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EFFECT OF POTASSIUM AND ZINC ON YIELD MINERAL COMPOSITION AND QUALITY OF LEMON GRASS UNDER SALINE CONDITION

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ABSTRACT

Effect of potassium and zinc on yield, chemical composition and quality of lemon grass (Cymbopogon flexuosus) under saline condition was studied at Bichpuri, Agra under greenhouse conditions. Soil salinity significantly, decreased growth characters, herb and oil yield, content and uptake of K and Zn and increased the content and uptake of sodium in crop at both cuttings over control. The growth characters (plant height and number of tillers) at both cuttings improved significantly with K and Zn application. Application of potassium increased the herb and oil yield, content and uptake of K, Na and Zn and decreased Na content. Zinc application decreased the content of Na and enhanced the content and uptake of K and Zn by lemon grass plants. Total herb and oil yield of lemon grass was significantly increased with zinc sulphate application. Total citral content was not affected significantly with soil salinity, K and Zn levels in any cutting.

Keywords: Potassium, zinc, yield, composition, quality, lemon grass, saline condition

INTRODUCTION

In arid and semi arid region, soil salinity adversely affects the crop productivity. Application of fertilizer (K) to the growth medium may minimize the harmful effects of salinity on the growth and yield of crops. An application of zinc enhances the yield and decreases the adverse effect of soil salinity (Shukla and Mukhi 1980). Lemongrass grass (*Cymbopogion flexuosus*) is an important aromatic crop and has gained considerable economic importance as its essential oil is being used in the formulation of different blends of perfumes, cosmetics, beverages, pharmaceuticals etc. Investigation have shown that the herb and oil yield of lemongrass consistently decreased with increase in the soil salinity and the increased K and Zn levels had significant effect on the yield (Prasad et al. 2010). The effect of potassium and zinc sulphate on the growth and yield of lemongrass under saline condition has not been studied. In the present study, the effects of potassium and zinc sulphate, on the yield of lemongrass under saline condition were evaluated.

MATERIALS AND METHODS

A green house experiment was conducted at R.B.S. College Bichpuri, Agra during 2008-2009. The soil used in green house experiment had pH 8.0, EC 0.23 dSm^{-1}, organic carbon 3.4 g kg^{-1}, available N 65 mg kg^{-1}, P 4.4 mg kg^{-1}, K 75 mg kg^{-1} and DTPA Zn 0.55 mg kg^{-1}. The soils of different salinity levels were prepared from normal soil by adding calculated amounts of $MgCl_2$, $MgSO_4$, $CaCl_2$ and NaCl to the soil. After mixing soil lots of two salinity levels thoroughly, ten kg of soil was filled in polyethylene lined earthen pots. The treatments consisted of two levels of salinity (control and 8 dSm^{-1}), four levels of K (0, 15, 30 and 45 mg K_2O kg^{-1}) and four levels of $ZnSO_4$ (0, 7.5, 15.0 and 30.0 mg kg^{-1}). The experiment was conducted in split plot design with three replications. A basal dose of 40 mg N, 20 mg P_2O_5 kg^{-1} was applied in each pot through urea and single superphosphate, respectively. Three slips of lemongrass were planted in each pot. The crop was irrigated with deionized water throughout the growth period as and when required. The crop was harvested on December 4, 2008 and June 22, 2009 and herb yield was recorded. Growth parameters were also recorded at both harvests. The plants sample were analysed for K and Na by flame photometer and Zn by AAS in diacid extract (Jackson, 1973). The essential oil content in the fresh herbage was determined by hydro-distillation using Clevengers apparatus. The essential oil yield was computed by multiplying the herb yield with the oil content. The citral content in the essential oil of lemongrass was estimated by gas liquid chromatography (GLC).

