Pak. j. sci. ind. res. Ser. B: biol. sci. 2011 **54** (2) 111-113

Short Communication

Response of Rice to Zn Application Under Salt Affected Soil in Hafizabad District, Pakistan

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(Received August 10, 2010; revised October 8, 2010; accepted October 10, 2010)

Abstract. The effect of different levels of Zn (0, 5, 10 and 15 kg/ha) was evaluated on growth and ionic concentration of rice variety (cv. CM.204) directly sown on raised bed under saline-sodic soil. Tillering, number of grains/spike, 1000 grain weight and paddy yield significantly (p = 0.05) increased with the increase in the rate of Zn application. Paddy yield was the maximum at the application of 15 kg Zn/ha, being 29% more than the control treatment. The maximum number of tillers/hill (62), number of grains/spike (121) and 1000 grain weight (26.40 g) were recorded with Zn application @ 15 kg/ha. The maximum paddy yield (7906 kg/ha) was attained @ 15 kg Zn/ha. The maximum Zn (45 ppm) in grain was determined from treatment receiving 15 kg Zn/ha followed by 10 kg Zn/ha (38 ppm).

Keywords: rice response, Zn application, saline-sodic soil

Zn deficiency is found to be a widespread phenomenon in lowland rice areas of Asia, and next to nitrogen (N) and phosphorus (P) deficiency (Quijano-Guerta *et al.,* 2002; Neue and Lantin, 1994). Zn deficiency may be alleviated by adding Zn compounds to the soil or plant, but due to high cost of Zn fertilizers, it places sizable burden on poor farmers. It is therefore advisable that breeding efforts should be intensified to improve the tolerance to Zn deficiency in rice cultivars (Singh *et al.,* 2003; Quijano-Guerta *et al.,* 2002). Zn deficiency has been linked with a wide range of soil conditions: high pH (>7.0), low available Zn content, prolonged submergence and low redox potential, high organic matter and bicarbonate content, high magnesium to calcium ratio, and high available phosphorus (Neue and Lantin, 1994). High soil pH seems to be the major factor that leads to Zn deficiency in the calcareous soils of the Indo-Gangetic plains of India and Pakistan (Qadar, 2002), whereas perennial wetness is the major cause for Zn deficiency in peat soils and in coastal saline soils (Quijano-Guerta *et al.,* 2002; Neue and Lantin, 1994).

Soils in Pakistan are predominantly calcareous and alkaline in nature with high soil pH and ECe values. Low availability of zinc is due to the high pH value and calcium concentration in most saline soils especially in case of rice where reducing conditions exist. In saline sodic soils, the dominance of exchange sites by sodium ions causes Zn ions to be lost by leaching especially under irrigation with water having high Na contents. These conditions are highly conducive for zinc deficiency in rice. However, when wheat is grown after rice, soil zinc availability increases under upland crop condition due to oxidation of zinc compounds. Therefore, application of zinc fertilizer needs to be studied using cropping system approach.

The present work was undertaken to study the response of rice to Zn on raised bed cropping system in saline-sodic soil and to enhance the rice yield in saline-sodic soil.

A field experiment was carried out to investigate the effect of Zn application (5, 10 and 15 kg Zn/ha) on growth and ionic concentration of rice variety (cv. CM-204) sown on raised beds as direct seeding on salt-affected soil (Table 1) at a farm in Farooqabad, Sheikhupura District, Pakistan during Kharif season, 2007. Treatments were applied randomly using randomized complete block design (RCBD) with three replications. The treatments planned for this study were as follows: control, Zn @ 5 kg/ha, @ 10 kg/ha and @ 15 kg/ha. Half dose of N and full dose of P and K @ 100, 80 and 50 kg/ha, respectively, were applied to all treatments at sowing. The remaining half dose of N was applied at the tillering stage. The crop was irrigated with tubewell water (Table 1) throughout the growth period. Necessary plant protection measures were undertaken whenever required. The crop was harvested

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Table 1. Physico-chemical analysis of the soil and water

