Original Research Article

Effect of nitrogen fertilizer on the incidence of insect pests in four rice cultures

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ABSTRACT

Aim: To determine the effect of local rice cultures and inorganic nitrogen fertilizer on the incidence of stem borer, *Scirpophaga incertulas* (Walker); Leaffolder, *Cnephalocrocis medinalis* (Guenee); and Gall midge, *Orseolia oryzae* (Wood Mason) and on grain yield of rice.

Study design: A field experiment for two consecutive years was carried out in a split plot arrangement in randomized block design with three replications.

Place and duration of the study: Department of Entomology, Agricultural Research Station, Nellore, Andhra Pradesh during Kharif, 2013 and 2014.

Methodology: The rice cultures (NLR 20104, NLR 20106, NLR 3135 and NLR 33892) were attributed to experimental main plots and nitrogen levels (40, 80, 120, 160 and 200 kg ha^{-1}) were attributed to the sub plots. Observations on incidence of stem borer, gall midge and leaf folder was recorded in randomly selected 10 hills per subplot in replication and per cent incidence was calculated.

Results: The pest incidence of the treatments with high N rate as 160 and 200 kg/ha were higher (31.43 & 43.86 % stem borer, 9.23 & 13.59 % leaffolder and 2.75 & 3.00 % gall midge, respectively) than that of lower N rate i.e. 40 and 80 kg ha^{-1} (19.24 & 20.04 % stem borer, 7.37 & 7.95 % leaffolder and 1.42 & 1.93 % gall midge, respectively). Different rice cultures significantly influenced the leaf folder incidence but not stem borer and gall midge. Highest leaffolder incidence (13.44 %) was noticed in NLR 20104 culture which was followed by NLR 3135 culture with 9.64 % leaffolder incidence. Gall midge and leaffolder incidence was not significantly influenced by the combined effect of rice culture and nitrogen levels, in contrast interaction effect has a significant influence on stem borer incidence. Significantly lowest stem borer incidence (18.21 %) was noticed with NLR 3135 rice culture treated with 40 N ha^{-1}, which was statistically on par with the NLR 20106 rice culture treated with 40 kg N ha^{-1} (18.23 %) and NLR 20104 rice culture treated with 40 kg N ha^{-1} (19.76 %). Among the rice cultures, NLR 33892 culture might be due to having higher physiological indices had produced significantly highest grain yield (5955 kg ha^{-1}). The highest/optimum grain yield (5726 kg ha^{-1}) produced by plots that received 120 kg N ha^{-1}. Further increase in nitrogen level beyond 120 kg

ha^{-1} did not significantly improve the grain yield. Optimal N rate was revealed to be 120 kg ha^{-1} for four rice cultures for reducing the stem borer/leaf folder/gall midge incidence so as to minimize the cost of inputs for pest control measures and for achieving high grain yield.
Conclusions: The incremental doses of nitrogen fertilizer significantly enhanced stem borer, leaffolder and gall midge infestation on rice, which further affect the grain yields.
decrease medical as well as financial burden, hence improving the management of cirrhotic patients. These predictors, however, need further work to validate reliability.

Keywords: Rice cultures, insect pest, nitrogen levels, yield.

