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Influence of Farming Systems on Yellow Stem Borer (*Scirpophaga incertulas*) Suppression and Natural Enemy Dynamics in Summer Rice Ecosystems

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ABSTRACT

The yellow stem borer (YSB)*, Scirpophaga incertulas* (Walker), is a monophagous pest and an economically important pest that causes substantial yield loss in paddy. Due to injudicious use of synthetic chemicals for the management of the yellow stem borer leads to harmful effects on human health and natural enemies in the paddy ecosystem. Hence, the present study was conducted to evaluate different farming methods like natural farming (NF), organic farming (OF), conventional farming (CF) and farmers' practices (FP) against YSB in paddy. The experiment was carried out at the Agricultural and Horticultural Research Station, Honnavile, Shivamogga during the summer cropping seasons of 2021 and 2022. The results revealed that farmers practices (Chlorantraniliprole 0.4% GR @ 12kg/ha) significantly reduced dead heart (6.49 %) and white ear head (3.22 %) incidence in paddy. This was followed by conventional farming (Chlorantraniliprole 0.4% GR @ 10kg/ha), which recorded dead heart (6.89 %) and white ear head (3.85 %). However highest percentage of dead heart and white ear head was observed in natural farming and organic farming treatment. A significantly higher population of natural enemies (coccinellids and spiders) was recorded under natural farming (9.98), followed by organic farming (9.65).The yield was significantly higher in the conventional farming that is 55.76q/ha followed by farmer's practices 55.18q/ha. The highest cost-benefit ratio was recorded in the natural farming plot followed by the conventional farming plot, compared to other treatments.

Keywords: natural farming, organic farming, Chlorantraniliprole, dead heart, white ear head.

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INTRODUCTION

Rice (*Oryza sativa* L.), is a vital staple food for over half of the world's population and is often referred to as "king of cereals". Its production and consumption is largely concentrated in Asian countries (Mathur, Reddy, Rajamali, & Moorthy, 1999; Mohd Nizam, Haji Baharudin,& Ahmad, 2023).In Asia, India is the largest area under rice, accounting for 28.5 per cent of the global rice area. In India, rice was grown on an area of46.38 million hectares with a production of 130.29 million tonnes and a productivity of 28.12 q/ha in 2021-2022 (Anonymous, 2023).The green revolution substantially increased rice productivity through the adoption of high-yielding varieties, irrigation, and improved agronomic practices. However, this intensification of rice cultivation has also led to a heavy reliance on synthetic fertilizers and chemical pesticides under conventional farming (CF) to maximize crop productivity and manage insect pests. Although these inputs have contributed significantly to yield enhancement, their indiscriminate and prolonged use has raised serious concerns regarding environmental pollution, biodiversity loss, pesticide resistance, degradation of soil health, and potential risks to human health, thereby threatening the long-term sustainability (Veeranna et al., 2023b; Veeranna et al., 2023c).It has led to many negative environmental effects, such as the reduction of biodiversity and natural biological control, high pesticide residues in rivers, drinking water, and agricultural products, rapid and high insecticide resistance in pests, secondary pest outbreaks, environmental pollution and ecological imbalance (Hong-xing et al., 2017; Barbieri et al., 2021; Raut et al., 2023). In contrast, organic farming (OF) emphasizes the use of organic manures and biological inputs, but its large-scale adoption is often constrained by the limited availability of bulky organic manures, high transportation costs, and increased labour requirements (Malakannavar et al., 2024). As an eco-friendly alternative to conventional agriculture, natural farming (NF) has gained considerable attention in recent years. The concept, popularized by Subhash Palekar during the mid-1990s, emerged as an alternative to the input-intensive green revolution model(Kumar et al., 2023). Natural farming emphasizes the use of locally available natural inputs and ecological processes to improve soil health, enhance biodiversity, and conserve ecosystem functions (Veeranna et al., 2023a). By fostering the abundance and activity of natural enemies, NF contributes to sustainable insect pest management while maintaining the ecological balance and resilience of rice ecosystems.

