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Influence of Different Doses of Gypsum on Growth of Herb (*Cymbopogon flexuosus)* Lemongrass var. Krishna

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ABSTRACT

Experiment was conducted to study the influence of gypsum on the growth of herb *Cymbopogon flexuosus)* Lemongrass var. Krishna at CIMAP Research Centre, Hyderabad during October 2010 to May, 2011. In the experiment, five different levels of gypsum (0- 4.0 tons/ha) was applied and tested. In the experiment it was observed that application of gypsum did not influence the pH of the soil but resulted in a significant decrease in the EC of the soil. Gypsum application resulted in moderate decrease in the bicarbonate content of the soil. Similar types of results were noticed in case of chlorides, calcium and sulphate. It was also observed that between second and third stages of observations the sulphate and chloride content increased drastically and it was, perhaps, more due to continued irrigation with saline water. The number of leaves per plant also increased with gypsum application up to a level of 3 tons per hectare. Similar types of results were noticed in case of number of tillers per plant; leaf weight, leaf area and leaf dry weight.

Keywords: Lemon grass, Gypsum, PH, Electrical conductivity, Carbonte, Sulplhate.

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INTRODUCTION

Lemon grass (Cymbopogon flexuous) is a perennial herb widely cultivated in the tropics and subtropics. The reported adaptation zone for lemon grass is: temperature 18 to 29ºC with an annual precipitation of 0.7 to 4.1 meters and a soil pH of 5.0 to 5.8. Since the plants rarely flower or set seed, propagation is by root or plant division. Cymbopogon flexuous Stapf (Andropogon flexuous Nees ex Steud.), Malabar or Cochin grass, is distributed in the Tinnivelli district and in Travancore. According to Stapf, the oil, which is known in commerce as lemon-grass oil, is obtained from two wholly different plants, the oil coming from the Malabar Coast being produced from Cymbopogon flexuous Stapf, whilst the other species of lemon-grass, designated as Cymbopogon citrates Stapf, yields oil which, though very similar, is not identical with the former[1]. Essential oil isolated from Cymbopogon flexuous (citral-type), is reported to contain citral-b from 14% to 35% and citral-a from 23% to 56%, while geraniol type is reported to contain geraniol from 17% to 88 % [2]. Oil from lemon grass is widely used for fragrance in perfumes and cosmetics, such as soaps and creams. Citral, extracted from the oil, is used in flavoring soft drinks, in scenting soaps and detergents, as a fragrance in perfumes and cosmetics and as a mask for disagreeable odors in several industrial products. Citral is also used in the synthesis of ionones used in perfumes and cosmetics. As a medicinal plant, lemon grass has been considered a carminative and insect repellent. Lemon grass is used in herbal teas, other non-alcoholic beverages, and in confections. Lemon grass is generally recognized as safe for human consumption as plant extract/essential oil [3]. There are many reports that application of gypsum on normal soils has shown improved crop yields which may be possible due to supplementation of soil with sulphur and calcium. Gypsum also act as source of plant nutrients i.e. calcium and sulphur to plants. It has 17% sulphate which is the most absorbable form of sulphur for plants.calcium,which is supplied in gypsum is essential for the biochemical mechanisms by which most plant nutrients are absorbed by roots. Without adequate calcium, uptake mechanisms would not function properly. It was also concluded gypsum supplied at lower rates may increase crop yields on normal soils due to supplementation of plant nutrients [4]. Gypsum (CaSO4 .2HO) is one of the most commonly occurring sulfate minerals in soils. It may be present in trace amounts in soils or dominate the pedon as in gypsiferous soils with a gypsie or petrogypsic horizon [5].Gypsum provide a source of calcium (Ca2+) to replace excessive Na+ from the cation exchange sites [6,7] while others (i.e., sulphuric and phosphoric acid) increase the dissolution of calcite in calcareous saline sodic soils [8,9].

MATERIALS AND METHODS

The present study was undertaken to study the influence of different levels and a method of application of gypsum on the growth of herb *Cymbopogon flexuosus* variety 'Krishna' during October, 2010 to May 2011. As per the standardization of protocol and the available literature sources the sequence of experiments were carried out at the research farm of Central Institute of Medicinal and Aromatic Plants, Research Centre, Boduppal, Uppal, Hyderabad. The experimental site is located at the altitude of 542 m above mean sea level with a geographical bearing of 78^0 8’ longitudes and $17^0$32’ latitude, Semi -arid tropical climate zone of Hyderabad has an average rainfall of 800 mm per year. The soil of the experimental field was a red sandy loam (alficusto chrept) with pH 7.8 (1.25 soils to solution

ratio), EC - 0.42 ds/m, organic C -0.3%, total N -0.03%, available P- 10 ug /g soil and exchangeable K-128 ug/g soil. Experiments were conducted during the period from October, 2010 to May 2011. In the first experiment gypsum was applied at five different levels to study its influence in reducing soil salinity.

Treatment table

Experiment I: Different doses of Gypsum were applied in the following composition on herb i.e., lemongrass variety Krishna as shown in **Table-1 and Table-2** Shows the replication of treatments with Gypsum**.**

Plantation: Fully grown slips of size 4-6" were planted in field at 60x60 cm spacing in 3x4 m plots as per the lay out plan.

