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Effect of Nitrogen, Phosphorus and Potassium (NPK) Application on Insect Pests Infesting Transplanting Aman Rice (*Oryza sativa* L.)

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Original Research Article

ABSTRACT

The study was conducted in the experimental area of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh, during the period from July to October 2016 to find out the effect of different levels of NPK on insect pests in transplant aman rice. BRRI dhan33 was used as the test crop in this experiment. The experiment comprised of different NPK (Nitrogen, Phosphorus and Potassium) fertilizers doses as treatment where, T_0 = absolute control, no NPK fertilizers, T_1 = NPK @ 45, 50, 40 kg/ha, T_2 = NPK @ 70, 25, 40 kg/ha, T_3 = NPK @ 70, 50, 20 kg/ha, T_4 = NPK @ 70, 50, 40 kg/ha, T_5 = NPK @ 70, 50, 60 kg/ha, T_6 = NPK @ 70, 75, 40 kg/ha and T_7 = NPK @ 95, 50, 40 kg/ha. The experiment was laid out in a Randomized complete block design (RCBD) plot with three replications. Data were recorded on different types of insect pests that were identified for the entire growing period with their number and incidence on rice plants. During the entire growing period 5 selected hills/plot were monitored with clear observation on yellow stem borer, leaf folder, rice hispa, grasshopper, brown planthopper, green leafhopper and

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rice bug insects and pests. The lowest number of infestation of insects and pests was observed from T_5, whereas the highest number was found in T_7 treatment. In case of incidence percent of dead heart, data were observed at 25^{th}, 45^{th} and 65^{th} days after transplanting (DAT), respectively. Data recorded from each plot revealed that the lowest incidence of dead heart was observed in T_5 (3.64%, 4.23% and 4.47% at NPK 70, 50, 60 kg/ha), while the highest incidence of dead heart was found in T_7 (10.37%, 13.56% and 14.73%, respectively) treatment. In terms of white head incidence, at 60, 70 and 80 DAT, data recorded from each plot revealed that the lowest incidence of white head was found in T_5 (2.35%, 2.66% and 3.12%, respectively), whereas the highest incidence of white head was observed in T_7 (7.57%, 8.26% and 8.64% at NPK @ 95, 50, 40 kg/ha).

Keywords: Oryza sativa; nitrogen; phosphorus; potassium; insects pests.

1. INTRODUCTION

Rice (*Oryza sativa*) is the most important food crop around the world and the staple food for approximately more than two billion people in Asia (Hien *et al*., 2006). Rice is the most nutritious cereal crops and is an ideal host for over 800 species of insect (Barr and Smith, 1975). In tropical Asia, more than 100 species of insects are persistent on rice. In Bangladesh, about 175 insect pest species have been reported, which cause damage to the rice plants (Mustafi *et al*., 2007), among them, 20-30 species are economically important (Miah and Karim, 1984). Major pests cause damage about 28% to Aman crops and the annual estimated loss of rice in Bangladesh due to insect pests amounts to 1.38 to 6.21 million tons (BRRI, 2018). At high population density, crop loss may be 100% (Rahman *et al*., 2004). Nutrient management is the most important practice in rice production system, but it may affect the response of rice to insect pests. Positive interaction between nutrients and pest can be identified and it provides guidelines for optimizing total agro-ecosystem function (Magdoff *et al*., 2000). Some aman rice pests are green leafhopper, rice hispa, green stink bug, rice leafroller, yellow stem borer and rice bug. The beneficial insects are categorized as predator and parasites, collectively known as natural enemies which are able to interact with their prey and consequently to regulate them at reasonably lower level. Ninety-nine species of parasites and 88 species of a predator of rice insect pests have been recorded in Bangladesh (Wahiduzzaman, 1993). The application of nitrogen fertilizer in plants can normally increase herbivore's feeding preference, food consumption, survival, growth, reproduction, and population density, except few examples that nitrogen fertilizer reduces the herbivore performances. Higher nitrogen doses cause for higher sucking pests' incidence. Phosphorus has not been considered as important or limiting as nitrogen for phytophagous insects. However, phosphorus is a determinant of growth rate and population density. Phosphorus is an important component for the population growth of phytophagous insects as it is required for RNA synthesis. Potassium induced change in rice plant at profound effect on insect-host interactions. The increase of K in rice plant causes a reduction in the feeding rate of Brown Plant Hopper *Nilaparvata lugens* (Vaithilingan *et al.,* 1975) and *Nephotettix* sp. (Subramanian and Balasubramnian, 1976). To make the green revolution successful and to mitigate the adverse effects of fertilizers to the crop productive environment, judicious use of fertilizers is considered as one of the important aspects of cultural practices in integrated pest management (IPM) which influences the activity of insect pests and ultimate effect on growth, development and yield of crop plant. Some fragmentary works have been done on the effect of fertilizers on some fewer insect pests like stem borer and brown planthopper (BPH) by different workers like Pathak and Ram (1999), Rangini *et al*. (2005) and Sarwar (2012) at different parts of the world. But in Bangladesh research work on the effect of NPK on the major insect pests is scanty. The comprehension of these interactions between NPK and insect pests will turn into the reason for an outline of the sustainable rice production framework.