RESULTS AND DISCUSSION

Growth studies

The plant height and number of tillers decreased significantly with 8.0 dSm^{-1} salinity level over control at both harvests. The adverse effect of soil salinity on these growth characters was more pronounced at Ist cutting than at IInd cutting. The plant height and tillers increased significantly with increasing levels of potassium. The plant height increased from 114.4 to 127.9 cm at first cutting and

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from 105.4 to 118.4 cm at second cutting with 45 mg K_2O kg^{-1} soil. The corresponding increases in number of tillers in first and second cutting increased from 31.01 to 38.5 and 34.8 to 43.4, respectively. Singh et al. (1998) also reported similar results. The plant height and number of tillers at both harvests increased significantly with increasing levels of zinc sulphate which may be due to low status of available Zn in soil. Similar results were reported by Rajeswar Rao and Shukhmal Chand (1996).

Yield

The crop produced more herbage and dry matter at first harvest than at second cutting, irrespecting of various treatments. Similar results were reported by Singh (1999) in palmarosa. The herb and dry matter yields of lemongrass decreased significantly at first cutting due to 8 dSm^{-1} by 30.8 and 31.0 % over control, respectively. The adverse effect of soil salinity on lemongrass production is due to osmotic effect which lowers the osmotic potential of the medium, a possibility under salt stress condition (Girdhar 1986). The herb and dry matter yields of lemongrass increased significantly with increasing levels of potassium at both cuttings. The increases in herb yield at first cutting due to 10, 20 and 30 mg K_2O kg^{-1} levels over control were 11.3, 21.1 and 27.2%, respectively. The corresponding increases at second cutting were 11.5, 22.0 and 29.9 percent. The significant response of lemongrass crop to potassium application is due to low status of potassium in soil. Frequent crop harvesting might have depleted K from soil to give response to added K. Singh et al. (1998) also reported a significant response of lemongrass crop to K application. The crop grown with $ZnSO_4$ levels (7.5, 15.0 and 30.0 mg kg^{-1}) produced 4.5, 9.0 and 9.5% more herb yield at first cutting over control, respectively. The significant response of lemongrass to zinc application up to 30 mg $ZnSO_4$ kg^{-1} level is due to low status of zinc availability in the soil. The favourable influence of Zn on yield of lemongrass was reported by Rajeswara Rao and Sukhmal Chand (1996) and Aishwath (2012).

Oil content

Data (Table 1) revealed that the percentage of oil in lemongrass tended to decrease with EC level of 8 dSm^{-1} over control significantly. Similar results were reported by Prasad et al. (1997). The oil content in lemongrass improved significantly with K application which may be due to beneficial role of K in the formation of fatty acid. Singh et al. (1998) also reported an improvement in oil percentage with potassium application. Application of zinc, in general, increased the oil content in lemongrass and maximum value was recorded with 30 mg $ZnSO_4$ kg^{-1} treatment. Zinc functions in plants largely as a metal activator of enzymes like cysteine desulphydrases, dihydropeptidase, glycylgycine, dipeptidase etc. Thus, addition of zinc might have activated the enzymes responsible for the production of oil, and caused higher oil content. Beneficial effects of zinc application were also reported by Rajeshwara Rao and Sukhmal Chand (1996) and Aishwath (2012).

Table 1: Effect of zinc levels on growth, yield and quality of lemon grass

Treatments	Height (cm)		Tillers/pot		Herb yield (g/pot)		Dry matter (g/pot)		Oil content (%)		Total critical content (%)	
	I cutting	II cutting	I cutting	II cutting	I cutting	II cutting	I cutting	II cutting	I cutting	II cutting	I cutting	II cutting
Salinity (dSm^{-1})												
Control	128.2	119.4	39.2	44.3	138.7	127.8	52.5	48.3	0.75	0.77	90.0	90.1
8	114.6	114.1	30.4	34.5	95.9	86.6	36.3	32.8	0.59	0.61	89.7	89.8
CD= 0.05)	2.29	1.91	0.97	1.08	6.40	4.90	1.35	1.29	0.011	0.012	NS	NS
Potassium (mg kg^{-1})												
0	114.4	105.4	31.0	34.8	98.1	89.0	37.1	33.6	0.60	0.61	89.7	90.0
15	119.7	109.6	34.9	39.4	110.6	100.3	41.8	37.9	0.64	0.66	89.8	90.1
30	123.3	114.9	36.4	41.6	124.4	113.3	47.1	42.8	0.70	0.72	89.9	89.8
45	127.9	118.4	38.3	43.4	134.9	126.9	51.0	48.0	0.74	0.77	90.1	90.0
CD= 0.05)	3.21	2.67	1.35	1.52	8.96	6.83	1.90	1.81	0.015	0.016	NS	NS
$ZnSO_4$ (mg kg^{-1})												
0	115.4	107.5	30.3	33.1	110.1	101.3	41.6	38.3	0.65	0.66	89.8	89.8
7.5	120.4	111.7	35.7	40.7	115.2	104.7	43.6	39.6	0.67	0.69	89.7	89.9
15.0	124.4	114.6	37.8	42.5	121.0	110.8	45.8	41.9	0.68	0.70	89.8	90.2
30.0	124.9	114.9	37.9	42.54	121.7	112.1	46.1	42.4	0.68	0.71	90.0	90.1
CD= 0.05)	3.21	2.67	1.35	1.52	8.96	6.83	1.90	1.80	0.015	0.016	NS	NS

