

## RESEARCH PAPER

### Comparative efficacy of combination and sole Insecticides against yellow stem borer and ear head bug

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#### ABSTRACT

The present investigation has been conducted in rice crop were carried out at Students' Instructional Farm, A. N. D. U. A. & T., Kumarganj, Ayodhya (U.P.) during *Kharif* 2021. The population of yellow stem borer, leaf folder, ear head bug, brown plant hopper, white backed plant hopper and green leaf hopper initiated after sowing till harvesting. Among the various treatments evaluated for the management of rice yellow stem borer and ear head bug, T<sub>2</sub>-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> treated plots found most effective and gave maximum yield of 31.69 q/ha followed by T<sub>3</sub>-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> treated plot with 30.09 q ha<sup>-1</sup>. The maximum net return and cost: benefit ratio of Rs. 16849.20 and 1:5.16 was found in T<sub>2</sub>-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> followed by T<sub>8</sub>-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> i.e., Rs. 7209.00 ha<sup>-1</sup> and 1:3.27 The efficacy of remaining treatments in order to their superiority were T<sub>1</sub>-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (1:4.02), T<sub>5</sub>-Acephate 70% SP 500 g ha<sup>-1</sup> (1:3.75), T<sub>3</sub>-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (1:1.50), T<sub>7</sub>-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (1:1.20), T<sub>4</sub>-Imidacloprid 40% + Ethiprol 40% WG 400 g ha<sup>-1</sup> (1:0.41) and T<sub>6</sub>-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (1:0.15).

**Keywords:** Rice, Insect Pests, Yellow Stem Borer, Ear Head Bug, Management

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#### INTRODUCTION

Rice (*Oryza sativa*), is the most important crop of the world which occupies foremost status in human food requirement. It is the staple food of more than 60 per cent of the world's population because of the major source of calories. About 90 per cent of all rice grown in the world is produce and consumed in the Asian region. About 90% of all rice grown in the world is produced and consumed in the Asian region by six countries namely China, India, Indonesia, Bangladesh, Vietnam, and Japan. China was the world's largest producer of paddy in 2020, turning out over 211.86 million metric tonnes of the grain. In the 2019-20 crop year China harvest 30.8 million hectares of rice, while India had the greatest harvest area at 44 million hectares. At the end of fiscal year 2021 India had the

largest acreage under rice of 45.0 million ha with production of 120 million tons and average productivity of about 2.7 thousand kg ha<sup>-1</sup>. In addition to having the greatest rice harvest area, India was the leading rice exporter in the fiscal year 2022–2023. 18.75 million metric tonnes of rice were exported from India at that time. In India rice is grown over an area of about 46.37 million ha which produces 130.83 million tonnes with an average productivity of 2809 kg ha<sup>-1</sup> (Agricultural Statistics at a Glance 2023).

Uttar Pradesh is the largest rice growing state only after West Bengal in the country, in which it is grown over an area of 5.86 million hectares with production of 15.56 million tonnes (2020-21). Uttar Pradesh ranks seventh after Punjab, Tamil Nadu, Haryana, Andhra Pradesh,

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Karnataka and West Bengal. The protein content of milled rice is usually 6 to 7 per cent. The fat content of rice is low (2.0 to 2.5 per cent) and much of the fat is lost during milling. Rice contains a low percentage of calcium. The byproducts of rice milling are used for various purposes. Rice bran is used as cattle and poultry feed. Rice husk can be used in manufacture of insulation materials, cement, card board and as a litter in poultry keeping. Rice straw can be used as cattle feed as well as litter during winter. Rice yield is affected by many factors in which, climatic conditions and pest epidemics are most important. Reduction in the rice yield is due to many biotic and abiotic stresses such as, pests, diseases, soil fertility, rainfall, water logging and climatic conditions. Amongst the various threats to rice productivity, damage by various types of insect pests is considered significant as it can cause large scale reduction both in quality and quantity of rice. Worldwide, around 52 per cent of the rice production is lost yearly due to biotic agents, of which 21 per cent is attributed by insect-pests (Yarasi *et al.*, 2008). In modern agriculture, high yielding rice varieties are extensively grown with the use of fertilizers and manures. Such cultivation pattern of rice accidentally or in advertently offers infestation of a large number of insect pests, which results in to severe loss in crop yields (Neeta *et al.*, 2013). However, farmers face huge economic losses in paddy cultivation in every year. Among the major yield limiting factors pests are said to be an important one. Pest causes 30% production loss in India (Sachan *et al.*, 2006; Dhaliwal *et al.*, 2010). More than 100 insect-pest species are exhibited to attack rice crop (Mandal and Mondal, 2018; Sharma *et al.*, 2018). Among them, yellow stem borer, *Scirpophaga incertulas* (Walk.), plant hoppers both brown plant hopper; *Nilaparvata lugens* (Stal) and white-backed plant hopper; *Sogatella furcifera* (Horvath)], rice gall midge, *Orseolia oryzae* (Wood Mason) and leaf folder, *Cnaphalocrocis medinalis* (Guenee) are very important and responsible for huge economic crop losses (Seni and Naik, 2018). The yield loss estimates due to yellow stem borer, brown plant hopper and gall midge are 25-30, 10-70 and 15-60%, respectively. Leaf folder 10% and other pests 25% also cause yield losses (Krishnaiah and Varma, 2013). Ear bug is one of the serious pests of rice in India and sometimes reduce yield by as much as 30% (Tiwari *et al.*, 2014). The yellow stem borer, *Scirpophaga incertulas* (Walker) is the principal devastator causing, at vegetative stage is called 'dead heart' and reproductive stage is called 'white ear' leading to major economic damage (Satpathi *et al.*, 2012).