1. INTRODUCTION

Rice (*Oryza sativa* L.) belongs to the family of grasses (Poaceae), which is one of the most important cereal crops worldwide. It is the staple food for more than two billion people in developing countries (1). Andhra Pradesh ranks third in production in India which produces 128.95 lakh tons of rice and contributes 12 % of total rice produced in country. Insect pests are the major biotic constraints in enhancing rice productivity that cause 20- 30 per cent losses every year, besides diseases and weeds. Incidence of Yellow stem borer, *Scirpophaga incertulas* (Walker) on rice was reported throughout the country with a varied level of severity and the reported yield losses ranged from 3 to 65 per cent (2). This loss may go up to 70-90 % during the years of severe devastation. The rice leaffolder, *Cnephalocrocis medinalis* (Guenee) is one of the destructive pests affecting in all the rice ecosystem in Asia. The yield loss is from 30 to 80 per cent under epidemic condition (3). It was considered as minor pest, but now has assumed the major pest status in the entire country particularly in area of high fertilizer usage. Although occasional outbreaks or severe damage to the rice crop by rice gall midge were reported prior to the 1960's (4), the rice gall midge problem became extensive following the introduction and widespread of dwarf and high yielding cultivars. The Asian rice gall midge, *Orseolia oryzae* (Wood Mason) has been reported as a pest in several asian countries. Saroja and Raju (1981) reported that gall midge population increased with increasing levels of nitrogen.
Large scale cultivation of high yielding varieties, monocropping, close planting, water regime, excessive use of nitrogenous fertilizers further aggravated the pest incidence. Nitrogen plays key role in rice production and it is required in large amount. Nitrogen is the most important limiting nutrient in rice production (6). Though the nitrogen has a positive influence on the production of effective tillers per plant, yield and yield attributes (7 and 8) excessive or high level of nitrogen usage increases leaffolder, stem borer and gall midge infestation (9, 10, 11). The information on the influence of nitrogenous fertilizer levels on the pest complex of rice is scanty. It is necessary to find out the response of each and every rice cultivar against major insect pests at different nitrogen levels. A suitable combination of variety and rate of nitrogen is necessary to reduce insect pest incidence and for getting better yields. The present study was aimed to identify the optimum dose of nitrogen against field incidence of insect pest and to result higher grain yield.

2. MATERIAL AND METHODS

In order to explore the effect of different rice cultivars (4 rice cultures) and the effect of various N fertilizer doses (5 levels) on the incidence of rice insect pests the experiments were conducted in a split plot arrangement in randomized block design (RBD) with three replications. The rice cultures (NLR 20104, NLR 20106, NLR 3135 and NLR 33892) were attributed to experimental main plots and nitrogen levels (40, 80, 120, 160 and 200 kg N ha^{-1}) were attributed to the sub plots. The total number of plots were 60 and the unit plot size was 4 m X 2.5m. the main and sub plots were partitioned with bunds 1m high and 0.5 m wide. Rice seedlings were transplanted at 30 days after sowing with inter and intra row spacing 15X10 cm at two seedlings per hill in to the sub-plots. Nitrogen was applied in 3 splits i.e 25 % as basal, 50 % at 15 days after transplantation at maximum tillering stage and 25 % at panicle initiation stage. Total phosphorous was applied as basal and potash was applied as 50 % basal and 50 % at panicle initiation stage for all treatments. Fertilizer treatments are given in Table 1. Source of fertilizer was Urea, Diammonium phosphate (DAP) and Murate of Potash (MOP). The susceptibility of four cultures of rice against stem borer, *S. incertulas*; leaffolder, *C. medinalis* and gall midge, *O. oryzae* was studied in five levels of nitrogenous fertilizers.

Observations on the incidence of stem borer in terms of dead hearts were recorded at 30 days after transplantation (DAT). Observation on dead heart incidence was recorded by counting the total number of tillers and number of dead hearts in randomly selected 10 hills per subplot in replication by leaving the border lines from sides at 30 DAT and the per cent dead hearts incidence was calculated using the following formula.

$$\text{Per cent stem borer incidence} = \frac{\text{Number of dead hearts}}{\text{Total number of tillers}} \times 100$$

Observation on the leaffolder incidence in terms of number of damaged leaves by leaffolder was recorded at the time of peak leaffolder infestation. The observations were recorded in randomly selected 10 hills per subplot in replication by leaving the border lines form sides and the per cent leaffolder damaged leaves were calculated as follows.

$$\text{Per cent leaffolder damage} = \frac{\text{Number of damaged leaves}}{\text{Total number of leaves}} \times 100$$