Rice production faces significant challenges due to insect pests and diseases, which can cause substantial yield losses throughout the growing season. The estimated loss of 10%-30% annually is significantly high, being four times greater than the average for other major cereal crops (Savary et al., 2019).The rice crop can be attacked by more than 100 species of insects, and 20 of them can cause serious economic loss (Basit & Bhattacharya, 2001;Heinrichs et al., 2017). Among the insect pests of rice, yellow stem borer (YSB) *Scirpophaga incertulas* (Walker) (Lepidoptera: Pyralidae) is a key and destructive monophagous insect pest of rice distributed across all agroclimatic zones of India. Larvae of YSB bore into the stem and feed inside the central shoots of rice tillers during the vegetative stage and cause 'dead heart' and 'white ear' results if feeding coincides with panicle initiation stage (Jiang & Cheng, 2003; Suresh et al., 2011; Lu et al., 2017). In both phases, the central tiller and panicle can be easily pulled out by hand and show feeding near the base (Devi & Sowndarya, 2022). YSB on rice gains top priority across rice-growing regions of India as its damage is at both vegetative and reproductive crop stages and causes yield losses to a greater extent (Prasad, Gupta, & Kanaujia, 2007, Pallavi, Sharanabasappa, & Megaladevi, 2018;Pallavi&Sharanabasappa, 2018). Natural enemies of rice insect pests comprise a diverse assemblage of predators and parasitoids that serve as important biological control agents. Among these, predators such as ladybird beetles, spiders, dragonflies, damselflies, and mirid bugs play a significant role in naturally suppressing yellow stem borer populations, thereby contributing to ecological balance and sustainable pest management in rice ecosystems (Suneel Kumar, Khan, M.A., Arvind Kumar, & Kuldeep Sharma, 2008; Rahaman, Islam, Jahan, & Mamun, 2014; Parasappa, Narasa Reddy,& Neelakanth, 2017).Effective sustainable management of yellow stem borer is essential for ensuring food security and supporting the livelihoods of millions of people around the world (Subedi, Bohara, Thapa, &Timilsena, 2024).

Although several studies have compared yellow stem borer incidence and natural enemy diversity under conventional and organic farming systems, information on the influence of natural farming on yellow stem borer infestation and the abundance of natural enemies in rice is still limited, particularly under the agro-climatic conditions of India. Furthermore, comparative evaluations involving natural farming, organic farming, conventional farming, and farmers' practices under field conditions are scarce. Therefore, the present study was undertaken to evaluate the effect of different farming systems on yellow stem borer infestation and the abundance of natural enemies in rice.

MATERIALS AND METHODS

Experimental site

The trial was conducted at the Agricultural and Horticultural Research Station, Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences, Honnavile, Shivamogga, Karnataka, India (13° 54' 40'' N, 75° 40' 26'' E, and 622 m above sea level) under the Southern Transition Zone (Zone-7) during the summer seasons of 2021 and 2022. Seeds of the RNR 15048 (Telangana Sona) paddy variety were soaked in water for one day in a drum, then removed, shaded for a day, and subsequently sown on a wet nursery bed. After sprouting, the RNR 15048 variety seedlings were transplanted into the field with a spacing of 30 cm x 10 cm on 25th February 2021 and 23rd February 2022. Agronomic practices were applied according to the treatment recommendations. In natural farming (NF), the seeds were treated with *beejamrutha* (local cow dung 5kg, water 20 liters, cow urine 5 liters and lime 50 g), while in organic and conventional farming; they were treated with Azospirilum (4 g/Kg) and PSB (4 g/Kg). In contrast, no seed treatment was applied in the farmers' practices. In conventional farming, recommended farmyard manure (FYM) @ 7.5 t/ hawas applied three weeks before transplanting and the recommended dose of N, $P_2O_5$and K_2O were given in the form of Urea, Diammonium Phosphate and Muriate of Potash, respectively. Nitrogen was given in three splits, 50 per cent as basal and 25 per cent at tillering (30 DAT) and remaining

