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Research article

EFFECT OF SILICATE SOLUBILIZING BACTERIA AND FLY ASH ON MEAN LEAF ERECTNESS OF RICE (*ORYZA SATIVA* L.) IN LOW, MEDIUM AND HIGH SILICON SOILS

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ABSTRACT: The leaf erectness is known to be one of the important factors that affect light conditions in plant population. Thereby triggers photosynthetic activity. A field experiment was carried out in low Si soil and observations made on leaf erectness at tillering stage and correlated with Si uptake and dry matter production. The leaf openness varied greatly due to application of graded levels of fly ash with and without SSB and FYM. Application of fly ash @ 100 t ha^{-1} with SSB and FYM registered the lowest value (16.7) which was on par with application of 50 t ha^{-1} fly ash +SSB and FYM. This parameter was negatively and significantly correlated with Si content (r = -0.83) and uptake (r = -0.92) in rice plant at tillering. Similarly, significant and negative correlation (r= -0.70) was observed with grain yield in loamy sand soil with low Si status. In sandy loam soil with low to medium Si status the parameter was best correlated with grain yield (r=-0.94) and negatively, significantly correlated with Si content (r =-0.55) and uptake (r=-0.82) in plant at tillering. Among the different treatments, application of SSB + FYM recorded the lowest leaf openness of 14.9 which was on par with SSB (16.4) followed by FYM (17.4) whereas control recorded the highest leaf openness of 20.0. The interaction between different main treatments and graded levels of fly ash has not rendered significant change in leaf openness under high soil Si status.

Key words: Silicon in Rice, low, medium and high Si soils, mean leaf erectness, Fly Ash, with Silicate Solubilizing Bacteria and Farm Yard Manure.

INTRODUCTION

Agriculture continues to be an important sector of the Indian economy. It accounted for 14.2 per cent of the GDP (2010-11, advance estimates of CSO) and 58 per cent of employment in the country (as per 2001 census). At present, Indian agriculture is passing through challenging times. There is an urgent need to elevate yields to a higher growth trajectory. For this, the requisite technology development and dissemination are yet to come through. In India, rice is cultivated in 44 million ha, with an annual production of about 131.27 million tonnes (FAO, 2011). In Tamil Nadu, rice is grown in an area of 2.07 million ha with the production of 7.15 million tonnes (2011-12). At accelerating current growth rate of 1.8 per cent of population in India, if rice requirement is to cope up with population. Rice is a silicicolus plant that absorbs Si in the form of mono silicic acid (H_4SiO_4) through active aerobic respiration and accumulates large amount that is several fold greater than those of other macronutrients from the growing medium. The yield level of rice has to be triggered by 25 to 30 per cent from the present level of 1.9 tonnes per ha if the country is to remain self-sufficient by 2020. 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 additions of silicate solubilizing bacteria and FYM with graded levels of fly ash on the availability of Si under submerged conditions are not yet studied in detail. Hence field experiment conducted in low, medium and high Si soils and observations made on leaf erectness at tillering stage which was known to be important parameter for yield improvement.

MATERIALS AND METHODS

Mean leaf openness was measured at tillering stage. Immediately after severing, the main tiller from the hill is placed against a vertical board on which a paper of suitable size will be secured at its four corners. The culm itself acts as the vertical axis with the leaves dropping normally from the axis, the position of the tip and collar of each leaf is marked on the paper. A line is drawn between the two points and the angle between this line and the vertical axis measured with a protractor. Mean leaf openness is the mean values of all leaves except the top one on the main culm.

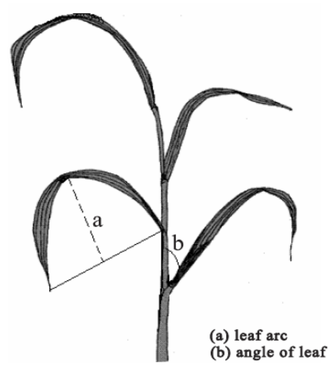

Figure-1: Diagram illustrating the definition of leaf arc (Zanao Junior *et al.* 2010)

RESULTS

In low Si soil the leaf openness varied greatly due to application of graded levels of fly ash with and without SSB and FYM. Among the treatments, application of SSB and FYM recorded the lowest leaf openness of 17.8 followed by FYM (18.4) and SSB (19.3) whereas; control recorded the highest leaf openness of 20.0. Among the graded levels of fly ash, application of fly ash @ 100 t ha^{-1}(17.7) was on par with 75 t ha^{-1} in loamy sand soil. In interaction application of 100 t ha^{-1} fly ash with SSB and FYM registered the lowest value (16.7) which was on par with application of 50 t ha^{-1} fly ash +SSB and FYM. This parameter was negatively and significantly correlated with Si content (r = -0.83) and uptake (r = -0.92) in rice plant at tillering. Similarly, significant and negative correlation (r= -0.70) was observed with grain yield in loamy sand soil with low Si status (Table-1).