Treatment imposition: The crop was planted on 10.10.2010. Gypsum was applied 10 days after planting.

Maintenance: The crop was kept weed free and regularly irrigated.

Observations recorded

Soil chemical properties: Observations on the soil pH, E.C, carbonates/bicarbonates, chlorides, calcium and magnesium, sulphates were taken at interval. The soil samples were collected at regular intervals of time i.e., (15, 30, 45, 60, 75, 90, 105, 120 days) as shown in **Table-3**. The average values were taken for each treatment with different replicates. Titrations were performed with the different procedures like carbonates and bicarbonates, chlorides, calcium and magnesium and sulphates. The details are presented here.

Procedures for pH, Electrical Conductivity, Carbonates and Bicarbonates, Chlorides, Calcium, Magnesium and Sulphates are presented here:

Estimation of pH and E.C. in soil samples

Introduction: Procedure for estimation of the pH and E.C of the given soil samples is presented here:

pH: The pH meter is switched on and allowed to warm for about 10minutes. Set 0 correction and checked the meter with buffer solutions (7.0 and 4.0 pH) and set the buffer correction. Then the electrode tip was immersed in the soil suspension and the reading shown by the meter was noted down. This gives the pH of the soil.

Electrical Conductivity: After recording the soil pH, the soil suspension was allowed in the beaker to settle for some time. Checked with conductivity meter the saturated calcium sulphate solution having E.C 2 milli *mhos*/cm at 25^0c before proceeding with the sample. Sucked the supernatant liquid with the conductivity cell first and then immersed the electrode bulb completely without air bubbles and measured the conductivity by adjusting

the knob until getting maximum dark in the magic indicate and expressed the conductivity in milli mhos/cm at 25^{0}C to the nearest decimal point.

Carbonates and Bicarbonates: The estimation of carbonates and bicarbonates in the soil sample is based on simple acidimetric titration using different indicators which work in alkaline pH range (above 8.2) and in acidic pH (below 6.0)

Calcium and Magnesium: The usual method for the determination of calcium and magnesium in the soil is by versenate (EDTA) titration (Chang and Bray 1951) [10].

Determination of Chlorides: Chloride ion is universally present in small amounts in almost all natural waters and its content goes up appreciably with salinity. This estimation may be carried out when the electrical conductivity is greater than 1mmhos/cm at 25^{o}C (Mohr's titration) [11].

Estimation of Sulphates: While traces of sulphates occur universally its content can be appreciable in most saline water showing higher values of EC. Sulphates in solution are quantitatively precipitated and estimated gravimetrically as $BaSO_4$.The sulphate content in many irrigation waters may be quite low and therefore a large volume of the sample has to be first concentrated to about 100ml and the estimation itself is also time consuming. Turbidimetric and colorimetric methods of determination of sulphate have been described earlier. The procedure given here is based on EDTA titration as described by (Jackson 1973) [12].

Observations on herb

Observations were taken at different intervals starting from 10 days after gypsum application. In each treatment two plants were removed at random from the plants and washed under tap water. Fresh and dry weights of individual components were taken separately. Later observations were recorded. Details about the observations recorded are presented here in **Table-4**.

Details about the methods followed in observations;

A) Height of plant (cm): The height of the regular plants was measured from the base of the plant and expressed as average in cms (approx. 200 leaves/clump).
B) Number of leaves/plant: The leaves were separated from the stem. The number of fresh and entire leaves were recorded and expressed as average (approx. 350 leaves/clump).
C) Number of tillers/plant: The number of tiller per clump were counted and expressed as average.
D) Fresh weight of plant (g): Two plants from each treatment were selected randomly. The fresh weight of the plant of each plant was taken by using electronic balance and it is expressed as average.
E) Leaf area (Sq.cm)/leaf: The area of the leaf was measured by using Systronics Leaf area meter and it is expressed as average.
F) Dry weight of leaves /plant (g): The leaves from two plants were dried in oven at 100 ^{0}C till constant weight and the dry weight was recorded.

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RESULTS AND DISCUSSION

Experimental studies with application of Gypsum – observations and results

Soil properties: The results pertaining to the initial soil properties are presentedin **Table-5**. The pH of the soil studied over a period of 120 days indicated that except at three stages pH was not influenced by the application of gypsum (**Table-6**). Gypsum application resulted in a significant decrease in the EC of the soil. This indicates the reduction in the salinity of the soil due to treatment as in the above mentioned analysis (**Table-7**). The Bicarbonate content of the soil water was also influenced by the treatments. Increasing the Gypsum application resulted in moderate decrease in the Bicarbonate content of the soil (**Table-8**). Similar types of results were noticed in case of Chlorides, Calcium plus Magnesium and Sulphate (**Table-9, Table-10, and Table-11**). It was also noticed that between second and third stages of observation the sulphate and chloride content increased drastically and it was probably more due to continued irrigation with saline water. It also indicates that for reducing the salinity split application of gypsum may be more ideal.

