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Effect of calcium silicate and need based nitrogen on pests management in aerobic rice (*Oryza sativa* L.)

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ABSTRACT

The dynamic and severity of pests attack has shifted with the adaptation and spread in rice. Excessive use of chemicals for pest and diseases control in agriculture is known to degrade the environment. Use of silicon (Si) and nitrogen (N) management in aerobic rice involves a proper choice and blend of compatible tactics to keep the pests at low level. The present investigations were done to know the effect of calcium silicate and nitrogen on the pest infestation in aerobic rice. The results revealed a significant decreases of pests *i.e.* Leaf folder (*Cnophalocrosis medinalis*), Brown plant hopper (*Nilaparvata lugens*), White backed plant hopper (*Sogatella turcifera*), Green leaf hopper (*Nephotetticx virescens*) with the application of calcium silicate at 2 t ha^{-1}and 90 kg N ha^{-1} (30 kg N ha^{-1}as basal+ LCC-3) and par with 60 kg N ha^{-1} (No basal + LCC-3). This study suggested the importance of Si and LCC based N application for achieving to keep the pests population and higher grain yield and straw yield.

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INTRODUCTION

Aerobic method is a new concept of growing rice. Aerobic" rice grows well under dry conditions in the absence of flooding offers a promising means to combat the looming water crisis. Farmers can use 30 to 40 per cent less irrigation water by growing aerobic rice in the tropics. In rice, Si is mainly located in epidermal cell walls, mid lamellae and the intercellular spaces of sub-epidermal tissues (Kim *et al*., 2002). In the presence of Si, plant tissues can undergo silicification which, together with lignin, contributes to the strengthening of cell walls in leaves and xylem vessels (Ma *et al*., 2001). Therefore, it has been proposed that Si plays an important role in the formation of mechanical or physical barriers restricting the penetration of pests (Datnoff *et al*., 2001). Rice is considered to be a Si accumulator plant and tends to actively accumulate Si to tissue concentrations of 5 per cent or higher (Epstein, 1994). Application of N fertilizers is an important practice for increasing rice yields. However, when applied in excess may limit yield because of lodging, promote shading and susceptibility to pests and diseases. Information on the importance of Si in Indian rice farming system is limited (Prakash, 2002). Si has been reported to raise the optimal level of N in rice. N has been and will continue to the key input in augmenting India's food grain production, particularly the rice. However, adoption of any real-time N management studies and application Si on pests in aerobic rice is very limited. With this background information, the present investigations were done for the pests management by the optimum application of calcium silicate and nitrogen in aerobic rice.

MATERIAL AND METHODS

A field experiment was conducted at eastern dry zone soils of Bengaluru (North), Karnataka, India in *Kharif* on sandy loam soil. The soil reaction was slightly acidic (6.6), with medium organic carbon (6.5 g kg^{-1}) and available N content (331.6 kg ha^{-1}). Similarly, available soil K_2O and P_2O_5 values were low (115 kg ha^{-1}) and medium (35.8 kg ha^{-1}), respectively. The aerobic rice cultivar of BI-34 was sown in 30 x 20 cm spacing with one seeds per hill by using the split plot design with three replications. The treatments consisted of four main plots *viz*., control (No N), 60 kg N ha^{-1} (No basal + LCC-3), 90 kg N ha^{-1} (30 kg N ha^{-1} as basal + LCC-3) and 100 kg N ha^{-1} as urea (RDF) and two sub plots *viz*., with (calcium silicate at 2 t ha^{-1}) and without silicon (Si) treated plots. The recommended N (RDF) was 100 kg N ha^{-1} applied in three splits with 50 per cent at sowing and 25 per cent each at maximum tillering stage and before flowering stages. Periodically LCC readings were taken in ten top most fully expanded leaves randomly and N was applied based on the LCC-3 critical values if the LCC values falls below the LCC-3 30 kg N ha^{-1} was applied on the same day. The observations on various pest *viz.*, leaf folder (*Cnophalocrosis medinalis*), Brown plant hopper (*Nilaparvata lugens*), White backed plant hopper (*Sogatella turcifera*), Green leaf hopper (*Nephotetticx virescens*) recorded at harvest of the rice crop in accordance with standard evaluation system by adopting 0-9 scale and calculated per cent disease intensity (PDI) by Wheeler, (1969).The analysis of variance for grain and straw yield, pest and diseases were worked out by feeding the replicated data into the INDOSTAT software.