25 per cent panicle initiation (60 DAT) stage. Full dose of P_2O_5, K_2O and $ZnSO_4$ were given as basal dose at the time oftransplanting.In organic farming, recommended dose of FYM and the recommended dose of N, $P_2O_5$and K_2O was applied through FYM as N equivalent basis. Whereas, in natural farming, *ghanajeevamrutha* (local cow dung 100 kg, cow urine 10 liters, 2 kg jiggery, and 2 kg pulse flour)@ 1000 kg/ hawas applied to well-prepared soil three weeks before transplanting and *jeevamrutha* (local cow dung 10 kg, cow urine 10 liters, 2 kg jiggery, 2 kg pulse flour, water 200 liters, and handful of soil) @ 500 L/ hathrough manual sprinkling to soil at the time of transplanting and at 30, 60 and 90 days after transplanting. In farmers practices treatment 5 ton of FYM applied at the time of puddling and inorganic Fertilizers of N, P_2O_5 and K_2O i.e 190:50:45 kg ha^{-1} were given in the form of Urea, Diammonium Phosphate and Muriate of Potash, respectively. Nitrogen was given in three splits, 50 per cent as basal and 25 per cent at tillering (30 DAT) and the remaining 25 per cent at panicle initiation (60 DAT). Full dose of P_2O_5, K_2O and $ZnSO_4$ were given as a basal dose at the time of transplanting.

Experimental design

The field experiment was designed in a Randomized Block Design (RBD) with four treatments, five replications, and each plot covering 828 m² (46 m x 18 m). Each plot is separated by 30 cm-wide bunds to ensure easy accessibility for monitoring of crop, cultural operations and the effective application of botanicals (Dhasparnikashaya and Agniastra)and insecticide was Chlorantraniliprole.

Treatment details

Treatments	Particulars
T1	**Natural farming*:**Dhasparnikashaya@ 15 L/ha + Agniastra @ 15 L/ha + Dhasparnikashaya@ 15 L/ha
T2	**Organic farming:** Azardirachtin 10000 ppm @ 1000 mL/ha
T3	**Conventional farming:** Chlorantraniliprole 0.4% GR @ 10kg/ha
T4	**Farmers' practice:** Chlorantraniliprole 0.4% GR @ 12kg/ha

*Sequence of spraying in Natural Farming- 1st spray - dashaparnikashaya, 2nd spray- 7DAS-Agniastra, 3rd spray -14 DAFS - dashaparnikashaya

Preparation of botanical extract along with cow dung and cow urine

The local Maland Gidda cow breed was selected for collecting cow dung and urine, which were later used in the preparation of dashaparnikashaya and agniastra.

Dashaparnikashaya: The preparation involves add 200 liter water in a plastic drum. Collect neem leaves 5kg, karanja leaves, *Lantana camara*, dhatura, arecanut, tulsi, mango, papaya, marigold leaves 2kg each,green chilli 500g, garlic 500g, ginger 200g, cow dung 2 kg, and cow urine 10 liters. All the plant materials were crushed before and added to the drum. Cover the drum with a gunny sack and place it in a shaded area. Let the mixture ferment for 21 days. During this period, rotate the drum three times a day to ensure proper aeration and mixing. After 21 days, strain the solution to separate the solid materials from the liquid extract. The liquid extract was stored for up to 6 months (Raskar &Wani, 2014).

Agniastra: Take tobacco leaves of 1 kg, green chilli 500 g, garlic 500 g, and neem leaves 5 kg. Grind the leaves, green chilli, garlic and add 20 liters of cow urine and allow to ferment for 24 hours. Boil the mixture until the bubbles appear and repeat it for

5 times. Filter the solution using a muslin cloth before spraying. For one hectare, mix 15 liters of agniastra with 500 liters of water and can be sprayed (Shyam et al., 2019).