The pH of irrigation water should be in the range of 6.0 to 7.0 is most desirable. Water becomes more acidic as pH value below 7.0, if it is above 7.0 there is an alkalinity in the soil. In the above table, it was observed that the pH range is above 7.0. So the soil was alkaline. If the salinity is more than 1.0 mS/cm, it will effectively damage the plants. Monitoring of salinity helps manage the effects of soluble salts on plant growth. EC is an indicator of water quality, soil salinity and fertilizer concentration. Carbonates were not present in the soil water where as the presence of bicarbonates was observed. Chlorides are universally present in almost all waters and chloride salts will accumulate in saline soil. When Cl^- concentrations are high, it can be toxic to plants. The crop yields are not significantly affected by the soil Ca/Mg ratio as long as both nutrients are present in adequate amounts. Presence of sulphates in the soils can have a destructive effect on plant and reduction in agricultural productivity through metal contamination of soils.

pH of the soil: The results pertaining to the soil pH as influenced by different treatments during the experimental period is presented in **Table-6.**The pH of the soil studied over a period of 120 days indicated that except at three stages pH was not influenced significantly by the application of gypsum. And it was observed that different levels of gypsum application resulted in significant increase when compared to control (T_0).

Electrical Conductivity of the soil: The results pertaining to the soil EC as influenced by different treatments during the experimental period is presented in **Table-7** and **Figure-1**. The E.C of the soil increased with time in case of treatments where gypsum is applied. This indicates the diminishing influence of gypsum on soil E.C. Among the treatments perceptible decrease in E.C was observed in case of treatment one (T_1).

Carbonates and Bicarbonates: The result pertaining to the soil carbonates and bicarbonates as influenced by different treatments during the experimental period is presented in **Table-8**. The Bicarbonate content of the soil water was also influenced by the treatments. Bicarbonates were drastically increased in the third and fourth stages. Increasing the gypsum application resulted in moderate decrease in the bicarbonate content of the soil.

Chlorides: The result pertaining to the soil chlorides as influenced by different treatments during the experimental period is presented in **Table-9**. Chlorides are universally present in almost all waters. It was also noticed that between third and fourth stages observations, the chloride content increased drastically and it was probably more due to continued irrigation with saline water.

Calcium and Magnesium: The result pertaining to the soil calcium and magnesium as influenced by different treatments during the experimental period is presented in **Table-10**. It was observed that Ca and Mg was increased drastically in third, fourth and fifth stages and again there is a significant reduction in the Ca and Mg. The crop yields are not significantly affected by the soil Ca/Mg ratio as long as both nutrients are present in adequate amounts.

Sulphates: The result pertaining to the soil sulphates as influenced by different treatments during the experimental period is presented in **Table-11**. It was also noticed that between third, fourth and fifth stages observations the sulphate content increased drastically and it was more due to continued irrigation with saline water and sudden rainfall.

Morphological characters: The crop was harvested at 75 days and 180 days after planting as shown in **Table-12**. It was observed that the application of gypsum influenced the plant height in both the harvest durations. The plant height increased with time and also it increased with application of gypsum up to three tons of application per hectare (**Table-13 and Figure-2**).The number of leaves per plant also increased with application with gypsum up to a level of 3 tons per hectare. Similar type of results were noticed in case of number of tillers per plant, leaf weight, leaf area and leaf dry weight (**Table-14 and Figure-3, Table-15, Table-16 and Figure-4, Table-17, Table-18**).

Plant Height (cms): The results pertaining to the plant height as influenced by different treatments during the experimental period is presented in **Table-13 and Figure- 2**. The crop was harvested after the second observation. The crop was again harvested after the 6^{th} observation. Plant height increased with time and also with increase in gypsum application up to T_3 level corresponding to three tons of gypsum/ha (T0, T1, T2, T3, T4 refers that 0, 0.966, 1.449, 1.932, 2.415).

Number of leaves: The results pertaining to the number of leaves as influenced by different treatments during the experimental period is presented in **Table-14 and Figure-3**.A significant improvement in the number of leaves of plant was noticed up to treatment T_3 at all stages of observation. Increase in number of leaves indicates increase in photo synthetically active leaf area and increase in biomass production (T0, T1, T2, T3, T4 refers that 0, 0.966, 1.449, 1.932, 2.415).

Number of Tillers: The results pertaining to the number of tillers as influenced by different treatments during the experimental period is presented in **Table-15**. Number of tillers was significantly higher compared to the control (T_0) with all levels of gypsum application. It shows that the increase levels of gypsum have the positive effect, in terms of high yield in lemon grass.

Leaf weight (gm): The results pertaining to the leaf weight (gm) as influenced by different

treatments during the experimental period is presented in **Table-16 and Figure- 4** Gypsum application significantly increased the leaf weight with increase in gypsum dosage level up to four tons/ha.

Leaf Area (Sq.cm): The results pertaining to the leaf area (Sq.cm) as influenced by different treatments during the experimental period is presented in **Table-17**. Area of the leaf was calculated by Systronics leaf area meter machine using the 200 sq.cm plate and the values were recorded. Area of the leaf was increased with the gypsum application up to a level of 3 tons per hectare (T0, T1, T2, T3, T4 refers that 0, 0.966, 1.449, 1.932, 2.415).

Leaf Dry Weight (gm): The results pertaining to the leaf dry weight as influenced by different treatments during the experimental period is presented in Table-18**.** Dry weight of the leaves was increased with gypsum application up to a level of 3 tons per hectare. The crop was harvested at 75 days and 180 days.

