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Influence of nitrogen on yield and uptake of nutrients by sorghum (*Sorghum bicolor*) in relation to soil salinity

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ABSTRACT

A greenhouse experiment was conducted at R.B.S. College Bichpuri, Agra (U.P.) to study the effect of varying salinity levels on sorghum (Sorghum bicolor) in relation to N fertilization. The treatments comprising four salinity levels (control, 4, 8 and 12dSm^{-1}) and four nitrogen levels (0, 40, 80 and 120 Kgha^{-1}) were evaluated in factorial randomized block design with three replications. As compared to normal condition, the magnitude of decrease in green foliage and dry matter yield was higher at higher salinity levels. A significant increase in green foliage and dry matter yield was recorded with EC 4 dSm^{-1}over control but minimum green foliage and dry matter yield was recorded at 12dSm^{-1}.However, application of nitrogen in soil resulted significant improvement in green foliage and dry matter yield as compared to control. The maximum value of green foliage and dry matter yield was recorded with 120 Kg Nha^{-1}over control. The interaction between soil salinity and nitrogen had a significant effect on green foliage and dry matter yield. The minimum and maximum values of green foliage and dry matter yield were recorded under 12 dSm^{-1} + no nitrogen and 4 dSm^{-1} + 120 Kg Nha^{-1}treatments, respectively. Nitrogen uptake by sorghum was recorded maximum at 4dSm^{-1} salinity level, but higher levels of salinity decreased N uptake. Sodium uptake increased significantly at higher salinity levels over control. But P, K, Ca and Zn uptake by sorghum decreased significantly as compared to control. Nitrogen application under all salinity levels had a positive effect on uptake of nutrients by sorghum.

Keywords: Nitrogen, salinity, sorghum, nutrient uptake, yield

INTRODUCTION

Sorghum is grown as both grain and fodder crop in all the zones of country. Use of sorghum is very popular. In Utter Pradesh sorghum is grown for fodder purpose due to its nutritive green roughage used by cattle. It is luxurious vegetative growth favours its production as fodder crop. Fodder sorghum is used in various forms of cattle feed like silage crop, soiling crop, and green roughage depending upon its availability. Sorghum may tolerate mild acidity to mild salinity of soil under pH 5.5 to 8. Saline soils are characterized by presence of excessive quantity of natural soluble salts in the root zone to interfere with plant growth and productivity. The maintenance of optimum level of soil fertility is essential for successful crop production in saline soil as problem is more nutritional nature. This can be said more for nitrogen and for phosphorus to some extent. Nitrogen has specific vital role in growth, development, quality and quantity of crop. This nutrient plays an important role in biosynthesis of amino acids, nucleic acid and proteins. Applications of fertilizers at moderate level of salinity with in tolerance limit ofthe crop in question are reported to improve crop growth. Significant response to application of nitrogen has been reported by several workers (Kumar and Singh, 2019). Therefore, the present study was undertaken to evaluate the optimum dose of nitrogen and its interaction with soil salinity for sorghum crop.

METERIALS AND METHODS

A greenhouse experiment was conducted at R.B.S. College Bichpuri, Agra (U.P.) using sorghum as test crop. The four levels each of salinity (Control, 4, 8 and 12dSm^{-1}) and nitrogen (0, 40, 80 and 120 Kg ha^{-1}) were evaluated in factorial randomized design with three replications. The salinity levels were created artificially by adding the calculated amount of $CaCl_2$, $MgSO_4$, $MgCl_2$ and NaCl into the soil. After mixing the soil lots of different EC thoroughly 10 kg soil were filled in pots. The required earthen pots of similar size and shape for experiment were selected, cleaned and lined with polythene sheet. At approximate moisture level, the soil of each pot was pulverized and

seeded with 10 seed of sorghum. The recommended dose of P_2O_5 and K_2Owere applied through single superphosphate and muriate of potash, respectively. The plants were thinned to five when they attained 5-7 cm height. The crop was irrigated as and when needed. The crop was harvested after 60 days of sowing and green foliage and dry matter yield was recorded. These samples were wet digested with nitric and per-chloric acid. Phosphorus, K, Na were determined in the acid extract by molybdateVanadate yellow color method and flame photometer, respectively. Calcium and magnesium were determined as per method of Jackson (1973).Zinc content in the acid extract was determined on atomic absorption spectrophotometer. The uptake of various nutrients by plants was worked out by multiplying their content values with corresponding yield data.