The present study was aimed to identify the optimum doses of NPK against field insect pests infesting the rice and to result higher grain yields as well as better quality of rice.

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was conducted during the period, July to October 2016, in the experimental area of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh. The geographical location of the experimental site was under the subtropical climate and its climatic conditions are characterized by heavy rainfall during the month of April to September and scanty rainfall during the rest period of the year.

2.2 Experimental Material

BRRI dhan33, high yielding rice variety developed by Bangladesh Rice Research Institute (BRRI), Gazipur, Bangladesh was used as experimental material.

2.3 Treatments

The experiment comprised of the following NPK doses as treatment.

T_0 = Untreated control, no NPK fertilizers,
T_1 = NPK @ 45, 50, 40 kg/ha
T_2 = NPK @ 70, 25, 40 kg/ha
T_3 = NPK @ 70, 50, 20 kg/ha
T_4 = NPK @ 70, 50, 40 kg/ha
T_5 = NPK @ 70, 50, 60 kg/ha
T_6 = NPK @ 70, 75, 40 kg/ha
T_7 = NPK @ 95, 50, 40 kg/ha

In each of the treatment Nitrogenous fertilizer was applied in three splits at an equal amount where phosphorus and potash fertilizer were applied at a single dose as basal.

2.4 Experimental Design and Layout

The experiment was laid out in a randomized complete block design (RCBD) plot with three replications, where the experimental area was divided into three blocks representing the replications to reduce soil heterogeneity. Each block was divided into 8 unit plots as treatments demarked with raised bunds. Thus, the total numbers of plots were 24. The unit plot size was 4.0 m × 2.5 m. The distance maintained between two blocks and two plots were 0.5 m and 0.5 m, respectively.

2.5 Intercultural Operations

Fertilizers other than NPK such as zinc, boron, Sulphur were applied as per recommended for BRRI dhan33 by Bangladesh Rice Research Institute (12.0, 2.0 and 10.0 kg/ha respectively). Other intercultural operations such as the raising of seedlings, land preparation, manuring, irrigation and drainage, weeding etc. were done as per necessity.

2.6 Assessment of Infestation

Five hills were selected at random per replicate for each treatment. The dead heart tiller and white head infested tiller were counted. In case of the dead heart, it was counted in the vegetative growth stage and white head infested tillers were counted at reproductive stage converted into per plant. Hopper burn was counted in tillering, panicle initiation, before ripening and after ripening stage. The observation was recorded at the first observation of symptom and was continued up to maturity at seven days interval.

During the entire growing period, 5 selected hills/plots were monitored with clean observation and yellow stem borer, leaf folder, rice hispa, brown planthopper, green leafhopper and rice bug insect pests were observed in different growth stages as insect populations of rice plants.

The number of Dead Heart, white head, hopper burn infested tiller per five hills was counted and divided by a total number of tillers in five hills and then multiplied by 100 to assess the percentage of infestation. For Example,

% dead heart/ infested tillers =(no. of dead heart infested tiller/Total no. of tiller per five hills) x 100

2.7 Collection of Data and Statistical Analysis

The data obtained for different characters were statistically analyzed to observe the significant difference among the treatments. The mean values of all the characters were calculated and analysis of variance was performed by using MSTAT-C software. The significance of the difference among the treatments means was estimated by the Least Significant Difference (LSD) test at 5% level of probability (Gomez and Gomez, 1984).

3. RESULTS AND DISCUSSION

3.1 Number of Different Insect Population

The numbers of identified insects were recorded and presented in Table 1. For different levels of NPK fertilizers numbers of different insect pests showed statistically significant differences under the present trial.