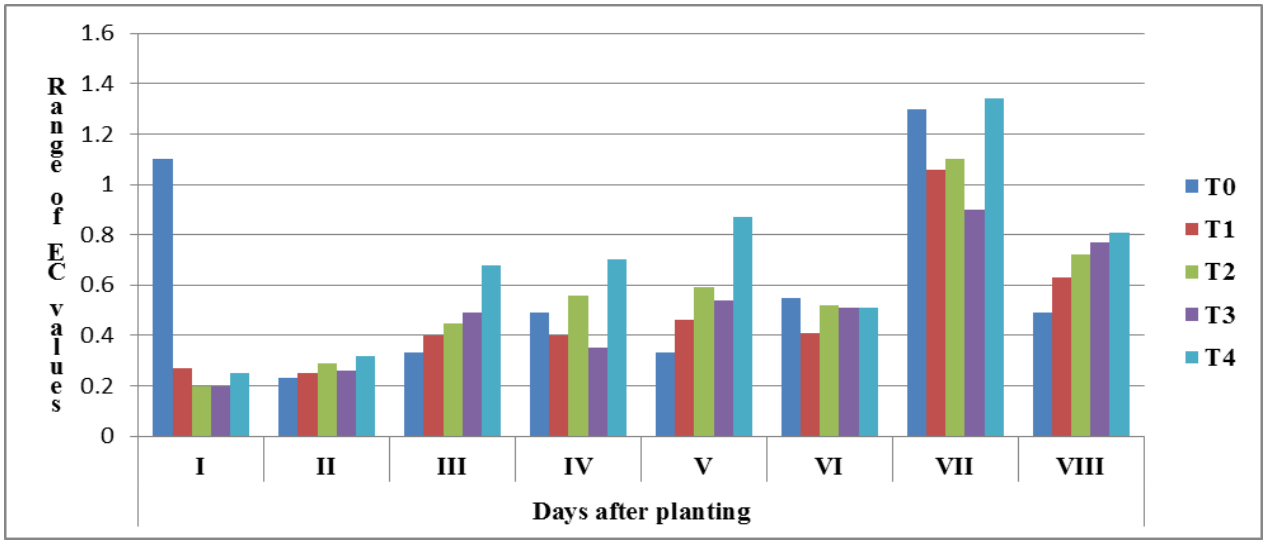

Figure 1: Influence of different levels of gypsum on the soil EC at different days after planting.

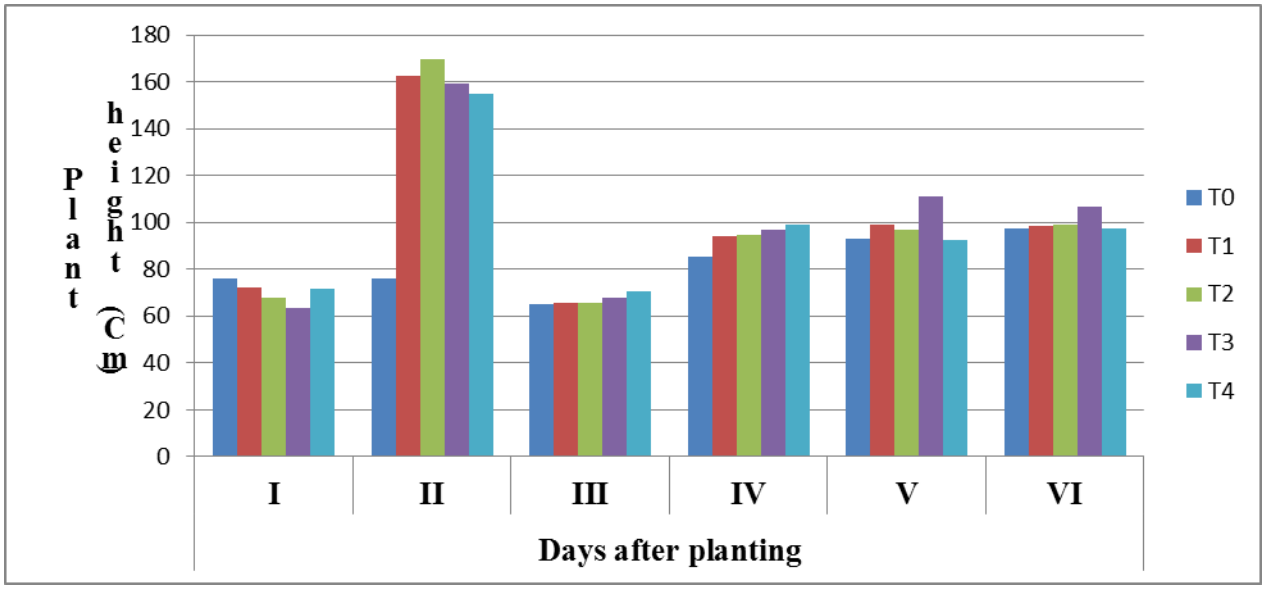

Figure 2: Influence of different levels of gypsum on the plant height (cm) at different days after planting.