Evaluation of yellow stem borer infestation and natural enemy populations

Observations on the infestation of yellow stem borer (YSB) were recorded by selecting 10 random hills per plot at the vegetative stage (30 days after transplanting) and the reproductive stage. Treatments were imposed when pest populations reached economic threshold levels of 5-10% dead hearts. The percentage of dead hearts was recorded at one day before application (DBA) as a pretreatment count, and subsequently at 3, 7, 14, and 21 days after application (DAA). The percentage of white ear heads was recorded at the pre-harvest stage. The percentage of dead heart (DH) and white ear head (WEH) was calculated using the formulas outlined by Heinrichs et al. (1985):

The natural enemy populations (coccinellids and spiders) of the yellow stem borer were recorded by 10 random hills per plot at DBA, 3 DAA, 7 DAA, 14 DAA, and 21 DAA. The number of predatory coccinellids and spiders was assessed through visual observations.

$$\text{Per cent dead heart} = \frac{\text{Total number of dead hearts}}{\text{Total number of tillers}} \text{X } 100$$

$$\text{Per cent white ear head} = \frac{\text{Total number of white ears}}{\text{Total number of tillers}} \text{X } 100$$

Assessment of yield and cost-benefit ratio

Grain and fodder yields were analyzed and expressed in quintals per hectare (q/ha), while the cost-benefit ratio (C:B) of each treatment was calculated by using the following formula and expressed as rupees per hectare.The averagemarket price of rice sold at Rs 2140/q in 2021 and Rs 2240/q in 2022.

$$\text{Cost} - \text{Benefit Ratio} = \frac{\text{Gross Returns (Rs/ha)}}{\text{Totat Cost of Production (Rs/ha)}}$$

Statistical Analysis

The percentage data for dead heart and white ear head were transformed using the arc sine method, and the number of coccinellids and spiders were transformed using √X + 0.5. Mean comparisons of significant treatments were performed at the 5% level using Duncan’s Multiple Range Test (DMRT), following the procedure described by Gomez & Gomez (1984).

RESULT

Evaluation of the yellow stem borer infestation on rice

The study demonstrates the effectiveness of different farming practices in the management of YSB infestations in rice. The findings indicate that farmer’s practices and conventional farming methods were more effective at reducing stem borer populations compared to natural and organic farming practices. The results of two seasons revealed that farmers' practices (Chlorantraniliprole 0.4% GR @ 12kg/ha) significantly ($p<0.05$) recorded lowest incidence levelsof DH 6.49 % and WEH3.22 % caused by YSB, significantly superior over other treatments. This was followed by conventional farming (Chlorantraniliprole 0.4% GR at 10 kg/ha), which showed DH of 6.83% and WEH of 3.85%, both of which were on par with each other. Similarly, organic farming (Azardirachtin 10000 ppm @ 1000 mL/ha) and natural farming (Dhasparnikashaya @ 15 L/ha + Agniastra @ 15 L/ha + Dhasparnikashaya @ 15 L/ha) with (DH 9.10 % and WEH 7.17%) and (DH 9.53 % and WEH 7.54%) respectively, also reduced stem borer infestation in rice but they were less effective compared to the other methods (Table 1).

Natural enemies' population

In the two-year study indicated that there was a significantly higher population of natural enemies' (coccinellids and spiders) was observed in the natural farming plot (9.98), which was superior over other treatments. This was followed by an organic farming plot (9.65) both of which were on par with each other. However, a lower population of natural enemies was observed in conventional farming (7.62) and farmers' practices (7.00) (Table 2).

Yield and Economic Analysis

The cost of production is higher in conventional farming compared to the other farming practices, but it recorded the highest grain and fodder yield, with 55.76 q/ha and 76.95 q/ha, respectively, which was closely followed by the farmers' practices plot, which recorded 53.18 q/ha and 74.85 q/ha, both of which were on par with each other. Whereas, lowest grain and fodder yield was recorded in natural farming plot (41.10 and 65.07 q/ha) respectively, followed by organic farming plot (50.39 and 70.51 q/ha) (Fig. 1 and Fig. 2). The highest C:B ratio had been recorded in natural farming (2.14), followed by conventional farming (1.99) and farmers' practices (1.92). However, the lowest C:B ratio was recorded in organic farming (1.30) (Table 3).

