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EFFECT OF SILICA ON YELLOW STEM BORER IN RICE

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ABSTRACT

The study on influence of Si applied in forms of fertilizer formulations against yellow stem borer, *Scirpophaga incertulas* Walker infesting rice through field experiment was carried out at Central Research Farm, Department of Entomology, College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar during *kharif*, 2014. It was observed that foliar application of orthosilicic acid @4 ml/ l applied at 20, 35, 50 and 65 days after transplanting (DAT) was the best treatment in reducing deadheart and white ear head incidence and increased the grain yield. Higher uptake of silica established a negative correlation with stem borer incidence, whereas, the same produced a significant and positive correlation with grain yield.

Key words: Yellow stem borer, dead heart, white ear head, grain yield, orthosilicic acid, fertiliser formulation, foliar spray

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Rice is attacked by 20 major pests in India (Pathak and Khan, 1994) and yellow stem borer is one of the key pests that cause nearly 40-60% yield loss (Jayaraj and Muthukrishnan, 2013). Even though a lot of chemicals are available to combat this pest, yet, satisfactory control has not yet been achieved, and rather indiscriminate use of pesticides resulted in erosion in environmental quality. Induction of plant resistance through application of certain macro and micro nutrients in rice ecosystem has proved to be effective for management of stem borers. Silicon in particular has been studied to impart a fair degree of resistance in rice against stem borers. Panda et al. (1977) and Ranganathan et al. (2006) studied the effect of silicon in controlling yellow stem borer in rice. Therefore, an attempt was made to evaluate the field efficacy of certain silicon fertilizers in rice against yellow stem borer.

MATERIALS AND METHODS

A rice variety Swarna (135 days) was transplanted in the field of Central Research Farm, Department of Entomology, Orissa University of Agriculture and Technology, during 2014, with all recommended agronomic practices. Different formulations of silicon fertilizers were applied both as basal and foliar sprays on different dates on rice. A total of nine treatments including a control were taken in a R.B.D. with three replications each (Table 1). Silicon was applied as foliar spray in the form of orthosilicic acid four times at 20, 35, 50 and 65 days after transplanting (DAT) and calcium silicate, fly ash and steel slag each were applied as basal soil application.

Observations on yellow stem borer in terms of deadheart were recorded at weekly interval starting from 15 DAT and white ear head at 7 days before harvesting. The plant sample at maximum deadheart and white ear head stages were collected and analysis of silica uptake by the plant was determined in the laboratory of ICAR-National Rice Research Institute, Cuttack as per the method suggested by Wei-min et al. (2005). The grain yield was computed from each subplot and converted to q/ha. All the data were subjected to statistical analysis as per the method suggested by Gomez and Gomez (1984) with necessary transformation wherever required. The correlation between silica uptake at maximum dead heart stage, white earhead stage and grain yield were also worked out as suggested by Gomez and Gomez (1984).

RESULTS AND DISSUSSION

Effect of silicon on yellow stem borer

Incidence (deadheart): The data in Table 1 reveal that there was no significant difference between the treatments up to 29 DAT, as far as the incidence was concerned. However, significant differences between

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Table 1. Effect of silicon on the incidence of yellow stem borer in rice

Treatments	Incidence of deadheart (%) at							Mean dead heart (%)	Mean white earhead (%)
	15 DAT	22 DAT	29 DAT	36 DAT	43 DAT	50 DAT	57 DAT		
T_1: Orthosilicic acid @ 2ml/l	0.00(0.71)	0.33(0.88)	0.41(0.91)	1.92(1.54)	4.07(2.13)	3.61(2.03)	2.31(1.68)	1.81(1.41)	4.05(2.13)
T_2: Orthosilicic acid @ 4ml/l	0.00(0.71)	0.75(1.09)	0.83(1.12)	1.47(1.39)	3.05(1.87)	2.88(1.84)	1.60(1.44)	1.51(1.35)	3.33(1.95)
T_3: Calcium silicate @ 0.5t/ha	0.00(0.71)	0.38(0.90)	0.37(0.90)	2.11(1.62)	4.58(2.25)	3.26(1.93)	2.41(1.70)	1.87(1.43)	4.52(2.24)
T_4: Calcium silicate @ 1t/ha	0.00(0.71)	0.78(1.10)	1.10(1.27)	1.91(1.54)	4.43(2.21)	2.83(1.82)	2.12(1.61)	1.88(1.46)	4.21(2.15)
T_5: Fly ash @ 250kg/ha	0.00(0.71)	1.05(1.24)	1.12(1.27)	2.70(1.78)	3.95(2.10)	3.06(1.88)	2.39(1.70)	2.04(1.52)	5.82(2.49)
T_6: Fly ash @ 500kg/ha	0.00(0.71)	1.03(1.23)	0.75(1.09)	2.55(1.74)	3.69(2.04)	3.33(1.92)	2.00(1.57)	1.91(1.47)	4.82(2.28)
T_7: Steel slag @ 250kg/ha	0.00(0.71)	0.33(0.88)	0.74(1.08)	3.15(1.91)	4.43(2.22)	3.79(2.07)	3.32(1.95)	2.25(1.54)	7.46(2.81)
T_8: Steel slag @ 500kg/ha	0.00(0.71)	0.86(1.13)	1.13(1.28)	2.61(1.76)	4.37(2.21)	3.38(1.96)	2.50(1.73)	2.12(1.55)	5.28(2.39)
T_9: Control	0.00(0.71)	1.81(1.52)	2.79(1.76)	7.69(2.89)	10.48(3.3)	7.56(2.83)	4.71(2.27)	5.00(2.18)	11.44(3.45)
SE_m(±)C.D.(0.05)CV(%)	0.00NS-	0.16NS-	0.17NS-	0.100.309.80	0.100.297.48	0.130.3911.11	0.090.289.31	—-	0.180.546.44

Figures in parentheses $\sqrt{x + 0.5}$ transformed values

the treatments with respect to deadhearts were observed from 36 DAT onwards. At 36 DAT, the control treatment showed 7.69% deadhearts while T_2 produced only 1.47 % deadhearts, remaining at par with T_1, T_4 and T_3 treatments, respectively. A similar trend more or less existed for rest of the observation period. As regards to mean performance, it was observed that treatment T_2 was the best with only 1.15% deadhearts as against 5.0% in untreated control.