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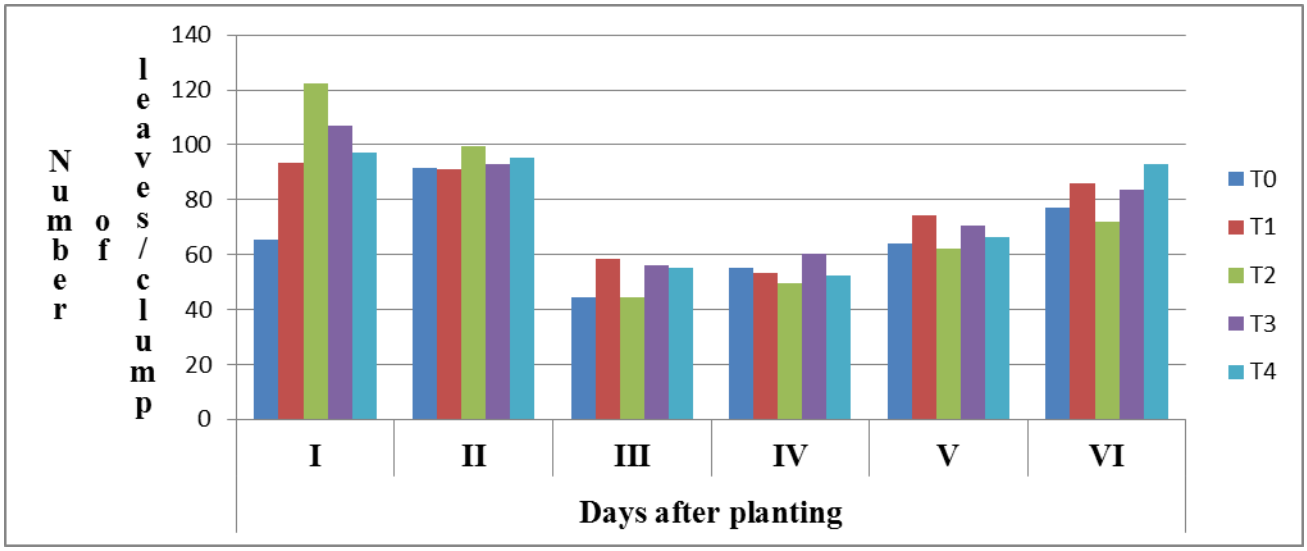

Figure 3: Influence of different levels of gypsum on the number of leaves at different days after planting.

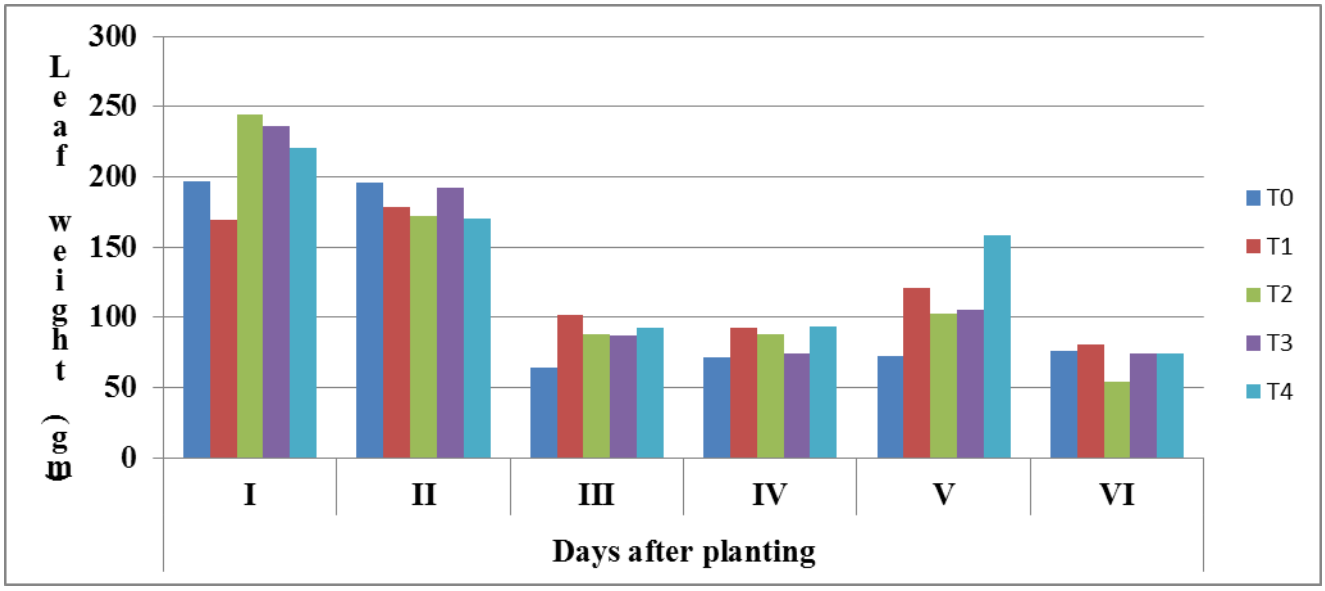

Figure 4: Influence of different levels of gypsum on the leaf weight (gm) at different days after planting.

Table-1: Different levels of gypsum applications

S.No	Treatment	Gypsum tons/ha	Gypsum Kg/plot
1.	T_0	0	0
2.	T_1	1	1.932
3.	T_2	2	3.864
4.	T_3	3	5.796
5.	T_4	4	7.728

Note: The treatment composition of Gypsum was taken as 0, 1, 2, 3, 4 tons/ha.

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Table 2: Shows the replication of treatments with Gypsum correspondingly the information has been provided in parenthesis.

