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EFFECT OF SILICON ON BLAST DISEASE AND LEAF FOLDER INCIDENCE IN RICE UNDER DIFFERENT METHODS OF ESTABLISHMENT

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Abstract

Field experiment was conducted during Kuruvai season (July – Nov2019) at Department of Agronomy, Annamalai University, Tamilnadu, India to study the effect of silicon on blast disease and leaf folder incidence in rice under different methods of establishment. The treatments are arranged in split plot design and replicated twice. The main plots consisted of M_1- Dry Seeded Rice (DSR), M_2- Wet Seeded Rice (WSR) and M_3- Transplanted Rice (TR) and sub plots are S_1- Recommended dose of fertilizers (RDF), S_2 - S_1 + Calcium Silicate @ 100 kg Si ha^{-1} + SSB, S_3 - S_1 + Calcium Silicate @ 200 kg Si ha^{-1} + SSB, S_4 - S_1 + Diatomaceous Earth @100 kg Si ha^{-1}, S_5 - S_1 + Diatomaceous Earth @200 kg Si ha^{-1}, S_6 – S_1 + Fly ash@ 100 kg Si ha^{-1} + SSB and S_7 – S_1 + Fly ash@ 200 kg Si ha^{-1} + SSB. Among the methods of establishment, transplanted rice recorded least incidence and per cent leaf damage of rice blast and leaf folder which was followed by wet seeded rice and dry seeded rice. Regarding silicon sources, Diatomaceous Earth @ 200 kg Si ha^{-1} + RDF gave higher protection to rice against rice blast and leaf folder. The higher incidence and leaf damage of blast and leaf folder was observed in RDF alone. Among the interaction effect between establishment methods and sources of silicon, transplanted rice fertilized with Diatomaceous Earth @200 kg Si ha^{-1} recorded the least incidence and per cent damage of rice blast and leaf folder. Thus the present study can be concluded that rice planted at 15x10 cm and fertilized with Diatomaceous Earth @200 kg Si ha^{-1} + RDF is a successful practice to decline the blast disease and leaf folder incidence and per cent leaf damage in rice.

Key words: silicon sources, establishment methods, Rice, leaf blast, leaf folder.

Introduction

Rice is grown in different ecosystem at worldwide in an area of about 162.41million ha^{-1} with the production of 496.46 million tonnes, having the productivity of 4.56 tonnes ha^{-1} (USDA, 2020). About 3 billion people depend on rice for their daily consumption and energy need (Carriger and Vallee, 2007). The productivity of rice has been reduced due to various factors, in particular diseases and insect pests. Among the diseases, Rice blast is the most spreading disease and it spread around 85 countries globally (Gilbert *et al.,* 2004) and also causes great damage. This disease generally causes yield loss of 10-20 per cent and it vary up to 80 per cent (Koutroubas *et al.,* 2009). The major diseases that cause quantitative and qualitative losses in rice are rice blast, brown spot, bacterial leaf blight, sheath blight, sheath rot, Bakanae, stem rot, tungro, false smut and post-harvest diseases (Sharma and Bambawale, 2008). The major pests are brown plant hopper (BPH), Nilaparvata lugens (Stal.), White backed plant hopper (WBPH), Sogatella furcifera (Horvath); Green leafhopper (GLH), Nephotettix virescens (Distant); Stem borer, *Scirpophaga incertulas* (Walker), Leaf folder Cnaphalocrocis medinalis (Guenee) and gall midge, Orseolia oryzae (Wood-Mason) (Chandramani *et al*., 2010). Among the insect pests, rice leaf folder losses upto 11.18 per cent in India (Shanmungam *et al.,* 2006) and the yield loss may vary from 30 to 80 per cent (Nanda and Bisoi, 1990).

