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Fly ash as a source of silicon and potassium for mitigating Ear head bug (*Leptocorisa acuta*) in rice under different abiotic stress condition

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Abstract
Experiments were carried out in two field conditions (induced drought and flood stress) to analyse the effect of fly ash on ear head bug population. The population of ear head bug was assessed at regular intervals on plants imposed with treatments including fly ash, Silicate Solubilizing Bacteria (SSB), Farm yard manure (FYM), and graded levels of soil test based potassium. The results revealed that the combination of Fly ash, SSB, FYM, with graded level of soil test based potassium significantly reduced the incidence of ear head bug as compared to untreated plots. The silicon content was analysed in ear head at flowering stage and it was negatively correlated with the insect population. As the age of the plant increased, silicon content proportionately increased in the plants at different growth stages. The Si present in the fly ash gets deposited in plant which in turn inhibits the feeding activity of ear head bug. Application of fly ash as a source of silica and potassium with SSB, FYM with STBK reduced the ear head bug population and increased the yield in rice.

Keywords: Fly ash, silica, ear head bug incidence

Introduction
Insect pests are one of the major biological constraints that limit crop production throughout the world (Ukwungwu, 1990) [13]. Among all insect control methods, the planting of pest resistant varieties is one of the most effective (Ukwungwu, 1990) [13] because it leaves no insecticide residues in food or the environment, and is constantly effective. However, pest damage may also be reduced through careful management of the nutrient requirements of the crop or amendments with mineral nutrients, such as silicon (Si), that reduce crop susceptibility to pests (Meyer and Keeping, 2005) [8]. This is because the development of phytophagous insects often depends on the physiological condition of host plants, and particularly their nutrient and stress status (Sétamou *et al*., 1993) [11]. For many years, Si deficiency in crops went unrecognized, and this element was widely regarded as non-essential for plant growth, although often present in the highest concentration amongst inorganic constituents (Jones and Handreck, 1967) [5]. However, there is now a greater consensus amongst scientists in the role of Si as a "functional" plant nutrient (Bhavnagary *et al*., 1988; Epstein, 1999) [1, 4]. Silica content in the plant is reported to play an important role in strengthening the cell walls of the plants (Painter, 1951) [9] and enhances resistance to both pests and diseases in the field (Qin and Tian, 2004) [10] and in storage (Korunic, 1997) [6].
Fly ash is a major industrial waste in India. It is a by-product of thermal power station where electricity is produced by burning finely powdered coal. Fly ash considered to be a rich source of Si and application of fly ash in Si deficient soils has been demonstrated to improve the Si content of rice and growth (Lee *et al*., 2006) [7]. Chandramani *et al.* (2009) [2] reported that the combination of FYM, biofertilizers, lignite fly ash and neem cake applied in splits reduced insect pests and increased the content of Si and potassium in plants which induced resistance to pests in plants. Sujatha *et al*. (1987) [12] suggested that phenol, silica, phosphorous, potassium, calcium, sulphur and iron contents were positively correlated with resistance, while the protein, nitrogen, zinc and manganese contents were negatively correlated with resistance. Hence silicon content in rice plant was found to be negatively correlated with the incidence of ear head bug in rice.

Materials and Methods
Two field experiments were conducted under induced drought and flood condition in split plot design with three replications. The plot size was 5x4 m^2 with 4 main plot treatments and 5 sub plot treatments.

The main plot treatments, M1 – Control (0 fly ash), M2 – fly ash @ 25 t ha^{-1} + silicate solubilizing bacteria (SSB) @ 2 kg ha^{-1}, M_3 - fly ash @ 25 t ha^{-1} + Farm yard manure (FYM) @ 12.5 t ha^{-1}, M_4 - fly ash @ 25 t ha^{-1} + (SSB) @ 2 kg ha^{-1} + FYM @ 12.5 t ha^{-1} were followed and subplot treatments were graded level of soil test based Potassium (STBK), S_1 - Control, S_2 - 25% STBK, S_3 - 50% STBK, S_4 - 75% STBK, S_5 - 100% STBK. The fly ash was applied before transplanting followed by incorporation of silicate solubilizing bacteria and farm yard manure. The rice variety BPT 5204 was selected for field experiment. The observations of pests were observed under natural condition. The occurrence of adult population of Ear head bug (EHB) was recorded by hill estimation. The observation of 50 hills was randomly selected from each plot. From that the average occurrence of EHB was expressed in individuals per 5 hills. The rice plant samples are randomly selected from each experimental plot and analysed for silicon and phenol content in different parts *viz.*, leaf blade, leaf sheath cum stem and ear head at flowering stage. The data obtained from field experiments were subjected to statistical scrutiny and the analysis was carried out in Agres Agdata. Square root transformation was followed for converting the population numbers. The treatment means were compared by Duncan's Multiple Range Test (DMRT) at p=0.05 for their significance.

