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Studies on influence of different levels of Nitrogen and Sulphur on herbage and essential oil yield of Palmarosa (*Cymbopogon martinii*)

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Abstract
A field experiment was conducted on growth and yield parameters of Palmarosa at Medicinal and Aromatic plants Research station, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad, during kharif 2016-17 and 2017-18. An experiment with Randomised Block Design was conducted with the objective to "Study the influence of Nitrogen and Sulphur on herbage and essential oil yield of palmarosa by following the technical programme as T1(100-60-40 Kg NPK/ha), T2(150-60-40 NPK/ha), T3(200-60-40 NPK/ha), T4(100-60-40 NPK/ha+30 kg Sulphur), T5(150-60-40 NPK/ha+30 kg Sulphur), T6(200-60-40 NPK/ha+30 kg Sulphur), T7(100-60-40 NPK/ha+60 kg Sulphur), T8(150-60-40 NPK/ha+60 kg Sulphur), T9(200-60-40 NPK/ha+60 kg Sulphur. The fresh herbage yield per hectare was highest (12.25 t) with 200:60:40 kg NPK/ha+60kg Sulphur/ha followed by 200:60:40 kgNPK/ha+30kg Sulphur/ha while the lowest yield per hectare (8.50t) was noticed with 100:60:40 kgNPK+60 kg Sulphur/ha. Considering the importance of crop, every effort is being made to increase the oil production of the crop by using improved nutrient management practices.

Keywords: Palmarosa, nitrogen, sulphur, herbage yield and oil yield

Introduction
Cymbopogon martinii commonly known as Palmarosa or Rosha grass is a tall perennial tufted hedge native to most parts of sub tropical India. The species occurs in patches in open shrub forests in parts of Madhya Pradesh, Maharashtra and Andhra Pradesh and Telangana states in India where it is commercially collected and distilled for its oil. In recent, the crop is cultivated commercially and oil is extracted and sold in the market. It is universally accepted that the use of chemical fertilizers is an integral part of the package of practices (like use of improved seeds, proper soil and water management, improved cultural practices, plant protection measures, postharvest operations etc.) However literature on nutrient management in palmarosa is lacking. Therefore, the requirement of nutrients should be worked out with prime consideration to soil test values and biological yield potential for specific locations (Jayalakshmi *et al.* 2013) [4]. The sulphur is increasingly being recognized as fourth major nutrient after nitrogen, phosphorus and potassium play major role in oil yielding crops (Bhat *et al*. 1992 and Yousuf *et al*. 2014) [2, 11]. In general oil yielding crops require more sulphur than phosphorus for high yield and quality. The importance of Sulphur in agriculture is increasingly emphasized and its role in crop production is well documented. Sulphur can improve N uptake and nitrogen use efficiency and improves overall yields by mitigating hidden soil S deficiency. Hence, a field experiment was carried out at Medicinal and Aromatic Plants Research Station, Rajendranagar, Hyderabad during 2016 to 2018 to study the effect of Nitrogen and Sulphur on herbage and essential yield of palmarosa with the following objectives.

1. To study the growth characters of *Plumbago zeylanica*
2. To standardize the package of practices *viz* spacing and influence of organic manures on root yield

Materials and Methods
A field experiment was conducted on influence of different levels of Nitrogen and Sulphur on herbage and essential oil yield of palmarosa (*Cymbopogon martinii*) at Medicinal and Aromatic Plants Research Station, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad.
An experiment was conducted with Randomised Block Design replicated thrice with the objective to study the influence of Nitrogen and Sulphur on herbage yield and essential oil yield of palmarosa with three levels of Nitrogen and three levels of Sulphur by following the technical programme as T1(100-60-40 Kg NPK/ha), T2(150-60-40 NPK/ha),

T3(200-60-40 NPK/ha), T4(100-60-40 NPK/ha+30 kg Sulphur), T5(150-60-40 NPK/ha+30 kg Sulphur), T6(200-60-40 NPK/ha+30 kg Sulphur), T7(100-60-40 NPK/ha+60 kg Sulphur), T8(150-60-40 NPK/ha+60 kg Sulphur), T9(200-60-40 NPK/ha+60 kg Sulphur. The observations on growth and yield parameters of Palmarosa during two seasons of kharif 2016-17 and kharif 2017-18 were recorded.

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) [3], where 'F' value was found to be significant at 5% level of probability. Critical difference (C.D.) was also calculated.

Results and Discussion

The present study on different levels of nitrogen and sulphur on Herbage yield and oil yield in Telangana region revealed that there was influence on the growth parameters as well as yield and oil production of palmarosa.