Application of chemical pesticide is a proven method to manage the diseases and insect pests in rice. But continuous usage of these chemical pollutes the environment. Regular consumption of these chemical accumulated produce causes several diseases to human being. Hence, the usage of these chemicals in crop should be reduced and also enhanced the yield of crops. One

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such strategy is enrichment of silicon in plants. Rice plants accumulate up to 10% silicon (Si) mainly in the form of amorphous Si dioxide particles (Ma and Takahashi, 2002). Sufficient Si supply enhances the plant's strength and rigidity and improves defense against biotic (attacks by insect pests and fungi) and abiotic (strong rain, wind, salinity, and drought) stresses as reported by Guntzer *et al.* (2012) and Meharg and Meharg (2015). Hence, application of Silicon in paddy soil might be an option to enhance rice yield (Marxen *et al.,* 2016) and to decrease the disease and pest incidence and also to reduce the demand for pesticides (Guntzer *et al.,* 2012). The level of damage due to various diseases and insect pests will vary in different rice ecosystems. At this juncture, it is essential to identify the suitable silicon source to minimize the disease and insect pest infestation in rice for different methods of establishment. Therefore, field experiment was conducted to study the effect of silicon sources on blast disease and leaf folder incidence in rice under different methods of establishment.

Materials and Methods

Field experiment was conducted during Kuruvai season (July – Nov 2019) at Department of Agronomy, Annamalai University, Tamilnadu, India to study the effect of silicon on blast disease and leaf folder incidence in rice under different methods of establishment. The experimental plots were arranged in split plot design with two replications. The main plots consisted of M_1- Dry Seeded Rice (DSR), M_2- Wet Seeded Rice (WSR) and M_3- Transplanted Rice (TR) and sub plots are S_1- Recommended dose of fertilizers (RDF), S_2 - S_1 + Calcium Silicate @ 100 kg Si ha^{-1} + SSB, S_3 - S_1 + Calcium Silicate @ 200 kg Si ha^{-1} + SSB, S_4 - S_1 + Diatomaceous Earth @100 kg Si ha^{-1}, S_5 - S_1 + Diatomaceous Earth @200 kg Si ha^{-1}, S_6 – S_1 + Fly ash@ 100 kg Si ha^{-1} + SSB and S_7 – S_1 + Fly ash@ 200 kg Si ha^{-1} + SSB. The paddy crop was fertilized with 120:40:40 kg NPK ha^{-1}. Silicon sources were incorporated into the soil a week before sowing/ planting and SSB also applied. Recommended plant protection measures were given to all the treatment plots. Observation on rice blast and leaf folder was recorded at tillering and flowering stages. The per cent incidence of blast and leaf folder was calculated as suggested by Jawahar *et al.* (2015 and 2019a). The per cent leaf damage for individual was calculated by using a mobile application called Bio leaf as suggested by (Machado and Rodrigues, 2016). The data were statistically analyzed as suggested by Gomez and Gomez (1984).

Results and Discussion

Rice establishment methods and silicon sources significantly influenced on blast and leaf folder incidence and per cent leaf damage in rice crop (Table 1 and 2). Among the methods of establishment transplanted rice recorded lesser incidence and per cent leaf damage for blast and leaf folder at tillering and flowering stage when compared to wet seeded rice and dry seeded rice. Transplanted rice recorded least rice blast incidence 2.09% at tillering and 4.85% at flowering stage. It also recorded the lesser leaf damage of 2.33 and 4.22 % at tillering and flowering stage, respectively. Similarly, transplanted rice offered higher protection against leaf folder which recorded the least incidence of 2.36 and 3.22 % at tillering and flowering stage, respectively. The per cent leaf damage due to leaf folder in transplanted rice was 1.28 and 3.02 at tillering and flowering stage, respectively. Optimal plant spacing, proper air circulation and easy entry of sun light to the crop canopy minimized the blast and leaf folder incidence and leaf dame in rice.

Table 1: Effect of silicon sources on blast incidence (%) and individual leaf damage (%) in rice at tillering and flowering stage under different methods of establishment.

