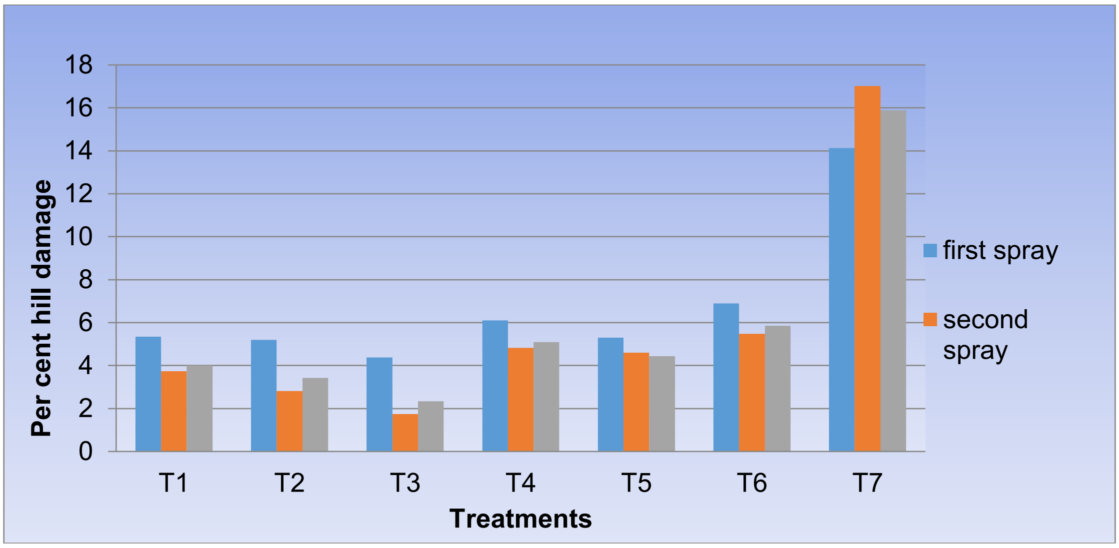

Fig. 2. Bar graph showing Per cent of hill damaged by rice earhead bug

Table 1. Efficacy of insecticides on grain damage by earhead bug and grain yield

Treatment	Dose/ha	Mean earhead bug infested grain (%)	Yield (q/ha)
Imidacloprid 17.8 SL	300 ml/ha	10.25 (13.91)	27.61
Thiamethoxam 25 WG	100 gm/ha	9.07 (12.00)	28.67
Dinotefuran 20 SG	200 gm/ha	7.64 (10.05)	32.50
Clothianidin 50 WDG	50 gm/ha	11.92 (15.83)	23.33
Acetamiprid 20 SP	50 gm/ha	10.48 (14.15)	24.40
Chlorpyriphos 50 EC + Cypermethrin 5% EC	1200 ml/ha	13.04 (17.21)	23.18
Control		16.90 (22.88)	18.51
SE(m) ±		0.39	3.15
CD at 5%		0.98	1.05

