

Original Research Article

<https://doi.org/10.20546/ijcmas.2020.912.420>

Studies on the Effect of Nitrogen and Potassium Fertilizers on Growth, Herbage and Oil Yield of Palmarosa in Irrigation Condition (*Cymbopogon martini* [Roxb.] Will. Watson)

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ABSTRACT

Keywords

Palmarosa,
Nitrogen,
Potassium,
Essential oil yield,
Herbage

Article Info

Accepted:

xx November 2020

Available Online:

xx December 2020

An investigation was carried out at Medicinal and Aromatic Plant Research Station Rajendranagar, Sri Konda Laxman Telangana State Horticultural University, Mulugu (V & M), Siddipet Dist., Telangana State during the period of 2017-20 to determine the effect of Nitrogen and Potassium fertilizers on growth, herbage and oil yield of Palmarosa in irrigation condition. The study was conducted with the application of different levels of Nitrogen i.e, 0kg/ha, 100kg/ha, 200kg/ha, different levels of potassium 0kg/ha, 61.5kg/ha, 123kg/ha. The parameters in terms of fresh herbage yield, oil yield were significantly differed with respect to the different dosage of Nitrogen and potassium. The maximum plant height (198.35cm), no. of tillers/clump (46.86), fresh herbage yield (44.98 t/ha), essential oil yield (4.78 ml/kg) were found in N₃K₃ while the minimum plant height, no. of tillers/clump, fresh herbage yield, essential oil yield were found in N₁K₁.

Introduction

Palmarosa (*Cymbopogon martini* [Roxb.] Will. Watson) commonly known as Rosha grass. It is a tall perennial tufted hedge which contains a sweet smelling oil of rose like odour. Palmarosa oil also has notes of rye bread, tea and clary sage (Mallavarapu *et al.*, 1998). It is native of most parts of sub-tropical India and grows in warm humid

areas. The oil is extensively used as perfumery raw material in soaps, perfumes, cosmetics preparations and in the manufacture of mosquito repellent products. It is used for flavoring tobacco products, foods and non-alcoholic beverages (Prakasa Rao *et al.*, 1985). The volatile oil is used as a remedy for lumbago, stiff joints, skin diseases and for bilious complaints (Rajeswara Rao, 1999). The oil is a very rich source of high grade

geraniol (75- 90%) and the crop is regarded as the cheap source of geraniol. Moreover it is a hardy crop which can be grown on varied types of soil and climatic conditions. It can even tolerate drought and could be grown on marginal waste lands including saline/sodic/alkaline soils. Palmarosa grows wild in India, particularly in Madhya Pradesh, Maharashtra, and Andhra Pradesh. It is also found in lesser frequency in Karnataka, Tamilnadu and Uttar Pradesh. India accounts for 70% of the total annual world production of palmarosa oil (Lawrence 1985) and is a major supplier to the world market. The growth and yield of Palmarosa plantation mainly depend upon the proper selection of variety and its nutritional management.

Nitrogen is most recognized in plants for its presence in the structure of protein molecule. Nitrogen fertilization enhanced the development of the aerial parts. The crop is being cultivated in large area and the application of nitrogen fertilizer was found to increase herbage and oil yields (Prakasa Rao *et al.*, 1985; Yadav *et al.*, 1985; Rajeswara Rao *et al.*, 1991). Potassium is a key essential plant nutrient although it is not a constituent of any plant part. It acts as catalyst for many of the enzymatic processes which are necessary for plant growth. It also regulates the opening and closing of stomata which affect carbon dioxide uptake for photosynthesis (Somida 2002). Potassium uptake is very high by palmarosa under irrigated condition (Prakasa Rao and Ganesha Rao 1996). Lemongrass (*C. flexuosus*), Tagetes minuta and palmarosa (*C. martinii*) also responded to K application (Prakasa Rao *et al.*, 2001; Singh *et al.*, 2005; Singh and Ganesha Rao 2005). Recently, there is evidence that K may become a limiting factor in the cultivation of some essential oil bearing plants in red soil regions (Prakasa Rao *et al.*, 1996). The present work was therefore undertaken to study the cultivation practices

of different nitrogen and potassium fertility levels by Palmarosa crop.

Materials and Methods

The experiment entitled “Studies on the effect of Nitrogen and Potassium fertilizers on growth, herbage and oil yield of Palmarosa in irrigation condition (*Cymbopogon martinii* [Roxb.] Will.Watson)” was carried out for three years (2017-2020) at Medicinal and Aromatic Plant Research Station Rajendranagar, SKLTSHU, Hyderabad.

