Annals of Plant and Soil Research 21(4): 371-375 (2019)

Relative salt tolerance of lemon grass cultivars

SANDEEP SINGH* AND VINAY SINGH

Department of Agricultural Chemistry and Soil Science, Raja Balwant Singh College, Bichpuri, Agra (U.P.) -283105

Received: July, 2019; Revised accepted: September, 2019

ABSTRACT

A green house experiment was conducted to study the permissible limit of soil salinity for lemon grass cultivars in relation to yield, quality and utilization of nutrients. The treatments namely two cultivars (Pragati and Kavery) and five levels of soil salinity (Control, 4, 8, 12 and 16 dSm^{-1}) were evaluated in factorial randomized block design with three replications. The results revealed that the herb and dry matter yields of lemon grass cultivars decreased with the levels of soil salinity. Between both the genotypes, Pragati gave relatively higher yields of herbs and dry matter. The oil content and citral content in lemon grass oil decreased with increased salinity levels. The oil percentage in Kaveri plants was higher than that of Pragati cultivar. The uptake of N, P, K, Ca, Mg and Zn decreased with increasing levels of soil salinity. On the other hand, sodium uptake increased with soil salinity levels. In general, Pragati cultivar utilized relatively higher amounts of nutrients than Kaveri. The soil properties and available N, P and K content in post harvest soil were markedly affected by soil salinity levels.

Keywords: Lemon grass cultivars, soil salinity, quality, nutrients uptake, yield

INTRODUCTION

Saline soils are characterized by the presence of excessive quantities of neutral soluble salts in root zone to interfere with plant growth. These soils occur in regions of arid and semi arid climate. Most of the adverse effects of the salts are related to the decreased osmotic potential of the stressed root media. Lemon grass is the chief source of citral which finds innumerable use in perfumery and medicine. The oil is extensively used for scenting soaps detergents and an array of the other products. Plant species vary greatly in the amounts of sodium that they may accumulate and mary species tend to exclude sodium from their leaves, although they may accumulate it in their stems or roots. The effect of high concentration of Na ions in solution varies with the species. Some are more tolerant while others are sensitive. High concentrations of sodium in solution are more toxic to plants than osmotic concentration to affect the quality of produce adversely. The effect of salinity on the growth and yield of lemon grass cultivars has not been studied. The present study was carried out to study the permissible limit of soil salinity for lemon grass cultivars in Agra region.

MATERIALS AND METHODS

A greenhouse experiment was conducted at R.B.S. College Bichpuri, Agra (U.P.) using lemon grass as test crop. The soil used in green house experiment had pH 7.9, EC 0.24 dSm^{-1}, organic carbon 3.2 g kg^{-1}, available N 65 mg kg^{-1}, P 4.4 mg kg^{-1} and K 75 mg kg^{-1}. The five levels of salinity (Control, 4, 8, 12 and 16 dSm^{-1}) and two cultivars (Pragati and Kaveri) were evaluated in factorial randomized design with three replications. The salinity levels were created artificially by adding the calculated amounts 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, three slips of lemon grass were planted in each pot of lemon grass. The recommended dose of N, P_2O_5 and K_2O were applied through urea single superphosphate and muriate of potash, respectively.. The crop was irrigated as and when needed. The crop was harvested after 60 days of sowing and herb and dry matter yield was recorded. These samples were wet digested with nitric and perchloric acid. Phosphorus, K, Na were determined in the acid extract by molybdate vanadate yellow color method and flame photometer. 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.

K.V.K. R.B.S. College Agra (U.P.)

Yield studies

Herb yield:

The herb yield of both cultivars decreased significantly with higher levels of soil salinity (Table 1). However, non-significant decreases in herb yield of lemongrass cultivars were recorded at salinity, level of 4 dSm^{-1} over control. The significant reduction in herb yield was observed under EC level of 16 dSm^{-1}. The magnitude of reduction with 16 dSm^{-1} level was 14.4 per cent over control. The higher EC levels (12 and 16 dSm^{-1}) also differed significantly with each other in respect of herb yield of lemongrass cultivars. The reduction in yield of lemon grass due to high salinity of soil may be due to accumulation of excess salts in root zone which inhibits plant growth by decreasing osmotic potential of the soil solution. The decrease in yield under high salinity may again be attributed to decreased physiological availability of water in plants.

