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IMPACT OF NITROGEN AND SILICON AMENDMENTS ON HOPPER POPULATION IN RICE

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ABSTRACT

Present study showed that total dry weight values of rice plants were significantly higher in the plant with high nitrogen (N) application (100kg/ ha) as compared to low nitrogen (30 kg/ ha) treatment whereas the silicon (Si) amendment had very little effect on biomass accumulation but both the elements are associated with hopper pest population densities in rice. Here the correlation coefficient values were high- r= 0.759 to 0.999 and r= 0.726 to 0.996 for brown planthopper *Nilaparvata lugens* (*Stål*) and green leafhopper *Nephotettix virescens* (Dist.) respectively when the calculation was made between insect population and plant biomass after application of nitrogen 0 to 100 kg/ ha. However, when calcium silicate was added 140 kg/ ha or above with high doses of nitrogen the *N. lugens* and *N. virescens* incidence reduced in comparison to others. Consequently, the interaction between nitrogen and silicon play a significant role in resistance to these hopper pests.

Key words: Rice, calcium silicate, phosphate, potash, interaction, *Nilaparvata lugens*, *Nephotettix virescens*, fertilizer, biomass, correlation coefficient, biomass

Rice (*Oryza sativa* L.) is an important crop as well as a high silicon(Si) accumulating plant, with reported Si contents reaching levels as high as 10% of total shoot dry weight (Epstein 1999). Currently available evidence indicate that, in rice plant , Si accumulation increases plant resistance against *N. lugens* (Yang et al. 2017; Roy et al. 2023), while high nitrogen (N) levels are associated with increased pest population densities in the rice crop (Satpathi et al., 2012). Numerous studies had shown that high level N- fertilizer application in rice crop increased survival, fecundity, and egg hatchability of nymphs and adults of *N. lugens* (Lu et al., 2007) whereas silicon application enhanced resistance against this insect pest to rice crop (He et al. 2015). Consequently the behavior of many insect pests were affected by plants fertilized with Si and the mechanisms by which defenses had shown by alerting a plant's physiology, could potentially make its resistance to insect pests (Slansky, 1990). Although many insect herbivores, arthropods, and other pests have their behavior affected by plants fertilized with Si, the mechanisms by which the Si-mediated anti herbivore defense remains to be determined (Reynolds et al., 2016; Debona et al., 2017, Islam et al. 2020). In the present study the investigation involved in to assess the effects of Si and N in addition to recommended doses of phosphate and potash (RDPK) on population parameters of *N. lugens* and *N. virescens* in West Bengal, India.

MATERIALS AND METHODS

The experiment was conducted at the Chakdaha Regional Research Sub Station of Bidhan Chandra Krishi Viswavidyalay (BCKV), India, in a split-plot design with 4 doses of nitrogen as the main treatment and 7 doses of silicon (calcium silicate dust)were the sub treatments. The experimental site was located between 20.50^0 to 24.50^0 North latitude and 86.00 to 89.00^0 East longitude with a mean sea level of 9.75 m in West Bengal, India. Four nitrogen levels i.e., 0 kg N ha^{-1} (N1), 30 kg N ha^{-1} (N2), 60 kg N ha^{-1} (N3) and 100 kg N ha^{-1} (N4) were taken as main plot treatment for a locally acceptable variety (IET 4786) during both boro and kharif seasons of 2021-22 and 2022-23 in West Bengal . Seven doses of calcium silicate applied along with recommended dose of phosphate viz. 60 kg phosphate/ ha and potash viz. 60 kg potash/ha or (RDPK) were taken as subplot treatment i.e. T1= RDPK + Calcium silicate @ 180 kg ha-1, T2 =RDPK+ Calcium silicate @ 160 kg ha-1+, T3=RDPK + Calcium silicate @ 140 kg i ha-1 , T4=RDPK+ Calcium silicate @ 120 kg Calcium ha-1, T5 = RDPK+ Calcium silicate @ 100 kg ha-1 and T6= RDPK+ Calcium silicate @ 80kg ha-1,T7= RDPK+ Calcium silicate @ 60 kg ha-1,T8= RDPK only as soil amendment .Root and shoot systems of rice plants (tillers) were harvested following exposure to the various treatments (described above), dried at

70°C for 3 days, then weighed. Hopper infestation, was analyzed with the help of *N. lugens* and *N. virescens* and their incidence data were counted from 10 rice hills out of 625 hills randomly from a 5 m^2 plot. For the practical way of counting the insect, both the plant hoppers were recorded only from three rice plants (tillers)/ hill. The number of *N. lugens* and *N. virescens* were recorded at weekly interval at 15 days after transplanting the rice crop.

