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Evaluation of organic amendments on the incidence of major lepidopteran pests in rice

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Abstract
A field experiment was carried out during *Kharif* 2017 summer 2018 to evaluate relative efficacy of organic amendments on the incidence of major lepidopteran pests in rice. Five organic amendments *viz.*, vermicompost, farmyard manure, poultry manure, neem cake and sheep manure along with chemical fertilizer (RDF) were evaluated. Among the organic amendments tested, neem cake recorded lowest percent leaf folder, *Cnaphalocrosis medinalis* Guenee damage (5.96%) as against the untreated control. Addition of organic amendments like sheep manure and poultry manure recorded moderate leaf damage (9.85%). The present investigation indicated that increase in NPK doses increased the incidence of leaf folder (12.16%). The effect of organic amendments on yellow stem borer *Scirpophaga incertulas* Walker infestation was noticeable in test crop. The observation at 45 DAT revealed that maximum damage by the borer was noticed at NPK (12.41%) followed by FYM (12.24%) and vermicompost (10.34%). Results revealed that soil amendments decreased the infestation of leaf folder and yellow stem borer. Implication of the study in eco-friendly management of lepidopteran pests is discussed.

Keywords: Rice, organic amendments, yellow stem borer, rice leaffolder

Introduction
Rice (*Oryza sativa* L.) is one of the most significant cereals and is the staple food for more than two billion people. More than 90 percent of the world's rice is grown and consumed in Asia where 60 percent of the people of the earth relish [1]. Yellow stem borer, *S. incertulas* (Walker) (Lepidoptera: Crambidae) a monophagous pest of paddy is considered as the most important nuisance of rain fed, low land and flood-prone rice ecosystems [2]. The extent of damage caused by stem borer varied from 80 to 97 percent [3]. The rice leaffolder (RLF), *C. medinalis* (Guenee) was considered as a minor or sporadic pest in the past in many Asian countries. However, now it has been assumed as one of the important insect pests and become a major threat to rice production in tropical and subtropical Asia [4]. Rice production relay predominantly on use of synthetic chemicals to control insect-pests. The indiscriminate use of synthetic chemicals immensely raised the new problem such as pest resurgence, development of insecticide resistance in target insects, unendurable level of pesticide resistance and toxicity to other non-target organisms [5]. So there is a need to develop new pest management strategies which reduce the insecticide usage. The nutrient management can play a vital role in pest management strategy. The nutrient management may affect response of rice to pests, as well as development pattern of pest populations. Soil fertility practices can impact the physiological susceptibility of crop plants to insect pests by either affecting the resistance of individual plant to attack or by altering plant acceptability to certain herbivores [6]. As rice production system is changing due to the development of new technology and yield is getting higher, the interaction between nutrient management and pests is becoming more complicate and more important. Hence, the present study was undertaken to assess the effect of organic amendments on intensity of major insect pests of rice for sustainable rice production system.

Materials and Methods
A field experiment was conducted at College of Agriculture, Shivamogga during *Kharif* 2017 summer 2018. A popular commonly growing rice variety Jyothi was taken as the test variety. Soil samples were taken from the surface 15 cm before treatment applications. Samples of each amendment were collected one week before application to plots and were analysed for NPK content.

The experiment was replicated four times with six treatments *viz.*, T_1: vermicompost, T_2: farmyard manure, T_3: poultry manure, T_4: neem cake,T_5: sheep manure andT_6: chemical fertilizer (RDF). The plot size was 1.5 x 3 m. All the organic amendments were applied one time before transplanting. The quantity of organic manures was applied an *N- equivalent* basis. T_1: vermicompost- 5.80 t/ha, T_2: farmyard manure 20t/ha, T_3: poultry manure 3.30 t/ha, T_4: neem cake 1.92 t/ha, T_5: sheep manure 1.20 t/ha andT_6: chemical fertilizer (RDF).Whereas, in case of NPK treatment, it was applied as per package of practices. The observations on the incidence of two lepidopteran insect-pests (yellow stem borer and rice leaf folder) was recorded at fortnightly interval on ten randomly selected plants in each treatment by following Standard Evaluation System (IRRI). Percent dead hearts and white ears was recorded by counts taken on number of dead hearts/white ears on ten randomly selected hills at every 15 days interval. The percent leaf damage was recorded by counting total number of leaves and infested leaves at 30, 45 and 60 days after transplanting. The damaged leaves and total leaves from ten randomly selected hills were observed and percent leaf damage were calculated. Leaf folder *C. medinalis* damage was recorded in the form of percent leaf infestation during the vegetative and panicle initiation stage of crop. The crop was harvested when more than 85 percent of the grains matured in all treatments. Data on grain yield were collected from each treatment/subplot. The grain yields obtained from various treatments were expressed as q/ha.