Table 1: Effect of soil salinity on yield oil and total citrus content in oil of lemon grass cultivars

Treatment	Yield (g/pot)		Oil content (%)	Citral content (%)
	Herb	Dry matter		
Soil salinity (dSm^{-1})				
Control	130.20	49.46	0.83	90.45
4	129.41	48.81	0.81	90.20
8	119.68	45.57	0.79	90.90
12	114.78	43.42	0.75	89.90
16	110.99	42.04	0.73	85.85
SEm±	1.02	0.68	0.041	85.85
CD (P = 0.05)	12.15	1.42	0.086	3.30
Varieties				
Pragati	123.34	46.11	0.77	89.20
Kaveri	120.73	45.57	0.79	89.70
SEm±	0.89	0.59	0.036	2.88
CD (P = 0.05)	1.79	NS	NS	NS

The adverse effect of salinity on metabolic and enzymatic activity of the plants leads to decreased growth and finally yield. The findings of the present study are similar to the work of Prasad *et al.* (2010) and Singh and Singh (2019) who observed decreased yields with an increase in soil salinity. The cultivar Pragati produced higher quantity of herb and it was significantly superior to Kaveri. The more herb yield of Pragati cultivar may be due to its genetic nature and relatively more tolerance to soil salinity. Varietal variation was also reported by Singh *et al.* (2019).

Dry matter yield:

Increasing levels of soil salinity decreased the dry matter yield of both cultivars over control (Table 1). The dry matter yield of Pragati cultivar of lemongrass decreased from 49.47 to 42.52 g/pot Similarly, dry matter yield of Kaveri decreased from 49.45 to 41.57 g/pot with 16 dSm^{-1} treatment. Kumar (2019) also reported similar results. The dry matter yield of cultivar Pragati was relatively higher than Kaveri. However, the difference in dry matter production was statistically non-significant.

Oil content:

It is evident from the data (Table 1) that the increasing levels of soil salinity tended to decrease the oil percentage in lemongrass plants significantly over control. The oil content decreased from 0.82to 0.72 per cent of Pragati cultivar of lemongrass. The corresponding reductions in oil content of Kaveri cultivar were from 0.84 to 0.75 per cent. The percentage of oil was slightly lower in Pragati cultivar than that of Kaveri Singh and Singh (2019) also reported that the salinity stress caused a decline in the primary metabolite causing intermediary products to become available for secondary metabolite synthesis.

Citral content:

The oil content in Kaveri cultivar had relatively higher total citral content as compared to Pragati. The total citral content in lemongrass oil was not markedly influenced by soil salinity levels. However, lower amounts of total citral content in oil in both cultivars were recorded under 16 dSm^{-1} soil salinity levels. Singh *et al.* (2019).

Table 2: Effect of soil salinity on uptake of nutrients (mg/pot) by lemon grass cultivars

Treatment	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Sodium	Zinc
Soil salinity (dSm^{-1})							
Control	383.2	59.3	605.8	242.2	318.9	160.7	2.84
4	373.4	56.0	588.2	229.7	292.9	231.8	2.72
8	329.6	48.0	507.0	202.0	247.8	245.6	2.43
12	306.0	41.2	423.3	170.7	210.5	267.0	2.18
16	286.0	36.0	344.8	136.1	168.1	285.9	1.96
SEm±	2.47	1.23	2.77	13.3	2.84	4.74	0.27
CD (P = 0.05)	5.19	2.58	5.82	2.80	5.97	9.95	0.56
Varieties							
Pragati	393.4	38.3	498.2	196.2	251.3	240.9	2.44
Kaveri	331.0	33.2	489.4	189.4	244.0	232.6	2.40
SEm±	2.15	1.07	2.41	1.16	2.47	4.12	0.23
CD (P = 0.05)	4.52	2.24	5.06	2.44	5.19	8.66	NS