Observations on the incidence of gall midge in terms of silver shoots were recorded at 30 days after transplantation (DAT). Observation on gall midge incidence was recorded by counting the total number of tillers and number of silver shoot in randomly selected 10 hills per subplot in replication by leaving the border lines from sides and the per cent gall midge incidence was calculated using the following formula.

$$\text{Per cent stem borer incidence} = \frac{\text{Number of silver shoots}}{\text{Total number of tillers}} \times 100$$

3. RESULTS AND DISCUSSION

Stem borer

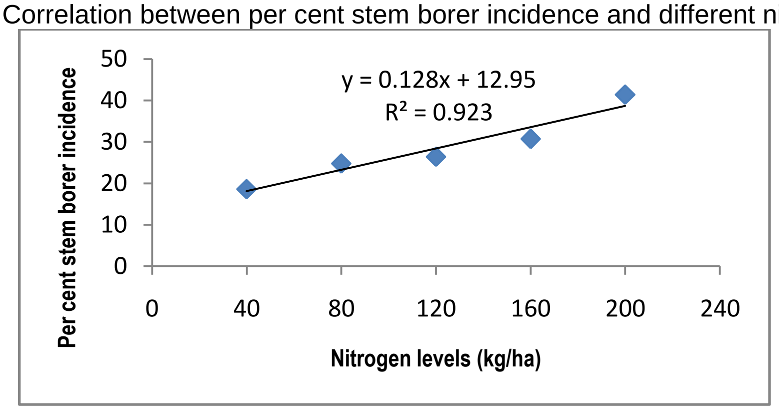
The data presented in Table 1. revealed that individual effect of N levels and interaction effect of rice culture and N levels was found to be significant in case of stem borer. Significantly lowest per cent incidence of stem borer (19.24 %) was recorded in the plots treated with 40 kg N ha-1, followed by the plots treated with 80kg N ha-1 (20.04 %), 120 kg N ha-1 (27.67 %) and 160 kg N ha-1 (31.43 %). The treatment which received 80 kg N ha-1 and 120 kg N ha-1 suffered with moderated stem borer incidence. The results further show that the pest incidence increases with the increase in nitrogen fertilizer doses. The highest stem borer incidence (43.86 %) was recorded with 200 kg nitrogen application per hectare. The dead hearts and white ears caused by yellow stem borer increased with higher nitrogen levels (12). The young stem borer larvae feed within the leaf sheath, and older larvae feed inside the stem and vascular tissues. The application of nitrogen fertilizer can increase the succulence in stems and leaves, which can lead to greater stem borer attack, higher larval weights and shorter the developmental time. Liu and Qin reviewed the population of Yellow stem borer in china and found that the rates of damage, densities, and the weight and sizes of larval body of stem borer increased significantly with the increase in nitrogen. Findings of the present study are also in accordance with Singh et al, who reported that NPK ratio of 120-60-60 kg ha-1 increased the susceptibility of rice crop to stem borers. Saha and Saharia, reported the incidence of stem borers from 8.36 % in plots without nitrogen fertilizers to 20.12 % in those treated with 100 Kg N ha-1. This relationship is further substantiated by the positive correlation established between damage incidence and nitrogen levels (r= 0.960) (Fig. 1).

Table 1: Per cent Incidence of Stem borer as affected by rice cultures and nitrogen levels**

Variety/N levels	NLR 20104 (V1)	NLR 20106 (V2)	NLR 3135 (V3)	NLR 33892 (V4)	Mean*
40 kg N/ha (N1)	19.76[a]	18.23[a]	18.21[a]	20.76[b]	19.24[a]
80 kg N/ha (N2)	23.82[c]	27.81[ef]	23.81[c]	24.71[c]	20.04[b]
120 kg N/ha (N3)	27.72[e]	31.71[g]	24.81[cd]	26.42[de]	27.67[c]
160 kg N/ha (N4)	34.56[h]	29.72[fg]	31.76[g]	29.71[f]	31.43[d]
200 kg N/ha (N5)	50.72[k]	42.64[j]	42.56[j]	39.62[i]	43.86[e]
Mean	31.32	30.02	28.23	28.24	
		SEM ±	**CD @1%**	**CV %**	
	Variety	0.3685	NS	24.68	
	N levels	0.4120	1.179		
	Interaction	0.8241	2.360		

*Means separated in column followed by the same letters are not significantly different at *P* = .01. **Mean of two years

Fig. 1: Correlation between per cent stem borer incidence and different nitrogen levels.