GR1T1(1.932Kg)	GR3T1(1.932Kg)
GR1T2(3.864Kg)	GR3T2(3.864Kg)
GR1T3(5.796Kg)	GR3T3(5.796Kg)
GR1T4(7.728Kg)	GR3T4(7.728Kg)
GR2T1(1.932Kg)	GR4T1(1.932Kg)
GR2T2(3.864Kg)	GR4T2(3.864Kg)
GR2T3(5.796Kg)	GR4T3(5.796Kg)
GR2T4(7.728Kg)	GR4T4(7.728Kg)

(G: gypsum, T: treatment, R: replication)

Table 3: Table showing the different stages of soil samples was collected at regular intervals of time i.e., (15, 30, 45, 60, 75, 90, 105, 120 days).

S.No	Regular intervals	Code
1	15	Stage I
2	30	Stage II
3	45	Stage III
4	60	Stage IV
5	75	Stage V
6	90	Stage VI
7	105	Stage VII
8	120	Stage VIII

Table 4: Table showing the different stages of fresh plant samples was collected at regular intervals of time i.e., (30, 60, 90, 120, 150, 180 days).

S.No	Regular intervals	Code
1	30	Stage I
2	60	Stage II
3	90	Stage III
4	120	Stage IV
5	150	Stage V
6	180	Stage VI

Table 5: The results pertaining to the initial soil properties are presented here.

Treatment	pH	EC	Carbonates and Bicarbonates (m.eq/lt)	Chlorides (m.eq/lt)	Calcium and Magnesium (m.eq/lt)	Sulphates (m.eq/lt)
T_0	7.80	0.21	0.52	13.90	13.90	13.23
T_1	8.10	0.28	0.53	14.80	14.02	14.01
T_2	8.15	0.40	0.53	14.50	14.65	15.02
T_3	8.00	0.25	0.54	14.32	14.80	14.65
T_4	8.12	0.20	0.52	15.00	15.60	16.90
F'- Test	NS	*	NS	NS	NS	*
C.D.(P=0.05)	1.02	0.04	0.06	1.82	1.88	1.89
C.V.%	7.85	10.34	8.01	7.74	7.94	7.88

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Table 6: Influence of different levels of Gypsum on the soil pH at different stages.

Treatment	Days after planting							
	I	II	III	IV	V	VI	VII	VIII
T_0	6.60	8.10	8.00	6.70	8.00	7.52	6.08	7.34
T_1	8.17	8.10	7.98	7.83	7.90	8.05	7.94	7.66
T_2	8.20	8.00	7.95	7.88	7.75	8.05	8.01	7.62
T_3	8.15	8.05	7.98	8.08	7.73	7.92	8.05	7.70
T_4	8.12	7.98	7.83	7.90	8.05	7.88	7.97	7.41
F'- Test	*	NS	NS	*	NS	NS	*	NS
C.D.(P=0.05)	1.07	1.02	1.02	1.05	0.98	1.02	1.06	0.99
C.V.%	8.38	7.81	7.85	8.38	7.60	7.96	8.58	8.03

Note: Stage I, II, III, IV, V, VI, VII, VIII refers to 15, 30, 45, 60, 75, 90, 105, 120 days after planting NS: Non-significant * Significant at P=0.05

Table 7: Influence of different levels of Gypsum on the soil EC at different stages.

Treatment	Days after planting							
	I	II	III	IV	V	VI	VII	VIII
T_0	1.10	0.23	0.33	0.49	0.33	0.55	1.30	0.49
T_1	0.27	0.25	0.40	0.40	0.46	0.41	1.06	0.63
T_2	0.20	0.29	0.45	0.56	0.59	0.52	1.10	0.72
T_3	0.20	0.26	0.49	0.35	0.54	0.51	0.90	0.77
T_4	0.25	0.32	0.68	0.70	0.87	0.51	1.34	0.81
F'- Test	*	*	*	*	*	*	*	*
C.D.(P=0.05)	0.06	0.04	0.06	0.06	0.08	0.07	0.12	0.10
C.V.%	9.16	7.95	8.42	6.82	8.53	8.10	6.25	9.13

Note: Stage I, II, III, IV, V, VI, VII, VIII refers to 15, 30, 45, 60, 75, 90, 105, 120 days after planting. NS: Non-significant * Significant at P=0.05

Table 8: Influence of different levels of Gypsum on the Carbonates and Bicarbonates (m.eq/lt) at different stages.

Treatment	Days after planting							
	I	II	III	IV	V	VI	VII	VIII
T_0	1.00	0.60	2.00	1.80	0.60	1.40	0.60	0.40
T_1	0.60	0.75	2.25	3.05	0.60	0.80	1.10	0.45
T_2	0.55	0.70	2.25	2.55	0.55	0.85	1.25	0.55
T_3	0.60	0.55	2.35	2.35	0.70	0.80	1.10	0.40
T_4	0.55	0.65	2.00	2.60	0.60	0.70	1.10	0.50
F'- Test	*	*	*	*	*	NS	*	*
C.D.(P=0.05)	0.07	0.08	0.31	0.32	0.09	0.11	0.16	0.06
C.V.%	6.93	7.25	8.65	7.94	8.69	7.13	9.61	7.98

Note: Stage I, II, III, IV, V, VI, VII, VIII refers to 15, 30, 45, 60, 75, 90, 105, 120 days after planting. NS: Non-significant * Significant at P=0.05

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Table 9: Influence of different levels of Gypsum on the Chlorides (m.eq/lt) at different Stages.