Uptake of nutrients by plants

Nitrogen:

The levels of soil salinity affected the uptake of nitrogen by the crop significantly, but the higher levels of salinity had more adverse effect on the uptake of N by the crop in comparison to lower EC levels and control (Table 2). The minimum average values of nitrogen uptake by the both cultivars of lemon grass were recorded at EC level of 16 dSm^{-1}. The extent of reduction in nitrogen uptake by the crop was higher due to 16 dSm^{-1} salinity level as compared to 12 dSm^{-1} salinity level. (Kumar 2019). As regards the varietal effect, relatively higher uptake of nitrogen was observed in Pragati cultivar of lemon grass.

Phosphorus:

There was a significant reduction in P uptake by the plants of both cultivars with increasing salinity levels (Table 2). The minimum values of P uptake by lemon grass cultivars were recorded under EC level of 16 dSm^{-1}. The higher salinity had more adverse effect on the uptake of P by plants than those of lower salinity levels. The reduction in P uptake with soil salinity level may be ascribed to lower dry matter production. (Singh *et al.* 2019). The higher P uptake was recorded in case of Pragati cultivar plants than Kaveri plants.

Potassium

The potassium uptake decreased significantly with an increase in soil salinity levels over control (Table 2). The EC levels of 12 and 16 dSm^{-1} decreased the uptake of potassium significantly over control The minimum K uptake values were recorded under EC level of 16 dSm^{-1}. The reduction in K uptake may be due to an increase in sodium concentration in the soil solution. Similar results were also reported by Singh and Singh (2019). Between the cultivars, the higher values of K uptake were recorded in Pragati cultivar of lemon grass.

Calcium:

A significant reduction in calcium uptake by the lemon grass cultivars was observed with an increase in salinity levels over control (Table 2). The minimum value of calcium uptake by the crop was recorded at 16 dSm^{-1} soil salinity level. Thus, the higher levels of soil salinity had more adverse effect on the uptake of calcium by the cultivars than that of lower level. This decrease in Ca uptake may be ascribed to reduction in dry matter yield as well as calcium content in lemongrass plants. Significantly higher uptake of calcium was noted in Pragati cultivar of lemon grass.

Magnesium:

A study of (Table 2) reveals that the uptake of Mg decreased significantly with increasing levels of soil salinity over control. This may be due to reduction in dry matter yield as well as Mg content in plants at higher salinity levels. Prasad *et al.* (1997) also observed reduction in Mg uptake with increasing soil salinity levels. The higher uptake of Mg by plants was recorded in case of Pragati cultivar.

Sodium:

The uptake of sodium by plants increased significantly with increasing levels of soil salinity. In general, the uptake of sodium increased up to EC level of 16 dSm^{-1}. Prasad *et al.* (1997) also reported an increase in sodium uptake by plants with increasing soil salinity levels. The uptake of sodium was higher in plants of Pragati as compared to another cultivar.

Zinc:

A study of (Table 2) reveals a significant reduction in zinc uptake by lemon grass plants due to increasing soil salinity levels over control. The Zn uptake by Pragati cultivar reduced from 2.85 to 1.98 mg/pot with 16 dSm^{-1} soil salinity. The corresponding decrease in Zn uptake by plants of Kaveri cultivars was from 2.82 to 1.94 mg/pot. This reduction in zinc uptake may be attributed to lower dry matter production at higher salinity levels. Between the two cultivars of lemon grass, higher zinc uptake was recorded in plants of Pragati cultivar (Singh and Singh 2019).