There is no significant difference in stem borer incidence among four rice cultures tested. Highest (31.32 %) stem borer incidence was recorded in NLR 20104 culture which was followed by 30.02 per cent in NLR 20106, 28.23 per cent dead hearts in NLR 3135 and NLR 33892. All four cultures were more or less equally suffered with stem borer incidence at different nitrogen doses.

The interaction effect of rice culture and different nitrogen levels significantly affected the incidence of stem borer. Significantly lowest stem borer incidence (18.21 %) was noticed with NLR 3135 rice culture treated with 40 kg N ha-1, which was statistically on par with the NLR 20106 rice culture treated with 40 kg N ha-1 (18.23 %) and NLR 20104 rice culture treated with 40 kg N/ha (19.76 %). It was followed by the V4N1 with 20.76 % stem borer incidence. Stem borer incidence was found to be significantly highest with the combined effect of NLR 20104 rice culture and 200 kg N ha-1 (V1N5). It was followed by the interaction of V2N5 and V3N5 with 42.64 and 42.56 per cent leaffolder incidence.

Leaffolder

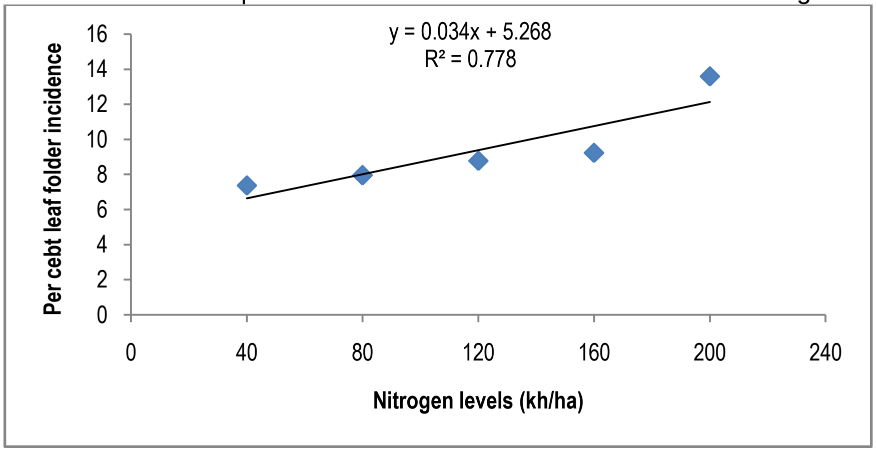
The data presented in Table. 2 revealed that individual effect of rice culture and N levels was found to be significant and interaction effects were non significant in case of leaf folder. The lowest per cent incidence (7.37 %) of leaffolder was recorded in the plots treated with 40 kg N ha-1, and it was on par with the other treatments viz., 80 kg N ha-1, 120 kg N ha-1 and 160 kg N ha-1 with per cent leaffolder incidence of 7.95, 8.78 and 9.23 %, respectively and leaffolder incidence was increased drastically (13.59 %) in the plots applied with 200 kg N ha-1 and significantly differed with all other treatments. These results were supported by the positive correlation obtained between damage incidence and nitrogen levels with correlation coefficient, r= 0.882. (Fig. 2). The highest leaffolder incidence in the plots with 200 kg N ha-1 might be due to the positive effect of nitrogen fertilization on egg laying and survival of leaffolder larvae. Moreover, the significant effect of higher nitrogen fertilization in the small scale experiment was attributed mainly to an oviposition choice of the moths in plots with higher nitrogen doses. Kraker reviewed 15 published papers on field trials and found that in a large number of trials the increase in nitrogen fertilization led to higher injury levels by leaffolders. In the laboratory experiments the use of nitrogen fertilizer affected several bionomic characteristics of rice leaffolder, including the increase in larval survival rate, leaf area consumed, pupal weight, moth longevity, fecundity and preference of oviposition (16, 17).