Parameters	Unit	Water value	Soil value
pH (1:1)	-	8.0	8.7
ECe (1:1)	dSm^{-1}	2.5	5.5
SAR	$(m.mole\ L^{-1})^{1/2}$	-	17.38
RSC	$m.mole\ L^{-1}$	13.6	7
OM	%	-	1.33
Na	$mg\ kg^{-1}$	305.4	539
K	$mg\ kg^{-1}$	19.9	31.6
Ca	$mg\ kg^{-1}$	20.6	88
Mg	$mg\ kg^{-1}$	6.3	7.2
Sand	%	-	33
Silt	%	-	42
Clay	%	-	25
Texture Class			Loam

at maturity and data on tillering, plant height, spike length, number of grains/spike, 1000-grain weight, straw and paddy yields were recorded at the time of harvesting. Plant samples were dried in oven at 60 ºC to a constant weight and the dry matter yield was recorded. Ground plant samples were digested in perchloric-nitric diacid (2:1 1N) mixture (Rhoades, 1982) to estimate Na, K, Ca, Mg and Zn concentrations in grain and straw using atomic absorption spectroscopy. The data was analysed by MSTATC statistical package.

Different doses of Zn application to rice showed statistically non significant effect on plant height, spike length and straw yield applying direct sowing technology on raised beds (Table 2). Tillering, number of grains, 1000-grain weight and paddy yield increased significantly with the increase in the rate of Zn application and was maximum on application of 15 kg/Zn ha; paddy yield was about 29% more than that of the control. These results agree with the findings of Khan *et al.,* 2003. Maximum number of tillers (62), number of grains per spike (121) and 1000-grain weight (26.40 g) was recorded for Zn application @ 15 kg/ha (Table 2). The positive response of rice to Zn application at higher rate might be due to Zn deficiency in the soils due to specific micro climate (Saif and Rana, 1980; Kausar *et al.,* 1979). Further, Zn is involved in the N metabolism of the plant and its deficiency decreases the level of RNA and ribosome contents. This reduction in RNA synthesis leads to inhibition of protein formation which could be corrected with Zn application. Similar findings have also been reported by Verma and Neue (1984) and Yoshida *et al.* (1970).

Ionic concentrations of Ca, Mg, Na and K in straw and paddy were found to be statistically non-significant except Zn concentration in grains (Table 3). Maximum Zn concentrations in grains were obtained by the application of Zn @ 15 kg/ha followed by 10 kg/ha. This might be the result of the mild decrease in soil pH due to marked increase in the availability of Zn in soil and leaves (Khan *et al.,* 2004) which in turn significantly increased Zn concentration in rice grain and straw. Similar observations have also been reported by Takkar and Singh (1978).

Table 3. Effect of Zn application on grain and straw yields (kg/ha), Ca and Zn content in grains

Treatment	Grain yield	Straw yield	Ca (%)	Zn (ppm)
Control	6146 c	19224	0.04	30 d
5 kg Zn/ha	6720 b	19480	0.11	35 c
10 kg Zn/ha	7173 b	19960	0.24	38 b
15 kg Zn/ha	7906 a	21400	0.04	45 a
LSD(0.05)	528.9	NS	NS	-

Table 2. Effect of Zn application on plant height, number of tillers, spike length, number of grain per spike and 1000 grain weight of rice

Treatment	Plant height (cm)	No. of tillers	Spike length (cm)	Number of grain/spike	1000-grain weight (g)
Control	118	41.76 c	31.77	112 b	24.26 b
5 kg Zn/ha	120	43.52 c	32.66	115 ab	25.43 b
10 kg Zn/ha	122	52.40 b	35.99	119 a	26.70 a
15 kg Zn/ha	125	62.20 a	33.32	121 a	26.40 a
LSD(0.05)	NS	6.26	NS	6.41	0.84

Conclusion

It is deduced from the present study that application of different levels of Zn improves paddy yield significantly, Zn dressing is hence important under raised bed direct seeding technique in salt-affected soils, but the amount varies 10-15 kg Zn/ha^{-1} depending on the variety and the extent of soil salinity/sodicity.

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