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RESEARCH PAPER

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Impact of Seedling Spacing and Fertilizer on Brown Plant Hopper, *Nilaparvata lugens* Stal. Incidence in Rice Field

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ABSTRACT

In order to assess the relative impact of seedling spacing and dose of fertilizers (N, P and K) on the occurrence of brown plant hopper (BPH), Nilaparvata lugens Stål. and yield attributes of paddy, field trials for three consecutive years (2007-2009) were carried out at three different agro-ecological locations of West Bengal. Seedlings of paddy cultivar Swarna mashuri (MTU-7029) was transplanted under three alternative doses of fertilizer and two alternative spacing (20 x 15 cm and 20 x 20 cm) conditions. Population of N. lugens was found to vary in accordance to the applied dose of fertilizer and spacing. Numerically, maximum number of BPH with 1.70 individuals /hill was noted at 120 kg N/ha. While minimum number of BPH individuals (1.09/hill) was observed at 40 kg N/ha. Incidence BPH was inversely proportional to applied dose of P, highest being noted (1.60 individuals/hill) at no P condition and lowest (1.29/hill) at 40 kg P/ha situation. Similar to P application, maximum, BPH incidence was noted when no K was applied (1.33/hill) and minimum (0.92/hill) at 40 Kg K/ha application. The interaction between N and P was below the statistical level of significance. In consideration of seedling spacing, comparatively more BPH number was noted at spacing 20 x 15 cm (2.38 individuals /hill) than 20 x 20 cm (1.83 individuals /hill). The relative interaction between fertilizer (D) and date of transplanting (T), spacing (S) x fertilizer (D) and spacing (S) x fertilizer (D) x date of transplanting (T) were statistically insignificant.

Key words: Insect pest, BPH, Phosphate, Potash and Plant

INTRODUCTION

Though insect pests have been regarded as an important constrain in agriculture through the centuries, occurrence of pest outbreaks have increased with the change of pest complexities, in the last two decades . Some insects have gained momentum, whereas others have declined in importance. There are convincing documents that 'minor pest species' have been favored by selective crop intensification. Intensification engrosses the changes in cultural practices such as (i) increase of crop-cycle per year, (ii) augmentation of agricultural chemicals (fertilizer and pesticides), (iii) improvement of irrigation facilities, and (iv) Enhancement of higher plant densities (Faleiro *et al.,* 1989, Teetes, 1981).

Paddy (*Oryza sativa* L.) is the prime cash crop in West Bengal, India. Brown plant hopper (BPH), *Nilaparvata lugens* Stal. is one of the most important insect pests in Indian subcontinent. BPH has assumed major pest status in some parts of India due to injudicious cultivation practices which includes high fertilizer input and narrow seedling spacing (Singh *et al*., 1992).

Nymphs and brachypterous adults of BPH move by walking and hopping; macropterous adults move by flying, walking, and hopping. First- to fifth-instar nymphs can move 4.8, 10.0, 18.5, 20.7, and 21.1 cm, respectively, at 16°C by hopping (Mochida, 1970). Flight activity seems to continue under conditions of low temperature, high humidity, and weak wind (Ohkubo, 1973).

Though this insect is known to occur in Asia since late forties, it was considered a minor pest of rice (Diwakar, 1998). The large scale resurgence of BPH is one of the most important effect accompanying the introduction of the successful "green revolution" practices in tropical Asian rice. BPH was first officially recorded in Bangladesh in 1969. Catches in light traps near Dacca show that the insect population has gradually increased since 1970 (Alam *et al*., 1977). In temperate regions population of BPH is characterized by discrete periods of seasonal appearance, low initial density, steep and steady growth, clumped spatial distribution, and violent fluctuations from year to year. *N. lugens,* a temporary inhabitant, arrives from long distances barely in the rice growing season. Its high potential fecundity, high adaptability to its host in various stages, and high tolerance to crowding cause its uneven, clumped spatial distribution within a field. These characteristics also cause the steep and steady growth in population that enables the insect to increase to destructive levels despite its low initial density