## MATERIALS AND METHODS

The present investigation was conducted under field conditions at students' Instructional Farm, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh, India during *Kharif*, 2021

on rice variety of NDR-2065. The quantification of the insect pests population was done under field conditions in the plot size kept 4×3 meter with border 1 meter and line to line spacing kept 20 cm and plant to plant spacing kept 15 cm. The details of experiment are given in. The occurrence of the insect pests was recorded 20 days after

transplanting (DAT). The pest population were recorded randomly selected 10 hills per plot at weekly intervals to pre-harvesting. The meteorological data of weather parameters were obtained from the Department of Agricultural Meteorology, College of Agriculture, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, (U.P.). The correlation coefficient between insect pests population and weather parameters like maximum and minimum temperature (°C), relative humidity (%), rainfall (mm) and sunshine (hrs.) were worked out.

## RESULTS AND DISCUSSION

An experiment was conducted during *Kharif* 2021 and 2022 to find out the effectiveness of certain combination and sole insecticides *viz.* T<sub>1</sub>-Profenofos 40 + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup>, T<sub>2</sub>-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml/ha, T<sub>3</sub>-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup>, T<sub>4</sub>-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup>, T<sub>5</sub>-Acephate 70% SP 500 g ha<sup>-1</sup>, T<sub>6</sub>-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup>, T<sub>7</sub>-Imidacloprid 70% WG 150 g ha<sup>-1</sup>, T<sub>8</sub>-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> and T<sub>9</sub>-Control (water spray) under tests against yellow stem borer and ear head bug/hill.

### During *Kharif* 2021

#### Yellow stem borer (*Scirpophaga incertulas*)

##### First spray

The incidence of rice yellow stem borer was recorded one day before spray regularly throughout the experiment and ranged from 9.63-10.73% dead heart. All the treatments were significantly superior over control, when observations were made on 3 days after spray. The treatment T<sub>2</sub>-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> showed significant lower damage by yellow stem borer (dead heart) where mean dead heart percent was 3.97 % and provide more protection to rice against yellow stem borer. The next treatment in order to superiority were T<sub>3</sub>-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (4.23 per cent dead heart) and T<sub>1</sub>-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (4.43 per cent dead heart) which was at par with each other. T<sub>6</sub>-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (4.72 per cent dead heart) was the next best treatment and at par with T<sub>5</sub>-Acephate 70% SP 500 g ha<sup>-1</sup> (5.27 per cent dead heart) followed by T<sub>4</sub>-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> (5.56 per cent dead heart), T<sub>8</sub>-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> (5.65 per cent dead heart) and T<sub>7</sub>-Imidacloprid 70% WG 150 g/ha (6.42 per cent dead heart). However, the highest damage was found in treatment T<sub>9</sub>-Control (water spray) with mean infestation 10.77 per cent dead heart (Table 4.5).

When the observations were made on 7 days after spray, all the treatments were found significant superior over control. The treatment T<sub>2</sub>-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> had significant lower damage (dead heart) of yellow stem borer with mean 2.69 per cent of dead heart. The next treatment in order of superiority were T<sub>3</sub>-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (3.49 per cent dead heart), T<sub>1</sub>-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (3.65 per cent

dead heart), T<sub>6</sub>-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (4.20 per cent dead heart), T<sub>5</sub>-Acephate 70% SP 500 g ha<sup>-1</sup> (4.89 per cent dead heart), T<sub>4</sub>-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> (5.00 per cent dead heart) and T<sub>8</sub>-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> (5.50 per cent dead heart) and T<sub>7</sub>-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (6.42 per cent dead heart) (Table 4.5).

After 15 days after spray, treatment T<sub>2</sub>-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> showed significant lower damage (dead heart) of yellow stem borer (2.99 per cent dead heart) followed by T<sub>3</sub>-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (4.09 per cent dead heart) and T<sub>1</sub>-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (4.18 per cent dead heart). T<sub>6</sub>-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (4.66 per cent dead heart), T<sub>5</sub>-Acephate 70% SP 500 g ha<sup>-1</sup> (5.09 per cent dead heart), T<sub>4</sub>-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> (5.54 per cent dead heart) and T<sub>8</sub>-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> (6.00 per cent dead heart). T<sub>7</sub>-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (7.05 per cent dead heart) was the least effective treatment against yellow stem borer damage. All the treatments were significantly superior over control (Table 4.5).

When the observations were made on over all mean days after spray, all the treatments were found significant superior over control. The treatment T<sub>2</sub>-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> showed significant lower dead heart (3.22 per cent). The next treatment in order of superiority were T<sub>3</sub>-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (3.93 per cent dead heart) which was at par with T<sub>1</sub>-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (4.09 per cent dead heart). T<sub>6</sub>-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (3.53 per cent dead heart) was the next best treatment followed by T<sub>5</sub>-Acephate 70% SP 500 g ha<sup>-1</sup> (5.08 per cent dead heart), T<sub>4</sub>-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> (5.37 per cent dead heart), T<sub>8</sub>-Thiamethoxam 25% WG 100 g/ha (5.72 per cent dead heart) and T<sub>7</sub>-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (6.53 per cent dead heart) (Table 4.5).