Estimation of Silicon in plant samples

The powdered samples of different parts of rice plant viz., leaf blade, leaf sheath cum stem, ear head, were dried in an oven at 70 ºC for 2-3 hrs prior to analysis. A 0.1 g sample was digested in a mixture of 7 ml of HNO_3 (62 per cent), 2 ml of hydrogen peroxide (H_2O_2) (30 per cent) and 1ml of hydrofluoric acid (46 per cent) kept in for 10-15 min for pre-digestion. The samples were digested using microwave digester (Microwave reaction system Antonpaar Multiwave 3000 solv) with following program 500 watt for 17 minutes with a ramp at 10 ºC per minute to reach the temperature of 150 ºC, 500 watt for 10 minutes for holding the temperature of 150 ºC and venting for 10 minutes. The digested samples were diluted to 50ml with 4% boric acid (Ma *et al.,* 2002).

The Si concentration in the digested solution was determined by transferring 0.1 ml of digested aliquot to a plastic centrifuge tube, added with 3.75 ml of 0.2 N HCl, 0.5 ml of 10 per cent ammonium molybdate and 0.5 ml of 20 per cent tartaric acid and 0.5 ml of reducing agent 1- amino -2- napthol- 4- sulfonic acid (ANSA) and the volume was made up to 12.5 ml with distilled water and kept it for one hour. After one hour, the absorbance was measured at 600 nm with a UV- Visible spectrophotometer. Similarly, standards (0, 0.2, 0.4, 0.8, and 1.2 ppm) were prepared by using 1000 ppm, by following the same procedure. The stock standard of silica was obtained from Merk.

The data obtained from field experiments were subjected to statistical scrutiny (Snedecor and Cochran, 1967) [5] and the analysis was carried out in Agres Agdata. Square root transformation was followed for converting the population numbers. The treatment means were compared by Duncan's Multiple Range Test (DMRT) at p=0.05 for their significance (Gomez and Gomez, 1985).

Result and Discussion (Tables 1 & 2)

Ear head bug (*Leptocorisa acuta* Thumb) *vs* silica content in Si content at flowering

The incidence of ear head bug during the milky stage was observed. The application of fly ash with SSB and FYM showed significant reduction in ear head bug population and recorded the least ear head bug population of 0.13 per 5 hill under drought and 0.1 per 5 hill under flood stress condition followed by fly ash with FYM (0.22 per 5 hill), under drought and (0.23 per 5 hill) under flood condition, fly ash with SSB (0.22 per 5 hill) under drought and (0.33 / 5 hill under flood condition and control (0.38 per 5 hill) under drought and (0.31 per 5 hill) under flood condition. Among the graded level of STBK, application of 100 per cent STBK recorded 0.15 per 5 hill under drought and 0.11 per 5 hill under flood condition which was on par with 75 per cent K, followed by 50 per cent (0.26 per 5 hill), under drought and (0.25 / 5 hill), under flood condition, 25 per cent K (0.32 per 5 hill) under drought (0.3 / 5 hill) under flood condition and control (0.37 per 5 hill) under drought and (0.41 / 5 hill) under flood stress condition. The interaction effect showed significant difference and recorded no incidence in the plots receiving fly ash with SSB and FYM with 100 per cent STBK. In flood stress condition the interaction effect did not show any significant difference in the treatments. The per cent reduction in the ear head bug was 73.1 per cent.

In the flowering stage under drought stress condition the Si content was increased due to the addition of fly ash with SSB and FYM and showed significant difference which recorded the highest mean Si content of 3.65 per cent in leaf blade, 2.99 per cent in leaf sheath cum stem and 2.03 per cent in ear head. The control recorded the Si content of 1.87 per cent in ear head, respectively. The graded level of STBK showed significant difference and recorded the highest mean silicon content of 1.96 per cent in ear head due to the addition of 100 per cent K. The interaction effect of treatment did not show significant difference. Under flood stress condition, in flowering stage the Si content was increased due to the addition of fly ash with SSB and FYM and showed significant difference which recorded the highest mean Si content of 1.79 per cent in ear head whereas control recorded 1.65 per cent in ear head. Among the graded levels of STBK, the mean Si content of 1.74 per cent in ear head was recorded due to the addition of 100 per cent STBK which was on par with 75 per cent. The interaction effect of treatment did not show any significant difference.