Table 2. Per cent Incidence of leaf folder as affected by rice cultures and nitrogen levels**

Variety/N levels	NLR 20104 (V1)	NLR 20106 (V2)	NLR 3135 (V3)	NLR 33892 (V4)	Mean
40 kg N/ha (N1)	10.26	4.10	6.67	5.13	7.37[a]
80 kg N/ha (N2)	11.54	6.15	8.97	5.38	7.95[a]
120 kg N/ha (N3)	12.31	7.18	9.74	8.97	8.78[a]
160 kg N/ha (N4)	12.31	6.92	10.26	7.44	9.23[a]
200 kg N/ha (N5)	20.77	11.28	12.56	9.74	13.59[b]
Mean	13.44[c]	7.13[a]	9.64[b]	7.33[a]	
		SEM ±	CD @ 5%	CV %	
	Variety	0.82	2.274	27.45	
	N levels	0.92	2.542		
	Interaction	1.83	NS		

*Means separated in column/row followed by the same letters are not significantly different at *P* = .05. **Mean of two years

Fig. 2: Correlation between per cent leaf folder incidence and different nitrogen levels.



Leaffolder incidence was significantly varied among four rice cultures ranging from 13.44 % in NLR 20104 to 7.13 % in NLR 20106. The rice culture NLR 33892 recorded on par leaffolder incidence (7.33 %) with the NLR 20106 which was followed by the rice culture NLR 3135 with 9.64 % leaffolder incidence. Baby rani, Islam and Karim, and Punithavalli et al, reported that the plant characters like leaf thickness, trichome density and trichome length were significantly higher on some genotypes which were resistant to leaffolder damage. The leaffolder thrived well on susceptible rice genotypes but failed to grow, survive and reproduce satisfactorily on resistant genotypes (22). Low fecundity and low survival percentage of leaffolder on resistant and wild genotypes than susceptible and other cultivated genotypes has a potential antibiosis factor leading to considerable reduction in the population build up of leaffolder compared with that in a susceptible variety (23). The poor growth of leaffolder larvae due to deficiencies of primary nutrients and also potential antibiosis factor in some of rice genotypes (24)

Gall midge

Gall midge incidence was significantly differed across different nitrogen levels (Table 3). The results indicate that significantly lowest gall midge incidence (1.42 %) was recorded in the plots treated with 40 kg N ha-1, followed by the plots treated with 80kg N ha-1 (1.93 %) and 120 kg N ha-1 (2.72 %). The treatment which received 160 kg N ha-1 and 200 kg N ha-1 were on par with each other and recorded highest per cent (2.75 and 3.00 %, respectively) gall midge incidence. The results further show that the gall midge incidence increases with the increase in nitrogen fertilizer doses. The increased midge incidence was attributed to luxuriant growth associated with nitrogen fertilization. Such growth predisposes plant to severe damage by herbivores. This result is in agreement with Ukwungwu, who stated that addition of nitrogen fertilizer resulted in a significant increase in pest damage. Similar results were reported by Saroja and Raju, who reported that gall midge population increased with increasing levels of nitrogen. These results were supported by the positive correlation obtained between damage incidence and nitrogen levels (r= 0.948) Fig.3.