**Second spray**

At the time of second spray, the damage of rice yellow stem borer was recorded as white ear per cent recorded on one day before spray ranged from 7.60-9.02% white ear. All the treatments were significantly superior over control, when observations were made on 3 days after spray. The treatment T<sub>2</sub>-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> showed significant lower damage (White ear) of yellow stem borer with mean infestation 2.98 per cent of white ear. The next treatment in order of superiority were T<sub>3</sub>-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (3.23 per cent white ear), T<sub>1</sub>-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (3.58 per cent white ear), T<sub>6</sub>-Emamectine Benzoate 5%

SG 250 g ha<sup>-1</sup> (3.72 per cent white ear), T<sub>5</sub>-Acephate 70% SP 500 g ha<sup>-1</sup> (4.62 per cent white ear), T<sub>4</sub>-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> (4.88 per cent white ear), T<sub>8</sub>-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> (5.00 per cent white ear) and T<sub>7</sub>-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (5.75 per cent white ear) (Table 4.5).

When the observations were made on 7 days after spray all the treatments were found significant superior over control. The treatment T<sub>2</sub>-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> showed significant lower damage of yellow stem borer (White ear) where mean infestation 2.36 per cent of white ear. The next treatment in order of superiority were T<sub>3</sub>-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (2.82 per cent white ear) and T<sub>1</sub>-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (2.99 per cent white ear) which were at par with T<sub>2</sub>. Next best treatment was T<sub>6</sub>-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (3.86 per cent white ear), followed by T<sub>5</sub>-Acephate 70% SP 500 g ha<sup>-1</sup> (3.93 per cent white ear), T<sub>4</sub>-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> (4.67 per cent white ear) and T<sub>8</sub>-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> (4.84 per cent white ear). T<sub>7</sub>-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (5.36 per cent white ear) was least effective treatment (Table 4.5).

At 15 days after spray, all the treatments were found significant superior over control. The treatment T<sub>2</sub>-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> showed significant significantly higher against yellow stem borer (White ear) (3.00 per cent of white ear) followed by T<sub>3</sub>-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (3.83 per cent white ear), T<sub>1</sub>-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (3.94 per cent white ear) and T<sub>6</sub>-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (4.02 per cent white ear). Least effective treatment was T<sub>7</sub>-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (5.81 per cent white ear). However, the highest population was found in treatment T<sub>9</sub>-Control (water spray) with mean infestation 9.95 per cent white ear (Table 4.5).

When the observations were made on over all mean days after spray all the treatments were found significant superior over control. The treatment T<sub>2</sub>-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> showed most effective (2.78 per cent of white ear) against YSB damage and provide more protection to rice. The next treatment in order of superiority were T<sub>3</sub>-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (3.29 per cent white ear), T<sub>1</sub>-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (3.50 per cent white ear), T<sub>6</sub>-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (3.87 per cent white ear), T<sub>5</sub>-Acephate 70% SP 500 g ha<sup>-1</sup> (4.47 per cent white ear), T<sub>4</sub>-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> (4.94 per cent white ear) and T<sub>8</sub>-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> (5.10 per cent white ear) and T<sub>7</sub>-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (5.64 per cent white ear) (Table 4.5).

**Table 4.5 Effectiveness of combination and sole insecticides against Rice yellow stem borer during Kharif 2021**

Tr No	Treatments	Dose ha <sup>-1</sup>	*Mean per cent incidence of yellow stem borer ( <i>Scirpophaga incertulas</i> )	
			Dead heart (%)	White ear (%)

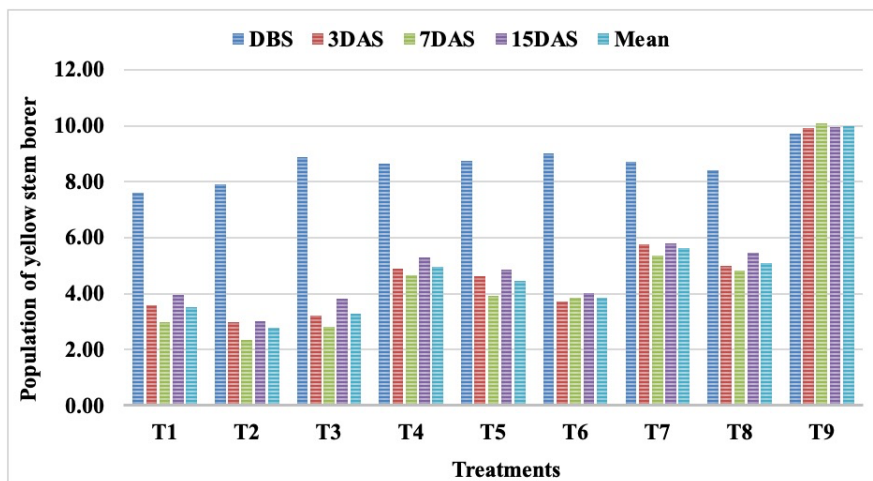
Comparative Efficacy Of Combination And Sole Insecticides Against Yellow Stem Borer And Ear Head Bug