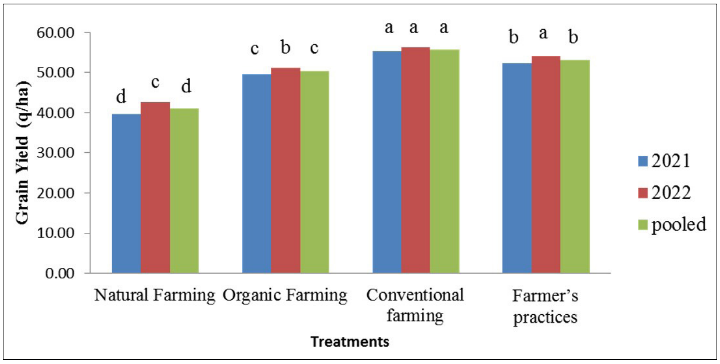

Figure 1. Effect of different farming practices on rice grain yields.

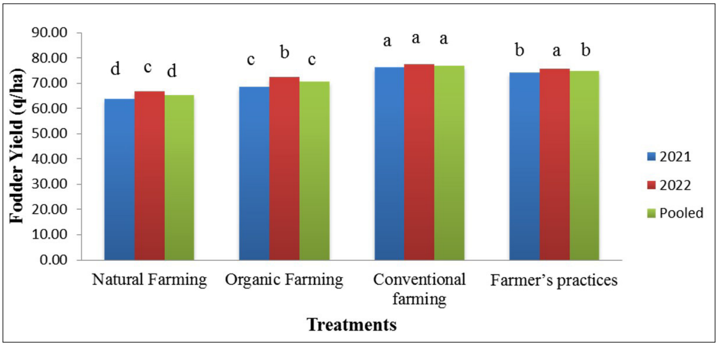

Figure 2. Effect of different farming practices on rice fodder yields.

DISCUSSION

Different farming methods were evaluated for the management of rice yellow stem borer. On other hand, we also studied impact of farming methods on natural enemies in rice ecosystem. The present study revealed that application of Chlorantraniliprole 0.4% GR effectively reduced the DH and WEH in farmer's practices and conventional farming methods, while also increases the yield in both the farming systems. Present findings conform with the findings of Suri & Brar, 2013; Sarao & Kaur, 2014; Rahaman & Stout, 2019; Jaglan, Chaudhary, Ahlawat, &Yadav, 2023; Suresh,Tayde, & Chandar, 2023, Pallavi et al., 2017 indicates that application of Chlorantraniliprole 0.4% GR at vegetative stage was found effective against YSB and increases yield in rice. Similarly, Hassani et al. (2022) reported that the lowest percent of dead heart and white ear head was recorded in the application of Chlorantraniliprole0.4% GR against striped rice stem borer *Chilo suppressalis* under rice ecosystem.

The organic farming and natural farming treatments slightly reduced the yellow stem borer infestation in rice. The results are in agreement with the findings of Sharma & Aggarwal, (2014); Madhu, Anand, Warghat, & Tayde,(2020); Singh & Sarao, (2023) who revealed that azadirachtin effectively reduces the dead heart and white ear heads and also increases grain yield. The present findings are consistent with those of Nagaraju et al. (2023), who reported that natural farming with hand weeding recorded the lowest incidence of white ears (14.73%) compared with other farming systems. Similarly, Mohapatra (2018) demonstrated that the application of Handiausadha (pot mixture of 5 L fermented cow urine + 1 kg fresh cow dung + 1 kg Karanj leaves + 1kg Neem leaves + 1 Kg *Calotropis* leaves and 50 g Gur) was effectively reduce the incidence of yellow stem borer and also incurred highergrain yield and cost-benefit ratio. Similarly, application of cow urine-based extracts of neem, nochi and adhatoda leaves @ 15% were moderately effective in controlling stem borer, *S.incertulas* during both vegetative and reproductive stages of the rice (Anil Kumaret al., 2024).Among the botanicals, garlic and chilli extract 5% effectively reduce the dead heart 5.69% and 5.48% (Nishanthini&Kandibane, 2022).The reduced incidence of yellow stem borer in the organic farming (OF) and natural farming (NF) systems may also be attributed to the higher abundance of natural enemies observed in these eco-friendly farming systems compared with conventional farming (CF) and farmers' practice (FP).In contrast, the effectiveness of natural enemies in conventional farming is often reduced by the broad-spectrum insecticides, which adversely affect their abundance and biological control potential (Alam et al., 2016).