Incidence (white earhead); The data on white ear head at 113 DAT (Table 1) reveal that the treatment T_2 was the best with the least white earheads (3.3%) which remained at par with most of the other silicon treatments excluding T_7 (7.46% white earhead), whereas, untreated control showed11.44% white ear head.

It was observed that irrespective of the treatments, the mean number of deadhearts and white earheads were even less than half the value of these parameters in untreated control. In various silicon treatments, production of less deadhearts and white earheads might be attributed to failure of neonate larvae to penetrate the leaf sheath and stem due to higher silica deposition. Bandong and Litsinger (2005) also studied excessive stem hardening in rice due to silica mediated lignin and cellulose deposition on leaf sheath cell, which caused less penetration. Chandramani et al. (2010) also suggested that reduction in stem borer incidence in rice was caused due to wearing of mandibles of early larval instars which might have prevented further penetration to cause deadhearts and white earheads. The present findings derive supported from these.

Silicon uptake and grain yield

The data on amount of silicon taken by rice plants in various treatments at maximum deadheart (43 DAT) and white ear head stage (113 DAT) are presented in Table 2. These observations reveal that the plants in T_2 contained 15.30 % silica followed by T_4 (15.10%) and T_1 and T_3, each with 15% silicon content. At this stage a corresponding value for untreated control was also 11.20%. Silicon content at white ear head stage (113 DAT) was found to be maximum in T_2 (15.50 %) which was significantly different from rest of the treatments. The treatment T_1 and T_4 retained each of 13.50% silica, whereas, control treatment had least amount of silicon (10.20%).

These indicate that when silica was applied, the plants absorbed silicon. Orthosilicic acid being a source of well available silicon to rice plants might have caused higher mobility into plant system as compared to other form of fertilizers. Ma and Takahashi (2002) stated that rice was a good silicon accumulator and responded to available form of silicon and when silica level in paddy straw was below 11% the plants could accumulate more silica. Thus, treated rice plants accumulated more silica than the untreated plants in the present findings.

Table 2. Silica uptake in rice infested by yellow stem borer vs. grain yield

Treatments	Silica uptake (%)		
	Maximum deadheart – 43DAT	Maximum White earhead- 113 DAT	Grain yield (q/ha)
T_1: Orthosilicic acid @ 2ml/l	15.00 (3.94)	13.50 (3.74)	39.37
T_2: Orthosilicic acid @ 4ml/l	15.30 (3.97)	15.50 (4.00)	45.08
T_3: Calcium silicate @ 0.5t/ha	15.00 (3.94)	12.20 (3.56)	32.54
T_4: Calcium silicate @ 1t/ha	15.10 (3.95)	13.50 (3.74)	37.78
T_5: Fly ash @ 250kg/ha	12.30 (3.58)	10.50 (3.32)	28.89
T_6: Fly ash @ 500kg/ha	13.60 (3.75)	10.60 (3.33)	31.43
T_7: Steel slag @ 250kg/ha	14.00 (3.81)	10.70 (3.35)	31.43
T_8: Steel slag @ 500kg/ha	14.00 (3.81)	11.90 (3.52)	32.06
T_9: Control	11.20 (3.42)	10.20 (3.27)	23.97
SE_m(±)CD(0.05)CV(%)	0.050.162.46	0.040.121.92	3.219.6116.53

Figures in parentheses $\sqrt{x + 0.5}$ transformed values

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Effect of silica on rice grain yield

The data on grain yield (Table 2) revealed that highest yield of 45.08 q/ha was obtained with treatment T_2 which was statistically at par with T_1 (39.37 q/ha) and T_4 (37.78 q/ha). The treatment T_3 (32.54 q/ha) was at par with T_8 (32.06 q/ha) and T_6 (31.43 q/ha) and rest of the treatments. However, the control treatment (T_9) registered the lowest grain yield of 23.97 q/ ha. Kornodorfer and Lepsch (2001) also observed higher grain yield in rice due to silicon application. Higher grain yield in rice due to silica fertilization also has been observed by Fallah et al. (2014) and Kasturi Thilagam et al. (2014), and the present findings are also in line with these.

Correlation between silicon content and other parameters

The data on correlation studies between silicon content *vs* deadheart and white earhead is presented in Table 3. The silicon content in plants was found to be negatively and significantly correlated to deadheart (r = -0.72*) and white earhead (r = -0.69*), whereas, it was found to be significantly and positively correlated to grain yield (r = -0.95**).

Table 3. Correlation coefficients - silica content, infestation parameters and grain yield

S. No.	Silica content (%) vs	Correlation coefficient (r)
1	Deadheart (maximum DH stage)	-0.72*
2	White ear head (maximum WEH stage)	-0.69*
3	Grain yield	0.95**

* Significant at p=0.05; ** Significant at p=0.01

It is highlighted in the present findings that the increase in silicon level was positively correlated with grain yield, and as discussed it was negatively correlated with deadhearts and white earheads.

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