			First spray					Second spray				
			DBS	3 DAS	7 DAS	15 DAS	Mean	DBS	3 DAS	7 DAS	15 DAS	Mean
T <sub>1</sub>	Profenophos 40% + Cypermethrin 4% EC	1250 ml	9.93 (18.36)	4.43 (12.15)	3.65 (11.0)	4.18 (11.78)	4.09 (11.64)	7.60 (15.99)	3.58 (10.88)	2.99 (9.94)	3.94 (11.44)	3.50 (10.75)
T <sub>2</sub>	Chlorpyriphos 50% + Cypermethrin 5% EC	750 ml	10.03 (18.47)	3.97 (11.49)	2.69 (9.37)	2.99 (9.90)	3.22 (10.25)	7.89 (16.29)	2.98 (9.93)	2.36 (8.82)	3.00 (9.96)	2.78 (9.57)
T <sub>3</sub>	Novaluron 5.25% + Indoxacarb4.5% w/w SC	750 ml	9.63 (18.08)	4.23 (11.86)	3.49 (10.73)	4.09 (11.65)	3.93 (11.42)	8.87 (17.32)	3.23 (10.29)	2.82 (9.60)	3.83 (11.28)	3.29 (10.39)
T <sub>4</sub>	Imidacloprid 40% + Ethiprol 40% WG	100 g	9.93 (18.36)	5.56 (13.64)	5.00 (12.89)	5.54 (13.61)	5.37 (13.38)	8.63 (17.02)	4.88 (12.76)	4.67 (12.47)	5.28 (13.28)	4.94 (12.84)
T <sub>5</sub>	Acephate 70% SP	500 g	9.87 (18.30)	5.27 (13.26)	4.89 (12.78)	5.09 (13.04)	5.08 (13.03)	8.73 (17.14)	4.62 (12.40)	3.93 (11.44)	4.86 (12.72)	4.47 (12.19)
T <sub>6</sub>	Emamectin Benzoate 5% SG	250 g	10.17 (18.59)	4.72 (12.53)	4.20 (11.81)	4.66 (12.46)	4.53 (12.27)	9.02 (17.44)	3.72 (11.05)	3.86 (11.33)	4.02 (11.56)	3.87 (11.31)
T <sub>7</sub>	Imidacloprid 70% WG	150 g	9.73 (18.18)	6.42 (14.67)	6.13 (14.34)	7.05 (15.40)	6.53 (14.80)	8.72 (17.15)	5.75 (13.87)	5.36 (13.37)	5.81 (13.95)	5.64 (13.73)
T <sub>8</sub>	Thiamethoxam 25% WG	100 g	9.67 (18.11)	5.65 (13.74)	5.50 (13.55)	6.00 (14.18)	5.72 (13.82)	8.40 (16.84)	5.00 (12.92)	4.84 (12.70)	5.45 (13.48)	5.10 (13.04)
T <sub>9</sub>	Control (Water spray)	-	10.73 (19.12)	10.77 (19.15)	10.35 (18.74)	10.80 (19.16)	10.64 (19.02)	9.72 (18.17)	9.93 (18.37)	10.08 (18.48)	9.95 (18.39)	9.99 (18.41)
CD @ 5%			NS	0.78	1.72	1.38	0.64	NS	1.52	1.39	0.91	0.58
S.Em.±			-	0.26	0.57	0.46	0.21	-	0.51	0.46	0.30	0.19

Figures in the parenthesis are Angular transformed values, NS= Non-significant, DBS= Day before spray, DAS= Days after spray

\*Mean of three replications

First Spray



Second Spray

Fig. 4.3: Evaluate the effectiveness of combination and sole insecticides against rice yellow stem borer during Kharif 2021 Ear head bug (*Leptocoriza. acuta*)

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### First spray

The incidence of ear head bug/hill was recorded one day before ranged from 10.90-12.15 ear head bug/hill. All the treatments were significantly superior over control, when observations were made on 3 days after spray. The treatment **T<sub>4</sub>**-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> showed significant lower infestation of ear head bug/hill with mean infestation 4.15 ear head bug/hill. The next treatment in order of superiority were **T<sub>2</sub>**-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> (4.86 ear head bug/hill), **T<sub>1</sub>**-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (5.25 ear head bug/hill), **T<sub>3</sub>**-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (5.85 ear head bug/hill), **T<sub>7</sub>**-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (6.20 ear head bug/hill), **T<sub>5</sub>**-Acephate 70% SP 500 g ha<sup>-1</sup> (6.75 ear head bug/hill), **T<sub>8</sub>**-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> (6.98 ear head bug/hill) and **T<sub>6</sub>**-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (7.25 ear head bug/hill) (Table 4.6).

When the observations were made on 7 days after spray, all the treatments were found significant superior over control. The treatment **T<sub>4</sub>**-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> showed significant lower infestation 3.47 ear head bug/hill. The next treatment in order of superiority were **T<sub>2</sub>**-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> (3.93 ear head bug/hill), **T<sub>1</sub>**-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (4.36 ear head bug/hill), **T<sub>3</sub>**-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (4.78 ear head bug/hill), **T<sub>7</sub>**-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (4.92 ear head bug/hill), **T<sub>5</sub>**-Acephate 70% SP 500 g ha<sup>-1</sup> (5.40 ear head bug/hill), **T<sub>8</sub>**-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> (5.53 ear head bug/hill) and **T<sub>6</sub>**-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (6.07 ear head bug/hill) (Table 4.6).