Table-1: Effect of Graded Levels of Fly Ash in conjunction with SSB and FYM on mean Leaf Erectness of Rice in Low, Medium and High Si soils

Main Treatments/Factor	Loamy sand with low Si status						Sandy loam with medium Si status						Sily clay loam with high Si status					
	Levels of fly ash (t ha^{-1})						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	0	25	50	75	100	Mean
Control	22.4	20.1	19.8	19.2	18.7	**20.0**	16.9	15.6	15.8	16.4	16.6	**16.2**	24.2	21.2	18.9	18.4	17.3	**20.0**
SSB	21.5	19.5	18.8	18.4	18.4	**19.3**	16.3	14.7	14.9	15.7	16.08	**15.5**	20.4	16.0	15.3	15.6	14.6	**16.4**
FYM	21.1	18.6	18.1	17.1	17.1	**18.4**	15.2	13.7	14.4	14.7	14.9	**14.5**	22.2	17.0	16.7	15.7	15.5	**17.4**
SSB + FYM	20.6	17.8	17.0	17.0	16.7	**17.8**	14.7	13.06	13.65	14.04	14.33	**13.9**	19.0	15.7	14.1	13.2	12.7	**14.9**
Mean	**21.4**	**19.1**	**18.4**	**17.9**	**17.7**		**15.7**	**14.2**	**14.6**	**15.2**	**15.4**		**21.4**	**17.5**	**16.2**	**15.7**	**15.0**	
	SE d			CD (P=0.05)			SE d		CD (P=0.05)				SE d			CD (P=0.05)		
Factor (F)	0.1			0.3			0.04		0.1				1.0			3.1		
Level (L)	0.1			0.2			0.02		0.03				0.6			1.3		
F at L	0.2			0.5			0.04		0.1				1.4			NS		
L at F	0.2			0.4			0.02		0.05				1.2			NS		

Among the treatments, application of SSB and FYM recorded the lowest leaf openness of 13.9 followed by FYM (14.5) and SSB (15.5) whereas; the control recorded the highest leaf openness of 16.62 in medium Si soil. Among the graded levels of fly ash application of 25 t ha $^{-1}$ of fly ash registered lower leaf openness of 14.2 in sandy loam soil. In interaction application of 25 t ha^{-1} fly ash with SSB and FYM the lowest value (13.06). This parameter was best correlated with grain yield (r=-0.94 and negatively, significantly correlated with Si content (r =-0.55) and uptake (r=-0.82) in plant at tillering in sandy loam soil with medium Si status. In Si rich silty clay loam soil application of graded levels of fly ash and different treatments individually revealed consistent variation in mean leaf openness. Among the different treatments, application of SSB + FYM recorded the lowest leaf openness of 14.9 which was on par with SSB (16.4) followed by FYM (17.4) whereas control recorded the highest leaf openness of 20.0.

Among the graded levels of fly ash application 100 t ha $^{-1}$ of revealed the lowest value of leaf openness (12.7) which was on par with application of 50 and 75 t ha^{-1} fly ash. The interaction between different main treatments and graded levels of fly ash has not rendered significant change in leaf openness under high soil Si status.

DISCUSSION

In the tropics, rice growth tends to become excessive and mutual shading among the population is often cause low grain yield. Under such environmental condition, leaf openness may consume greater importance than it does under temperate conditions. The decreased leaf openness is a desirable character for high photosynthetic activity, which was observed in the different sources of Si application. Among the different main plot treatments, application of SSB + FYM recorded the lowest leaf openness followed by FYM and SSB. The results were corroborated with the findings of Balasubramaniam (2003) and Chandramani (2009). The formation of opal phytoliths in rows above leaf veins and margins as trichomes, lumens and increase in lignin and hemicellulose content of cell walls might be a reason for erectness in leaves (Miller, 1960, Yoshida *et al*., 1969, Sangster and Hodson, 1986, Ando *et al.*, 2002, Jonathan and Pitchay, 2005). Application of fly ash @ 25 t ha $^{-1}$ registered lower leaf openness in sandy loam and loamy sand soils due to low to medium Si status. Response of leaf openness to fly ash application in silty clay loam soil was limited due to higher inherent soil Si status. Similar results were noticed by Camarago and Korndorfer (2001). In interaction narrow leaf erectness was noticed on application of fly ash @ 25 t ha^{-1} with SSB + FYM which might be due to higher release of silicic acid to soil solution and increased plant uptake.

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