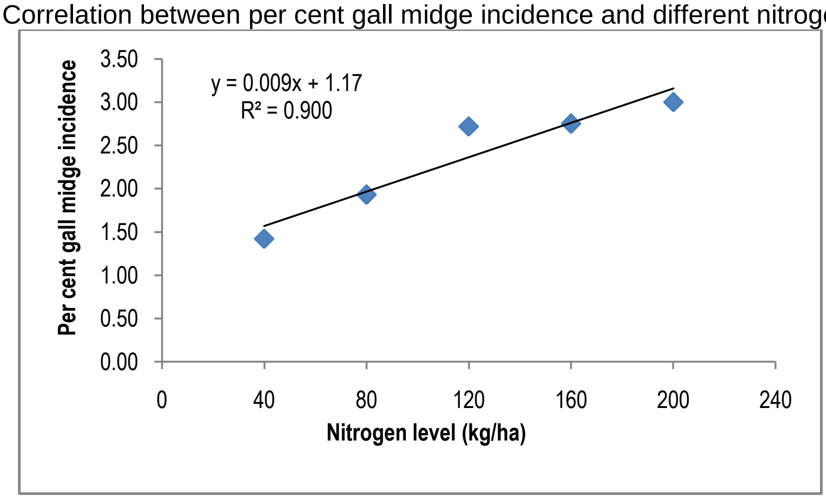
Table 3. Per cent Incidence of gall midge as affected by rice cultures and nitrogen levels**

Variety/N levels	NLR 20104 (V1)	NLR 20106 (V2)	NLR 3135 (V3)	NLR 33892 (V4)	Mean

40 kg N/ha (N1)	0.67	2.00	2.00	1.00	1.42^{a}
80 kg N/ha (N2)	1.05	2.67	1.67	2.33	1.93^{b}
120 kg N/ha (N3)	2.56	2.33	2.67	3.33	2.72^{c}
160 kg N/ha (N4)	3.67	3.00	2.33	2.00	2.75^{d}
200 kg N/ha (N5)	2.33	2.67	3.00	4.00	3.00^{d}
Mean	2.06	2.53	2.33	2.53	
		SEM ±	**CD @ 5%**	**CV %**	
	Variety	0.24	NS	39.39	
	N levels	0.269	0.745		
	Interaction	0.538	NS		

*Means separated in columns followed by the same letters are not significantly different at *P* = .05. **Mean of two years

Fig. 3: Correlation between per cent gall midge incidence and different nitrogen levels.



There is no significant difference in gall midge incidence among four rice cultures tested. Highest gall midge of 2.53 % was recorded in NLR 20106 and NLR 33892 and lowest incidence was noticed NLR 20104 (2.06 %). All four cultures were equally affected with gall midge.

Grain yield

The rice culture had found to be significant influence on grain yield of rice (Table 4). Among the rice cultures, NLR 33892 culture might be due to having higher physiological indices had produced significantly highest grain yield (5955 kg ha-1), whereas NLR 20106 and NLR 3135 were at par with each other with grain yield of 5469 & 5562 kg ha-1, respectively. Significant lowest grain yield was attained with NLR 20104 (4919 kg ha-1). The report of the Netanos and Kiotrogas, showed that the cultivars of rice which have higher physiological indices will have better growth and higher yield. Azarpour et al, also reported the same. Significant variations in the grain yield of rice varieties have also been reported by many workers (29, 30, 31, 32).

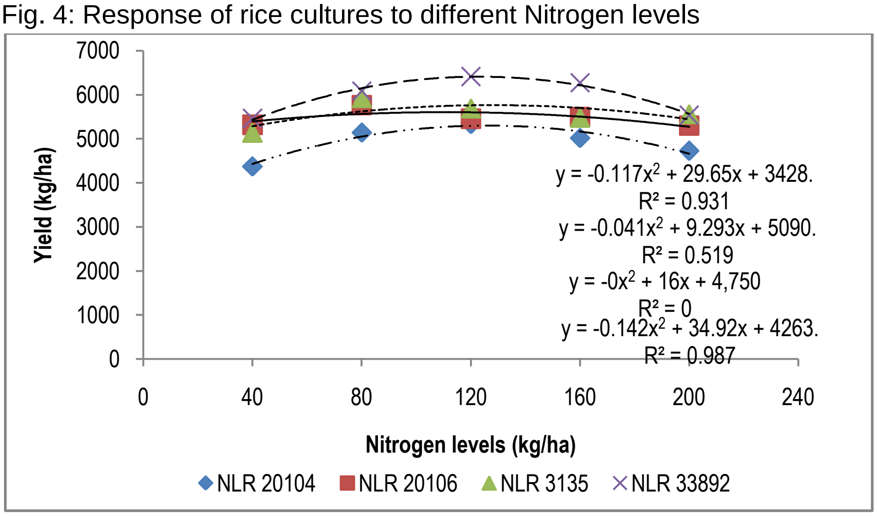
Table 4. Grain yield(Kg/ha) of rice cultures under different nitrogen levels.**