Statistical analysis

The data obtained from various experiments was statistically analyzed. Different parameters observed in the experiments were subjected to Duncan's Multiple Range Test (DMRT) ($P = 0.05$).

Results and Discussion

The data on effect of organic amendments on the incidence of leaf damage (%) by leaf folder in rice genotype Jyothi was presented in Table 1.The mean percent leaf damage in *Kharif* 2017 varied significantly from 8.22 to 13.10 and 7.93 to 11.49 percent among different organic amendments at 30 and45 days after transplanting(DAT) respectively. Neem cake (T1) recorded lowest percent leaf damage (5.21%) as against the untreated control (T6) (13.10%). Addition of organic amendments through sheep manure (T5) and poultry manure (T3), recorded moderate infestation with 8.22 to 9.42 percent leaf damage when compared to NPK (T6) with 13.10 to 11.49 percent leaf damage from 30 DAT to 45 DAT.

During summer 2018, leaf damage was varied from 4.86 to 11.21 and 5.72 to 12.26 percent in different treatments at 30 and 45 DAT respectively. The plot receiving neem cake (T1) recorded lowest percent leaf damage (5.72%) as against the untreated control (T6) (12.26%). Addition of organic amendments like sheep manure (T5) and poultry manure (T3), recorded moderate infestation with 8.35 to 12.26 percent leaf damage. The entire data indicated that increase in NPK doses increased the incidence of leaf folder (Table 2).

Effectiveness of NPK fertilizers alone and in combination with organic amendment sources were evaluated against yellow stem borer, *S. incertulas* in rice variety Jyothi under field condition. Data on extent of damage by YSB at vegetative and reproductive stage of rice in *Kharif*2017 are presented in Table 1.The impact of different doses of organic amendments on stem borer infestation was noticeable in test crop. The observation at 45 DAT result revealed that maximum damage (13.16% DH) by the borer was noticed at NPK (T6) followed by FYM (T2) and vermicompost (T1) with 13.22 and 11.36 percent DH which remained on par with each other. The lowest infestation (6.69% DH) recorded in neem cake (T4) which is on par with sheep manure (T5),The observation on white earhead (WH) recorded at 90 DAT revealed that maximum damage (10.18% WH) was recorded in NPK (T6) followed by FYM (T2) 8.46 percent. Lower infestation was recorded in neem cake (T4) with 3.62 percent WH and showed on par effect with each other when compared to control (T6). The treatment with neem cake recorded significantly higher grain yield (40.10q/ha) which was on a par with sheep manure applied to plot (38.20q/ha) (Table 1).

During summer 2018, maximum damage of dead heart (11.65%) by the yellow stem borer was noticed at NPK (T6) followed by FYM (T2) and vermicompost (T1) with 11.26 and 9.32 percent DH. The lowest infestation (6.10% DH) recorded in neem cake (T4) which was on par with sheep manure (T5). Maximum white earhead damage was registered prior to harvest *i.e.*, 90 DAT. Highest damage (8.10% WEH) was recorded in NPK (T6) followed by FYM (T2) with 6.80 percent. Lower infestation was recorded in neem cake (T4) with 2.64 percent WEH. The treatment with neem cake recorded significantly higher grain yield (36.20q/ha) which was on a par with sheep manure (35.40q/ha) (Table 2).

The pooled data of *Kharif* 2017 and summer 2018, was shown in Table 3. Results revealed that the treatment neem cake (T4) sustained the lowest percent leaf damage at 30 DAT (4.91%), 45 DAT (5.96%) and as against highest infestation untreated control (11.88% and 12.16%) on corresponding dates respectively, in plots receiving NPK (T6). Increased inorganic fertilization resulted in increased leaf folder infestation than organic amendment (Table 3)

The effect of organic amendments on stem borer infestation was noticeable in test crop. The observation at 45 DAT revealed that maximum damage (12.41% DH) by the borer was noticed at NPK (T6) followed by FYM (T2) and vermicompost (T1) with 12.24 and 10.34 percent DH which remained on par with each other. The lowest infestation (7.91% DH) was recorded in neem cake (T4) which was on par with sheep manure (T5). Similar findings have been reported [7, 8] with the use of organic manures in suppressing the incidence of YSB.