Both the nymphs and adults of the brown plant hopper (*Nilaparvata lugens*) remove plant sap from phloem cells. Such sap removal combined with the blockage of phloem vessels by the insects' feeding heaths, cause the tillers to dry out and turn brown. This condition is called "hopper burn", and it can cover large patches in rice fields under heavy pest pressure. The brown plant hopper can also transmit the ragged stunt and grassy stunt viruses. The loss in grain yield ranged from 10% in moderately affected fields to 70% in those severely affected (Kulshreshtha *et al.* 1974). The damage to the standing crop sometimes reached 100%. The brown planthopper has become a serious threat to rice production throughout Asia. The increase in severity of the insect appears to be associated with the technology used in modern rice culture. Chelliah *et al.* (1985) have mentioned the frequent occurrence of hopper burn from Tamilnadu. Gunathilagaraj *et al*. (1997) and Heinrichs, (1979) have reported the cases of outbreak of BPH. Hopper burn was also reported by Nath *et al.* (1978) from West Bengal. Das *et al.* (1972) from West Bengal have also reported the perilous activity of BPH leading to crop failure. BPH population from West Bengal was estimated as early as 1968; a serious incidence was first noted in a small area of Hooghly district in 1973. In 1975, nearly 2000 hectares rice field area was damaged due to this pest attack. Further, in 1977 more than 4000 hectares in Midnapur, 24 Parganas, Malda, Murshidabad, Howrah and Hooghly were affected (Nath *et al.*, 1978). But it become a serious problem of West Bengal in last twenty years with wide spread expanse of cultivation of high yielding early maturing improved cultivars. Chatterjee *et al*. (1978) recorded a significant increase of BPH population in a closely planted susceptible "*Jaya*" variety at high dose of N. Judicious cultivation practice with proper NPK input and appropriate seedling spacing are indispensible. In this contemplation and to assess the relative impact of seedling spacing and dose of fertilizers (N, P and K) on the occurrence of brown plant hopper (BPH), *Nilaparvata lugens* Stål. and yield attributes of paddy, field trials for three consecutive years (2007-2009) were carried out at three different agro-ecological locations of West Bengal.

MATERIAL AND METHODS

Experimental layout: Field study was conducted during three consecutive *kharif* crop years (2007-2009) in untreated field of paddy cultivar *Swarna mashuri* (MTU 7029). Transplantation to main field was done with 35-day old seedlings at 10 x15 cm spacing on 20-22 standard meteorological weeks (SMW). The soil of the experimental field was sandy loam with PH value 6.2 and EC value 0.29 mmhs/cm. Field management was done following national protocol with befitting modifications.

Each plots was treated with three dose of N (40, 80 and 120 Kg/ha) and thee dose of P (0, 40 and 80 Kg/ha) . Each treatment was replicated four times in a factorial randomized block design.

Three alternative dose of N in combination with two alternative dose of P were applied in different fields in a factorial randomized block design and accordingly incidence of BPH population was assessed.

Further, in order to assess the impact of seedling spacing and the dose of NPK on BPH incidence, two selected dose of NPK fertilizer (NPK-120: 60: 60 and 60: 30: 30 per hectare) as factor 'A', two specific gap of seedling spacing (20 x 15 cm and 20 x 20 cm) as factor 'B' and date of seedling transplanting as factor 'C' were considered. The data thus generated were subjected to split plot analysis considering spacing the main plot and other factor in subplot.

Assessment of BPH population: Assessment of adult BPH population was done weekly by hill estimation. In each occasion 20 hills were thoroughly examined while walking slowly through the field in zigzag manner in each plot. A steel pan with foaming water having 10 cm diameter was also used to assess BPH population. BPH incidences were recorded at 80, 90 and 100 days after seedling transplantation (DAT) respectively. Observation from such 5 occasions at each DAT was averaged. There were five replications in each year for three successive years.

RESULTS AND DISCUSSION

In order to assess the relative impact of seedling spacing and dose of fertilizers (N, P and K) on the occurrence of brown plant hopper (BPH), *Nilaparvata lugens* Stål. and yield attributes of paddy, field trials for three consecutive years (2007-2009) were carried out at three different agro-ecological locations of West Bengal. The results are delineated below.