A higher abundance of natural enemies was observed in the natural farming (NF) and organic farming (OF) plots than in the conventional farming (CF) and farmers' practice (FP) plots. The greater abundance of natural enemies under NF and OF is likely attributable to the reduced use of synthetic pesticides and the availability of a more suitable habitat, which supports predator survival and activity. Enhanced populations of natural enemies may improve the natural regulation of yellow stem borer. These findings are consistent with those of Kiyan, Tanaka, and Yuki (2023), who reported that organic farming significantly enhanced the abundance and diversity of spiders, particularly web-weaving spiders, in rice ecosystems. The results were in line with Rahmana et al. (2020) and Ogah, Omoloye, Nwilene, & Nwogbaga (2011), who observed natural enemies like lady bird beetle and spider were abundant in the neem extract sprayed rice field. Seni (2019) found to be essential oil Neemazal 1EC @ 1000 ml ha^{-1}wassafe to the natural enemies in rice ecosystem. There was a slight reduction in natural enemies' population observed in farmer's practices and conventional farming plots applied with Chlorantraniliprole 0.4% GR. Rahaman & Stout (2019)and Jaglan, Chaudhary, Ahlawat,& Yadav (2023) also reported that application of Chlorantraniliprole 0.4% G was less harmful to the natural enemies in the rice ecosystem.

In this study natural farming treatment was recorded highest cost-benefit ratio and moderate yield. The superior economic returns under NF were primarily attributed to its lower cost of cultivation, as it relies on locally available natural inputs for crop nutrition and the management of yellow stem borer. However, Chlorantraniliprole 0.4% GR in conventional farming showed the highest efficacy in reducing yellow stem borer infestation and also recorded the highest yield. These findings are in line with Rahaman& Stout, 2019 reported that Chlorantraniliprole 0.4% G effectively reduces the stem borer incidence in rice and also increases yield. This current study demonstrated that cow-based inputs and plant extracts can serve as an alternative to synthetic chemicals for the management of insect pests. The use of cow-based inputs such as cow dung and urine, combined with plant extracts, can be effectively integrated into pest management strategies. This approach not only aids in managing insect pest but also promotes environmental conservation and supports the long-term sustainability of rice cultivation.

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Table 1. Efficacy of different farming methods on the incidence of *Scirpophaga incertulas* on paddy at AHRS, Honnavile.

Treatments	2021			2022			Pooled		
	Days before application	Mean dead heart incidence (%)	Mean white ear head incidence (%)	Days before application	Mean dead heart incidence (%)	Mean white ear head incidence (%)	Days before application	Mean dead heart incidence (%)	Mean white ear head incidence (%)
T1-Natural Farming	18.23 (25.12)	11.14 (18.96)a	8.08 (16.10)a	13.71 (21.43)	8.54 (16.77)a	7.01 (15.12)a	15.97 (23.36)	9.53 (17.91)a	7.54 (15.63)a
T2-Organic Farming	19.22 (25.85)	10.70 (18.98)a	7.53 (15.81)a	14.60 (22.06)	7.29 (15.98)a	6.81 (15.00)a	16.91 (24.05)	9.10 (17.54)a	7.17 (15.46)a
T3- Conventional farming	20.68 (26.87)	8.17 (16.83)b	4.02 (11.47)b	15.51 (22.95)	5.36 (13.21)b	3.68 (10.96)b	18.10 (25.04)	6.83 (15.14)b	3.85 (11.26)b
T4-Farmer's practices	19.95 (26.45)	7.95 (16.24)b	3.45 (10.49)b	15.10 (22.61)	5.34 (13.03)b	2.99 (9.79)b	17.52 (24.69)	6.49 (14.75)b	3.22 (10.30)b
SEm±	1.60	1.28	0.62	2.05	0.74	0.87	1.50	0.55	0.85
CD(P=0.05)	NS	3.94*	1.91*	NS	2.27*	2.67*	NS	1.70*	2.60*