3.1.1 Yellow stem borer

The data presented in table 1 revealed that the number of yellow stem borer varied from 1.67 to 9.33 for different levels of NPK fertilizers. The lowest number (1.67) of yellow stem borer was observed from T5 (NPK @ 70, 50, 60 kg/ha) treatment whereas the highest number (9.33) was found in T7 (NPK @ 95, 50, 40 kg/ha) treatment. The optimum dose of NPK fertilizers was more effective in controlling yellow stem borer, whereas excessive application of NPK fertilizers increased the incidence of yellow stem borer. Rangini *et al.* (2005) reported that yellow stem borer (YSB) infestation was extensively occurred early tillering to the maximum tillering stage.

3.1.2 Leaf folder

In the present study, the number of leaf folder varied from 1.13 to 12.67 upon described treatments. Data revealed that the lowest number (1.13) of leaf folder was recorded from T5 (NPK @ 70, 50, 60 kg/ha) treatment, while the highest number (12.67) was observed from T7 (NPK @ 95, 50, 40 kg/ha) treatment. However, our result is not in conformity with the findings of de Kraker *et al.* (1996). He found that the average density of leaf folder larvae at the highest nitrogen level was eight times more than that at the zero-nitrogen level.

3.1.3 Rice hispa

The range of rice hispa was between 1.13 to 3.27 for different levels of NPK fertilizers under the study. The lowest number (1.13) of rice hispa was recorded from T5 treatment (NPK @ 70, 50, 60 kg/ha) while the highest number (3.67) was observed from T7 treatment (NPK @ 95, 50, 40 kg/ha). Singh *et al*. (1990) in Punjab indicated that the NPK at 120:60:60 kg/ha increased the susceptibility of rice to infestation by rice hispa.

3.1.4 Brown planthopper

The lowest number (1.93) of brown planthopper was found from T5 (NPK @ 70, 50, 60 kg/ha) treatment, whereas the highest number (9.47) was recorded from T7 treatment (NPK @ 95, 50, 40 kg/ha). Madhuri (2016) reported that the lowest BPH population (2.87/hill) was found in control treatments which were devoid of all types of nutrients. Whereas without micronutrients, other treatments with only nitrogen produced higher incidence or in combination with boron, zinc etc. caused lower incidence.

3.1.5 Green leafhopper

In consideration of green leafhopper, data revealed that the numbers of green leafhopper in 5 selected hills vary from 2.47 to 11.67 for different levels of NPK fertilizers. The lowest number (2.47) of green leafhopper was recorded from T5 treatment (NPK @ 70, 50, 60 kg/ha), while the highest number was observed from T7 (11.67) treatment (NPK @ 95, 50, 40 kg/ha). Dash *et al*. (2007) reported that the nutrient level 60:30:30 kg NPK with ZnSO4 recorded the lowest GLH population.

3.1.6 Rice bug

In case of rice bug, the numbers of rice bug differ from 1.73 to 8.60 per 5 selected hills due to different levels of NPK fertilizers. The lowest number (1.73) of rice bug was observed from T5 treatment (NPK @ 70, 50, 60 kg/ha), whereas the highest number (8.60) was found from T7 treatment (NPK @ 95, 50, 40 kg/ha). Mahadev *et al*. (1995) reported that the crop applied with N either alone or coupled with P exhibited a lower incidence of rice bug.

3.2 Infestation of Rice by Different Insects and Pests in Different Stages

3.2.1 Dead heart incidence by yellow stem borer at 25, 45 and 60 Days after transplanting

In case of incidence of dead heart, at 25 DAT, data recorded from each plot revealed that the lowest incidence of dead heart was observed in T5 (3.64%), while the highest incidence of dead heart was found in T7 (10.37%) treatment. At 45 DAT, from each plot, it was revealed that the lowest incidence of dead heart was observed in T5 (4.23%), while the highest incidence of dead heart was found in T7 (13.56%) treatment. At 65 DAT, data recorded from each plot revealed that the lowest incidence of dead heart was observed in T5 (4.47%), while the highest incidence of dead heart was found in T7 (14.73%) treatment. In case of incidence of dead heart decrease/increase over control, the highest decrease was observed in T5 at 25, 45 and 60 DAT as -61.36, -59.17 and -59.58 respectively. On the other hand, the increase of dead heart incidence was found in T7 at 25,45 and 60 DAT as +10.08, +30.89 and +33.18 respectively.