***In consideration to the effect of N and P* (Table 1):** Incidence of BPH population varied statistically in accordance to the applied doses of N. Numerically, highest BPH incidence (1.70 individuals/hill) was noted at 120 kg N/ha. This was followed by 80 kg N/ha (1.39/hill). The lowest (1.09/hill) was being observed when 40 kg N/ha was applied. From the study, it is thus apparent that nitrogenous fertilizer boost canopy growth rate and softens the paddy vegetative tissue. N also promotes rapid tiller generation which in turn provides conducive microclimate for accommodation of substantial number of BPH (Table 2). Hokyo *et al*. (1975). have stated that rearing of BPH nymphs on paddy plant which was fertilized with high dose of N have generated significantly more progeny in comparison to those that were reared with no or low nitrogen. Faleiro *et al*. (1989) have also reported 7.49 BPH individuals per tiller when the field was fertilized with high dose of N. Significant impact of N levels on the incidence of BPH population was also documented by Prasad *et al*. (2003).

BPH population was negatively influenced by the applied P dose, higher the applied dose lower would be the incidence and vice versa. Incidence of BPH population was highest (1.60 individuals/hill) where P was not applied. This value was statistically significant with the other higher doses. At 40 kg P/ha level, BPH population reduced abruptly (1.29 individuals/hill) compared to the no P application treatment. However, incidence of BPH population varied insignificantly at 40 and 80 kg P application. Abraham (1957) has noted that application of N in combination with P suppressed BPH incidence.

Incidence of BPH varied statistically inconsideration of plant growth. Numerical abundance of BPH population increases at first slowly and then abruptly. At 80 DAT, the population was 1.07 individuals/hill. The population, at 90 DAT, subsequently increased to 1.42 individuals/hill which then subsumed at 100 DAT with 1.08individuals /hill (Table 1). Sharma (1978) from Bangalore have reported that the generation of peak population of BPH was associated with the flowering stage of paddy crop. Srinivasa *et al.* (1991) from the study at Bangalore (Hebbal) have also documented that maximum BPH incidence appears in November followed by sudden decline in December. Satpathi *et al.* (2002) from the red and laterite zone of West Bengal have observed two definite incidence peaks of BPH, first one at 3rd week of September and the next one at 4th week of October.

Combinations of different dose of both N and P have significant positive impact on yield parameters and yield components (Table 4). Maximum number of tillers was counted at 120 kg N/ha application (4.40/hill). This was followed by 80 kg P/ha (4.57/hill). Number of effective tillers/hill and yield per hectare did not show any effect beyond 80 kg N and 40 kg P/ha as given in Table A. The interaction between nitrogen (N) and Phosphate (P) was also below the statistical level of significance. Digar (1960) form laterite soil of Birbhum, West Bengal have observed that a combination of 34 kg N + 67 kg of P_2O_5/ha was suitable combination for best production of *kharif* paddy.

***In consideration to the effect of N and K* (Table 3):** Variations in the incidence of BPH populations due to different N and K dose at different days after seedling transplanting was noted. Higher the dose of N the higher was the abundance of BPH. BPH population was 0.84 individuals/hill when N was not applied to the field. It then increased to1.05 individuals/hill following the application of 40 Kg N/ha. Abundance of BPH population attained up to 1.23 individuals/hill when 80 Kg N/ha was applied. Maximum number of BPH population was recorded at120 Kg N/ha.

Incidence of BPH was inversely proportional to the applied dose of K. When K was not applied, field incidence of BPH was 1.33 individuals/hill (Table 3). BPH population was comparatively low (0.92 individuals/hill) when 40 Kg K/ha was added. Chang (1971) have noted that application of K at 200 and 250 kg/ha significantly suppressed BPH infestation. Infestation by BPH could be checked by 42.12% at 250 kg K/ha application. Pande *et al*. (1964).) Also have reported that 200 kg K/ha reduced BPH menace.

BPH population gradually increases as the growth stage of paddy advances. At 80 DAT, the incidence was 1.05 individuals/hill. This then increased up to 1.36 individuals/hill at 90 DAT which was statistically significant. At 100 DAT, the population subsumed drastically with 0.97 individuals/hill being the lowest among all of the growth stages observed.

Table 1. Effect of alternative dose of nitrogen (N) and phosphate (P) on BPH incidence at different days after transplanting. (mean population of BPH individuals /40 hills).