RESULTS AND DISCUSSION

Results revealed that the green foliage yield of sorghum decreased significantly at higher levels of soil salinity. However, a significant increase in green foliage yield was recorded with EC 4 dSm^{-1} over control. The minimum yield was recorded at higher EC level of 12 dSm^{-1}. The harmful effect of higher salinity levels on sorghum production is due to osmotic effect which lowers the osmotic potentials of the medium, a possibility under salt stress environment (Kumar *etal.* 2018). Green foliage yield of sorghum increased significantly with nitrogen application as compared to control. The increase in green foliage with 40, 80 and 120 Kg N ha^{-1} were 12.4, 29.4 and 49.3 per cent over control respectively. The maximum green foliage yield was obtained with 120Kg N ha^{-1}. Positive effects of N application have also been reported by Singh *et al.*(2015). The interaction effect of salinity and nitrogen on green foliage yield was significant. Green foliage yield increased with N application at all salinity levels, but it tended to reduce the yield with increasing salinity levels in presence and absence of nitrogen. The minimum green foliage yield was recorded under 12 dSm^{-1} + no nitrogen treatment (Table-1). Almost similar trend was observed with respect to dry matter yield of sorghum. Dry matter yield increased significantly with4 dSm^{-1} and there was a reduction in yield at higher levels of salinity. Similar results were also reported by Kumar *et al*(2018). Similarly, with respect to N, the mean dry matter yield with all the levels of N improved significantly over control. The increase in dry matter yield with 40, 80 and 120 kg N ha^{-1} over control were 11.5, 31.0 and 47.5 per cent, respectively. This result supports the finding of Golada *etal.* (2017). The interaction effect of soil salinity and nitrogen improved the dry matter yield at lower salinity levels (4 dSm^{-1}) under all N levels ,but a significant reduction was observed with respect the dry matter yield of sorghum at higher levels of salinity over control. The maximum dry matter yield was obtained with 120 Kg N ha^{-1} + 4 dSm^{-1}. Dry matter yield of sorghum increased with N application at all salinity levels.

Table 1: Effect of salinity and nitrogen levels on green foliage and dry matter yield of sorghum

Salinity levels (dSm^{-1})	Nitrogen (Kg ha^{-1})				Mean
	0	40	80	120	
			Green foliage yield(g/pot)		
0	400.0	450.0	510.0	600.0	490.0
4	405.0	460.0	518.0	612.0	498.7
8	360.0	410.0	490.0	540.0	450.0
12	250.0	270.0	310.0	360.0	297.5
Mean	353.7	397.5	457.0	528.0	
C.D.(P=0.05)	N, 3.48	S, 3.48	N x S 6.97		Dry matter yield (g/pot)
0	82.0	91.0	106.0	120.0	99.7
4	83.0	92.0	109.0	123.0	101.7
8	70.0	80.0	96.0	107.0	88.2
12	51.0	56.0	64.0	72.0	60.7
Mean	71.5	79.7	93.7	105.5	
C.D.(P=0.05)	N, 1.66	S, 1.66	N x S 3.32		

NUTRIENT UPTAKE

Nitrogen: Data (Table 2) revealed that the lower level of salinity (4dSm^{-1}) enhanced significantly the uptake of nitrogen by sorghum crop, but higher levels of salinity (8 and 12 dSm^{-1}) decreased the uptake of nitrogen by crop in comparison to control. The reduction in nitrogen uptake by sorghum at higher salinity level of 12 dSm^{-1} over control was 36.2%. These findings are in agreement with those of Kumar *et al.* (2018). The value of nitrogen uptake by sorghum increased significantly with every increase in the levels of nitrogen supply over control. A consistent increase in N uptake was recorded up to 120Kg N ha^{-1} Kumar and Singh (2019) also reported higher N uptake with its application.