Ear head bug (*Leptocorisa acuta* Thumb) *vs* Phenol content at flowering

Under drought stress condition, the total phenol content showed significant difference between the main plot treatments in flowering stage. The highest mean total phenol content of 0.94 mg g^{-1} in ear head was recorded due to the addition of fly ash with SSB and FYM whereas control, recorded 0.73 mg g^{-1} in ear head. Among the graded levels of STBK, 100 per cent K recorded the highest mean total phenol content of 0.95 mg g^{-1} in ear head. The control recorded the lowest total phenol content 0.72 mg g^{-1} in ear head. The interaction of treatments did not show significant difference in the total phenol content in ear head.

Under both drought and flood condition, the ear head bug incidence was less due to the application of fly ash with SSB and FYM. The soluble Si taken up by plants can produce phenolic and phytoalexin in response to infection by pathogen thereby silicon nutrition suppress brown spot. This might be due to the mechanism (i) Si acting as a physical barrier and (ii) soluble Si acting as a modulator of host resistance to pathogen, (iii) Si is deposited beneath the cuticle to form a cuticle – Si double layer which mechanically impede penetration of fungi and thus disrupt the infection process

(Datnoff and Rodrigues, 2005) [3]. The phenols also play a role in conferring resistance to pathogen. This might be due to (i) direct toxicity to the pathogen (ii) The oxidation products of phenols being more toxic might inhibit the pathogen (iii) It might interfere with electron transport system leading to a blockage in the energy release. (iv) Binding with enzymes and inactivating them. (Williams, 1996) [15]. The treatment effect of application of fly ash with SSB and FYM reduced the ear head bug incidence over control. This might be due to the Si present in the fly ash gets deposited in plant which in turn inhibits the feeding activity of ear head bug. The antibiosis mechanism of resistance in rice to ear head bug was due to the presence of defensive chemicals like phenol. The results were coping up with the findings of Vidyachandra *et al.* (1981) [14], Sujatha (1987) [12] and Meyer and keeping (2005) [8].

Table 1: Effect of fly ash as a source of silicon and potassium on the population of ear head bug in rice under drought and flood stress condition

Treatments	Ear head bug under drought stress						Ear head bug under flood stress					
Main/Sub	Soil Test Based K (%) (S)					Mean	Soil Test Based K (%) (S)					Mean
	0	25	50	75	100		0	25	50	75	100	
M_1	0.5 (0.70)	0.4 (0.63)	0.4 (0.63)	0.3 (0.54)	0.3 (0.54)	0.38	0.6 (0.77)	0.35 (0.59)	0.3 (0.55)	0.15 (0.38)	0.15 (0.38)	0.31
M_2	0.4 (0.63)	0.4 (0.63)	0.3 (0.54)	0.3 (0.54)	0.2 (0.43)	0.32	0.45 (0.67)	0.40 (1.31)	0.35 (0.59)	0.25 (0.50)	0.2 (0.45)	0.33
M_3	0.3 (0.54)	0.3 (0.54)	0.2 (0.43)	0.2 (0.43)	0.1 (0.32)	0.22	0.35 (0.59)	0.3 (0.55)	0.25 (0.50)	0.15 (0.38)	0.1 (0.32)	0.23
M_4	0.3 (0.54)	0.2 (0.43)	0.15 (0.38)	0	0	0.13	0.25 (0.50)	0.15 (0.38)	0.1 (0.32)	0	0	0.1
Mean	0.37	0.32	0.26	0.15	0.15	-	0.41	0.3	0.25	0.13	0.11	-
	SEd			CD(P=0.05)			SEd			CD(P=0.05)		
M	0.022			0.07			0.11			0.37		
S	0.025			0.05			0.10			0.22		
M at S	0.051			0.11			0.22			NS		
S at M	0.051			0.10			0.21			NS		

M_1 –Control, M_2 - FA @ 25tha^{-1} + SSB @ 2kg ha^{-1}, M_3 - FA @ 25tha^{-1} + FYM @ 12.5t ha^{-1}, M_4-FA @ 25 t ha $^{-1}$ + SSB + FYM

Table 2: Effect of fly ash with SSB + FYM with soil test based K on silicon content (%) at flowering stage in ear head of rice under drought stress