Ramzan *et al*. (1992) reported that high infestation of yellow stem borer is correlated with the high use of nitrogenous fertilizers in the rice field.

3.2.2 White head incidence by yellow stem borer at 60, 70 and 80 DAT

In terms of white head incidence, at 60 DAT, 70 DAT and 80 DAT, data recorded from each plot revealed that the lowest incidence of white head was found in T5 (2.35%, 2.66% and 3.12% @ 95, 50 and 40 kg/ha), while the highest incidence of white head was observed in T7 (7.57%, 8.26% and 8.64% respectively) treatment. In case of incidence of white head decrease/increase over control, the highest decrease was observed in T5 at 60, 70 and 80 DAT as -54.19, -54.45 and -47.56 respectively. Whereas, the increase of white head incidence was found in T7 treatment at 60,70 and 80 DAT as +47.56, +41.44 and +45.21respectively. Chakraborty (2011) observed that the incidence of white head (WH) was 206.72% higher than the control field when the field was fertilized by 140 kg N/ha.

3.2.3 Leaf folder incidence in leaf at 30, 45 and 60 DAT

In consideration of leaf folder incidence, at 30 DAT, 45 DAT and 60 DAT data recorded from each plot revealed that the lowest incidence of leaf folder was found in T5 (3.47%, 3.94% and 4.04% respectively), while the highest incidence of leaf folder was observed in T7 (8.05%, 8.56% and 9.18% respectively) treatment. In case of incidence of leaf folder decrease/increase over control, the highest decrease was observed in T5 at 30, 45 and 60 DAT as -43.30, -40.66 and -41.79 respectively. Whereas, the highest increase of leaf folder incidence was found in T7 treatment at 30, 45 and 60 DAT as +31.54, +28.92 and +32.28 respectively. Mahadev *et al*. (1995) reported that the crop applied with N either alone or coupled with P exhibited a lowered incidence of leaf folder in the rice field at vegetative stage.

3.2.4 Brown planthopper incidence at 35, 50 and 65 DAT

In consideration of brown planthopper incidence, at 35 DAT, 50 DAT and 65 DAT data recorded in each plot revealed that the lowest incidence of brown planthopper was found in T5 (4.23%, 4.55% and 4.78% respectively), while the highest incidence of brown planthopper was observed in T7 (7.88%, 7.12% and 7.95% respectively) treatment. In case of incidence of BPH decrease/increase over control, the highest decrease was observed in T5 at 35, 50 and 65 DAT as -33.28, -26.14 and -29.50 respectively. Whereas, the highest increase in BPH incidence was found in T7 treatment at 35, 50 and 65 DAT as +24.29, +15.58 and +17.26 respectively. Similar findings were also reported by Sarwar (2012) earlier.

Table 1. Number of major insect pests during the growing period for different levels of NPK fertilizers

Treatment	Number of different insect pests in 5 selected hills						
	Yellow stem borer	Leaf folder	Rice hispa	Grasshopper	Brown planthopper	Green leafhopper	Rice bug
T0	7.67 b	10.27 b	3.27 b	11.13 b	7.27 b	9.27 b	6.33 b
T1	3.13 g	2.73 f	1.60 f	4.27 f	2.47 g	2.87 fg	2.60 f
T2	6.87 c	8.13 c	2.87 c	8.33 c	5.87 c	7.87 c	5.53 c
T3	6.33 d	7.33 d	2.47 d	6.33 d	5.33 d	6.13 d	4.80 d
T4	5.80 e	5.33 e	2.13 e	5.47 de	4.87 e	4.87 e	4.13 e
T5	1.67 h	1.13 g	1.13 g	3.33 g	1.93 h	2.47 g	1.73 g
T6	5.27 f	4.93 e	1.67 f	4.93 ef	4.27 f	3.07 f	3.80 e
T7	9.33 a	12.67 a	3.67 a	12.73 a	9.47 a	11.67 a	8.60 a
LSD(0.05)	0.470	0.751	0.293	0.899	0.467	0.522	0.495
CV(%)	4.65	6.52	7.07	7.26	5.13	4.95	6.04

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T0 = Untreated control, no NPK fertilizers *T1 = NPK @ 45, 50, 40 kg/ha*
T2 = NPK @ 70, 25, 40 kg/ha *T3 = NPK @ 70, 50, 20 kg/ha*
T4 = NPK @ 70, 50, 40 kg/ha *T5 = NPK @ 70, 50, 60 kg/ha*
T6 = NPK @ 70, 75, 40 kg/ha *T7 = NPK @ 95, 50, 40 kg/ha*

