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Research Article

Effect of Orthosilicic Acid Formulations on Leaf Folder Incidence in Lowland Rice

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ABSTRACT

Field experiments were conducted to study the effect of orthosilicic acid formulations on leaf folder incidence in lowland rice at Experimental Farm, Annamalai University, Tamil Nadu, India, during Navarai and Samba seasons of 2017. The treatments consisted of 100% NPK (T_1), T_1 + soil application of calcium silicate at 2 t/ha (T_2), T_1 + soil application of silicon at 120 kg/ha through fly ash (T_3), T_1 + soil application of 25 kg silixol granules ha^{-1} (T_4), T_1 + soil application of 50 kg silixol granules ha^{-1} (T_5), T_1 + foliar spray of silixol plus at 1 ml/L on 20, 40, and 60 DAT (T_6), 75% NPK (T_7), T_7 + soil application of calcium silicate at 2 t/ha (T_8), T_7 + soil application of silicon at 120 kg/ha through fly ash (T_9), T_7 + soil application of 25 kg silixol granules ha^{-1} (T_{10}), T_7 + soil application of 50 kg silixol granules ha^{-1} (T_{11}), and T_7 + foliar spray of silixol plus at 1 ml/L on 20, 40, and 60 DAT (T_{12}). The experiments were laid out by adopting randomized block design and replicated thrice. Among the various treatments imposed, treatment T_5 considerably reduced the leaf folder incidence in rice at tillering and flowering stages in both seasons. Therefore, the present study showed soil application of 50 kg silixol granules ha^{-1} along with 100% NPK and recommended plant protection measures effectively to minimize the occurrence of leaf folder in lowland rice.

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INTRODUCTION

Rice is a staple food crop for millions of people all over the world. It is extensively grown in 112 countries and consumed by 250 billion people. In India, rice is cultivated in almost all parts of the country in an area of 43.39 mha with a production of 104.32 mt having average productivity of 2.40 t/ha.[1] Rice yields have been reduced in post-green revolution era due to imbalance in fertilizer use, improper cropping system, and lack of suitable genotypes for various stress condition including drought, water logging pest, and diseases. Among them, insect pests greatly affect the rice production. Leaves feeding insect pest like leaf folder defoliates or removes leaf chlorophyll content at higher rate and causes lesser grain yield. During late 1980s, rice leaf folder was considered as a minor pest, but, at present, it become major rice pest and cause economical loss in rice.[2]

Nowadays, rice insect pests are controlled by an extensive use of insecticides. These insecticides not only control pests and also destroy the beneficial insects and causes environmental pollution.[3] The repeated use of insecticides at higher dose and more fertilizer rates positively influence on leaf folder incidence in paddy.[4] Hence, the use of lesser toxic compounds from natural plant origin, host plant resistance, biological control agents, and adoption of cultural method like crop rotation are given priority in IPM programs. Due to lack of resistance varieties to rice leaf folder, there is a need to induce plant resistance by alternate methods to reduce insect pests' population. One of the strategies is enrichment of silicon in rice shoot.

Silicon (Si), an agronomically beneficial element, plays a major role against biotic and abiotic stresses and improves crop yields. Si is the only element that does not damage crops even with excess accumulation. Rice is one of the higher silicon accumulating plants and absorbs Si from soil solution ranging from 150 to 300 kg/ha.[5] Si has been reported to be necessary for sustainable growth and yield paddy.[6,7] It is required for the development of strong leaves, stems, and roots. The formation of a thick silicate epidermal cell layer reduces the susceptibility of rice to insect pests, namely, stem borers, planthoppers, and mite pests. The beneficial effect of silicon against rice pests was earlier observed by Subramanian and Gopalswamy,[8] who reported that addition of silicate materials to the soil significantly reduced the incidence of *Cnaphalocrocis medinalis* and *Orseolia oryzae* in rice at tillering stage. Although silicon is the second largest element present in the soil, it is not readily available to plants due to its amorphous nature. In general, silicon is observed by the plants as orthosilicic acid (OSA) also called monosilicic acid from the soil solution for its normal growth and development.[9] As far as OSA formulations concern, a few researches have been conducted on rice in particular on rice pests. Hence, field experiments were programmed to study the leaf folder incidence due to OSA formulations in lowland rice along with traditional silicon sources.

