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Influence of nitrogen and sulphur nutrition on growth and yield of clove basil (*Ocimum gratissimum* L.)

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Abstract
The experiment was carried out at Medicinal and Aromatic Plant Research Station, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad during the *kharif* season of two consecutive years *i.e*., 2015-2016 and 2016-2017. In both the years, six weeks old seedlings were transplanted into 3m×3m plots at a spacing of 45×45 cm. The experiment was conducted with three levels of Nitrogen (100, 150 and 200 kg/ha) and three levels of Sulphur (60, 120 and 180 kg/ha) in Randomised Block Design with factorial concept replicated thrice. Application of Nitrogen, and Sulphur significantly influenced the growth and yield of clove basil. Among the different nitrogen levels, application of 200 kg N ha^{-} observed maximum fresh herbage yield per plot (16.28 kg), dry herbage yield per plot (5.80 kg), fresh herbage yield per hectare (18.64 t), dry herbage yield per hectare (5.95 t) and oil yield (6.43 ml kg^{-1}). Among the different sulphur levels, application of 60 kg S ha^{-} observed maximum fresh herbage yield per plot (13.52 Kg), dry herbage yield per plot (5.16 kg), fresh herbage yield per hectare (18.50 t), dry herbage yield per hectare (5.77 t) and oil yield (5.94 ml kg^{-1}). Among the interactions, $N_{200}S_{60}$ (200 kg N ha^{-1} and 60 kg S ha^{-1}) gives maximum fresh herbage yield per plot (19.00 kg), dry herb yield per plot (6.13 kgs) fresh herbage yield per hectare (20.90 t), dry herbage yield per hectare (6.63 t) and oil yield (6.66 ml kg^{-1}).From herb and oil yield maximization point of view 200 kg N ha^{-1} and 60 kg S ha^{-1} was found to be the best along with application of 70 kg P_2O_5 and 70 kg K_2O ha^{-1}.

Keywords: Clove basil, nitrogen, sulphur, herbage, oil

Introduction
Clove basil (*Ocimum gratissimum* L.) is an herbaceous plant which belongs to the family Labiatae and is indigenous to tropical areas especially India and also in West Africa (Prabhu *et al.,* 2009). The plant is perennial, under shrub with ovate, lanceolate green leaves. Flowers are small, pale yellow. Essential oil is pale yellow with high percentage of eugenol (70-75%). Eugenol is having high value in flavoring of all kinds of food products in food processing industry. Eugenol is also used in the synthesis of vanillin which is the world's mostly used flavor of all kinds of food products. *Ocimum gratissimum* has been used extensively in the traditional system of medicine in many countries. It possesses antimicrobial, relaxant, anti-inflammatory, hypoglycemic, analgesic properties with insect growth retardant and radical scavenging (Deepthanjali and Ajay., 2013) [1]. In India, the whole plant has been used for the treatment of sunstroke, headache and influenza, as a diaphoretic, antipyretic and for its anti-inflammatory activities (Prajapathi *et al*., 2003) [7].
Nitrogen is most recognized in plants for its presence in the structure of the protein molecule. In addition, nitrogen is found in important molecules like purines, pyrimidines and coenzymes. Sulphur is the fourth major nutrient for plants (Platan and Jennes, 1982) [5]. Insufficiency of sulphur is known to hamper N-metabolism and synthesis of S-containing amino acids and thus exerts adverse effects on both yield and quality of crop (Hore *et al*., 2014) [3]. In spite of great utility, little attention has been paid to evolve suitable package of practices for profitable cultivation of clove basil. Keeping this in view, the present investigation was undertaken to find out the effect of nitrogen and sulphur on growth and yield of Clove basil.

