Effect of graded levels of fly ash with SSB and FYM on the incidence of stem borer (*Scirpophaga incertulas*) (Lepidoptera: Pyralidae) in rice (*Oryza sativa* L.)

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ABSTRACT

Field experiments were conducted to investigate the effects of graded levels of fly ash with SSB and FYM on the incidence of rice stem borer (*Scirpophaga incertulas*) (Lepidoptera: Pyralidae) in rice crop in low and high Si soils under split plot design. The graded levels of fly ash incorporated in soil at five levels (0, 25, 50, 75 and 100 t/ha) one week before crop transplantation. It was found that fly ash had significant influence on the stem borer population over the control. On an average, with respect to borer incidence, higher dose of fly ash @ 100 t ha^{-1} markedly decreased infestation (16.9%) while, applications at 25 and 50 t ha^{-1} permitted slightly more dead hearts incidence, but differed significantly from control. In main plot treatments application of SSB + FYM recorded 16.1 per cent of stem borer incidence. In interaction application of fly ash @ 100 t ha^{-1} with SSB + FYM reported less per cent of dead hearts. Application of fly ash @ 100 t/ha had significant effect with meagre pest incidence of 11.6 per cent. Besides application of SSB and SSB+FYM alone played a major role in maintaining ETL of stem borer. The present study implies that due to suppressive effects of Si and K present in fly ash the incidence of the rice stem borer mitigated at crop vegetative stage and the use of soil incorporation strategy can create an unfavourable condition for pests to survive.

Key words: Rice, *Scirpophaga incertulas*, management, fly ash, SSB and FYM.

Rice (*Oryza sativa* L.) is the main staple food of around half of the world's population. In India, rice is cultivated in 44 million hectares, with an annual production of about 131.27 million tonnes (FAO, 2009). In Tamil Nadu, rice is being grown in an area of 2.07 mha with the production of 71.50 lakh tonnes (2009-10). One of the main problems and yield limiting factors is the attack of different kinds of insect pests in the rice fields. Rice stem borer *Scirpophaga incertulas* infest the rice crop right from nursery till harvest and cause complete loss of affected tillers (Salim and Masih, 1987). *S. incertulas* could attack most of the growing stages of rice plant, beginning with seedling through tillering and up to ear setting (Ranasinghe, 1992). Their caterpillars bore into the rice stem and hollow out the stem completely. The damage symptoms vary according to the growth stage of the plant. Yield loss is caused by a loss of bearing stems due to the production of deadhearts (the outright death of stems), stems attacked in the vegetative stage, smaller panicles borne by compensatory nodal tillers, whiteheads (empty panicles) caused by attack in the reproductive phase, a decrease in filled grains and lowering of panicle weight from late damage (Catling, 1992). Sarwar *et al.* (2010) reported the infestation of 10.4% deadhearts observed in aromatic rice, due to stem borers under natural field conditions. The increasing pressure on the land of the fast growing world's population has made it necessary to intensify rice production and efficient use of mineral fertilizers that can prove a quick way of boosting crop yield per unit area of land.

Soil fertility practices can impact the physiological susceptibility of crop plants to insect pests by either affecting the resistance of individual plant to attack or by altering plant acceptability to certain herbivores (Chau and Heong, 2005). Studies of plant resistance to insect pests have shown that resistance varies with the age or growth stage of the plant (Slansky, 1990). This advocates that resistance is related directly to the physiology of the plant and thus any factor that affects the physiology of the plant may lead to changes in resistance to insect pests.

Si and K are considered most important nutrient elements in conferring resistance to biotic stresses *viz*. insect pests, nematodes and diseases by forming Si. Potassium is also responsible for the improving the quality of produce. The release of Si from fly ash is higher than opal; these facts suggest that the availability of Si in the soil applied with fly ash is increased (Raghupathy, 1993). However, the addition of silicate solubilizing bacteria on the availability of Si under submerged conditions are not studied yet in detail. Addition of silicate sources to the soil not only increased available Si but also interacted with native soil and applied P and enhanced the solubility by reducing the fixation of added P in soil (Subramanian and Gopalswamy, 1990). Approximately 260 million tonnes of coal is being consumed per annum by 82 thermal power plants (TPPs) in India. It constitutes nearly 84 per cent of total power generation, which in turn, produces 112 million tonnes of fly ash per annum now it has been increased to 130 million tonnes, of which 70 million tonnes is being utilized (2007-08). Coal combusted fly ash contains 216 ppm of Si which can be effectively utilized as a silicate material (Lee *et al.,* 2006).

Therefore, the objective of this work was to assess effect of graded levels of fly ash with SSB and FYM application against the incidence of rice stem borer in rice crop to determine its potential effectiveness to improve farmers' income and to encourage its adoption by intensively rice growing farmers.

MATERIALS AND METHODS

The investigation was carried out in low and high silicon soils of two different locations with different varieties to fix the level of fly ash to be applied with and without SSB and FYM. The climate of this region was warm and humid with annual rain fall of 340 -780 mm, most of which received during wet season of October to January. The location selected for conducting field experiments were field No. N1 block at Eastern Farm of Agricultural Engineering College and Research Institute, Kumulur and farmer field at L. Abhisekapuram, Lalgudi, Tamil Nadu. The experiment was laid out in split plot design and replicated twice with the following treatments. Nitrogen doses and a dose of phosphorus were uniformly applied to all treatments based on DSSIFER. Normal cultural practices were carried out throughout the growth period, and no pesticide was used as plant protection measure. The main plot treatments viz., Control, SSB @ 2 kg ha^{-1}, FYM @ 12.5 t ha^{-1} and SSB + FYM. Sub-plot treatments were graded levels of fly ash @ 0,25,50,75 and 100 t ha^{-1}. The soil properties of field experiments were mentioned in Table 1.