Figures in the parentheses are average of transformed values = Arcsine; DBA- Day before application, *Significant at $p<0.05$; Means followed by common letters are not significantly different by DMRT test.

Table 2. Effect of farming practices on population of natural enemies in rice ecosystem at AHRS, Honnavile

Treatments	Mean number of Natural enemies/ hill					
	2021		2022		Pooled	
	DBA	Overall Mean	DBA	Overall Mean	DBA	Overall Mean
T1-Natural Farming	9.48 (3.15)	10.11 (3.23)[a]	8.58 (3.00)	9.85 (3.21)[a]	9.03 (3.08)	9.98 (3.23)[a]
T2-Organic Farming	10.06 (3.24)	9.86 (2.88)[a]	8.83 (3.03)	9.45 (3.15)[a]	9.45 (3.15)	9.65 (3.19)[a]
T3- Conventional farming	9.85 (3.21)	7.71 (3.04)[b]	9.16 (3.08)	7.52 (2.83)[b]	9.50 (3.15)	7.62 (2.85)[b]
T4-Farmer's practices	10.43 (3.30)	7.23 (2.78)[b]	10.24 (3.27)	6.77 (2.69)[b]	10.34 (3.29)	7.00 (2.73)[b]
SEm±	0.11	0.10	0.17	0.07	0.08	0.07
CD(P=0.05)	NS	0.31*	NS	0.21*	NS	0.22*

Figures in the parentheses are average of transformed values = $\sqrt{X+0.5}$; DBA- Day before application, *Significant at $p<0.05$; Means followed by common letters are not significantly different by DMRT test.

Natural enemies: Coccinellids and Spiders

Table 3. Economics of rice as influenced by different farming practices during summer season at AHRS, Honnavile.

Farming methods	2021				2022				Pooled			
	Cost of Production (Rs/ha)	Gross Income (Rs/ha)	Net income (Rs/ha)	C:B	Cost of Production (Rs/ha)	Gross Income (Rs/ha)	Net income (Rs/ha)	C:B	Cost of Production (Rs/ha)	Gross Income (Rs/ha)	Net income (Rs/ha)	C:B
T1-Natural Farming	916	76863	40588	2.12	908	86863	48188	2.25	912	80118	42643	2.14
T2-Organic Farming	1500	96282	21832	1.29	1507	104326	27236	1.35	1504	98217	22447	1.30
T3- Conventional farming	967	107224	53763	2.01	995	114730	58749	2.05	981	108685	53964	1.99
T4- Farmer's practices	1012	101346	48475	1.92	1023	110405	55014	1.99	1018	103666	49535	1.92

*Significant at $p<0.05$; Means followed by common letters are not significantly different byDMRT test.

(Rice seed cost: Rs 1875 /ha;T1:Dhasparnikashaya@ 15 L/ha + Agniastra @ 15 L/ha + Dhasparnikashaya@ 15 L/ha; T2:Azadirachtin @1000mL/ha- Rs 2364 /ha; T3:chlorantraniliprole 0.4% GR at 10 kg/ha - Rs 2418 /ha; T4: Chlorantraniliprole 0.4% GR at 12 kg/ha - Rs 2901 /ha.

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