The pooled data of white earhead (WEH) infestation revealed that maximum damage (9.14% WEH) was recorded in NPK (T6) followed by FYM (T2) 7.63 percent. Lower infestation was recorded in neem cake (T4) with 3.13 percent WEH and showed on par effect with each other when compared to control (T6). Sheep manure (T5) and poultry manure (T3), recorded moderate infestation with 3.74 to 4.27 percent when compared to control (T6). The treatment with neem cake recorded significantly higher grain yield (38.20q/ha) which was on a par with sheep manure applied to plot (35.30q/ha) (Table 3).Soil amendments strategy can create an unfavourable environment for pest inducing resistance through antibiosis or feeding inhibition [9]. Positive impact of chemical fertilizer on the incidence of paddy stem borer has been also reported [10]. In the present investigation, highest infestation of RLF and YSB was observed in plot receiving FYM+NPK. It has corroborated the research outcomes of plants grown with high levels of nitrogen fertilizer resulted in larger infestation of insect-pests [11].

Organic amendments have more effective than chemical

fertilizer to induce tolerance to lepidopteran pests. Their effects exhibited through decreasing incidence of RLF and YSB. Main mechanism of defence in rice genotype was recorded by low nitrogen and phosphate content and high potassium content in rice plant [12]. Though reduction in pest number is one aspect for yield increase there are several other factors which do account for higher grain yield in rice.

Table 1: Effect of organic amendments on the incidence of rice leaf folder and yellow stem borer during *Kharif* 2017

Tr. No	Treatment	Dosage (tons/ha) (N-equivalent basis)	Rice leaf folder Leaf damage (%)#		Yellow stem borer Dead heart/white earhead (%)#			Yield q/ha
			30 DAT	45 DAT	30DAT	45 DAT	90 DAT	
T_1	Vermicompost	5.89	10.43 (18.8)$^{bc\wedge}$	11.58 (19.88)^{a}	8.52 (16.92)^{a}	11.36 (19.66)^{ab}	6.24 (14.44)^{b}	34.70^{bc}
T_2	FYM	20.00	11.62 (19.9)^{ab}	12.16 (20.38)^{a}	9.19 (17.6)^{a}	13.22 (21.31)^{a}	8.46 (16.85)^{a}	33.10^{c}
T_3	Poultry manure	3.30	9.42 (17.86)^{cd}	10.11 (18.5)^{ab}	5.42 (13.35)^{bc}	9.20 (17.61)^{bc}	4.74 (12.43)^{bc}	36.60^{b}
T_4	Neem cake	1.92	5.21 (13.16)^{e}	6.20 (14.33)^{c}	4.30 (11.80)^{c}	6.69 (14.91)^{d}	3.62 (10.97)^{c}	40.10^{a}
T_5	Sheep manure	1.20	8.22 (16.65)^{d}	7.93 (16.27)^{bc}	5.89 (13.98)^{b}	8.18 (16.56)^{cd}	4.20 (11.83)^{c}	38.20^{a}
T_6	Control check (NPK) RDF	100:50:50 kg/ha	13.10 (21.21)^{a}	11.49 (19.75)^{a}	9.66 (18.10)^{a}	13.16 (21.24)^{a}	10.18 (18.56)^{a}	35.90^{c}
	SEm±		0.58	0.85	0.55	0.81	0.69	
	CD 5%		1.75	2.57	1.66	2.43	2.07	
	CV%		6.47	9.39	7.18	8.71	9.69	

* Genotype –Jyothi, #Mean of 10 hills, ^Figures in the parentheses are arcsine transformed values
In a column mean followed by same letter are not significantly different at p=0.05 as per DMRT

Table 2: Effect of organic amendments on the incidence of rice leaf folder and yellow stem borer duringsummer 2018