Table 2: Effect of salinity and nitrogen levels on uptake of N, P, K, Ca, Mg, Na (g/pot) and Zn (mg/pot) by sorghum

Treatments	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Sodium	Zinc
Salinity (dSm^{-1})							
Control	1.85	0.48	2.16	0.31	0.23	0.72	3.22
4	2.03	0.47	2.16	0.37	0.22	0.83	2.95
8	1.70	0.39	1.80	0.27	0.16	0.92	2.19
12	1.18	0.26	1.23	0.16	0.10	0.81	1.36
C.D. (P=0.05)	0.64	0.03	0.13	0.04	0.02	0.06	0.26
Nitrogen (Kgha^{-1})							
0	1.18	0.30	1.43	0.20	0.12	0.61	1.53
40	1.43	0.35	1.65	0.26	0.15	0.72	1.99
80	1.83	0.43	2.00	0.32	0.19	0.90	2.68
120	2.41	0.50	2.28	0.39	0.25	1.06	3.43
C.D. (P=0.05)	0.64	0.03	0.13	0.04	0.02	0.06	0.26

Phosphorus: Salinity levels significantly reduced the phosphorus uptake by sorghum plats in comparison to control. A drastic reduction in P uptake was noted at higher EC level of 12dSm^{-1}. These findings are in accordance with those of Kumar *et al.* (2018). Nitrogen application tended to increase the phosphorus uptake by sorghum. All the levels of nitrogen were found to be significantly superior over control in respect of P uptake by crop, but maximum P uptake by crop was recorded under 120 Kg N ha^{-1}. These results are similar with the findings of Singh *et al.* (2017).

Potassium: The data indicate that the potassium uptake by crop decreased significantly with increasing levels of soil salinity. The potassium uptake by sorghum reduced from 2.16 to 1.23 g/pot with higher EC levelof 12 dSm^{-1} as compared to control. These findings are in accordance with those of Kumar *et al.*(2018). The N application brought about significant increase in the uptake of potassium by sorghum over control. All the levels of nitrogen were found to be significantly superior in respect of K uptake by plants. These findings are in accordance with those of Golada *et al.* (2017).

Calcium and Magnesium: The higher salinity kevels reduced significantly the Ca uptake over control. A drastic reduction in Ca uptake was noted at EC levels of 12 dSm^{-1}. These results find support from the finding of Kumar *et al.*(2018). The application of nitrogen tended to increase the Ca uptake by sorghum. All the levels of N were found to be significantly superior over control. The highest value of Ca uptake was recorded at 120 Kg N ha^{-1} level. Similar results were found by Kumar and Singh (2019). Higher salinity levels reduced significantly the Mg uptake by sorghum plant over control and minimum value of Mg uptake by plants was recorded at higher soil salinity level (12 dSm^{-1}). Similar results were reported by Kumar *et al.*(2018). Nitrogen application influenced the uptake of Mg by sorghum. The uptake of Mg at 40 , 80 and 120 Kg N ha^{-1} was significantly greater than control. Similar results were found by Kumar and Singh (2019).

Sodium: The data (Table 2) further suggested that the sodium uptake by sorghum plant increased from 0.72 to 0.92 g/pot with EC level of 8 dSm^{-1} and at higher EC levels (12 dSm^{-1})

Its uptake decreased over lower EC levels. These findings are similar to Kumar *et al.*(2018). The nitrogen application had significant increase in uptake of Na by sorghum crop and all the levels of N were found to be significantly superior over control. Similar results were reported by Kumar *et al.* (2018).

Zinc: Increasing salinity level significantly reduced the Zn uptake by sorghum plant and all the salinity levels proved significantly detrimental over control. The drastic reduction in Zn uptake was noted at EC level of 12 dSm^{-1}. These findings are accordance with Kumar *et al.*(2018). Nitrogen fertilization had pronounced andsignificant changes in Zn uptake and the maximum uptake of Zn by sorghum was recorded with 120 Kg N ha^{-1}. All the levels of nitrogen were found to be significantly superior over control in respect of Zn uptake. Similar findings were reported by Singh *et al.* (2017)

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