Incidence of BPH in relation to Nitrogen (N) application		
N_{40}	N_{80}	N_{120}
1.09 (1.26)	1.39 (1.37)	1.70 (1.48)
Incidence of BPH in relation to Phosphate (P) application		
P_0	P_{40}	P_{80}
1.6 (1.45)	1.29 (1.34)	1.29 (1.34)
Incidence of BPH in relation to date of seedling transplanting (DAT)		
80 DAT	90 DAT	100 DAT
1.37 (1.37)	1.56 (1.44)	1.24(1.32)

Statistical analysis	
Source of variation	CD at 0.05%
Nitrogen (N)	0.170
Phosphate (P)	0.169
DAT (D)	0.168
N x P	NS
N x D	NS
P x D	NS
N x P x D	NS

NS: Not significant

In consideration of the interaction, factors like potassium (P) x date of transplanting (D) was statistically significant while the second order *i.e*. nitrogen (N) x Potassium (K) and nitrogen (N) x date of transplanting (D), and the third order nitrogen (N) x Potassium (K) x date of transplanting (D) interactions were no within the level of significance. Yield parameter of paddy varied significantly when combined application of N and K of different doses was applied. At 80 kg N and P application, both tiller and effective tiller number per hill were statistically higher than 0 and 40 kg N and P application. The interaction between two factors *i.e*. nitrogen (N) and potassium (K) for number of tillers per hill did not exhibit any significant effect. Further, the number of effective tillers per hill and yield per hectare differed statistically (Table 4).

Table 2. Impact of different levels of nitrogen (N) and phosphate (P) on paddy yield attributes.

Yield attributes of rice cultivar in relation to nitrogen (N) application								
Number of tillers/hill			Number of effective tillers/hill			Yield q/ha		
N_{40}	N_{80}	N_{120}	N_{40}	N_{80}	N_{120}	N_{40}	N_{80}	N_{120}
3.82 (2.08)	4.12 (2.15)	4.40 (2.21)	3.29 (1.95)	3.66 (2.04)	3.29 (1.95)	6.59 (2.66)	7.06 (2.75)	6.76 (2.69)

Yield attributes of rice cultivar in relation to phosphate(P) application								
Number of tillers/hill			Number of effective tillers/hill			Yield q/ha		
P_0	P_{40}	P_{80}	P_0	P_{40}	P_{80}	P_0	P_{40}	P_{80}
3.54 (2.01)	4.26 (2.18)	4.57 (2.25)	3.04 (1.88)	3.66 (2.04)	3.53 (2.01)	6.72 (2.69)	6.89 (2.72)	6.76 (2.69)

Statistical analysis					
Number of tillers/hill		Number of effective tillers/hill		Yield q/ha	
Source of variation	CD at 0.05%	Source of variation	CD at 0.05%	Source of variation	CD at 0.05%
Nitrogen (N)	0.123	Nitrogen (N)	0.154	Nitrogen (N)	0.053
Phosphate (P)	0.123	Phosphate (P)	0.154	Phosphate (P)	0.053
N x P	NS	N x P	NS	N x P	NS

NS: Not significant

Table 3. Effect of different levels of nitrogen (N) and Potassium (K) on BPH population at different days after transplanting. (Mean population of BPH individuals/40 hills).

Incidence of BPH in relation to Nitrogen (N) application			
N_0	N_{40}	N_{80}	N_{120}
0.84 (1.16)	1.05 (1.24)	1.23 (1.32)	1.38 (1.37)

Incidence of BPH in relation to potassium (K) application	
K_0	K_{40}
1.33 (1.35)	0.92 (1.29)

Incidence of BPH in relation to date of seedling transplantation DAT (D)		
80 DAT	90 DAT	100 DAT
1.05 (1.24)	1.36 (1.36)	0.97 (1.21)

Statistical analysis	
Source of variation	CD at 0.05%
Nitrogen (N)	0.167
Potassium (K)	0.119
DAT (D)	0.145
N x K	NS
N x D	NS
K x D	0.205
N x K x D	NS

NS: Not significant

In consideration to the effect of spacing and fertilizer doses: Relative variation of BPH number in consideration of seedling spacing, applied dose of fertilizer and days after seedling transplantation was noted (Table 5). BPH population was comparatively higher at 20 x 15 cm (2.38 individuals/hill) spacing than 20 x 20 cm (1.83 individuals/hill). Teetes (1981) have reported that compact seedling transplantation change paddy plant canopy growth which intern generates microclimatic environment, conducive for BPH multiplication. Prasad *et al*. (2003).have also concluded that dense seedling plantation influence BPH incidence positively. Transplantation of seedlings in higher number in small area is thus discouraged. It generates dense and bushy plant canopy and hinders plant growth. A situation, favorable for BPH growth and multiplication.