	Blast at Tillering								Blast at Flowering							
	Per cent Incidence				Per cent leaf damage				Per cent Incidence				Per cent leaf damage			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	4.90	4.30	3.99	4.40	5.32	4.67	4.23	4.74	7.85	7.23	6.77	7.28	7.40	6.66	6.22	6.76
S_2	3.95	3.35	3.04	3.45	4.45	3.80	3.36	3.87	7.09	6.47	6.01	6.52	6.58	5.84	5.40	5.94
S_3	2.95	2.27	1.96	2.39	3.23	2.58	2.14	2.65	5.83	5.21	4.75	5.26	5.31	4.57	4.13	4.67
S_4	2.20	1.51	1.14	1.62	2.43	1.78	1.34	1.85	4.93	4.31	3.85	4.36	4.31	3.57	3.13	3.67
S_5	1.89	1.09	0.72	1.23	1.94	1.29	0.85	1.36	4.44	3.82	3.36	3.87	3.67	2.93	2.49	3.03
S_6	3.12	2.45	2.13	2.57	3.54	2.89	2.45	2.96	6.17	5.55	4.81	5.51	5.56	4.82	4.38	4.92
S_7	2.65	1.99	1.68	2.11	3.00	2.35	1.91	2.42	5.48	4.86	4.40	4.91	5.00	4.26	3.82	4.36
Mean	3.09	2.42	2.09		3.42	2.77	2.33		5.97	5.35	4.85		5.40	4.66	4.22	
	M	S	MxS	SxM	M	S	MxS	SxM	M	S	MxS	SxM	M	S	MxS	SxM
S.Ed	0.17	0.09	0.27	0.22	0.21	0.11	0.26	0.25	0.22	0.18	0.26	0.25	0.21	0.13	0.28	0.33
CD(P=0.05)	0.34	0.19	0.55	0.45	0.43	0.23	0.53	0.51	0.45	0.36	0.53	0.50	0.42	0.27	0.56	0.66

This is agreement with the results of Sarao and Mahal (2013). Wet seeded rice was next best to transplanted rice. The higher blast and leaf folder incidence and per cent leaf damage was observed in dry seeded rice. It recorded 3.09 and 5.97 % blast incidence and also 3.42 and 5.40 % its leaf damage at tillering and flowering stage, respectively. For leaf folder, dry seeded rice recorded higher incidence of 3.71 % at tillering and 5.32 % at flowering stage. The Leaf damage due to leaf folder in dry seeded rice was 2.93 and 4.19 % at tillering and flowering stage, respectively. This could be due to improper arrangement of plants in row, clumpy growth and intermingling of leaves may provide favourable conditions for higher incidence of leaf folder, folding of leaves and easy leaf to-leaf movement of the larvae (Savary *et al.,* 2005). Higher water stress at dry seeded rice may favoured the incidence of blast due to level of water affects many processes viz., liberation and germination of spores and its infection in rice plant causing blast (Bonman and Leung, 2004).

Application of silicon sources greatly reduced the incidence and leaf damage of rice blast and leaf folder (Table 1 and 2). Among the sources of Si, Diatomaceous Earth @200 kg Si ha^{-1} + RDF recorded least rice blast incidence of 1.23 and 3.87 % at tillering and flowering stages, respectively. It also recorded the least leaf damage of 1.36 % at tillering and 3.03% at flowering stage. Similar trend of results were observed for leaf folder with Diatomaceous Earth @200 kg Si ha^{-1} + RDF, which recorded the least leaf folder incidence of 1.14 % at tillering and 2.41 % at flowering stage. The leaf damage due to leaf folder was 0.95 % at tillering and 1.55 % at flowering stage. This might be due to well solubilized nature of Diatomaceous Earth compare to other sources and supply plant available silicon to rice plant which can easily taken up in the transpiration stream and polymerized to amorphous silica (SiO2) through various mechanisms (Iler, 1979) and finally deposited on the epidermal layer (Yoshida, 1975) of rice. Hence it served as a physical barrier against blast and leaf folder. As plant grew older, Si content consistently increased in plants (Ishizuka,1964) and enhanced the production of phenolic compound which minimize the incidence of diseases and pest (Seebold *et al.,*2000 and Wattanapayapkul *et al*.,2011). Similar kinds of results were obtained by Jawahar *et al.(*2019b), who reported that application of OSA formulation (Silixol granules) @ 50 kg ha^{-1} + RDF significantly increased the Si absorb by the crop and offered higher protection against rice blast in low land condition. Higher accumulation silicon in the leaf breaks the mandibles of leaf folder when it feeds the leaves and caused functionless mandibles, therefore leaf folder die without food (Yoshida, 1975 and Chandramani *et al.,* 2010). These results are consonance with Jawahar *et al.*(2019a). Application of RDF alone recorded higher the incidence and damage per cent of blast disease and leaf folder which was recorded the rice blast incidence of 4.40 % at tillering and 7.28 % at flowering stage, blast leaf damage was 4.74 and 6.76 % at tillering and flowering stages, respectively. Leaf folder incidence at RDF alone was 4.95 % at tillering and 5.40 % at flowering stage and per cent leaf damage due to leaf folder was 3.71 and 6.53 % at tillering and flowering stages, respectively.