Treatment	Days after planting							
	I	II	III	IV	V	VI	VII	VIII
T_0	15.60	16.00	26.00	23.60	14.40	16.00	14.80	14.40
T_1	16.80	17.40	23.90	25.20	11.70	15.20	14.20	14.10
T_2	14.50	17.10	25.20	20.70	11.00	14.80	18.20	13.50
T_3	14.80	17.70	24.10	24.40	12.10	13.20	15.40	13.30
T_4	15.00	17.70	22.60	23.60	11.50	13.40	17.00	13.90
F'- Test	*	NS	*	*	*	*	*	NS
C.D.(P=0.05)	1.85	2.25	3.13	2.96	1.48	1.72	2.14	1.68
C.V.%	7.39	8.06	7.88	7.75	7.47	7.72	8.26	7.43

Note: Stage I, II, III, IV, V, VI, VII, VIII refers to 15, 30, 45, 60, 75, 90, 105, 120 days after planting. NS: Non-significant * Significant at P=0.05

Table 10: Influence of different levels of Gypsum on the Calcium and Magnesium (m.eq/lt) at different stages.

Treatment	Days after planting							
	I	II	III	IV	V	VI	VII	VIII
T_0	35.20	15.20	22.20	26.00	28.40	26.60	27.00	4.80
T_1	14.65	20.70	28.50	34.95	31.60	20.85	23.15	7.05
T_2	15.60	21.95	28.10	34.45	32.40	21.50	18.10	6.25
T_3	14.85	21.95	30.75	27.80	31.40	24.45	15.65	7.95
T_4	16.50	19.00	38.85	32.55	34.95	27.00	19.05	10.75
F'- Test	*	*	*	*	*	*	*	*
C.D.(P=0.05)	2.09	2.98	3.93	3.91	4.07	2.97	1.97	1.01
C.V.%	6.64	9.25	8.14	7.70	7.87	7.56	5.87	8.44

Note: Stage I, II, III, IV, V, VI, VII, VIII refers to 15, 30, 45, 60, 75, 90, 105, 120 days after planting. NS: Non significant * Significant at P=0.05

Table 11: Influence of different levels of Gypsum on the Sulphates (m.eq/lt) at different stages.

Treatment	Days after planting							
	I	II	III	IV	V	VI	VII	VIII
T_0	34.65	14.39	21.47	25.56	27.61	25.87	26.40	4.48
T_1	14.19	20.17	27.77	34.17	31.00	20.15	22.45	6.62
T_2	15.31	21.58	27.46	33.93	31.74	20.77	17.44	5.83
T_3	14.51	21.59	30.17	27.29	30.76	23.74	15.02	7.53
T_4	16.10	18.46	38.22	32.01	34.24	26.29	18.42	10.33
F'- Test	*	*	*	*	*	*	*	*
C.D.(P=0.05)	2.06	2.95	3.86	3.84	3.99	2.88	1.90	0.96
C.V.%	6.67	9.40	8.17	7.71	7.88	7.56	5.84	8.46

Note: Stage I, II, III, IV, V, VI, VII, VIII refers to 15, 30, 45, 60, 75, 90, 105, 120 days after planting. NS: Non-significant * Significant at P=0.05

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Table 12: Crop was harvested at 75 and 180 days after planting.

Treatment	Crop harvest	
	I	II
T_0	19.00	10.00
T_1	12.83	12.27
T_2	20.13	11.95
T_3	13.18	11.32
T_4	19.00	14.72

Note: Stage I & II refers to crop was harvested at 75 and 180 days after planting.

Table 13: Influence of different levels of Gypsum on the plant height (cm) at different Stages.

Treatment	Days after planting					
	I	II	III	IV	V	VI
T_0	76.00	76.00	65	85.50	93.00	97.50
T_1	72.12	162.62	65.5	94.25	98.87	98.37
T_2	67.62	169.62	65.75	94.62	97.00	99.00
T_3	63.62	159.37	67.62	97.12	111.25	106.87
T_4	71.87	154.87	70.5	99.12	92.62	97.62
F'- Test	*	NS	NS	*	*	*
C.D.(P=0.05)	8.82	21.04	8.48	12.44	14.13	13.20
C.V.%	6.34	8.09	7.69	8.12	8.81	7.57

Note: Stage I, II, III, IV, V, VI, VII, VIII refers to 15, 30, 45, 60, 75, 90, 105, 120 days after planting. NS: Non significant * Significant at P=0.05
Crop harvested at 75 and 180 days after planting

Table 14: Influence of different levels of gypsum on the number of leaves at different stages.