Variety/N levels	NLR 20104 (V1)	NLR 20106 (V2)	NLR 3135 (V3)	NLR 33892 (V4)	Mean
40 kg N/ha (N1)	4373	5765	5143	5465	5187^{b}
80 kg N/ha (N2)	5142	5320	5929	6083	5619^{a}
120 kg N/ha (N3)	5334	5458	5695	6416	5726^{a}
160 kg N/ha (N4)	5018	5300	5482	6272	5518^{a}
200 kg N/ha (N5)	4725	5498	5563	5538	5331^{b}
Mean	4919^{c}	5469^{b}	5562^{b}	5955^{a}	
		SEM ±	**CD @5%**	**CV %**	
	Variety	89	247	7.7	
	N levels	100	276		
	Interaction	199	614		

*Means separated in columns/row followed by the same letters are not significantly different at *P* = .05. **Mean of two years

Differences in the effects of nitrogen doses on rice grain yield was statistically significant (*P*=0.05). The highest/optimum grain yield (5726 kg ha-1) produced by plots that received 120 kg N/ha. Which was on par with the plots that received 80 kg N/ha and 160 kg N ha-1 with 5619 and 5518 kg ha-1 yield, respectively. Further increase in nitrogen level beyond 120 kg ha-1 did not significantly improve the grain yield. Lowest grain yield of 5187 kg ha-1 was recorded in the plots that received 80kg N ha-1 which was on par with the plots that received 200 kg N ha-1. The present study indicate that with increase of nitrogen content grain yield considerably increased to a certain extent (Fig. 4) (33, 34, 35, 36). The results of this study agree with the Peng et al, and Djaman et al, who reported curvilinear response of rice yield to nitrogen. Linear response of rice to nitrogen rate below 150 kg ha-1 and a plateau off when the nitrogen rate is greater than 150 kg ha-1 were reported by Harell et al.

Fig. 4: Response of rice cultures to different Nitrogen levels



4. CONCLUSION

The present investigation demonstrated that incremental doses of nitrogen fertilizer significantly enhanced infestation by stem borer, leaffolder and gall midge on rice. The pest incidence of the treatments with high N rate as 160 and 200 kg ha-1 were higher than that of lower N rate i.e 40 and 80 kg ha-1. The stem borer incidence of plots with low N rate (40 and 80 kg ha-1) was less than twenty per cent and caused less loss on grain yield compared to that of higher N rate (200 and 160 kg ha-1) with more than forty per cent stem borer incidence caused nearly seven per cent yield reduction. Further, application of N-fertilizers beyond 120 kg ha-1 did not result in any added advantage in terms of yield. Therefore the results suggest that the high N rate leads to a larger pest incidence, which further affect the grain yield of rice.

Different rice cultures significantly influenced the leaffolder incidence but not stem borer and gall midge. Optimal N rate was revealed to be 120 kg ha-1 for four rice cultures for reducing the stem borer/leaf folder/gall midge incidence so as to minimize the cost of inputs for pest control measures and for achieving high grain yield. Combination of nitrogen and rice cultures did not produce significant effect on incidence of leaf folder and gall midge, in contrast interaction effect has a significant influence on stem borer incidence.

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