$$\text{Per cent incidence of pests} = \frac{\text{Number of pest's incidence in rice hill}}{\text{Total number of rice hills}} \times 100$$

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under the following heads:

Grain and straw yield :

The data pertaining to grain yield as depicted in the Table 1. There was a significant increase in the grain yield of aerobic rice with LCC-3 based N application over RDF and control. The comparisons between different amounts of N, the treatment with 90 kg Nha^{-1} (30 kg N ha^{-1} as basal + LCC-3) and 60 kg N ha^{-1} (No basal + LCC-3) were on par with each other. There was significant increase in grain yield in sub plots with the application of calcium silicate at 2 t ha^{-1} over zero applied in sub plots. The N absorbed by the plant from tillering to panicle initiation helped to increase the number of productive tillers and that absorbed during panicle initiation to flowering increased the number of filled spiklets per panicles (Budhar, 2005). In the present study also, enhanced number of productive tillers and filled grain per panicles were observed wherever N was top dressed based on LCC at active tillering and panicle initiation stages. Inefficient and imbalance use of N fertilizer particularly at high levels of 100 kg N ha^{-1} (RDF), could reduce yield due to crop lodging, increased chaffy grains, increased disease and pest incidence and reduced profitability for farmers. This makes blanket recommendation of 100 kg N ha^{-1} could be highly inefficient for most of aerobic rice situations.

Application of calcium silicate at 2 t ha^{-1} along with 100 kg Nha^{-1} (RDF) recorded highest straw yield and the treatments with 60 kg N ha^{-1} (No basal + LCC-3) and 90 kg N ha^{-1} (30 kg N ha^{-1} as basal + LCC-3) were on par with each other. The LCC-guided N management with no other change in package of practices (RDF) for aerobic rice resulted in a total N fertilizer application of 60 kg N ha^{-1} compared with 100 kg N ha^{-1} in package of practices (RDF) of applying fixed-time N with two split doses. Application of N fertilizer whenever leaf greenness less than three on the LCC (the critical value) produced on par grain yield with 60 kg N ha^{-1} (without basal N) and 90 kg N ha^{-1} (with 30 kg N ha^{-1} as basal) of urea applying in two equal split doses, resulted in saving of 10 to 40 kg N ha^{-1} of fertilizer N. The results indicated that the fixed split N (25 kg N ha^{-1}) approach as well as real-time N management using LCC-3 performed well in respect of increasing the grain yield at this site in aerobic rice. In the present study, the LCC critical value three based N (30 kg N ha^{-1} as basal) and two splits of 30 kg N ha^{-1} each time matched the crop demand at different physiological stages and reduced the losses through nitrification, leaching and volatilization and resulted in the highest grain yield. Higher grain yield with Si treated plots are also in agreement with the findings of Munir *et al.* (2003); Singh and Singh (2005) and Singh *et al.* (2006).