Effect of salinity on soil properties

A study of the data (Table 3) reveals that the increasing salinity levels increased the EC of saturation extract of the soil and accumulation of soluble salts in soil was linear with salinity levels. The concentration of soluble salts in saturation extract of the soil under 16 dSm^{-1} salinity level was more than 4 times than that of soil having no salt (control). The lower levels of salinity also had a marked effect on EC of saturation extract. On an average, the accumulation of salts was slightly higher in soil growing Kaveri cultivar as compared to Pragati cultivar. However, no marked variation was noted in the accumulation of salts due to varieties of lemongrass.The values of soil pH were slightly increased with increasing salinity levels. The increase in soil pH with 16 dSm^{-1} EC level was only 0.4. The lower salinity level did not markedly affect the soil pH over control. The increase in pH is owing to an increase in sodium saturation of the soil and the increase in sodium of the soil is obvious because of the addition of sodium salts in adjusting in different EC levels of soil. The varieties of lemon grass did not affect the soil pH under different levels of soil salinity.

Table 3: Average EC se, pH, SAR se and available N, P and K under pot culture experiment (lemongrass)

Treatments	EC se dSm^{-1}	pH	SAR se	Available nutrient (kg ha^{-1})		
				N	P	K
Salinity levels (dSm^{-1})						
0	2.7	8.3	8.25	152.2	8.9	147.0
4	6.5	8.4	10.60	156.1	7.1	150.1
8	10.6	8.5	11.81	155.3	6.0	153.4
12	11.0	8.6	12.95	167.1	4.9	158.1
16	11.5	8.7	13.81	158.4	4.0	149.9
Varieties						
Pragati	8.5	8.6	11.20	157.6	6.0	151.0
Kaveri	8.6	8.5	11.74	157.9	6.3	152.5

The SAR of the soils markedly increased with increase in salinity levels up to 16 dSm^{-1} (Table 3). The SAR of soils with 4, 8, 12 and 16 dSm^{-1} salinity levels was 1.28, 1.43, 1.57 and

1.67 times than that of control, respectively. The cultivars of lemongrass did not affect the SAR under different levels of salinity. However, the higher value of SAR was recorded in Kaveri cultivar as compared to Pragati. The available nitrogen of post harvest soils markedly increased with increasing levels of soil salinity over control. The available N status of soils with 4, 8, 12 and 16 dSm^{-1} salinity levels was increased by 3.9, 3.1, 14.9 and 6.2 kg ha^{-1} over control, respectively. The differences in available N status of soils growing both cultivars of lemon grass were not marked. The values of available P decreased with increasing levels of soil salinity. The available P in soil with 4, 8, 12 and 16 dSm^{-1} salinity levels decreased by 1.8, 2.9, 4.0 and 4.9 kg ha^{-1} over control, respectively. The available P was slightly higher in soil growing Kaveri cultivars as compared to Pragati cultivar. The amount of available K in soils increased slightly with increasing levels of soil salinity (Table 4.13). However, no marked difference in available K was noted under different EC levels. Available K content in soils was not affected markedly with both cultivars of lemon grass.

REFERENCES

Jackson, M. L. (1973) Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi.

Kumar, A (2019) Influnce of nitrogen on yield and uptake of nutrients by sorghum (Sorghum Bicolor) in relation to soil salinity. *Annals of Plant and Soil Research***21**(2): 185-188.

Prasad, A., Chattopadhyay, A. and Sukhmal Chand (2010) Effect of zinc sulphate and farmyard manure on lemongrass (*Cymbopogon flexuous*) under sodic water irrigation. *Journal of the Indian Society Soil Science***58** (3): 315-322.

Prasad, A., Patra, D.D., Anwar, M. and Singh, D.V. (1997) Interactive effect of salinity and nitrogen on mineral N status in soil and growth and yield of german chamomile (*Matricaria chamomilla*). Journal of the Indian Society of Soil. Science **45**: 537-541.

Singh, S, and Singh, V. (2019) Response of lemon grass (*Cympopogon flexuosus*) to zinc application under saline condition. *Annals of Plant and Soil Research* **21** (3): 298-299.

Singh S., Kumar, A. and Singh, V. (Response of lemon grass (*Cymbopogon flexuosus*) to nitrogen under saline condition. *AnALS OF Plant and Soil Research* **21** (3): 217-220.