The meteorological data were collected from the Agricultural Research Institute, Rajendranagar for the experimental period of three years (2017-2020). It comes under sub tropical zone and is situated at latitude of 17⁰30¹ N and longitude of 78⁰42¹ E. It was normal weather data on total rainfall, maximum and minimum temperature, relative humidity, that prevailed during the period of experimentation.

The land used under the experimental layout was red with good drainage and low water holding capacity with uniform texture. The soil characteristics were, pH 7.20, electrical conductivity 0.67 dSm⁻¹, organic carbon 0.32%, Available Nitrogen 120 kg/ha, Available Phosphorus 48 kg/ha, Available Potassium 60 kg/ha.

The experiment was designed in Factorial Randomised Block Design with three replications with the spacing of 45*30 cm. At the time of planting, fertilizer application of 120 kg/ha of Single Super Phosphate was applied. In the experiment, different levels of Nitrogen i.e, 0kg/ha, 100kg/ha, 200kg/ha, different levels of Potassium 0kg/ha, 61.5kg/ha, 200kg/ha was applied.

The following agronomic practices of Palmarosa were recorded as follows,

Plant height (cm): The plant height was recorded before each harvest.

No. of tillers/clump: The number of tillers/clump were recorded 90 days after sowing, in each plot taking 5 plants into consideration.

Fresh herbage yield (t/ha): In each plot, the crop was harvested with sickle 20cm above the ground level and immediately weighted for obtaining plot yield. Then plot yield was transferred to yield per hectare. A total of 11 harvests were taken during three years.

Essential oil yield (ml/kg herbage): The essential oil extraction was done at laboratory of Medicinal and Aromatic Plant Research Station, Rajendranagar. Fresh leaves essential oil was estimated using Clevenger's apparatus (Clevenger 1928). The chemical constituents of Palmarosa like geraniol and geranyl acetate were determined by gas chromatography.

Results and Discussion

Plant height (cm)

A significant difference was observed on plant height due to application of different dosage of Nitrogen. The maximum plant height (191.81cm) was recorded with Nitrogen of 200 kg/ha while the minimum plant height (158.77cm) was recorded with Nitrogen of 0 kg/ha.

Plant height was not found significant due to application of different dosage of potassium. The maximum plant height (180.98 cm) was recorded with Potassium of 123kg/ha while the minimum plant height (166.62cm) was recorded with Potassium of 0 kg/ha.

The interaction effect of Nitrogen and Potassium showed significant variation on plant height (Table 1). The highest plant

height (198.35cm) was recorded with Nitrogen of 200 kg/ha and Potassium of 123kg/ha (N_3K_3) which was on par (194.75cm) with Nitrogen of 200 kg/ha and Potassium of 61.5kg/ha (N_3K_2) while the minimum plant height (149.25cm) was obtained with the application of Nitrogen of 0 kg/ha and Potassium of 0kg/ha (N_1K_1). The N application increased the biomass and essential oil yields through increased plant height. These results agree with the finding of Singh and Sharma (2001).

No. of tillers/clump

A significant difference was observed on number of tillers/clump due to application of different dosage of Nitrogen. The maximum number of tillers/clump (45.47) was recorded with Nitrogen of 200 kg/ha and the minimum number of tillers/clump (33.15) was recorded with Nitrogen of 0 kg/ha. Number of tillers/clump was not found significant due to application of different dosage of potassium. The maximum number of tillers/clump (41.67) was recorded with Potassium of 123kg/ha while the minimum number of tillers/clump (37.04) was recorded with Potassium of 0 kg/ha.

The interaction effect of Nitrogen and Potassium showed significant variation on number of tillers/clump (Table 1). The highest number of tillers/clump (46.86) was recorded with Nitrogen of 200 kg/ha and Potassium of 123 kg/ha (N_3K_3) while the minimum number of tillers/clump (31.25) was obtained from Nitrogen of 0 kg/ha and Potassium of 0kg/ha (N_1K_1). It was observed that plant height and tiller production at each cutting was highest.

Fresh herbage yield (t/ha)

A significant difference was observed on fresh herbage yield due to application of different dosage of Nitrogen. The maximum

fresh herbage yield (42.76 t/ha) was received with Nitrogen of 200 kg/ha while the minimum fresh herbage yield (28.01t/ha) was received with Nitrogen of 0 kg/ha. Fresh herbage yield was found significant due to application of different dosage of potassium.

The maximum fresh herbage yield (39.35 t/ha) was received with Potassium of 123kg/ha while the minimum fresh herbage yield (33.03 t/ha) was recorded with Potassium of 0 kg/ha.