Table 2. Incidence of rice yellow stem borer (dead heart) infestation for different levels of NPK fertilizers

Treatments	Incidence of rice yellow stem borer infestation (dead heart/plot) at different days after transplanting (DAT)					
	1st observation (25 DAT)		2nd observation (45 DAT)		3rd observation (65 DAT)	
	Dead heart (%)	Decrease/increase over control (%)	Dead heart (%)	Decrease/increase over control (%)	Dead heart (%)	Decrease/increase over control (%)
T0	9.42 b	--	10.36 b	--	11.06 b	--
T1	4.24 e	-54.99	5.16 e	-50.19	5.66 d	-48.82
T2	7.27 c	-22.82	8.47 c	-18.24	9.08 c	-17.90
T3	6.08 d	-35.46	6.24 d	-39.77	6.57 d	-40.60
T4	5.77 d	-38.75	5.96 de	-42.47	6.41 d	-42.04
T5	3.64 f	-61.36	4.23 f	-59.17	4.47 e	-59.58
T6	4.66 e	-50.53	5.48 de	-47.10	6.10 d	-44.85
T7	10.37 a	+10.08	13.56 a	+30.89	14.73 a	+33.18
LSD(0.05)	0.517	--	0.810	--	1.124	--
CV(%)	4.59	--	6.22	--	8.01	--

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T0= Untreated control, no NPK fertilizers *T1 = NPK @ 45, 50, 40 kg/ha*
T2= NPK @ 70, 25, 40 kg/ha *T3 = NPK @ 70, 50, 20 kg/ha*
T4 = NPK @ 70, 50, 40 kg/ha *T5 = NPK @ 70, 50, 60 kg/ha*
T6 = NPK @ 70, 75, 40 kg/ha *T7 = NPK @ 95, 50, 40 kg/ha*

Table 3. Incidence of rice yellow stem borer (white head) infestation for different levels of NPK fertilizers

Treatments	Incidence of rice yellow stem borer infestation (white head/plot) at different days after transplanting (DAT)					
	1st observation (60 DAT)		2nd observation (70 DAT)		3rd observation (80 DAT)	
	White head (%)	Reduction over control (%)	White head (%)	Reduction over control (%)	White head (%)	Reduction over control (%)
T0	5.13 b	--	5.84 b	--	5.95 b	--
T1	3.08 d	-39.96	2.97 e	-49.14	3.45 de	-42.02
T2	4.69 b	-8.58	5.16 b	-11.64	5.67 b	-4.71
T3	3.96 c	-22.81	4.06 c	-30.48	4.38 c	-26.39
T4	3.66 c	-28.65	3.83 cd	-34.42	4.08 c	-31.43
T5	2.35 e	-54.19	2.66 e	-54.45	3.12 e	-47.56
T6	3.19 d	-37.82	3.24 de	-44.52	3.99 cd	-32.94
T7	7.57 a	+47.56	8.26 a	+41.44	8.64 a	+45.21
LSD(0.05)	0.436	--	0.731	--	0.559	--
CV(%)	5.92	--	9.25	--	6.49	--

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T0= Untreated control, no NPK fertilizers *T1 = NPK @ 45, 50, 40 kg/ha*
T2= NPK @ 70, 25, 40 kg/ha *T3 = NPK @ 70, 50, 20 kg/ha*
T4 = NPK @ 70, 50, 40 kg/ha *T5 = NPK @ 70, 50, 60 kg/ha*
T6 = NPK @ 70, 75, 40 kg/ha *T7 = NPK @ 95, 50, 40 kg/ha*

Table 4. Incidence of leaf folder infestation for different levels of NPK fertilizers

Treatments	Incidence of leaf folder at different days after transplanting (DAT)					
	1st observation (30 DAT)		2nd observation (45 DAT)		3rd observation (60 DAT)	
	Leaf infestation (%)	Reduction over control (%)	Leaf infestation (%)	Reduction over control (%)	Leaf infestation (%)	Reduction over control (%)
T0	6.12 b	--	6.64 b	--	6.94 b	--
T1	3.84 ef	-37.25	4.56 e	-31.33	4.72 e	-31.99
T2	5.47 c	-10.62	5.93 c	-10.69	6.12 c	-11.82
T3	4.92 d	-19.61	5.34 d	-19.58	5.64 cd	-18.73
T4	4.57 d	-25.33	4.91 de	-26.05	5.23 de	-24.64
T5	3.47 f	-43.30	3.94 f	-40.66	4.04 f	-41.79
T6	4.05 e	-33.82	4.67 e	-29.67	4.91 e	-29.25
T7	8.05 a	+31.54	8.56 a	+28.92	9.18 a	+32.28
LSD(0.05)	0.403	--	0.502	--	0.643	--
CV(%)	4.57	--	5.15	--	6.29	--