Treatment	Days after planting					
	I	II	III	IV	V	VI
T_0	65.50	91.50	44.5	55.00	64.00	77.00
T_1	93.62	91.00	58.37	53.25	74.50	86.00
T_2	122.25	99.25	44.37	49.37	62.37	71.87
T_3	106.75	92.75	56.12	60.50	70.50	83.62
T_4	97.37	95.25	55.37	52.25	66.37	92.87
F'- Test	*	NS	*	*	*	*
C.D.(P=0.05)	15.69	11.54	6.88	7.46	7.96	10.14
C.V.%	9.93	7.59	8.16	8.47	7.24	7.57

Note: Stage I, II, III, IV, V, VI, VII, VIII refers to 15, 30, 45, 60, 75, 90, 105, 120 days after planting. NS: Non-significant * Significant at P=0.05 Crop harvested at 75 and 180 days after planting

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Table 15: Influence of different levels of gypsum on the number of tillers at different stages

Treatment	Days after planting					
	I	II	III	IV	V	VI
T_0	19.00	16.50	14.00	16.50	23.50	24.50
T_1	25.62	25.00	21.87	16.62	31.50	23.50
T_2	34.12	26.75	20.50	15.87	27.37	23.37
T_3	21.50	25.75	23.87	18.62	29.00	22.37
T_4	25.50	31.12	18.50	19.75	37.75	20.75
F'- Test	*	*	*	*	*	*
C.D.(P=0.05)	3.69	3.51	3.16	2.29	3.65	2.89
C.V.%	9.00	8.61	9.83	8.04	7.52	7.75

Note: Stage I, II, III, IV, V, VI, VII, VIII refers to 15, 30, 45, 60, 75, 90, 105, 120 days after planting. NS: Non-significant * Significant at P=0.05 Crop harvested at 75 and 180 days after planting

Table 16: Influence of different levels of Gypsum on the Leaf weight (gm) at different stages.

Treatment	Days after planting					
	I	II	III	IV	V	VI
T_0	197.00	196.00	64.00	71.00	72.50	76.00
T_1	169.62	178.12	102.00	92.25	121.12	80.62
T_2	244.00	172.37	88.00	88.00	102.25	54.12
T_3	236.00	192.12	86.62	74.12	105.50	74.25
T_4	221.00	170.00	92.75	93.37	158.25	74.50
F'- Test	*	*	*	*	*	*
C.D.(P=0.05)	32.19	23.89	11.48	10.04	13.80	8.71
C.V.%	9.26	8.08	8.14	7.37	7.57	7.44

Note: Stage I, II, III, IV, V, VI, VII, VIII refers to 15, 30, 45, 60, 75, 90, 105, 120 days after planting NS: Non significant * Significant at P=0.05
Crop harvested at 75 and 180 days after planting

Table 17: Influence of different levels of Gypsum on the Leaf area (Sq.cm) at different stages.

Treatment	Days after planting					
	I	II	III	IV	V	VI
T_0	51.23	39.80	30.10	32.10	33.10	34.60
T_1	42.65	45.82	33.07	48.32	43.05	36.30
T_2	42.75	47.07	39.97	37.70	35.67	36.40
T_3	48.62	47.65	39.82	41.80	60.85	41.32
T_4	52.42	37.72	36.37	48.00	46.15	39.75
F'- Test	*	*	*	*	*	*
C.D.(P=0.05)	5.91	6.33	5.37	5.26	7.70	5.20
C.V.%	7.63	8.92	9.19	7.77	10.80	8.48

Table 18: Influence of different levels of Gypsum on the Leaf dry weight (g) at different stages.

Treatment	Days after planting					
	I	II	III	IV	V	VI
T_0	47.00	49.00	16.50	21.50	29.50	32.50
T_1	54.37	44.53	22.87	31.87	38.75	24.87
T_2	67.25	42.87	15.00	30.00	37.62	27.12
T_3	71.50	47.87	22.25	27.25	34.75	25.00
T_4	71.00	42.37	21.12	39.75	36.50	26.12
F'- Test	*	*	*	*	*	*
C.D.(P=0.05)	9.55	5.95	2.70	3.65	4.65	3.21
C.V.%	9.43	8.06	8.49	7.46	8.06	7.26

Note: Stage I, II, III, IV, V, VI, VII, VIII refers to 15, 30, 45, 60, 75, 90, 105, 120 days after planting NS: Non significant * Significant at P=0.05 Crop harvested at 75 and 180 days after planting

SUMMARY AND CONCLUSIONS

Experiment was conducted to study the influence of gypsum on the growth of herb (lemongrass). As per the standardization of protocol, the observations and results obtained for the experiment is summarized. Experiment was laid out at the research farm of Central Institute of Medicinal and Aromatic Plants (CIMAP), Research Centre, Boduppal, Uppal, Hyderabad.

The results obtained are summarized here:

- The pH of the soil studied over a period of 120 days indicated that except at three stages pH was not influenced by the application of gypsum.
- Gypsum application resulted in a significant decrease in the EC of the soil. This indicates the reduction in the salinity of the soil due to treatment.
- The bicarbonate content of the soil water was also influenced by the treatments. Increasing the gypsum application resulted in moderate decrease in the bicarbonate content of the soil. Similar types of results were noticed in case of chlorides, calcium and sulphate.
- It was also noticed that between third, fourth and fifth stages observations the sulphate and chloride content increased drastically and it was probably more due to continued irrigation with saline water. It also indicates that for reducing the salinity split application of gypsum may be more ideal.
- Application of gypsum influenced the plant height in both the harvests. The crop was harvested at 75 days and 180 days after planting.
- The number of leaves per plant also increased with application with gypsum up to a level of 3 tons per hectare. Similar types of results were noticed in case of number of tillers per plant, leaves weight, leaf area and leaves dry weight.

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