Treatments	Total phenol content in leaf blade at flowering stage under drought stress						Total phenol content in leaf blade at flowering stage under flood stress					
Main/Sub	Soil Test Based K (%) (S)					Mean	Soil Test Based K (%) (S)					Mean
	0	25	50	75	100		0	25	50	75	100	
M_1	1.875	1.875	1.876	1.876	1.876	1.875	1.655	1.655	1.656	1.657	1.657	1.656
M_2	1.945	1.945	1.946	1.946	1.947	1.946	1.725	1.726	1.727	1.727	1.727	1.726
M_3	2.001	2.001	2.001	2.006	2.006	2.003	1.775	1.776	1.777	1.778	1.778	1.777
M_4	2.035	2.035	2.035	2.035	2.04	2.036	1.795	1.796	1.797	1.798	1.798	1.797
Mean	1.964	1.964	1.964	1.966	1.967		1.737	1.738	1.739	1.740	1.740	
	SEd			CD(P=0.05)			SEd			CD(P=0.05)		
M	0.006			0.02			0.0006			0.002		
S	0.001			0.002			0.0001			0.0004		
M at S	0.006			NS			0.0007			NS		
S at M	0.002			NS			0.0003			NS		

M_1 –Control, M_2 - FA @ 25tha^{-1} + SSB @ 2kg ha^{-1}, M_3 - FA @ 25tha^{-1} + FYM @ 12.5t ha^{-1}, M_4-FA @ 25 t ha $^{-1}$ + SSB + FYM

Conclusion
The increased content of Si, K and phenols in the ear head at flowering stage by the addition of FA + SSB + FYM contributed for anti-feeding action of ear head bug at flowering stage.

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References
1. Bhavnagary HM, Singh K, Majumder SK. Silicophosphates as new seed protectants: studies on the damage by Trogoderma granarim Everts and its effect on the germination of wheat seeds treated with silicophosphates. Seed Science and Technology. 1988; 16(2):507-513.
2. Chandramani P, Rajendran R, Sivasubramanian P, Muthiah C. Management of hoppers in rice through host nutrition – A novel approach Journal of Biopesticides. 2009; 2(1):99-106.
3. Datnoff LE, Rodrigues FA. The role of silicon in suppressing rice diseases. APSNET Feature Story, February, 2005, 1-28.
4. Epstein E. Silicon. Annual Review of Plant Physiology and Plant Molecular Biology. 1999; 50:641-664.
5. Jones LHP, Handreck KA. Silica in soils, plants, and animals. Advance Agronomy. 1967; 19:107-149.
6. Korunic Z. Rapid assessment of the insecticidal value of diatomaceous earths without conducting bioassays. Journal of Stored Products Research. 1997; 33(3):219-229.
7. Lee H, Sung CH, Lee YB, Kim PJ. Fly ash effect on improving soil properties and rice productivity in Korean

paddy soils. Bioresource technology. 2006; 97:1490–1497.
8. Meyer JH, Keeping MG. Impact of silicon in alleviating biotic stress in sugarcane in South Africa. Sugarcane International. 2005; 23:14-18.
9. Painter RH. Insect resistance in crop plants. Macmillan, New York, 1951.
10. Qin Z, Tian SP. Enhancement of biocontrol activity of *Cryptococcus laurentii* by silicon and the possible mechanisms involved. Phytopathology. 2004; 95:69-75.
11. Sétamou MF, Schulthess F, Bosque-Perez NA, Thomas-Odjo A. Effect of plant N and Si on the bionomics of *Sesamia calamistis* Hampson (Lepidoptera: Noctuidae). Bulletin of Entomological Research. 1993; 83:405-411.
12. Sujatha G, Reddy GPV, Murthy MMK. Effect of certain biochemical factors on the expression of rice varieties to BPH (*Nilaparvata lugens* Stal.). J Res. APAU. 1987; 15(2):124-128.
13. Ukwungwu MN. Host plant resistance in rice to the African striped borer, *Chilo zacconius* Bles. (Lepidoptera: Pyralidae). Insect Science and its Application. 1990; 11:639-647.
14. Vidhyachandra B, Ray JK, Das B. Chemical differences in rice varieties susceptible or resistance to gall midge and stem borer. IRRN. 1981; 6:7-8.
15. Williams DW. Dollar spot on bentgrass influenced by displacement of leaf surface moisture, nitrogen, and clipping removal. Crop Sci. 1996; 36:1304-1309.