MATERIALS AND METHODS

Field experiments were conducted at Field No A4 of wetland (January–April, 2017) and 11 D (September 2017–January, 2018) of the garden land, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, India, to study the effect of OSA formulations on leaf folder incidence in lowland rice. The treatments consisted of 100% NPK (T_1), T_1 + soil application of calcium silicate at 2 t/ha (T_2), T_1 + soil application of silicon at 120 kg/ha through Fly ash (T_3), T_1 + soil application of 25 kg silixol granules ha^{-1} (T_4), T_1 + soil application of 50 kg Silixol granules ha^{-1} (T_5), T_1 + foliar spray of Silixol plus at 1 ml/l on 20, 40, and 60 days after transplanting (T_6), 75% NPK (T_7), T_7 + soil application of calcium silicate at 2 t/ha (T_8), T_7 + soil application of silicon at 120 kg/ha through fly ash (T_9), T_7 + soil application of 25 kg silixol granules ha^{-1} (T_{10}), T_7 + soil application of 50 kg Silixol granules ha^{-1} (T_{11}), and T_7 + foliar spray of Silixol plus at 1 ml/L on 20, 40, and 60 days after transplanting (T_{12}). The experiments were laid out by adopting randomized block design and replicated thrice. The rice cultivar chosen for study is ADT 43 (short duration) and ADT49 (medium duration), respectively, for both the seasons. The rice crop was fertilized with 120:40:40 kg of N, P_2O_5, and K_2O ha^{-1} in Navarai and 150:50:50 kg of N, P_2O_5, and K_2O ha^{-1} during Samba in the form of urea (46%), DAP (18% N and 46% P_2O_5), and Muriate of Potash (60% K_2O). The entire dose of P_2O_5 and 25% of N and K was applied as basal, and the remaining N and K were applied in three equal splits at active tillering, panicle primordial initiation, and heading stages. Silixol granules and silixol plus sample investigated in this study were obtained as gift sample from Privi Life Sciences Pvt. Ltd., Navi Mumbai. It contains 1 and 2.05% OSA. Inorganic fertilizers and silicon sources were applied as per the treatments. Recommended plant protection measures were carried out for controlling insect pest. The damaged leaves and total leaves from 10 randomly selected hills were observed in each plot, and percentage incidence was calculated as suggested by Jawahar *et al*.[10] The individual leaf damage was calculated using a mobile application called Bio Leaf.[11]

RESULTS AND DISCUSSION

On close examination of the data furnished in the Tables 1 and 2 revealed that application of different sources of silicon along with graded levels of NPK significantly minimized the leaf folder incidence at tillering and flowering stages of rice during navarai and samba seasons. Among the various treatments tried, 100% NPK + soil application of 50 kg Silixol granules ha^{-1} considerably reduced the leaf folder incidence in rice at tillering and flowering stages during Navarai and Kuruvai seasons. It was closely followed by soil application of 25 kg silixol granules ha^{-1} along with 100% NPK. The treatment T_7 (75% NPK) had the least defense on leaf folder which recorded higher percentage incidence in both seasons. The percentage incidence of leaf folder ranged from 0.72 to 8.17 and 1.60 to 10.79 at tillering and flowering stages in both seasons. Regarding leaf damage, 100% NPK + soil application of 50 kg silixol granules ha^{-1} recorded least per cent leaf damage over other treatments at tillering and flowering stages in both seasons. Soil application of silicon performed well at different levels of NPK over foliar spray of silicon at all the stages in both seasons. With reference to silicon sources at different levels of NPK, silixol granules did cause lesser

Table 1: Effect of silicon sources on leaf folder incidence (%) in rice at tillering and flowering during Navarai season

Treatments	Tillering		Flowering	
	% incidence	% damage leaf^{-1}	% incidence	% damage leaf^{-1}
T_1 – 100% NPK	6.95	6.09	8.70	9.48
T_2 – T_1+soil application of calcium silicate at 2 t/ha	3.42	2.91	5.36	4.88
T_3 – T_1+soil application of silicon at 120 kg/ha through fly ash	2.73	2.40	5.19	4.42
T_4 – T_1+soil application of 25 kg silixol granules ha^{-1}	1.07	0.95	2.28	2.01
T_5 – T_1+soil application of 50 kg silixol granules ha^{-1}	0.72	0.64	1.60	1.90
T_6 – T_1+foliar spray of Silixol plus at 1 ml/L on 20, 40, and 60 days after transplanting	5.92	5.25	7.31	7.68
T_7 – 75% NPK	8.17	8.91	10.79	12.70
T_8 – T_7+T_7+soil application of calcium silicate at 2 t/ha	5.47	4.26	6.44	7.01
T_9 – T_7+soil application of silicon at 120 kg/ha through fly ash	3.94	3.64	5.79	5.23
T_{10} – T_7+soil application of 25 kg silixol granules ha^{-1}	2.34	1.76	4.76	3.15
T_{11} – T_7+soil application of 50 kg silixol granules ha^{-1}	1.46	1.02	3.53	2.72
T_{12} – T_7+foliar spray of Silixol plus at 1 ml/L on 20, 40 and 60 days after transplanting	6.40	6.04	7.58	9.26
SEd	0.17	0.15	0.33	0.25
CD (*P*=0.05)	0.37	0.32	0.69	0.52

