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Effect of Salinity Stress on Growth Performance of Lemongrass

Dheeraj Kumar[1] and Nishant Chauhan[2]

[1]*Department of Chemistry, K.R. (PG) College, Mathura*
[2]*Department of Chemistry, R.B.S. College, Agra*

***Abstract*: Salinity adversely reduces the overall productivity of plants. Out of 320 mha of total land in India about 8.5 mha is salt affected. Out of 15 agro climatic zones of India 8 are affected with salinity. Generally screening and cultivation of crops on the salt affected soil is the main approach of study. Lemongrass were planted in pots containing loamy soil with control 5.0, 10, 15 and 20 d S/m concentration of salts of chloride, sulphate, and bicarbonate (6:3:1) of sodium and calcium (4:1) to study their salinity tolerance. Various concentrations of salt had a significant effect upon the various growth characters. The findings suggest that the test species are tolerant to moderate salinity and might be tried on saline soil to obtain some biomass.**

Key Words: Salinity stress, Lemon Grass, loamy soil, and aromatic plant

I. INTRODUCTION

India is endowed with a rich wealth of medicinal plants. Extension of the allopathic system of medicinal treatment in India has generated a commercial demand for pharmacopoeial drugs and their products in the country.

The aromatic plants possess odoriferous and volatile substances in form of essential oils, gum exudates, balsam and oleo-resin in different parts like root, bark, wood, foliage and fruit. The chemical nature of these aromatic substances may be due to a variety of complex chemical compounds. Lemon grass (*Cymbopogon flexuosus* Steud.Wats) is an important perennial aromatic crop. The essential oil obtained from this crop is rich in citral contents and is used in perfumery, cosmetic and flavouring industries [1, 2]. It is estimated that 600 tonnes of oil of lemongrass are being produced annually both from cultivated and natural resources in India.

Soil salinity is a problem of global concern [3]. Some studies [4,5] estimated that terrestrial saline habitats constitute about 7% of the global land area i.e. centiare7 million km^2. Plant growth in saline soils is suppressed by nonspecific osmotic effects, toxic solutes and sodicity [6,7]. Most agricultural crops are sensitive to salinity [8,9]. Out of 320 mha of land in India, 8.5 mha is salt affected [10,11]. Out of 15 Agroclimatic zones of India 8 are affected with salinity. Most agricultural crops are sensitive to salinity. Salinity adversely reduces the overall productivity of plants including crops by inducing numerous abnormal morphological, physiological and biochemical changes that causes delayed germination, high seeding mortality, poor crop stand, stunted growth and lower yields [12-16]. These adverse effects of the salts are related to the decreased osmotic potential of the stressed root media but the extent of salt effect is altered by specific ions of the salt solution.

It appears that little information is available regarding the effect of salinity on the growth and productivity of aromatic plants [17, 18]. The present study is focussed to assess the tolerance of aromatic medicinal plants towards salinity at their vegetative growth. The findings may help in utilizing saline habitats for cultivation of aromatic medicinal plants which can serve as raw material for pharmacological companies and also for local medicinal uses.

II. MATERIAL AND METHODS

The soil for the experiment was collected from the upper layer (0-15 cm) of a cultivated field. The collected soil was air-dried, crushed and sieved through a 2 mm sieve and homogeneously mixed before subjecting to different treatments

A. Characterization of soil

The soil was subjected to physico-chemical analysis. The physico-chemical properties of the experimental soil are given in "Table1".

Table 1. Physico-Chemical properties of the experimental soil

S.No.	Characteristics	Value
1.	Sand (%)	64.5
2.	Silt (%)	15.8
3.	Clay (%)	19.7
4.	Textural Class	Sandy Loam
5.	pH(1:25soil water suspension)	8.0
6.	EC(dSm^{-1})	0.16
7.	Organic Carbon (g Kg^{-1})	3.2
8.	$CaCO_3$ (g Kg^{-1})	5.0
9.	Available N (mg Kg^{-1})	65.0
10.	Available P (mg Kg^{-1})	4.5
11.	Available K (mg Kg^{-1})	90.0

The results of mechanical analysis indicate that the soil used in greenhouse experiment was sandy loam in texture, alkaline in reaction, deficient in available Nitrogen, Phosphorous and moderate in Potassium [10, 11].

Experimental procedure: Response of the aromatic medicinal plants to different levels of salinity was evaluated under pot culture conditions. For this purpose, experiments were conducted with varying levels of salinity.