Total citral content

Soil salinity level (8.0 dSm^{-1}) did not affect the total citral content in lemongeass oil significantly as reported by Prasad et al. (2001). Potassium application did not affect significantly the total citral content in lemongrass oil at both cuttings. Singh et al. (1997) reported similar results. A slight improvement in total citral content was recorded with $ZnSO_4$ over control. Rajeshwara Rao and Sukhmal Chand (1996) also reported similar results.

Content and uptake of nutrients

There was a significant reduction in K content with salinity level (8 dSm^{-1}) over control. This may be due to the abundance of sodium in growth medium which occupies the exchange sites on the plants roots resulting in a reduced absorption of K by plants. The results of the present investigation find support from the work of Singh and Pal (2000). Application of K increased the level of K in plants significantly at both the cuttings and maximum value was recorded at 45 mg K_2O kg^{-1}. This increase in K content may be ascribed to increased availability of K in soil due to its application. Similar results were reported by Singh et al. (1998). A gradual decrease in K content in lemongrass plants was recorded up to 30 mg Zn kg^{-1} level. However, the decrease in K content in lemongrass at the level of 7.5 and 15.0 mg $ZnSO_4$ kg^{-1} as compared to control was non-significant. The minimum value of K content in lemongrass plants was recorded at 30 mg $ZnSO_4$ kg^{-1} indicating an antagonistic effect of Zn on K. The K uptake by the crop at both cuttings decreased significantly with an increase in soil salinity which may be due to an increased Na concentration in the soil solution. Similar results were reported by Prasad et al. (1997). The uptake of K by lemongrass at both cuttings increased significantly with its application over control. The increase in K uptake with increasing levels of K seems to be associated with increased K availability from applied K with a concomitant increase in crop yield. Singh et al. (1998) also reported an increase in K uptake with its application. There was a gradual and significant increase in the uptake of K by lemongrass up to 30 mg $ZnSO_4$ kg^{-1}.

Table 2: Effect of K and Zn levels on content and uptake of nutrients in lemon grass under saline condition