Tr. No	Treatment	Dosage (tons/ha) (N-equivalent basis)	Rice leaf folder Leaf damage (%)#		Yellow stem borer Dead heart/white earhead (%)#			Yield q/ha
			30 DAT	45 DAT	30DAT	45 DAT	90 DAT	
T_1	Vermicompost	5.89	8.75 (17.15)$^{b\wedge}$	10.22 (18.63)^{abc}	7.41 (15.73)^{ab}	9.32 (17.66)^{ab}	5.70 (13.79)^{b}	33.70^{bc}
T_2	FYM	20.00	9.34 (17.78)^{ab}	11.21 (19.55)^{ab}	7.10 (15.38)^{ab}	11.26 (19.6)^{a}	6.80 (15.1)^{ab}	31.60^{c}
T_3	Poultry manure	3.30	8.52 (16.92)^{b}	9.59 (17.95)^{bc}	6.20 (14.42)^{b}	8.14 (16.56)^{bc}	3.80 (11.19)^{c}	34.00^{b}
T_4	Neem cake	1.92	4.86 (12.29)^{c}	5.72 (13.73)^{d}	3.04 (9.97)^{c}	6.10 (14.07)^{c}	2.64 (9.26)^{d}	36.20^{a}
T_5	Sheep manure	1.20	7.38 (15.69)^{b}	8.22 (16.6)^{c}	5.63 (13.7)^{b}	7.64 (16.03)^{bc}	3.27 (10.36)^{cd}	35.40^{a}
T_6	Control check (NPK) RDF	100:50:50 kg/ha	11.21 (19.53)^{a}	12.26 (20.47)^{a}	8.42 (16.85)^{a}	11.65 (19.95)^{a}	8.10 (16.52)^{a}	32.50^{c}
	SEm±		0.72	0.69	0.70	0.87	0.64	
	CD 5%		2.17	2.07	2.12	1.23	1.92	
	CV%		8.69	7.71	9.82	9.06	10.02	

* Genotype –Jyothi, #Mean of 10 hills, ^Figures in the parentheses are arcsine transformed values
In a column mean followed by same letter are not significantly different at p=0.05 as per DMRT

Table 3: Effect of organic amendments on the incidence of rice leaf folder and yellow stem borer (Pooled data of two seasons)

Tr. No	Treatment	Dosage (tons/ha) (N-equivalent basis)	Rice leaf folder Leaf damage (%)#		Yellow stem borer Dead heart/white earhead (%)#			Yield q/ha
			30 DAT	45 DAT	30DAT	45 DAT	90 DAT	
T_1	Vermicompost	5.89	9.72 (18.16)$^{bc\wedge}$	10.78 (19.16)^{a}	7.97 (16.39)^{a}	10.34 (18.76)^{ab}	5.97 (14.14)^{b}	34.20^{bc}
T_2	FYM	20.00	10.48 (18.89)^{ab}	11.69 (19.99)^{a}	8.15 (16.58)^{a}	12.24 (20.48)^{a}	7.63 (16.04)^{a}	32.40^{c}
T_3	Poultry manure	3.30	8.97 (17.43)^{cd}	9.85 (18.29)^{ab}	5.81 (13.95)^{bc}	8.67 (17.12)^{bc}	4.27 (11.93)^{bc}	35.30^{b}
T_4	Neem cake	1.92	4.91 (12.8)^{c}	5.96 (14.13)^{c}	3.67 (11.04)^{c}	6.40 (14.65)^{d}	3.13 (10.19)^{c}	38.20^{a}
T_5	Sheep manure	1.20	7.80 (16.22)^{d}	7.83 (16.24)^{bc}	5.76 (13.89)^{b}	7.91 (16.33)^{cd}	3.74 (11.14)^{c}	36.80^{a}
T_6	Control check (NPK) RDF	100:50:50 kg/ha	11.88 (20.16)^{a}	12.16 (20.40)^{a}	9.04 (17.50)^{a}	12.41 (20.62)^{a}	9.14 (17.60)^{a}	34.20^{c}
	SEm±		0.63	0.74	0.62	0.84	0.66	
	CD 5%		1.96	2.28	1.91	2.57	2.02	
	CV%		7.42	8.51	9.37	8.65	9.40	

* Genotype –Jyothi, #Mean of 10 hills, ^Figures in the parentheses are arcsine transformed values
In a column mean followed by same letter are not significantly different at p=0.05 as per DMRT

Conclusion

It can be concluded that, there was conspicuous difference among organic amendments. Among organic amendments neem cake recorded lowest percent leaf folder, *Cnaphalocrosis medinalis* Guenee damage as against the untreated control. Addition of organic amendments like sheep manure and poultry manure recorded moderate leaf damage. The present investigation indicated that increase in NPK doses increased the incidence of leaf folder. The effect of organic amendments on yellow stem borer *Scirpophaga incertulas* Walker infestation was noticeable in test crop. The maximum damage by the yellow stem borer was noticed at NPK followed by FYM. Results revealed that soil amendments decreased the infestation of leaf folder and yellow stem borer incidence.

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