B. Crop tolerance to salinity

In order to assess the range of Salt/salinity status which can be tolerated by Lemongrass, studies were carried out in earthen pots each filled with 10 kg soil. The different salinity levels, i.e., control, 5,10,15 and 20 dSm^{-1} were created artificially in a normal sandy loam soil by adding salts of Chloride, Sulphate and Bicarbonate(6:3:1) of Sodium and Calcium(4:1). Different EC levels actually attained after equilibrium in the experiment were 0.7, 5.2, 10.1, 15.3 and 20.5dSm^{-1}. A polythene lining was provided inside the pots.

The basal doses of Nitrogen (N), Phosphorous (P_2O_5) and Potassium (K_2O) were applied in each pot at the rate of 75 mg/kg, 30 mg/kg and 30 mg/kg respectively through urea, single superphosphate and muriate of potash respectively at the time of sowing of each crop.

The slips of Lemongrass were planted in the pots. The pots were irrigated with deionised water for the establishment of seedling and further also when required. The various growth parameters viz. Plant height, herb yield and dry matter yield of leaves 17-21] were studied Plant samples were also collected at various growth stages.

III. RESULTS AND DISCUSSION

The results of the present study as obtained for the various growth parameters; yield, quality and uptake of nutrients for the plant are given below:

A. Relative salt tolerance of crops

1. Plant height

A slight increase in height of Lemongrass plants was recorded upto EC level of 10dSm^{-1} at all the cuttings. The plant attained only a nominal height at first cutting. Thereafter, there was a steady rise. The rate of increase in the plant height was quite slow after second cutting. A further study of "Table 2" clearly shows that the effect of soil salinity on plant height was significant at various stages of growth. The higher levels of soil salinity had an adverse effect on plant height of the crops.

Table 2. Effect of salinity levels on plant height (Cm) of Lemongrass at various cuttings of the crop

Crop cutting	Salinity Levels (dSm^{-1})						SEm±	CD at 5%
	Control	5	10	15	20	Mean		
I	91.0	92.8	93.7	82.0	73.0	86.5	1.72	5.27
II	80.0	80.5	81.6	70.6	61.1	74.8	1.41	4.35
III	87.0	87.7	88.5	75.1	66.3	80.9	1.12	3.56

2. Number of tillers per plant

The data on the number of tillers per plant at various cuttings are presented in "Table 3".

Table 3. Effect of salinity levels on number of tillers per plant of Lemongrass at various cuttings of the crop

Salinity Level (dSm^{-1})	Number of tillers per plant at various cuttings		
	I	II	III
Control	9.0	14.0	18.0
5	10.0	15.0	19.0
10	10.0	14.0	18.0
15	7.6	12.0	15.0
20	6.5	9.7	13.0
Mean	8.6	12.9	16.6
S Em ±	0.5	0.6	0.8
CD at 5%	1.7	2.0	2.5

It is clear from Table 3 that the number of tillers per plant of Lemongrass improved with decrease in soil salinity. However, this improvement was non-significant in crop. The higher level of salinity tended to decrease the number of tillers per plant and the extent of reduction in no. of tillers was more conspicuous at 20 dSm^{-1} salinity level. The extent of decrease in number of tillers in Lemongrass at 20 dSm^{-1} salinity level at first, second and third cuttings were 27.8, 30.7 and 27.7 percent respectively.

3. Herb Yield

The data on the effect of different soil salinity levels on herb yield of aromatic Lemongrass crop is summarised in "Table 4".

Table 4. Effect of salinity levels on herb yield at various cuttings of the crop

Crop cutting	Salinity Levels (dSm^{-1})						SEm ±	CD at 5%
	Control	5	10	15	20	Mean		
I	10.52	11.75	11.85	9.55	7.42	10.22	0.41	1.23
II	12.80	13.00	13.15	10.33	8.76	11.61	0.34	1.03
III	15.04	15.40	15.90	13.35	11.66	14.27	0.29	0.88

From the data, it can be inferred that herb yield of crops decreased significantly with higher level of soil salinity. The highest significant reduction in herb yield was observed under EC level of 20 dSm^{-1}. The magnitude of reduction with 20 dSm^{-1} was 29.5, 31.6 and 22.5 percent respectively in first, second and third cuttings of Lemongrass. The higher EC levels (15 and 20 dSm^{-1}) also differed significantly with each other in respect of herb yields for all the cuttings.

4. *Dry matter Yield*

The data on the effect of different salinity levels on dry matter yield of plant is presented in "Table 5".