At 15 days after spray all the treatments were found significant superior over control. The treatment **T<sub>4</sub>**-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> showed significant lower infestation 3.69 ear head bug/hill and at par with **T<sub>2</sub>**-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> (3.76 ear head bug/hill). **T<sub>1</sub>**-Profenofos 40%+Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (4.55 ear head bug/hill) was the next best treatment followed by **T<sub>3</sub>**-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (4.96 ear head bug/hill), **T<sub>7</sub>**-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (5.12 ear head bug/hill), **T<sub>5</sub>**-Acephate 70% SP 500 g ha<sup>-1</sup> (5.60 ear head bug/hill), **T<sub>8</sub>**-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> (5.81 ear head bug/hill). **T<sub>6</sub>**-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (6.28 ear head bug/hill) was the least effective treatment (Table 4.6).

Over all mean data showed that treatment **T<sub>4</sub>**-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> had significant lower population 3.77 ear head bug/hill and at par with **T<sub>2</sub>**-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> (4.18 ear head bug/hill) and **T<sub>1</sub>**-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (4.72 ear head bug/hill). Next best treatment was **T<sub>3</sub>**-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (5.20 ear head bug/hill) followed by **T<sub>7</sub>**-Imidacloprid 70% WG 150 g ha (5.41 ear head bug/hill), **T<sub>5</sub>**-Acephate 70% SP 500 g ha (5.92 ear head bug/hill), **T<sub>8</sub>**-Thiamethoxam 25% WG 100 g ha

(6.11 ear head bug/hill) and **T<sub>6</sub>**-Emamectine Benzoate 5% SG 250 g/ha (6.53 ear head bug/hill) (Table 4.6).

### Second spray

One day before second spray, ear head bug/hill population ranged from 9.55-11.89 ear head bug/hill. After 3 days after spray, all the treatments were significantly superior over control. The treatment **T<sub>4</sub>**-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> showed significant lower infestation of ear head bug/hill (4.13 ear head bug/hill). The next treatment in order of superiority were **T<sub>2</sub>**-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> (4.59 ear head bug/hill), **T<sub>1</sub>**-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (4.99 ear head bug/hill), **T<sub>3</sub>**-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (5.55 ear head bug/hill), **T<sub>7</sub>**-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (5.73 ear head bug/hill), **T<sub>5</sub>**-Acephate 70% SP 500 g ha<sup>-1</sup> (6.37 ear head bug/hill), **T<sub>8</sub>**-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> (6.56 ear head bug/hill) and **T<sub>6</sub>**-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (6.85 ear head bug/hill) (Table 4.6).

After 7 days of spray, all the treatments were found significant superior over control. The treatment **T<sub>4</sub>**-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> was significant superior (2.93 ear head bug/hill) than other treatments and provide more protection to rice. The next treatment in order of superiority were **T<sub>2</sub>**-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml/ha (3.38 ear head bug/hill) **T<sub>1</sub>**-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (3.88 ear head bug/hill), **T<sub>3</sub>**-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (3.89 ear head bug/hill), **T<sub>7</sub>**-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (4.52 ear head bug/hill), **T<sub>5</sub>**-Acephate 70% SP 500 g ha<sup>-1</sup> (5.04 ear head bug/hill), **T<sub>8</sub>**-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> (5.45 ear head bug/hill) and **T<sub>6</sub>**-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (5.78 ear head bug/hill) (Table 4.6).

Data presented in Table 4.6 showed that at 15 days after spray, all the treatments were found significant superior over control. The treatment **T<sub>4</sub>**-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> showed significant lower infestation 3.23 ear head bug/hill. The next treatment in order of superiority were **T<sub>2</sub>**-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> (3.55 ear head bug/hill), **T<sub>1</sub>**-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (4.25 ear head bug/hill), **T<sub>3</sub>**-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (4.42 ear head bug/hill), **T<sub>7</sub>**-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (6.02 ear head bug/hill), **T<sub>5</sub>**-Acephate 70% SP 500 g ha<sup>-1</sup> (5.35 ear head bug/hill), **T<sub>8</sub>**-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> (5.64 ear head bug/hill) and **T<sub>6</sub>**-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (6.02 ear head bug/hill).

When the observations were made on over all mean, all the treatments were found significant superior over control. The treatment **T<sub>4</sub>**-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> showed significant lower infestation 3.43 ear head bug/hill and provide more protection to and at par with **T<sub>2</sub>**-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> (3.84 ear head bug/hill). Next best treatment was **T<sub>1</sub>**-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (4.37 ear head bug/hill) followed by **T<sub>3</sub>**-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (4.62 ear head

Comparative Efficacy Of Combination And Sole Insecticides Against Yellow Stem Borer And Ear Head Bug