Among the interaction between establishment methods and silicon sources, Transplanted rice fertilized with Diatomaceous Earth @200 kg Si ha^{-1} + RDF recorded least rice blast incidence of 0.72% at tillering and 3.36 % at flowering stage and registered the leaf damage per cent of 0.85 % at tillering and 2.49 % at flowering stage. Similarly, it offered higher defence against

Table 2: Effect of silicon sources on leaf folder incidence (%) and individual leaf damage (%) in rice at tillering and flowering under different methods of establishment.

	Leaf folder at Tillering								Leaf folder at Flowering							
	Percent Incidence				Percent leaf damage				Percent Incidence				Percent leaf damage			
	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean	M_1	M_2	M_3	Mean
S_1	5.52	4.87	4.47	4.95	4.44	3.55	3.15	3.71	7.06	4.84	4.31	5.40	7.16	6.46	5.96	6.53
S_2	4.85	3.68	3.59	4.04	4.10	3.21	2.09	3.13	6.46	4.43	3.95	4.95	6.23	5.65	5.25	5.71
S_3	3.88	2.98	2.49	3.12	2.61	1.72	1.07	1.80	5.58	3.71	3.22	4.17	3.62	3.04	2.54	3.07
S_4	2.47	1.42	0.76	1.55	2.31	1.05	0.49	1.28	3.90	2.66	2.37	2.98	2.94	1.91	1.47	2.11
S_5	1.87	0.98	0.56	1.14	1.97	0.76	0.12	0.95	3.51	2.42	2.15	2.69	2.41	1.32	0.92	1.55
S_6	4.19	3.33	2.84	3.45	2.75	1.93	1.28	1.99	5.86	3.99	3.57	4.47	3.82	3.24	2.74	3.27
S_7	3.21	2.32	1.80	2.44	2.35	1.42	0.75	1.51	4.85	3.32	2.95	3.71	3.18	2.76	2.26	2.73
Mean	3.71	2.80	2.36		2.93	1.95	1.28		5.32	3.62	3.22		4.19	3.48	3.02	
	M	S	MxS	SxM	M	S	MxS	SxM	M	S	MxS	SxM	M	S	MxS	SxM
S.Ed	0.20	0.11	0.29	0.21	0.29	0.12	0.42	0.17	0.19	0.15	0.29	0.16	0.22	0.10	0.32	0.28
CD (P=0.05)	0.41	0.23	0.59	0.43	0.58	0.25	0.85	0.35	0.39	0.30	0.58	0.32	0.45	0.21	0.65	0.57

rice leaf folder and recorded the least incidence of 0.56 % at tillering and 2.15 % at flowering stage and also recorded the lesser leaf damage of 0.12 % at tillering and 0.92 % at flowering stage. This might be due to proper row arrangement of plants and easy entry sunlight in the crop canopy and also due to the silicon nutrition enhanced the resistant to rice plant against blast disease and leaf folder. This was followed by Fly ash @200 kg Si ha^{-1} + SSB + RDF and recorded the blast incidence of 1.68 % at tillering and 4.40 % at flowering stage and leaf damage of 1.91 % at tillering and 3.82 % at flowering stage of rice. Similarly, it recorded the rice leaf folder incidence of 1.80 % at tillering and 2.95 % at flowering stage and leaf damage of 0.75 % at tillering and 2.26 % at flowering stage. Calcium Silicate @ 200 kg Si ha^{-1} + SSB+ RDF were next in order. Therefore, fertilization of Diatomaceous earth @200 kg Si ha^{-1} + RDF under transplanted method of establishment significantly reduced the blast disease and leaf folder incidence and per cent leaf damage in rice crop and it can be recommended to the rice growers.

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