Table -5. Effect of salinity levels on dry matter yield (g/pot) of the crops at various cuttings

Crop cutting	Control	Dry matter yield (g/pot) at different Salinity Levels (dSm^{-1})					SEm ±	CD at 5%
		5	10	15	20	Mean		
I	4.45	4.72	4.75	3.07	2.65	3.92	0.13	0.40
II	5.18	5.25	5.38	3.71	3.14	4.53	0.11	0.34
III	6.21	6.32	6.48	5.45	4.48	5.78	0.09	0.28

A study of Table 5 reveals that atlower EC levels (5dSm^{-1}) the crop produce higher dry matter yield as compared to control EC levels. However, this increase in dry matter yield was statistically non-significant. The higher EC level (15 and 20 dSm^{-1}) gave lower yield over lower EC level and control. The extent of decrease in yield with 20 dSm^{-1} EC level was found to be 40.4, 39.3 and 27.8 percent in plant at first, second and third cutting, respectively over control.

5. *Relative salt tolerance of plant*

The herb yield of Lemongrass under EC levels of 10 $dSm^{-1}$was slightly higher with that in control EC level. ECupto 5.0 dSm^{-1}proved beneficial in enhancing the production of Lemongrass. Salinity up to a certain level (5.0 EC in this case) seems to lead osmotic adjustment that results in an increase in the yield. At salinity beyond the optimum level, growth and development are affected because of water stress caused by osmotic inhibition [16] and influx of ions in large quantities leading to toxicity. Significant reductions in yield over control were observed at EC 15.0 and 20dSm^{-1}.

Table 5 shows the effect of soil salinity on dry matter production of plant. The dry matter production of lemongrass increased upto salinity level of 10 dSm^{-1} and thereafter it significantly decreased with increase in the level of salinity. The lower dry matter yield of crop was recorded with 20 dSm^{-1} salinity level. The result obtained from experiment indicates that the dry matter yield of crops increased steadily up to harvesting stage. The soil salinity at higher levels had an adverse effect on dry matter production. The effect of high salinity levels was harmful in case of growth characters. These salinity levels resulted in appreciably lower number of tillers than those by control treatment. The yield of the crop is the joint venture of its contributing characters such as plant height, number of branches, etc. All these attributes were adversely affected with high soil salinity levels and, therefore, this effect resulted in lower dry matter yield [20-24].

Accumulation of salts (Saline Soil) disturbs the physiological and metabolic activities of the plants [25]. It leads to an increase in the osmotic pressure in the soil solution, limits the absorption of water by plants and consequently retards their growth [26]. In many cases, the reduced soil osmotic potential induces a similar reduction in the leaf potential while its gradients remain unchanged. This phenomenon is known as osmotic adjustment [27] which results in an accumulation of inorganic and organic solutes in the plant sap. Osmotic adjustment is a primary mechanism affecting growth and production of plants [28].

Excessive levels of salts may also alter the hormone balance of the plants and it may damage the plant cells and cytoplasmic organelles. It has been observed that plants may tolerate total salinity within their tolerance limits, but change in the ionic nature of the solution of the same concentration may alter their tolerance limits [29]. The adverse effects of salinity on metabolic and enzymatic activity of the plants lead to decreased growth and yield. Singh and Anwar [30] also reported a reduction in herb yield of Lemon grass at higher soil salinity level. Prasad et. al. (1997) [24] reported a reduction in herb yield of the mints at higher salinity levels.

In the present investigation, growth was measured in terms of plant height and number of tillers per plant. Irrespective of treatment these parameters were increased continuously and almost linearly up to the harvest. During early growth period, the roots are not well established, thus, the initial height of plant and the number of tillers per plant are also low. The height is closely related to the growth which is dependent on the osmotic pressure of the root medium, the growth depends on the maintenance of turgor while osmotic pressure under adjustment might retard growth until absorbed solutes(salts) or synthesized solutes (organic compounds) that affect the requisite adjustment will be added. Hence, the reduction in height and growth may be an outcome of the requirement for osmotic adjustment [17]. Similarly, the number of tillers per plant was also affected adversely with the salinity levels. The significant reduction in plant height with increasing levels of soil salinity (EC) is due to greater accumulation of salts in soil causing reduction in the availability of water to plants. Many workers reported similar findings [17-21]. The normal cell division which is responsible for production of tiller gets hindered under the saline conditions [31]. Increased salinity may reduce the tiller due to decrease in water potential of plant cell to the point that one or both of its components (osmotic potential and pressure potential) become limiting factor for plant growth [32].

IV. CONCLUSION

There was a steady rise in plant height till harvest. The higher levels of soil salinity were found to have an adverse effect on plant height and yield of the crop. The number of tillers per plant increased as the plant age was advanced but the higher salinity levels reduced levels reduced significantly the number of tillers over control. The number of tillers per plant increased irrespective of the treatments and reached the maximum level at first cutting. There was a significant reduction in the number of leaves from plant with higher salinity levels.

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