During the two consecutive years of study, the plant growth was significantly influenced by the treatments. Among the treatments, the treatment T5 (150-60-40 Kg NPK and 30 Kg Sulphur/ha) recorded the maximum plant height of 188.00 cm followed by T6 (200 – 60- 40 Kg NPK and 60 Kg sulphur/ha) and T7 (100 – 60 – 40 Kg NPK and 60 Kg sulphur/ha) recording 182.21 cm and 178.46 cm respectively.

Number of tillers per plant was significantly different among the treatments. The high test number of tillers per plant (24.22) was recorded in T9 (200 – 60 40 Kg NPK and 60 Kg sulphur/ha) followed by T5 (150 – 60-40 Kg NPK and 30 Kg sulphur/ha) and T4 (100 – 60 -40 Kg NPK and 30 Kg sulphur/ha) recording 21.63 and 20.56 tillers per plant respectively.

Leaf length and leaf width were reported to be maximum of 29.17 cm and 2.20 cm respectively in T4 (100 – 60-40 Kg NPK and 30 Kg sulphur/ha). Number of leaves per clump of 252.17 leaves and Fresh herbage yield of 0.22 Kg per hill were recorded in treatment T9 (200-60-40 Kg NPK and 60 Kg sulphur/ha).

Among different levels of Nitrogen and Sulphur on Herbage and oil yield of palmarosa, T9 (200-60-40 Kg NPK and 60 Kg sulphur/ha) registered the highest Fresh herbage yield of 6.84 t/ac/ harvest followed by T8 (150-60-40 Kg NPK and 60 Kg sulphur/ha) recording, 5.78 t/ac/harvest.

The higher herbage yield of palmarosa and increase of yield may be attributed to improved vegetative growth of plant represented by plant height, number of tillers per plant and number of leaves per clump. All the vegetative parameters which are increased due to favourable function of nitrogen being a major structural constituent of cell, thus helping in stimulation of cell division and cell elongation. These findings are in confirmity with the studies of Baboo and Rana (1995) [1], Naghera *et al.* (2000) [5] and Pawar *et al.* (2007) [8] in coriander crop. Indirectly the physical condition of soil *viz*., aggregation, aeration, permeability, water holding capacity and biological condition of soil, favoured and resulted in higher yield. Where Sulphur might be attributed to increased availability of nutrients owing to favourable environment created by sulphur and also it plays a significant role in overall biosynthesis processes. Similar results were in agreement in coriander with the findings of Nwaduke and Chude (1995) [6], Singh *et al.* (1999) [9] and Tripathi *et al.* (2001) [10] and Patel *et al*. (2008) [7].

The report of oil yield though it is non significant, the highest oil yield was recorded in treatment T9 (200 – 60 -40 Kg NPK and 60 Kg Sulphur / ha) with yield of 4.66 ml/ Kg herbage.

The same treatment T9 has recorded the highest oil yield of 8.07 Kg/ ac/harvest. The highest oil yield might be attributed to increased availability of nutrients owing to favourable environment created by sulphur and sulphur plays significant role in overall biosynthesis processes. Sulphur is an important constituent of glutathione which is involved in synthesis of essential oils. These findings are supported and the beneficial effect of sulphur on oil content and oil yield was observed in coriander (Singh *et al.* 1999 and Tripati *et al.* 2001) [9, 10].

Table 1: Effect of different levels of Nitrogen and Sulphur on Herbage and Essential oil yield of Palmarosa during 2016-17 and 2017-18