In consideration to the applied fertilizer dose, 120: 60: 60 kg NPK/ha accounted for higher and statistically significant BPH population with 2.27 individuals/hill. The value was 1.94 individuals/hill at 60: 30: 30 NPK/ha application. Chatterjee *et al*. (1978) have observed that BPH attained a considerable population size in closely planted susceptible rice cultivar 'Jaya' which was supplemented with high dose of N fertilizer. De *et al.* (1984) have also indicated that the skipping of the rows in a rice field to control BPH population do not affect yield unfavorably.

Table 4. Effect of different levels of nitrogen (N) and Potassium (K) and their interaction on yield parameter of rice cultivar.

Incidence of BPH in relation to nitrogen (N) application								
Number of tiller/hill			Number of effective panicle/hill			Yield q/ha		
N_0	N_{40}	N_{80}	N_0	N_{40}	N_{80}	N_0	N_{40}	N_{80}
3.3 (1.9	3.59 (2.02)	3.69 (2.05)	2.63 (1.77)	2.98 (1.87)	3.23 (1.93)	6.28 (2.60)	6.39 92.62)	6.66 (2.68)

Incidence of BPH in relation to potassium (K) application					
No of tiller per hill		No. of effective panicle/hill		Yield q/ha	
K_0	K_{40}	K_0	K_{40}	K_0	K_{40}
3.39 (1.97	3.56 (2.01)	2.91(1.85)	2.98 (1.87)	6.37 (2.62)	6.52 (2.62)

Statistical analysis					
Number of tiller/hill		Number of effective panicle/h		Yield q/ha	
Source of variatio	CD at 0.05%	Source of variatio	CD at 0.05%	Source of var	CD at 0.05
Nitrogen (N)	0.0134	Nitrogen (N)	0.150	Nitrogen (N)	0.0213
Potassium (K)	0.0109	Potassium (K)	0.1225	Potassium (K	0.0173
N x K	NS	N x K	0.150	N x K	0.0213

NS: Not significant

Incidence of BPH progressively increased from 80 DAT (1.70 individuals/hill) attaining the highest at 100 DAT (2.67 individuals/hill) and then subsumed rapidly. At 120 DAT incidence was 1.84 individuals/hill. The interaction between fertilizer (D) and date of transplanting (T), Spacing (S) x fertilizer (D) and Spacing (S) x fertilizer (D) x date of transplanting (T) were not at all statistically significant. Present observation was also supported by Pande *et al*. (1964). Adoption of higher number of seedlings during transplantation, application of high level of N fertilizer encourages BPH development (Kisimoto, 1956, Kanno, *et al.* 1977. and Katayama, 1975). Seedling spacing, nutrient supply and water management affects extensively canopy growth, induces microclimate which supports BPH population.

Table 5. Impact of seedling spacing and different doses of fertilizer (N : P : K) application on brown plant hopper population at different days after transplanting (Mean population BPH individuals/40 hills).

Mean for spacing (S)	
S_1 (20 x 15 cm)	S_2 (20 x 20 cm)
2.38 (1.70)	1.83 (1.53)

Mean for fertilizer dose (D)	
N:P:K/ha (120 : 60 : 60)	N:P:K/ha (60 : 30 : 30)
2.27 (1.66)	1.94 (1.56)

Mean for DAT (T)			
80 DAT	90 DAT	100 DAT	120 DAT
1.70 (1.48)	2.21(1.65)	2.67 (1.78)	1.84 (1.53)

Statistical analysis	
Source of variation	CD at 0.05%
Spacing (S)	0.058
Fertilizer dose (D)	0.087
DAT (T)	0.123
D x T	NS
S x D	NS
S x T	0.174
S x D x T	NS

NS: Not significant

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