Materials and Methods
The field experiments were carried out during the *kharif* season of two consecutive years *i.e*., 2015-2016 and 2016-2017 at Medicinal and Aromatic Plants Research Station, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad. In both

the years, nursery was raised in beds of convenient length and 1m width raised beds by mixing soil, sand and compost in the ratio of 3:1:1. The seeds were sown in the rows at a distance of 5 cm. Proper care of seedlings were taken until they become six weeks old. The seedlings was transplanted into 3×3 m^2 plots at a spacing of 45×45 cm. The experiment was conducted with three levels of Nitrogen (100, 150 and 200 kg/ha) and three levels of Sulphur (60, 120 and 180 kg/ha) andwas laid out in Factorial Randomized Block Design replicated thrice. The doses of fertilizers were adjusted with the application of urea, single super phosphate, muriate of potash. All the plots were applied with uniform dose of P and K at the rate of 70kg P_2O_5 and 70kg K_2O per hectare. Different doses of nitrogen in the treatments were given in 3 split doses, one third applied with full dose of phosphate, potash and sulphur and the remaining is applied in two split doses after first and second cuttings. The first harvest was obtained at 90-95 days after planting. Thereafter, it was harvested at every 65-75 days interval. Harvesting was done on bright sunny days for high and good quality oil. The observations were recorded at final harvest from five randomly selected plants. The projected yield per hectare was calculated on the basis of yield per plot, considering 75% area occupied by clove basil.

Statistical Analysis

The experimental data were analyzed by adopting analysis of variance (ANOVA) technique with respect to design of the experiment according to Gomez and Gomez (1984), where 'F' value was found to be significant at 5% level of probability. Critical difference (C.D.) was also calculated.

Results and Discussion

Nitrogen is the most recognized in plants for its presence in the structure of protein molecule. Nitrogen is found in important molecules like purines, pyramidines and coenzymes.

Sulphur is involved in the synthesis of amino acids, proteins, fatty acids which increase the protein quality.

The results obtained from the present investigation have been discussed under following heads:

Effect of Nitrogen (N): The pooled data presented in Table - 1 in case of Nitrogen showed that plant height increased from 73.57 to 85.86 cm with increasing level from 100-150 kgs ha^{-1} and there by decreased. Each increasing level of nitrogen showed increase in herb and oil yield parameters of clove basil. In respect of number of primary branches, decreasing trend of branches (21.46 to 19.69) was observed with increasing level of Nitrogen from 100 to 200 Kgs ha^{-1} Nitrogen is the most recognized in plants for its presence in the structure of the protein molecules. Nitrogen is found in important molecules like purines, pyramidines, and coenzymes.

Application of 200 kg N ha^{-} recorded significantly highest fresh herbage yield per plot (16.28 kg), dry herbage yield per plot (5.8 kg), fresh herbage yield per hectare (18.64 t), dry herbage yield per hectare (5.95 t) and oil yield (6.43 ml kg^{-1}) as compared to lower level of nitrogen i.e. Application of 100 kg N ha^{-} recorded fresh herbage yield per plot (11.48 kg), dry herbage yield per plot (3.72 kg), fresh herbage yield per hectare (16.17 t), dry herbage yield per hectare (5.03 t) and oil yield (3.85 ml kg^{-1}). This might be due to favorable function of nitrogen, being a major structural constituent of cell, help in stimulating the cell division and cell elongation. This findings are similar to the results reported by Saad *et al*. (2017) and Patel *et al*. (2013).

Effect of Sulphur (S): The pooled data presented in Table -1 showed the significant variations in case of sulphur individual effect but not in Nitrogen and interations in respect of plant height. The plant height was maximum (86.33cm) with increased level of sulphur (180kg ha^{-}).

But in respect of sulphur, the number of primary branches ranged between 19.62 to 19.55 cm with increasing level of sulphur from 60-180 Kgs ha^{-1} sulphur is involved in the synthesis of anine acids, proteins, fatty acids and increase protein quality.

Application of 60 kg S ha^{-} recorded significantly highest maximum fresh herbage yield per plot (13.52 kg), maximum dry herbage yield per plot (5.16 kg), fresh herbage yield per hectare (18.50 t), dry herbage yield per hectare (5.77 t) and oil yield (5.94 ml kg^{-1}) as compared to higher level of sulphur i.e. Application of 120 kg S ha^{-} recorded fresh herbage yield per plot (12.84 kg), dry herbage yield per plot (4.25 kg), fresh herbage yield per hectare (16.55 t), dry herbage yield per hectare (5.42 t) and oil yield (3.85 ml kg^{-1}). Hore *et al.* (2014) [3] and Patel *et al*. (2013) reported that upto 60 kg S ha^{-} and 30 kg S ha^{-} gives maximum yield in garlic and coriander respectively. In this experiment, results have shown the positive response to sulphur at 60 kg S ha^{-} and negative response at higher dose to sulphur *i.e.*120 kg S ha^{-} and 180 kg S ha^{-1}.