Treatment	Plant Height (cm)			No. of tiller/ plant			Leaf length (cm)			Leaf width (cm)		
	(1)			(2)			(3)			(4)		
	2016-17	2017-18	Means	2016-17	2017-18	Means	2016-17	2017-18	Means	2016-17	2017-18	Means
T1 100-60-40 Kg@ NPK/ha	174.00	174.26	174.13	19.73	18.53	19.13	26.60	27.62	27.11	1.57	1.62	1.59
T2 150-60-40 Kg@ NPK/ha	170.00	169.66	169.83	13.73	13.72	13.72	31.73	31.05	31.39	1.72	1.83	1.77
T3 200-60-40 Kg@ NPK/ha	158.00	187.93	172.96	18.06	17.62	17.84	28.20	29.32	28.76	2.05	1.98	2.01
T4 100-60-40 Kg@ NPK/ha + 30 Kg sulphur	156.00	188.33	172.16	20.08	21.05	20.56	28.66	29.68	29.17	2.20	2.21	2.20
T5 150-60-40 Kg@ NPK/ha + 30 kg sulphur	178.00	198.00	188.00	22.13	21.17	21.63	28.26	29.13	28.69	2.05	2.00	2.02
T6 200-60-40 Kg@ NPK/ha + 30 kg sulphur	175.00	189.43	182.21	16.20	17.25	16.72	25.33	24.34	24.83	2.02	1.96	1.99
T7 100-60-40 Kg@ NPK/ha + 60 kg sulphur	177.00	179.93	178.46	20.13	19. 91	20.02	26.86	27.80	27.33	2.05	2.02	2.03
T8 150-60-40 Kg@ NPK/ha + 60kg sulphur	168.00	173.46	170.73	18.33	18.26	18.29	25.93	24.82	25.37	1.82	1.92	1.87
T9 200-60-40 Kg@ NPK/ha +60 kg sulphur	168.00	179.80	173.90	23.73	24.71	24.22	29.00	27.93	28.46	2.20	2.21	2.20
SEM	0.06	3.99	2.02	2.08	2.45	2.26	2.04	3.01	2.52	22.28	23.49	22.88
CD	NS	11.97	5.98	6.25	7.21	6.73	NS	NS	NS	NS	NS	NS

Table 2: Effect of different levels of Nitrogen and Sulphur on Herbage and Essential oil yield of Palmarosa during 2016-17 and 2017-18

Treatment	No. of leaves/ clumps			Fresh herbage yield/ hill (kg)			Fresh herbage yield (t// ac/ harvest)			Oil yield (ml/kg)			Essential oil yield (Kg/ac/ harvest)		
	(5)			(6)			(7)			(8)			(9)		
	2016-17	2017-18	Means	2016-17	2017-18	Means	2016-17	2017-18	Means	2016-17	2017-18	Means	2016-17	2017-18	Means
T1 100-60-40 Kg@ NPK/ha	199.06	199.06	197.61	0.16	0.18	0.17	5.11	3.48	4.29	4.20	4.06	4.13	68.74	56.48	62.61
T2 150-60-40 Kg@ NPK/ha	143.53	145.52	144.52	0.15	0.17	0.16	5.23	4.02	4.63	4.22	4.26	4.24	70.64	68.48	69.56
T3 200-60-40 Kg@ NPK/ha	213.20	214.15	213.67	0.21	0.22	0.21	5.37	4.84	5.11	4.21	4.96	4.58	72.46	72.00	72.23
T4 100-60-40 Kg@ NPK/ha + 30 Kg sulphur	204.06	203.72	203.89	0.22	0.23	0.22	5.14	4.52	4.83	4.01	4.96	4.48	66.14	67.23	66.69

T5 150-60-40 Kg@ NPK/ha + kg sulphur	213.20	212.30	212.75	0.23	0.21	0.22	5.28	5.03	5.15	4.00	4.96	4.48	67.82	74.82	71.32
T6 200-60-40 Kg@ NPK/ha + 30 kg sulphur	202.00	205.01	203.50	0.20	0.20	0.2	5.63	5.21	5.42	4.08	4.96	4.52	73.71	75.52	74.61
T7 100-60-40 Kg@ NPK/ha + 60 kg sulphur	214.26	216.32	215.29	0.21	0.23	0.22	5.26	5.62	5.44	4.18	4.93	4.55	70.47	55.14	62.80
T8 150-60-40 Kg@ NPK/ha + 60kg sulphur	213.60	214.60	214.10	0.17	0.18	0.17	5.73	5.84	5.78	4.12	4.93	4.52	75.75	69.58	72.66
T9 200-60-40 Kg@ NPK/ha + kg sulphur	251.73	252.61	252.17	0.23	0.22	0.22	6.14	7.53	6.84	4.27	5.06	4.66	83.94	76.20	80.07
SEM	25.40	26.42	25.91	0.29	0.30	0.29	0.63	1.43	1.03	0.18	0.37	0.27	3.31	0.78	2.04
CD	NS	NS	NS	NS	NS	NS	1.90	NS	0.95	NS	NS	NS	9.93	2.15	6.04

Conclusion

Nitrogen, phosphorus, potassium, and sulphur played an important role in increasing herbage and oil yield of palmarosa. The fresh herbage yield per hectare was highest (12.25 t) with 200:60:40 kg NPK/ha+60kg Sulphur/ha. Though oil yield is non significant, the highest oil yield was recorded in same treatment where 200 – 60 -40 Kg NPK and 60 Kg Sulphur/ha applied recording 4.66 ml/oil yield per Kg herbage.

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