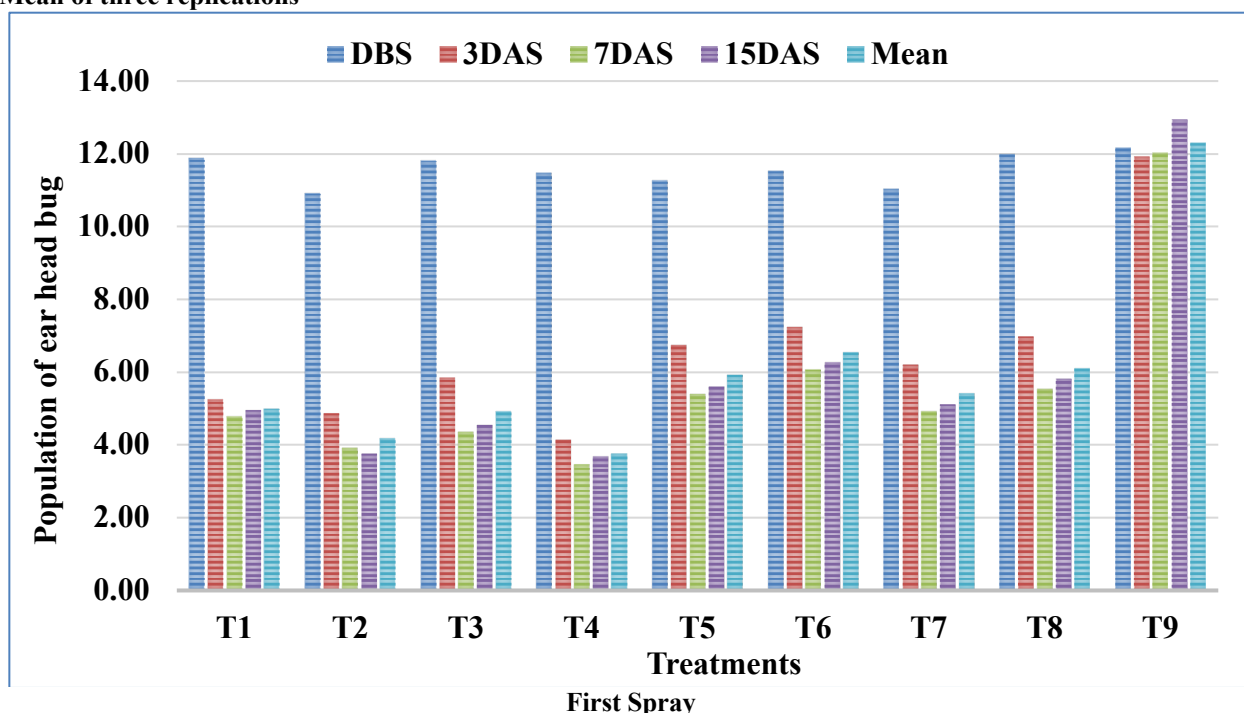
bug/hill), T<sub>7</sub>-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (5.03 ear head bug/hill), T<sub>5</sub>-Acephate 70% SP 500 g ha<sup>-1</sup> (5.59 ear head bug/hill), T<sub>8</sub>-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> (5.88 ear head bug/hill) and T<sub>6</sub>-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (6.22 ear head bug/hill) (Table 4.6).

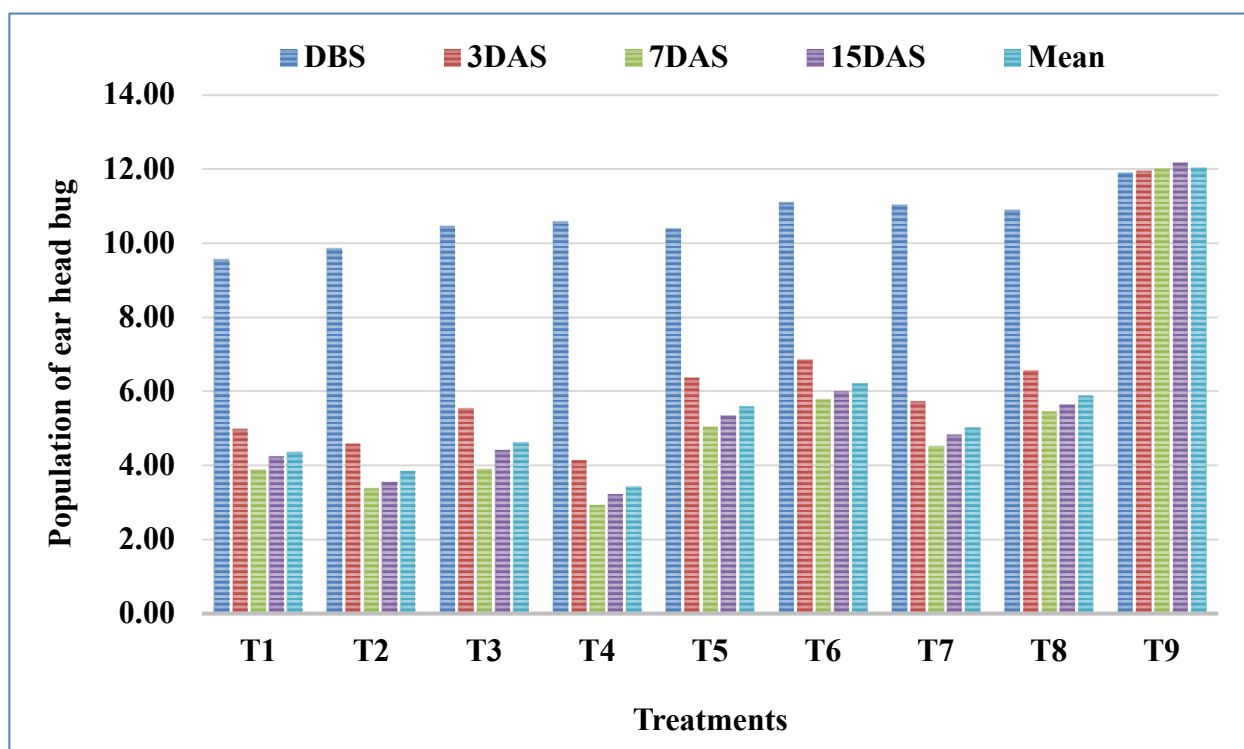
**Table 4.6: Effectiveness of combination and soles insecticides against Rice ear head bug during Kharif 2021**