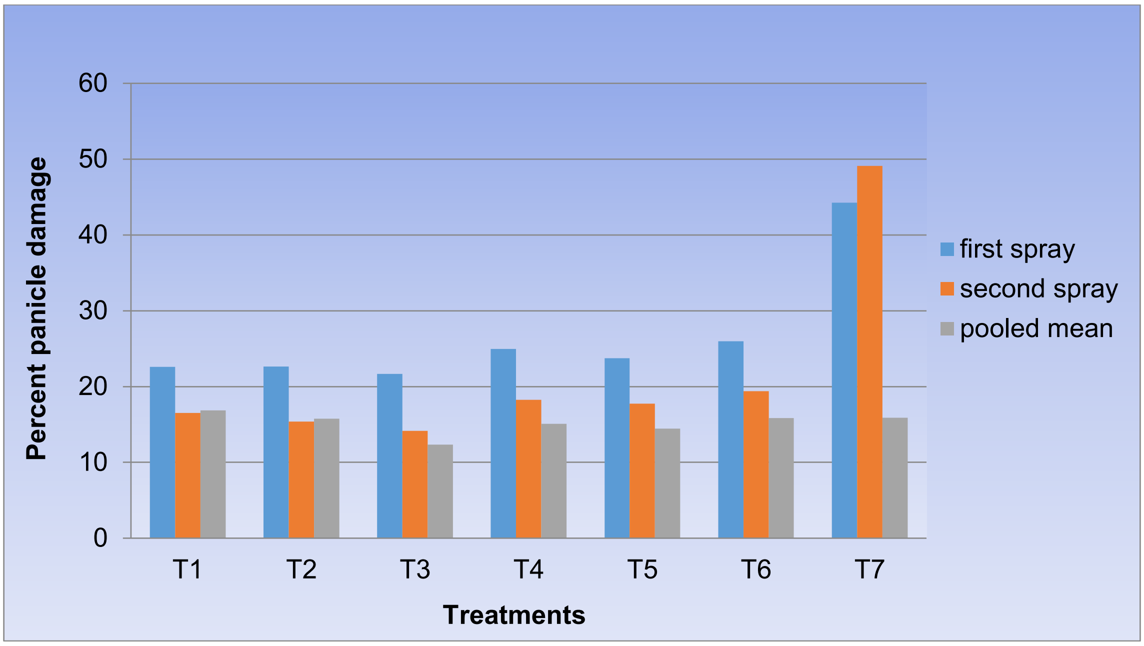

Fig. 3. Bar graph showing Percent of panicle damage by rice earhead bug

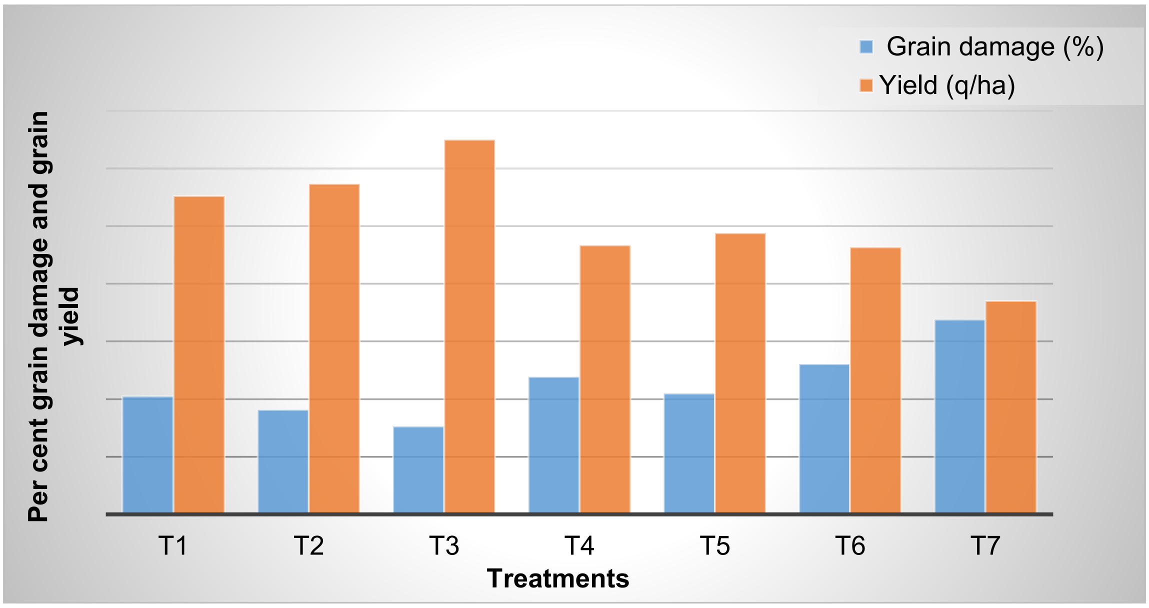

Fig. 4. Bar graph showing Percent of grain damage

On pooled basis the treatment of Dinotefuran 20 SG@200 gm/ha gave the highest yield of 32.50 q/ha followed by Thiamethoxam 25 WG @100 gm/ha, Imidacloprid 17.8 SL @ 300 ml/ha, Acetamiprid 20 SP@ 50 gm/ha and Clothianidin 50 WDG. Whereas, Chlorpyriphos 50 EC + Cypermethrin 5% EC 1200 ml/ha gave the lowest yield of 23.18 which was superior to control with 18.51 q/ha.

Economics of different treatments: The economics is calculated by considering the profit increase in different treatments over control (Venkatesh Hosamani et al., 2009; Zidan, 2012). The treatment of Dinotefuran 20 SG@ 200 gm/ha recorded the highest net profit (32040) and BCR (1:6.43). Whereas, Chloropyriphos 50 EC + Cypermerthin 5% EC 1200 ml/ha was the least effective with lowest income of 4340 and BCR of 1:0.86.

Table 2. Changes in various parameters against different treatments

Treatments	Dose/ha (Kg or ml)	Grain Yield (q/ha)	Increase in yield over control (q/ha)	Cost of treatments of two sprays (Rs/ha)	Labour charge (Rs/ha)	Total cost (Rs/ha)	Value of increased yield over control	Net Profit (Rs/ha)	ICBR
T1	300 ml/ha	27.61	9.10	840	500	1340	18200	16860	1:12.58
T2	100 gm/ha	28.67	10.16	800	500	1300	20320	19020	1:14.63
T3	200 gm/ha	32.50	18.51	4580	500	4980	37020	32040	1:6.43
T4	50 gm/ha	23.33	4.82	925	500	1425	9640	8215	1:5.76
T5	50 gm/ha	24.40	5.89	1350	500	1850	11780	9930	1:5.36
T6	1200 ml/ha	23.18	4.67	4500	500	5000	9340	4340	1:0.86
T7	-	18.51	-	-	-	-	-	-	-

4. CONCLUSION

The study concluded that earhead bug was observed from the tillering stage to the harvesting stage of the crop. The incidence of earhead bugs observed highest population 16.50 bugs/ hill in the 41st SMW. Among six insecticidal treatments, Dinotefuran 20SG @200gm/ha was found the most effective against earhead bug in 1st and 2nd spray, respectively. Dinotefuran 20SG @200gm/ha was found the most effective in reducing panicle and grain damage in 1st and 2nd spray, respectively.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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