Table 2: Effect of silicon sources on leaf folder incidence (%) in rice at tillering and flowering during samba season

Treatments	Tillering		Flowering	
	% incidence	% damage leaf^{-1}	% incidence	% damage leaf^{-1}
T_1 – 100% NPK	7.50	4.82	10.90	7.82
T_2 – T_1+soil application of calcium silicate at 2 t/ha	3.32	3.50	6.40	5.04
T_3 – T_1+soil application of silicon at 120 kg/ha through Fly ash	2.60	2.24	6.00	4.21
T_4 – T_1+soil application of 25 kg silixol granules ha^{-1}	0.68	0.39	1.87	1.62
T_5 – T_1+soil application of 50 kg silixol granules ha^{-1}	0.41	0.26	1.44	1.27
T_6 – T_1+foliar spray of Silixol plus at 1 ml/L on 20, 40, and 60 days after transplanting	5.88	4.65	9.81	6.41
T_7 – 75% NPK	8.02	5.10	14.47	8.33
T_8 – T_7+T_7+soil application of calcium silicate at 2 t/ha	5.40	4.02	9.33	4.95
T_9 – T_7+soil application of silicon at 120 kg/ha through Fly ash	4.17	3.98	6.73	5.21
T_{10} – T_7+soil application of 25 kg silixol granules ha^{-1}	1.05	1.46	3.02	2.35
T_{11} – T_7+soil application of 50 kg silixol granules ha^{-1}	0.99	1.25	2.64	2.19
T_{12} – T_7+foliar spray of Silixol plus at 1 ml/L on 20, 40, and 60 days after transplanting	6.07	4.39	9.27	7.65
SEd	0.13	0.10	0.21	0.17
CD (P=0.05)	0.28	0.22	0.44	0.36

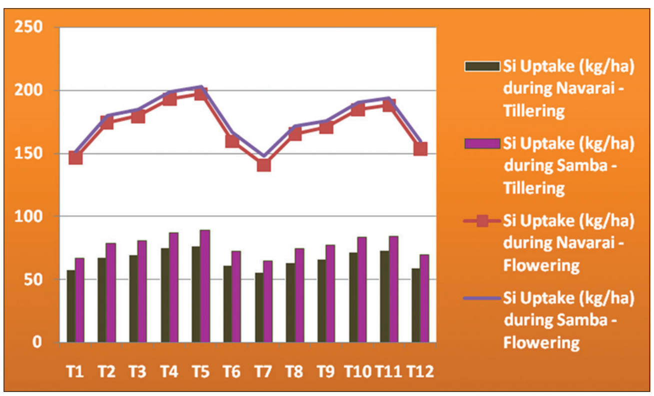

Figure 1: Effect of silicon sources on Si uptake of rice at tillering and flowering stages

damage over fly ash and calcium silicate. However, when silicon was combined with NPK, it was noticed that T_5 was comparable with T_{11}.

The maximum defense against leaf folder at 100% NPK + soil application of 50 kg silixol granules ha^{-1} could be due to higher accumulation of silicon in rice shoots. This is confirming with the silicon uptake of rice at tillering and flowering stages due to silicon sources [Figure 1]. As the plant grew older, silica content proportionally increased in plants which breaks mandibles of insect pest when it feeds the leaves resulted in functionless mandibles so that the leaf folder die without food. Increase in silicon uptake at all stages is mainly due to consistent availability of sufficient quantity of plant available silicon in soil. This is in consonance with the findings of Yoshida[5] and Chandramani *et al.*[12] Silicon-induced plant resistance against rice leaf folder was earlier reported by Jawahar *et al.*[10] Due to lesser Si content and inorganic chemicals, 75% NPK alone registered more leaf folder incidence in rice. Hence, it can be concluded that conjoint application of 100% NPK + 50 kg Silixol granules ha^{-1} as basal along with recommended pesticides is a viable practice to reduce the leaf folder incidence in lowland rice. The future research priorities are given to study the effect of OSA formulations with graded level pesticides on rice pests.

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