Observations on insect pest incidence were recorded at vegetative stages. In each treatment, an area of 1 m^2 was randomly selected at three different sampling sites in each treatment, and numbers of healthy and infested tillers were observed. Total number of plants in selected area was counted and then total numbers of tillers in the unit row area were also recorded in order to calculate pest percentages infestation. The observations on per cent infestation of stem borer (dead heart) were calculated using the following formulae:

Deadheart (%) = No. of deadhearts×100/ Total no. of tillers

The data checked for the need of transformation and data obtained from the above experiments were subjected to statistical scrutiny (Snedecor and Cochran, 1967) and treatment means were compared at 5% level of probability.

RESULTS AND DISCUSSION

The population of rice borers was significantly affected by different treatments though the highest prevalence was found in control in both low and high Si soils. The lowest prevalence of deadhearts was found in the treatment of fly ash @100 t/ha , while, the percentage of damage was slightly higher on application of fly ash @ 25 t/ha and 50 t/ha.

Table 1. Initial soil characterization used for experimentation

Particulars	Low Si soil	High Si soil
1. **Physical properties**		
Bulk density (Mg m^{-3})	1.42	1.38
Particle density (Mg m^{-3})	2.19	2.63
Total porosity (%)	35.1	47.5
Maximum water holding capacity (%)	30.2	40.3
Mechanical Composition Sand (%)	71.38	9.83
Silt (%)	10.41	54.65
Clay (%)	16.84	32.42
Soil Texture	ls	sicl
2. **Chemical properties**		
$pH_{1:2.5}$	7.2	8.24
$EC_{1:2.5}$ (dsm^{-1})	0.26	0.41
Cation Exchange Capacity (cmole(p)kg^{-1})	15.7	13.1
Organic Carbon (g kg^{-1})	0.14	0.67
Available Nitrogen (Alkaline permanganate N)(kg ha^{-1})	266.0	288.4
Available Phosphorus (Olsen's P)(kg ha^{-1})	33.0	13.0
Available Potassium (NH_4OAc K)(kg ha^{-1})	107.5	231.0
Available Silicon (NaOAc pH4.0 Si)(mg kg^{-1})	66 L	96 H
3. **DSSIFER based NPK recommendation**		
Nitrogen (Kg ha^{-1})	148.2	118.5
Phosphorus (Kg ha^{-1})	39.5	49.4
Potassium (Kg ha^{-1})	59.3	49.4

During the growing season, the relative prevalence of insect in the rice field environment could be ranked in the order of 25>50>75>100 t fly ash ha^{-1} treatments (Table 2). In low Si soils application of fly ash @ 100 t/ha with SSB + FYM recorded lowest prevalence of deadhearts (14.4 %) which was on par with 75 t ha^{-1} at same treatment. Application of SSB + FYM alone also recorded significant results (16.2 %). The results of SSB and FYM alone were on par with each other (18.3, 18.0). Muralikannan (1996) and Anthoniraj (1998) observed the presence of silica solubilizing bacteria (SSB) in rice ecosystem solubilized the native soil silicate and contribute to the silicon requirement of rice. In high Si soils main treatments and interaction effect though non-significant the results were within ETL of stem borer. The lowest stem borer prevalence of 11.6 per cent reported in treatments receiving fly ash @100 t ha^{-1} with SSB + FYM. Chandramani *et al.* (2009) reported the similar results on application of lignite fly ash + neem cake in splits.

Table 2. Effect of Graded levels of Fly Ash with /without SSB and FYM on stem borer incidence (percentage of dead heart per plot) in Rice under low and high soil Si status

Main Treatments	Low Si soil						High Si soil					
	Levels of fly ash (t ha^{-1})						Levels of fly ash (t ha^{-1})					
	0	25	50	75	100	Mean	0	25	50	75	100	Mean
Control	25.2	22.5	21.2	21.0	21.0	22.1	19.3	15.2	13.3	13.3	13.3	14.8
SSB	20.4	19.6	18.1	16.8	16.8	18.3	15.1	12.4	11.0	9.6	8.7	11.4
FYM	21.7	19.6	17.5	15.9	15.5	18.0	16.4	15.2	13.2	11.4	10.8	13.4
SSB + FYM	18.7	16.8	15.8	14.4	14.4	16.1	15.2	13.7	12.4	11.6	11.6	12.9
Mean	21.5	19.6	18.2	17.0	16.9	18.6	16.5	14.1	12.4	11.5	11.1	13.1

	Low Si soil SEd	Low Si soil CD(0.05)	High Si soil SEd	High Si soil CD(0.05)
Factor (F)	0.4	1.3	NS	NS
Level (L)	0.2	0.4	0.4	0.9
F at L	0.5	1.5	NS	NS
L at F	0.4	0.8	NS	NS

In contrast, in control treatment, crop nutrition inequity resulted to lower pest tolerance in host. These findings are in close conformity with those reported by Magdoff and Van (2000), who observed that nutrition imbalance could lower pest resistance.

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