Effect of interaction of Nitrogen and Sulphur (N x S): The maximum plant height was recorded in N_{100} S_{60} (91.10 cm) followed by N_{100} S_{180} (90.70 cm) when compared to N_{100} S_{120} (38.93cm) combination.

The interaction effect of nitrogen and sulphur levels were not significant in growth parameters like plant height and number of primary branches. But herb yield and oil yield parameters were found to be significant in clove basil. 3. The maximum number of primary braches (23.73) was recorded in N_{100} S_{180} followed by N_{150} S_{120} (22.36)

Among the interactions, $N_{200}S_{60}$ (200 kg N ha^{-1} and 60 kg S $ha^{-1)}$) recorded maximum fresh herbage yield per plot (19.00 kg), fresh herbage yield per hectare (20.90 t), dry herbage yield per hectare (6.63 t) and oil yield per Kg herbage (6.66 ml kg^{-1}) and was found to be significantly superior to remaining interaction treatments regarding herb and oil yield. This might be due to additive effect of nitrogen and sulphur which resulted in more availability and favorable effect on growth and yield attributes which ultimately enhanced herb yield and oil yield per hectare. Hore *et al.,* (2014) [3] reported similar result of the highest projected bulb yield with the interactions S_{60} N_{200} (60 kg S ha^{-1} and 200 kg N ha^{-1}) in garlic.

Table 1: Effect of sulphur and nitrogen on growth and yield of clove basil (Pooled data of two years).

Treatment	Plant height (Cm)	Number of Primary Branches	Fresh herbage yield (kg) per plot 3x3m	Dry herbage yield (kg) per plot 3x3m	Fresh Herbage Yield(t/ha)	Dry Herbage Yield(t/ha)	Oil Yield (ml/kg)
N_{100}	73.57	21.46	11.48	3.72	16.17	5.03	3.85
N_{150}	85.86	19.61	13.14	4.34	17.04	5.36	4.67
N_{200}	62.58	19.60	16.28	5.80	18.64	5.95	6.43
SEm (±)	72.56	17.23	15.27	4.87	1.66	0.56	2.72
CD at 5%	NS	NS	NS	1.47	5.03	1.70	8.24
S_{60}	78.77	19.62	13.52	5.16	18.5	5.77	5.94
S_{120}	56.92	21.50	12.84	4.25	16.55	5.42	3.85
S_{180}	86.33	19.55	14.55	4.44	16.81	5.15	5.16
SEm (±)	72.56	17.23	15.27	4.87	1.66	0.56	4.72
CD at 5%	219.43	NS	NS	NS	5.03	1.70	14.27
N_{100} S_{60}	91.10	20.33	8.63	2.80	13.80	4.20	3.36
N_{100} S_{120}	38.93	20.63	10.80	3.40	17.70	5.53	4.70
N_{100} S_{180}	90.70	23.73	15.03	4.96	17.03	5.35	5.96
N_{150} S_{60}	88.36	16.56	12.93	6.56	20.80	6.50	5.46
N_{150} S_{120}	88.50	22.36	14.66	3.56	16.63	5.20	5.00
N_{150} S_{180}	80.73	19.90	11.83	2.90	13.66	4.40	5.60
N_{200} S_{60}	56.86	22.26	19.00	6.13	20.90	6.63	6.66
N_{200} S_{120}	43.33	21.50	13.06	5.80	15.30	5.53	6.36
N_{200} S_{180}	87.66	15.03	16.80	5.46	19.73	5.70	6.26
SEm (±)	125.69	29.85	26.45	8.45	2.88	0.97	4.72
CD at 5%	NS	NS	NS	25.55	8.71	2.95	14.27

Conclusion

Among the different nitrogen levels, application of 200 kg N ha^{-} observed maximum fresh herbage yield (18.64 tonnes/ha) and oil yield (6.43 ml kg^{-1}). Among the different sulphur levels, application of 60 kg S ha^{-} observed maximum fresh herbage yield (18.50 tonnes/ha), and oil yield (5.94 ml kg^{-1}). Among the interactions, $N_{200}S_{60}$ (200 kg N ha^{-1} and 60 kg S $ha^{-1)}$) gave maximum fresh herbage yield (20.90 tonnes/ha) and oil yield (6.66 ml kg^{-1}).

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