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T0= Untreated control, no NPK fertilizers *T1 = NPK @ 45, 50, 40 kg/ha*
T2= NPK @ 70, 25, 40 kg/ha *T3 = NPK @ 70, 50, 20 kg/ha*
T4 = NPK @ 70, 50, 40 kg/ha *T5 = NPK @ 70, 50, 60 kg/ha*
T6 = NPK @ 70, 75, 40 kg/ha *T7 = NPK @ 95, 50, 40 kg/ha*

Table 5. Incidence of brown planthopper infestation for different levels of NPK fertilizers

Treatments	Incidence of brown planthopper at different days after transplanting (DAT)

	1st observation (35 DAT)		2nd observation (50 DAT)		3rd observation (65 DAT)	
	Tillers infestation (%)	**Reduction over control (%)**	**Tillers infestation (%)**	**Reduction over control (%)**	**Tillers infestation (%)**	**Reduction over control (%)**
T0	6.34 b	--	6.16 b	--	6.78 b	--
T1	4.78 cd	-24.61	4.94 de	-19.81	5.03 de	-25.81
T2	6.12 b	-3.47	5.78 bc	-6.17	6.14 bc	-9.44
T3	5.86 b	-7.57	5.56 bcd	-9.74	5.94 c	-12.39
T4	5.22 c	-17.67	5.34 cd	-13.31	5.78 c	-14.75
T5	4.23 d	-33.28	4.55 e	-26.14	4.78 e	-29.50
T6	4.93 c	-22.24	5.23 cde	-15.10	5.55 cd	-18.14
T7	7.88 a	+24.29	7.12 a	+15.58	7.95 a	+17.26
LSD(0.05)	0.578	--	0.726	--	0.667	--
CV(%)	5.69	--	7.26	--	6.22	--

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T0= Untreated control, no NPK fertilizers | *T1 = NPK @ 45, 50, 40 kg/ha*
T2= NPK @ 70, 25, 40 kg/ha | *T3 = NPK @ 70, 50, 20 kg/ha*
T4 = NPK @ 70, 50, 40 kg/ha | *T5 = NPK @ 70, 50, 60 kg/ha*
T6 = NPK @ 70, 75, 40 kg/ha | *T7 = NPK @ 95, 50, 40 kg/ha*

Table 6. Incidence of green leaf hopper infestation for different levels of NPK fertilizers

Treatments	Incidence of green leafhopper at different days after transplanting (DAT)					
	1st observation (35 DAT)		2nd observation (50 DAT)		3rd observation (65 DAT)	
	Leaf infestation (%)	Reduction over control (%)	Leaf infestation (%)	Reduction over control (%)	Leaf infestation (%)	Reduction over control (%)
T0	2.78 b	--	2.96 b	--	3.13 b	--
T1	1.58 f	-43.17	1.88 e	-36.49	1.94 d	-38.02
T2	2.59 bc	-6.83	2.78 bc	-6.08	2.97 b	-5.11
T3	2.24 cd	-19.42	2.46 cd	-16.89	2.81 b	-10.22
T4	2.03 de	-26.98	2.14 de	-27.70	2.45 c	-21.73
T5	1.12 g	-59.71	1.34 f	-54.73	1.56 e	-50.16
T6	1.84 ef	-33.81	1.94 e	-34.46	2.12 cd	-32.27
T7	3.96 a	+42.45	4.18 a	+41.22	4.34 a	+38.66
LSD(0.05)	0.380	--	0.367	--	0.332	--
CV(%)	9.51	--	8.53	--	6.94	--

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T0= Untreated control, no NPK fertilizers *T1 = NPK @ 45, 50, 40 kg/ha*
T2= NPK @ 70, 25, 40 kg/ha *T3 = NPK @ 70, 50, 20 kg/ha*
T4 = NPK @ 70, 50, 40 kg/ha *T5 = NPK @ 70, 50, 60 kg/ha*
T6 = NPK @ 70, 75, 40 kg/ha *T7 = NPK @ 95, 50, 40 kg/ha*