RESULTS AND DISCUSSION

Result showed that total dry weight values of rice plants were significantly higher in the plant with high N-application as compare to low N-treatment whereas the Si – amendment had very little effect on biomass accumulation. The dry weight values of biomass were recorded as given in Table 1. Similar observation was also recorded by Wu et al. (2017) where it was observed

Table 1. Correlation coefficient (r) between the hopper incidence and plant biomass

Plant biomass	*N. lugens*	*N. virescens*
Plant having low biomass (1.80 to 1.92 gm/ tiller) after application 0 kg nitrogen/ hectare	0.314	0.324
Plant having high biomass (2.04 to 2.68 gm/ tiller) after application 0 nitrogen	0.362	0.391
Plant having low biomass (2.38 to 2.66gm/ tiller) after application of 30 kg nitrogen/ hectare	0.326	0.339
Plant having high biomass (2.80 to 3.85 gm/ tiller) after application of 30 kg nitrogen/ hectare	0.362	0.399
Plant having low biomass (3.15 to 3.35gm / tiller) after application of 60 kg nitrogen/ hectare	0.759	0.726
Plant having high biomass (3.67 to 4.72 gm/ tiller) after application of 60 kg nitrogen/ hectare	0.799	0.796
Plant having low biomass (3.70 to 3.86 gm/ tiller) after application of 100 kg nitrogen/ hectare	0.969	0.995
Plant having high biomass (4.20 to 5.65 gm/ tiller) after application of 100 kg nitrogen/ hectare	0.999	0.996

Incidence of hopper pests under nitrogen and silicon effects

Treatments	No. of *N. lugens*/ 3 tillers	No. of *N. virescens*/ 3 tillers
Nitrogen treatments (N)		
N_0	9.34	39.92
N_{30}	10.53	44.49
N_{60}	13.13	47.90
N_{100}	15.33	49.99
F- test ($\rho \leq 0.05$)	0.451	0.537
CV%	22.18	9.63
Silicon effects (Si)		
Si1	8.13	36.02
Si2	9.85	39.01
Si3	9.09	41.16
Si4	11.47	44.57
Si5	12.60	46.30
Si6	14.87	49.89
Si7	14.07	52.16
Si8	16.54	55.49
F- test ($\rho \leq 0.05$)	0.468	0.742
CV %	24.52	14.72
Nitrogen (N)x Silicon (Si)	4.01	10.30

that in the absence of Si amendment, total dry weight values were significantly higher in plants provided with the high N treatment in comparison with plants provided with the low nitrogen. The correlation coefficient values were high (r= 0.759 to 0.999 and r=0.726 to 0.996 for *N. lugens* and *N. virescens* respectively) when the calculation was made between insect population and plant biomass after application of 0,30, 60 to 100 kg N/ hectare as given Table 1. Consequently the correlation coefficient was low (r= 0.314 to 0.362, r= 0.324 to 0.399 for BPH and GLH respectively in plots treated with @ 30kg/ hectare which was also at par with plants grown with 0 kg/ N ha. Correlation analysis indicated that the rice plant biomass due to excessive application of N in rice field were conducive to the increased infestation behaviour, and population buildup of both plant hopper and leaf hopper and the results support the observation of Li et al., 2021 where excess nitrogen fertilization shapes rice- planthopper interactions and the consequent positive effect on *Sogatella furcifera* (Horvath) infestation (Li et al., 2021). The studies on effect of nitrogen management on incidence of *N. lugens* and *N. virescens* indicated that a significant differences were recorded between the plots where nitrogen applied above 60 kg/ hectare. The highest numbers of both *N. lugens*/ *N. virescens* were recorded in plants treated with 100 kg nitrogen followed by 60 kg and 30 kg/ hectare. Although a substantial level of hopper populations were recorded in the treatments where nitrogen was not used but their difference were nonsignificant with plot treated with lowest dose of nitrogen.

Hopper incidence on different level of Si applications were recorded where higher doses particularly Si1, Si2, and Si3 exhibited significantly differ from control (Table 1). Although the remaining all the treatments were close to the untreated control but their differences were not significant. The variation of population might be due to Si depositing in plant tissue when it was applied 160 to 180 kg/ hector and the result corroborated with the finding of other workers where it was reported that the mechanisms have been proposed to account for Si-mediated plant defense against hopper pest involves amorphous Si depositing in plant tissues acting as a physical barrier, leading to increased rigidity and abrasiveness of plant tissues, thus reducing its digestibility to insect pests (Keeping and Meyer, 2006; Massey and Hartley, 2009). Soil amendments with Si through inorganic sources effectively caused biochemical and molecular changes that ultimately support the plant defenses against *N. lugens* (Roy et al., 2023). Silicon amendment also enhanced rice resistance to both *N. lugens* and *N. virescens*, thus the strong interaction between Si and N accumulation in rice may have important implications for the resistance of rice plants to insect herbivores when grown in the presence of high N or Si-amended soils. The study also showed that significantly increased *N. lugens* and *N. virescens* on rice plant grown using high 100 kg N treatment as compared to insect population on plots treated with 30 kg N/ hectare with very low doses of Silicon (Si4) treatment. However when Si was provided 140 kg/ or above hectare the *N. lugens* and *N. virescens* population reduced in comparison to others. From the present results it is to be concluded that an interaction existed between N and Si in rice plant where the differences in hopper populations drastically reduced between two treatments. The results also support the observations of Wu et al. (2017) who reported that high N fertilization levels reduced Si accumulation in rice plant. Although Si amendment enhanced rice resistance to hopper pests but the strong interaction between Si and N accumulation in rice may have important implications for both *N. lugens* and *N. virescens* where high Si or N – amended in rice field.

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CONFLICT OF INTEREST

No conflict of interest.

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