Si and N management on pests :

The results of the application of Si and LCC guided N management on control of pests are showed in the Table 2. It was observed that application of increased levels of N alone increased the incidence of pests. However, there was significant reduction in pests (P_1-Leaf folder: *Cnophalocrosis medinalis*, P_2-Brown plant hopper: *Nilaparvata lugens*, P_3-White backed plant hopper: *Sogatella turcifera*, P_4-Green leaf hopper: *Nephotetticx virescens*) with application of calcium silicate as source of Si along with varied levels of LCC-guided N, which ultimately resulted in increased grain yield. The possible mechanisms involved in control of insect pests and diseases due to application of Si through mechanically induced resistance, or through production of phytoalexins and phenolic compounds. It has been reported that Si suppresses insect pests such as stem borers, brown plant hopper, green leafhopper (Savant *et al.*, 1997), Ma and Takahashi (2002) most of plant Si occurs in the epidermis, which might dislodge young borer larvae before they can establish in the stem. Furthermore, Epstein (1999) suggested that Si deposted in the

Table 1 : Effect of Si and N management on grain and straw yield of aerobic rice

Treatments		Grain yield (t ha^{-1})			Straw yield (t ha^{-1})		
		-Si	+Si	Mean	-Si	+Si	Mean
0 kg N ha^{-1} (Control)		3.2	4.3	3.7	4.8	5.1	4.9
60 kg N ha^{-1} (No basal + LCC-3)		4.7	5.5	5.1	5.3	5.8	5.6
90 kg N ha^{-1} (30 kg N ha^{-1} as basal + LCC-3)		4.9	5.6	5.3	5.5	5.8	5.7
100 kg N ha^{-1} as (RDF)		4.4	4.5	4.5	6.2	6.2	6.2
Mean		4.3	5.0		5.5	5.7	
S.E. ±	Main (N)			0.08			0.04
	Sub (Si)			0.05			0.03
C.D. (P=0.05)	Main (N)			0.25			0.16
	Sub (Si)			0.48			0.12
Interaction	N x Si			0.16			0.25

Table 2 : Effect of Si and N management on per cent incidence pests in aerobic rice

Treatments		P_1			P_2			P_3			P_4		
		-Si	+Si	Mean	-Si	+Si	Mean	-Si	+Si	Mean	-Si	+Si	Mean
0 kg N ha^{-1} (Control)		2.20	1.60	1.90	2.40	1.60	2.00	1.50	0.90	1.20	2.50	1.80	2.15
60 kg N ha^{-1} (No basal + LCC-3)		2.40	1.70	2.05	3.20	1.70	2.45	1.20	0.50	0.85	2.10	1.20	1.65
90 kg N ha^{-1} (30 kg N ha^{-1} as basal+LCC-3)		2.90	1.80	2.35	3.60	1.60	2.60	1.10	0.70	0.90	2.30	1.30	1.80
100 kg N ha^{-1} as (RDF)		3.80	2.50	3.15	4.00	2.30	3.15	1.90	1.20	1.55	3.30	2.60	2.95
Mean		2.83	1.90	2.36	3.30	1.80	2.55	1.43	0.83	1.13	2.55	1.73	2.14
S.E. ±	Main (N)			0.11			0.08			0.04			0.06
	Sub (Si)			0.03			0.03			0.06			0.03
C.D. (P=0.05)	Main (N)			0.04			0.03			0.01			0.02
	Sub (Si)			0.01			0.01			0.02			0.01
Interaction	N x Si			0.03			0.02			0.01			0.02

Pest; P_1-Leaf folder (*Cnophalocrosis medinalis*), P_2-Brown plant hopper (*Nilaparvata lugens*), P_3-White backed plant hopper (*Sogatella turcifera*), P_4-Green leaf hopper (*Nephotetticx virescens*).

epidermal tissue may have several fuctios including support and protection as a mechanical barrier agaist herbivore invasions.

Conclusion :

Si depositions in monocots may provide a mechanical barrier against insect pests. The LCC-guided N management with no other change in package of practices (RDF) for aerobic rice resulted in a total N fertilizer application of 60 kg N ha^{-1} compared with 100 kg N ha^{-1} in package of practices (RDF) of applying fixed-time N with three split doses. The further increased in yield of aerobic rice due to the interaction effect of Si as calcium silicate at 2 t ha^{-1} along with LCC based N (time demand and sufficient amount).

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