Table 7. Incidence of rice hispa infestation for different levels of NPK fertilizers

Treatments	Incidence of rice hispa at different days after transplanting (DAT)					
	1st observation (25 DAT)		2nd observation (40 DAT)		3rd observation (55 DAT)	
	Leaf infestation (%)	Reduction over control (%)	Leaf infestation (%)	Reduction over control (%)	Leaf infestation (%)	Reduction over control (%)
T0	3.17 b	--	3.55 b	--	3.78 b	--
T1	1.90 e	-40.06	1.67 g	-52.96	1.86 f	-50.79
T2	2.89 bc	-8.83	3.03 c	-14.65	3.25 c	-14.02
T3	2.56 cd	-19.24	2.74 d	-22.82	2.85 d	-24.60
T4	2.34 d	-26.18	2.43 e	-31.55	2.67 d	-29.37
T5	1.15 f	-63.72	1.46 g	-58.87	1.66 f	-56.08
T6	1.85 e	-41.64	2.05 f	-42.25	2.24 e	-40.74
T7	4.86 a	+53.31	5.14 a	+44.79	5.83 a	+54.23
LSD(0.05)	0.443	--	0.254	--	0.355	--
CV(%)	9.80	--	5.26	--	6.69	--

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T0= Untreated control, no NPK fertilizers *T1 = NPK @ 45, 50, 40 kg/ha*
T2= NPK @ 70, 25, 40 kg/ha *T3 = NPK @ 70, 50, 20 kg/ha*
T4 = NPK @ 70, 50, 40 kg/ha *T5 = NPK @ 70, 50, 60 kg/ha*
T6 = NPK @ 70, 75, 40 kg/ha *T7 = NPK @ 95, 50, 40 kg/ha*

Table 8. Incidence of rice bug infestation for different levels of NPK fertilizers

Treatments	Incidence of rice bug at different days after transplanting (DAT)					
	1st observation (45 DAT)		2nd observation (55 DAT)		3rd observation (65 DAT)	
	Panicle infestation (%)	Reduction over control (%)	Panicle infestation (%)	Reduction over control (%)	Panicle infestation (%)	Reduction over control (%)
T0	3.48 b	--	3.65 b	--	3.82 b	--
T1	2.15 e	-38.22	2.22 ef	-39.18	2.45 e	-35.86
T2	3.14 bc	-9.77	3.42 bc	-6.30	3.68 bc	-3.66
T3	2.95 cd	-15.23	3.13 bcd	-14.25	3.34 cd	-12.57
T4	2.84 cd	-18.39	2.97 cd	-18.63	3.12 d	-18.32
T5	1.78 e	-48.85	1.96 f	-46.30	2.04 f	-46.60
T6	2.56 d	-26.44	2.64 de	-27.67	2.67 e	-30.10
T7	4.22 a	+21.26	4.75 a	+30.14	5.08 a	+32.98
LSD(0.05)	0.403	--	0.514	--	0.367	--
CV(%)	7.66	--	9.14	--	6.19	--

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

T0= Untreated control, no NPK fertilizers *T1 = NPK @ 45, 50, 40 kg/ha*
T2= NPK @ 70, 25, 40 kg/ha *T3 = NPK @ 70, 50, 20 kg/ha*
T4 = NPK @ 70, 50, 40 kg/ha *T5 = NPK @ 70, 50, 60 kg/ha*
T6 = NPK @ 70, 75, 40 kg/ha *T7 = NPK @ 95, 50, 40 kg/ha*

3.2.5 Green leafhopper incidence at 35, 50 and 65 DAT

For green leafhopper incidence, at 35 DAT, 50 DAT and 65 DAT, data recorded from each plot revealed that the lowest incidence of green leafhopper was found in T5 (1.12%, 1.34% and1.56% respectively), whereas the highest incidence of green leafhopper was observed in T7 (3.96%, 4.18% and4.34% respectively) treatment. In case of incidence of Green leafhopper decrease/increase over control, the highest decrease was observed in T5 at 35, 50 and 65 DAT as -59.71, -54.73 and -50.16 respectively. Whereas, the highest increase of Green leafhopper incidence was found in T7 treatment at 35, 50 and 65 DAT as +42.45, +41.22 and +38.66 respectively. Mahadev *et al*. (1995) reported that the crop applied with N either alone or coupled with P exhibited a higher degree of incidence of green leafhopper.