Tr. No.	Treatments	Dose/ha	*Mean population of Rice Ear head bug/hill									
			First Spray					Second Spray				
			DBS	3 DAS	7 DAS	15DAS	Mean	DBS	3 DAS	7 DAS	15DAS	Mean
T <sub>1</sub>	Profenophos 40%+ Cypermethrin 4% EC	1250ml	11.87 (3.52)	5.25 (2.40)	4.36 (2.20)	4.55 (2.25)	4.72 (2.23)	9.55 (3.17)	4.99 (2.34)	3.88 (2.09)	4.25 (2.18)	4.37 (2.21)
T <sub>2</sub>	Chlorpyriphos 50%+ Cypermethrin 5% EC	750ml	10.90 (3.38)	4.86 (2.32)	3.93 (2.10)	3.76 (2.06)	4.18 (2.16)	9.85 (3.22)	4.59 (2.26)	3.38 (1.97)	3.55 (2.01)	3.84 (2.08)
T <sub>3</sub>	Novaluron 5.25%+ Indoxacarb4.5% w/w SC	750ml	11.80 (3.51)	5.85 (2.52)	4.78 (2.30)	4.96 (2.34)	5.20 (2.39)	10.46 (3.31)	5.55 (2.46)	3.89 (2.10)	4.42 (2.22)	4.62 (2.26)
T <sub>4</sub>	Imidacloprid 40%+ Ethiprol 40% G	100g	11.46 (3.46)	4.15 (2.16)	3.47 (1.99)	3.69 (2.05)	3.77 (2.07)	10.57 (3.33)	4.13 (2.15)	2.93 (1.85)	3.23 (1.93)	3.43 (1.98)
T <sub>5</sub>	Acephate 70% SP	500g	11.25 (3.43)	6.75 (2.69)	5.40 (2.43)	5.60 (2.47)	5.92 (2.53)	10.38 (3.30)	6.37 (2.62)	5.04 (2.35)	5.35 (2.42)	5.59 (2.47)
T <sub>6</sub>	Emamectin Benzoate 5% SG	250g	11.52 (3.47)	7.25 (2.78)	6.07 (2.56)	6.28 (2.60)	6.53 (2.65)	11.08 (3.40)	6.85 (2.71)	5.78 (2.51)	6.02 (2.55)	6.22 (2.59)
T <sub>7</sub>	Imidacloprid 70% WG	150g	11.03 (3.40)	6.20 (2.59)	4.92 (2.33)	5.12 (2.37)	5.41 (2.43)	11.03 (3.40)	5.73 (2.50)	4.52 (2.24)	4.84 (2.31)	5.03 (2.35)
T <sub>8</sub>	Thiamethoxam 25% WG	100g	11.98 (3.53)	6.98 (2.73)	5.53 (2.46)	5.81 (2.51)	6.11 (2.57)	10.88 (3.37)	6.56 (2.66)	5.45 (2.44)	5.64 (2.48)	5.88 (2.53)
T <sub>9</sub>	Control (Water spray)	-	12.15 (3.56)	11.92 (3.52)	12.02 (3.54)	12.95 (3.67)	12.29 (3.58)	11.89 (3.52)	11.95 (3.53)	12.00 (3.54)	12.18 (3.56)	12.04 (3.54)
CD @ 5%			NS	(0.24)	(0.20)	(0.21)	(0.67)	NS	(0.24)	(0.17)	(0.20)	(0.44)
S.Em.±			-	(0.08)	(0.07)	(0.07)	(0.23)	-	(0.08)	(0.06)	(0.07)	(0.15)

Figures in the parenthesis are  $\sqrt{x + 0.5}$  transformed values, NS= Non-significant, DBS= Day before spray, DAS= Days after spray

\*Mean of three replications





Second Spray

Fig. 4.4: Evaluate the effectiveness of combination and sole insecticides against ear head bug during *Kharif* 2021

**Effect of combination and sole insecticides on yield of Rice**

The data on yield presented in Table 4.11 showed that during *Kharif* 2021 all the treatments gave significantly higher yield as compare to the Control (Water spray) (22.02 q ha<sup>-1</sup>). The treatment T<sub>2</sub>-Chlorpyriphos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> (31.23 q ha<sup>-1</sup>) recorded maximum yield which was at par with T<sub>1</sub>-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (30.21 q ha<sup>-1</sup>). Next best yield was recorded in T<sub>3</sub>-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (29.58 q ha<sup>-1</sup>) followed by T<sub>4</sub>-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup>, T<sub>5</sub>-Acephate 70% SP 500 g ha<sup>-1</sup> (27.72 q ha<sup>-1</sup>), T<sub>6</sub>-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (27.13 q ha<sup>-1</sup>), T<sub>8</sub>-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> (26.86 q ha<sup>-1</sup>) and T<sub>7</sub>-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (26.27 q ha<sup>-1</sup>).