Treatments	Potassium content (%)		Potassium uptake (mg/pot)		Sodium content (%)		Sodium uptake (mg/pot)		Zinc content (mg kg^{-1})		Zinc uptake (mg/pot)	
	I cutting	II cutting	I cutting	II cutting	I cutting	II cutting	I cutting	II cutting	I cutting	II cutting	I cutting	II cutting
Salinity (dSm^{-1})												
Control	1.02	1.03	535.2	497.9	0.34	0.36	178.4	174.0	57.4	60.0	3.01	2.90
8	0.94	0.94	340.7	307.9	0.42	0.41	152.3	134.3	53.3	55.4	1.93	1.81
CD(P=0.05)	0.007	0.007	8.89	8.84	0.01	0.01	0.70	0.70	0.70	0.70	0.1	0.1
Potassium (mg kg^{-1})												
0	0.89	0.90	330.3	302.8	0.39	0.41	144.7	137.9	57.5	59.4	2.13	1.99
15	0.97	0.98	405.8	371.8	0.38	0.40	158.9	151.8	56.6	58.8	2.36	2.23
30	1.02	1.01	475.5	432.7	0.38	0.39	178.8	167.1	54.0	57.0	2.54	2.44
45	1.05	1.06	535.5	508.5	0.37	0.38	188.7	182.3	53.3	55.6	2.71	2.66
CD(P=0.05)	0.011	0.011	12.45	12.38	0.001	0.001	1.00	1.00	1.00	1.00	0.1	0.1
$ZnSO_4$ (mg kg^{-1})												
0	0.99	1.00	403.7	371.4	0.40	0.41	166.5	156.9	44.3	48.7	1.84	186
7.5	0.98	0.99	427.1	392.0	0.39	0.41	170.0	162.4	56.2	58.0	2.45	2.29
15.0	0.99	0.99	452.9	415.0	0.37	0.39	169.3	163.4	58.8	61.6	2.69	2.58
30.0	0.98	0.97	455.9	423.7	0.36	0.39	165.8	161.0	62.1	64.5	2.85	2.73
CD P=0.05)	NS	0.011	12.45	12.38	0.001	0.001	1.00	1.00	1.00	1.00	0.1	0.1

Salinity level (8 dSm^{-1}) increased the Na content in lemongrass plants at both cuttings as compared to control which may be ascribed to the addition of sodium salts in soils. Potassium application had a significant adverse effect on Na content in lemongrass plants and minimum value was noted with 45 mg K_2O kg^{-1} application which may be ascribed to antagonistic relationship between Na and K. With increasing levels of zinc sulphate to the soil, a significant reduction in Na content was recorded over control and lowest value was recorded at 30 mg $ZnSO_4$ kg^{-1}. This reduction may be ascribed to adverse effect of Zn on Na absorption by the crop. Soil salinity (8 dSm^{-1}) increased the uptake of Na by the crop significantly over control. These results find support from the work of Prasad et al. (1997) who reported an increase in Na uptake by plants with increasing soil salinity. There was a gradual and significant increase in the uptake of Na by lemongrass up to 45 mg K_2O kg^{-1}. The increase in Na uptake by the crop with K application may be ascribed to higher dry matter production. Potassium has an antagonistic effect on Na content but increase in its uptake occurred up to 45 mg K_2O kg^{-1} at both cuttings. This may be due to the fact that the relative decrease in Na content by K application was less as compared to the increase in dry matter yield and, therefore uptake increased. Application of $ZnSO_4$ also increased the uptake of Na by lemongrass significantly over control. The increases in Na uptake were consistent up to 15 mg $ZnSO_4$ kg^{-1} level. The increase in Na uptake may be due to increased dry matter production with the application of $ZnSO_4$ to the soil.

The Zn content in lemongrass plants at both cuttings decreased significantly with salinity level (8 d Sm^{-1}) as reported by Singh et al. (1987). Zinc content in plants decreased from 57.5 mg kg^{-1} at control to 53.3 mg kg^{-1} with 45 mg K_2O addition. These results suggest an antagonistic effect of K on zinc nutrition of lemon grass crop. There was a consistent and significant increase in Zn content with increasing level of $ZnSO_4$ and the maximum value was recorded at 30 mg $ZnSO_4$ kg^{-1} addition. The increase in Zn content due to its addition may be ascribed mainly to increased availability of Zn in soil. Singh (1992) also reported an increase in Zn content its application. A significant reduction in Zn uptake by lemongrass at both cuttings was recorded due to increased soil salinity over control which may be due to lower dry matter production at the higher salinity level. Application of 45 mg K_2O kg^{-1} tended to increase the mean Zn uptake by lemongrass from 2.3 to 2.7 mg per pot. Increasing supply of $ZnSO_4$ resulted in a significant increase in the uptake of Zn by lemongrass over control. The magnitude of increase in Zn uptake was significant up to the highest level of $ZnSO_4$ application. This increase may be ascribed to greater dry matter production and improvement in zinc content in plants. Mishra and Singh (1996) also reported similar results.

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