3.2.6 Rice hispa incidence in leaf at 25, 40 and 55 DAT

For rice hispa incidence, at 25 DAT, 40 DAT and 55 DAT data recorded from each plot revealed that the lowest incidence of rice hispa was found in T5 (1.15%, 1.46% and1.66% respectively), whereas the highest incidence of rice hispa was observed in T7 (4.86%, 5.14% and 5.83% respectively) treatment. In case of incidence of Rice hispa decrease/increase over control, the highest decrease was observed in T5 at 25, 40 and 55 DAT as -63.72, -58.87 and -56.08 respectively. Whereas, the highest increase of Rice hispa incidence was found in T7 treatment at 25, 40 and 55 DAT as +53.31, +44.79 and +54.23 respectively. Pathak and Ram (1999) reported that minimum rice hispa incidence in controlled plots and enhanced doses of N resulted in significant increase in rice hispa incidence in the rice field. However, our result contradicts with the report of Pathak and Ram, it can be assumed that lower level of nitrogen responded to lower infestation.

3.2.7 Rice bug incidence at 45, 55 and 65 DAT

In case of rice bug incidence, at 45 DAT, 55 DAT and 65 DAT data recorded from each plot revealed that the lowest incidence of rice bug was found in T5 (1.78%,1.96% and 2.04% respectively), while the highest incidence of rice bug was observed in T7 (4.22%,4.75% and 5.08% respectively) treatment. In case of incidence of Rice bug decrease/increase over control, the highest decrease was observed in T5 at 45, 55 and 65 DAT as -48.85, -46.30 and -46.60 respectively. Whereas, the highest increase of Rice bug incidence was found in T7 treatment at 45, 55 and 65 DAT as +21.26, +30.14 and +32.98 respectively. Mahadev *et al*. (1995) reported that NPK @ 80,40,40 exhibited a lower incidence of rice bug than that of control absolute treatment.

4. DISCUSSION

The experiment comprised of different NPK fertilizer doses as treatment- T0 = Untreated control, no NPK fertilizers, T1= NPK @ 45, 50, 40 kg/ha, T2 = NPK @ 70, 25, 40 kg/ha, T3 = NPK @ 70, 50, 20 kg/ha, T4 = NPK @ 70, 50, 40 kg/ha, T5 = NPK @ 70, 50, 60 kg/ha, T6 = NPK @ 70, 75, 40 kg/ha and T7 = NPK @ 95, 50, 40 kg/ha. The experiment was laid out in a randomized complete block design (RCBD) plot with three replications. Total Six insect pests were recorded with varying numbers during the course of the experiment. The highest number of yellow stem borer (9.33), leaf folder (12.67), rice hispa (3.67), BPH (9.47), GLH (11.67), rice bug (8.60) were recorded from the observation T7 (NPK @ 95, 50, 40 kg/ha). Such results can be attributed to the higher amount of nutrients that make rice plants more succulent. In turn, insect pests find them palatable. In case of infestation level, it was revealed that, if the nitrogen dose increases, the incidence of insect pest also increases. Such outcomes can also be credited to make rice plants more succulent. However, increased level of potassium showed lower insect pests' infestation which can be attributed to the increased level of K content which in turn reduced N, Si, free sugar and soluble proteins of rice plant tissues that make the plants less succulent. It can be concluded that fertilizers can contribute a lion share in reducing insect pests' infestation. Good fertilizer management can help in pesticide reduction and more economic production.

5. CONCLUSION

Considering the above finding it is revealed that if the nitrogen dose increases, the incidence of insect pest also increased. In the term of percent of infestation, NPK @ 70, 50, 60 kg/ha (T5) was the best for the incidence of insect pest. However, imbalanced nutrition like 95 kg nitrogen, 50 kg phosphorus and 40 kg potassium incited more insect incidence, whereas balanced nutrients resulted in lower incidence of insect pests. Moreover, it is seen that increased dose of potassium has experienced less insect infestation. Among the different levels of NPK fertilizers, NPK @ 70, 50, 60 kg/ha was the best for the rice cultivation. Considering the situation of the present experiment, further studies in the following areas may be suggested: Different pest management practices and rice variety may be used in the future study. This experiment should be carried out in different agro-ecological zones AEZ) of Bangladesh for the confirmation of the results.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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