**Table 4.11: Effect of combination and sole insecticides on yield of Rice during the experiments**

Tr. No	Treatments	Dose ha <sup>-1</sup>	Yield (q ha <sup>-1</sup> )
			2021
T <sub>1</sub>	Prophenophos 40% + Cypermethrin 4% EC	1250 ml	30.21
T <sub>2</sub>	Chlorpyriphos50% + Cypermethrin 5% EC	750 ml	31.23
T <sub>3</sub>	Novaluron 5.25 % + Indoxacarb 4.5% w/w SC	750 ml	29.58
T <sub>4</sub>	Imidachloprid 40% + Ethiprol 40% G	100 g	29.29
T <sub>5</sub>	Acephate 70% SP	500 g	27.72
T <sub>6</sub>	Emamectin Benzoate 5% SG	250 g	27.13
T <sub>7</sub>	Imidachloprid 70% WG	150 g	26.27
T <sub>8</sub>	Thiamethoxam 25% WG	100 g	26.86
T <sub>9</sub>	Control (Water spray)	-	22.02
S.Em.±			0.39
CD at 5%			1.17

**Economics of treatments against Rice yellow stem borer & ear head bug**

The data pertaining to economics of various treatments during *Kharif* 2021 are presented in Table 4.12 depicted that maximum net return was found under the treatments T<sub>2</sub>-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> (Rs. 14967.40) and minimum in T<sub>6</sub>-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (Rs. 151.53). The cost: benefit ratio of different treatments revealed that T<sub>2</sub>-Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> (1:5.16) was most economical treatment followed by, T<sub>8</sub>-Thiamethoxam 25% WG 100 g ha<sup>-1</sup> (1:2.62), T<sub>5</sub>-Acephate 70% SP 500 g ha<sup>-1</sup> (1:3.53), T<sub>1</sub>-Profenofos 40% + Cypermethrin 4% EC 1250 ml ha<sup>-1</sup> (1:3.74), T<sub>3</sub>-Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (2:1.20), T<sub>7</sub>-Imidacloprid 70% WG 150 g ha<sup>-1</sup> (1:0.87), T<sub>4</sub>-Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> (1:0.58) and T<sub>6</sub>-Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (1:0.01).

**Table 4.12: Economics of treatments against Rice yellow stem borer & ear head bug during *Kharif*, 2021**

Tr. No	Treatments	Dose/ Quantity of Chemical Kg or Lit ha <sup>-1</sup>	Cost of one Spray (labour+ sprayer+ insecticides) (Rs ha <sup>-1</sup> )	No. of Sprays	Total cost of Treatments (Rs ha <sup>-1</sup> )	Grain Yield (q ha <sup>-1</sup> )	Save d Yield (q ha <sup>-1</sup> )	Value of Saved Yield (Rs ha <sup>-1</sup> )	Net Returns	Cost Benefit Ratio (C:B)
T <sub>1</sub>	Prophenophos 40% + Cypermetrin 4% EC	1250 ml	1950.00	2	3900.00	30.21	8.19	15888.60	11988.60	1:3.74
T <sub>2</sub>	Chlorpyrifos 50% + Cypermethrin 5% EC	750 ml	1450.00	2	2900.00	31.23	9.21	17867.40	14967.40	1:5.16
T <sub>3</sub>	Novaluron 5.25% +Indoxacarb 4.5% w/w SC	750 ml	3325.00	2	6650.00	29.58	7.56	14666.40	8016.40	1:1.20
T <sub>4</sub>	Imidachloprid 40% + Ethiprol 40% G	100 g	5660.00	2	11320.00	29.29	7.27	14103.80	2783.80	1:0.24
T <sub>5</sub>	Acephate 70% SP	500 g	1220.00	2	2440.00	27.72	5.7	11058.00	8618.00	1:3.53
T <sub>6</sub>	Emamectin Benzoate 5% SG	250 g	5450.00	2	10900.00	27.13	5.70	1151.53	151.53	1:0.01
T <sub>7</sub>	Imidachloprid 70% WG	150 g	2200.00	2	4400.00	26.27	4.25	8245.00	3845.00	1:0.87
T <sub>8</sub>	Thiamethoxam 25% WG	100 g	1100.00	2	2200.00	26.86	4.84	7973.30	5773.40	1:2.62
T <sub>9</sub>	Control (Water spray)	-	-	2	-	22.02	-	-	-	-

Rent of sprayer @ Rs. 100/day = Rs.200/-, Labour charge @ Rs. 250/day = Rs. 500/-, Cost of produce Rs. 1940/q

**CONCLUSION**

The treatments Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> and Imidacloprid 40% + Ethiprol 40% WG 100 g ha<sup>-1</sup> was found most effective treatments against yellow stem borer and ear head bug respectively. The highest yield obtained in the treatment Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> (31.69 q ha<sup>-1</sup>) followed by Novaluron 5.25% + Indoxacarb 4.5% SC 750 ml ha<sup>-1</sup> (30.09 q ha<sup>-1</sup>). The least effective treatment was Thiamethoxam 25% WG 100 g ha<sup>-1</sup> and yielded only 26.36 q ha<sup>-1</sup>. The maximum net return was found from the treatment Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> (₹ 16849.20) and minimum net return was found in Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (₹ 1729.40). The maximum cost: benefit ratio (1:5.16) was obtained from Chlorpyrifos 50% + Cypermethrin 5% EC 750 ml ha<sup>-1</sup> and least cost: benefit ratio obtained from Emamectine Benzoate 5% SG 250 g ha<sup>-1</sup> (1:0.15).



**Plate 3.1: General view of Rice at experimental site**



**Plate 3.2: Damage symptom and larvae of rice leaf folder**



**Plate 3.3: Adult and damage symptom of rice ear head bug**





Plate 3.4: Adult, larvae and damage symptom of rice yellow stem borer



Plate 3.6: Spraying of insecticide solution on rice

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