Table.1 Studies on the effect of Nitrogen and Potassium fertilizers on growth, herbage and oil yield of Palmarosa in irrigation condition during 2017-2020

Plant height (cm)				No. of tillers/clump				Fresh herbage yield/clump (kg)				
	K1	K2	K3	Mean	K1	K2	K3	Mean	K1	K2	K3	Mean
N1	149.25	160.76	166.32	158.77	31.25	33.65	34.56	33.15	0.86	0.98	1.17	1.00
N2	168.29	175.46	178.29	174.01	35.29	43.58	43.59	40.82	1.2	1.36	1.45	1.33
N3	182.34	194.75	198.35	191.81	44.59	44.96	46.86	45.47	1.49	1.5	1.61	1.53
Mean	166.62	176.99	180.98		37.04	40.73	41.67		1.18	1.28	1.41	
Factors	SE(M)+-		C.D at 5%		SE(M)+-		C.D at 5%		SE(M)+-		C.D at 5%	
N	5.2		10.2		2.1		4.2		0.12		0.25	
K	4.2		NS		1.2		NS		1.8		NS	
N*K	3.8		8.3		1.3		3.3		0.19		0.31	

Table.2 Studies on the effect of Nitrogen and Potassium fertilizers on growth, herbage and oil yield of Palmarosa in irrigation condition during 2017-2020

Fresh Herbage Yield/ha (t/ha)				Essential oil yield/kg (ml/kg herbage)				Essential oil yield/ha (kg/ha)				
	K1	K2	K3	Mean	K1	K2	K3	Mean	K1	K2	K3	Mean
N1	24.08	27.28	32.69	28.01	4.48	4.5	4.53	4.50	107.87	122.76	148.08	126.23
N2	33.57	37.89	40.39	37.28	4.58	4.61	4.62	4.60	153.75	174.67	186.6	171.67
N3	41.46	41.85	44.98	42.76	4.68	4.72	4.78	4.72	194.03	197.53	215	202.18
Mean	33.03	35.67	39.35		4.58	4.61	4.64		151.88	164.98	183.22	
Factors	SE(M)+-		C.D at 5%		SE(M)+-		C.D at 5%		SE(M)+-		C.D at 5%	
N	1.42		3.4		0.01		0.02		10.5		20.9	
K	3.2		4.68		0.01		0.02		8.2		17.3	
N*K	2.10		3.15		0.2		0.5		8.9		18.4	

Factor I : Levels of Nitrogen N1- 0 kg/ha., N2- 100 kg/ha., N3- 200 kg/ha.

Factor II : Levels of Potassium K1- 0 kg/ha., K2- 61.5 kg/ha., K3- 123 kg/ha

The interaction effect of Nitrogen and Potassium showed significant variation on fresh herbage yield (Table 2). The highest fresh herbage yield (44.98t/ha) was recorded with Nitrogen of 200 kg/ha and Potassium of 123 kg/ha (N₃K₃) while the minimum fresh

herbage yield (24.08t/ha) was obtained from Nitrogen of 0 kg/ha and Potassium of 0kg/ha (N₁K₁).

According to B.R.Rajeswara Rao (2001), addition of nitrogen (N) at 80 kg/ha per year

enhanced the total biomass yield by 57.6% and total essential oil yield by 60.3% in comparison to no N application. From series of an experiment conducted on lemon grass for more than a decade by Nair *et al.*, (1979) suggested that application of 100 kg N ha⁻¹ was found to be beneficial than control. These results also supported by Sundaravadivel *et al.*, (2000) who reported that the application of 75 Kg N ha⁻¹ produced highest levels of available nutrients (N, P and K) in the soil. Prakasha Rao *et al.*, (1985) observed that application of N fertilizers 100 kg N ha⁻¹ yr⁻¹ increased the herbage and essential oil yield of *C. flexuosus* while P and K fertilizers did not show any increase. Munnu singh (2008) reported that addition of potassium at 123 kg ha⁻¹ year⁻¹ gave the maximum total herbage yield of Palmarosa plants compared with zero level.

Essential oil yield (ml/kg herbage)

A significant difference was observed on oil yield due to application of different dosage of Nitrogen. The maximum oil yield (4.72 ml/kg) was recorded with Nitrogen of 200 kg/ha while the minimum oil yield (4.50 ml/kg) was recorded with Nitrogen of 0 kg/ha. Essential oil yield was found significant due to application of different dosage of potassium. The maximum oil yield (4.64 ml/kg) was recorded with Potassium of 123 kg/ha while the minimum oil yield (4.58 ml/kg) was recorded with Potassium of 0 kg/ha.

The interaction effect of Nitrogen and Potassium showed significant variation on essential oil yield (Table 2). The highest oil yield (4.78 ml/kg) was recorded with Nitrogen of 200 kg/ha and Potassium of 123 kg/ha (N₃K₃) which was on par (4.72 ml/kg) with Nitrogen of 200 kg/ha and Potassium of 61.5kg/ha (N₃K₂) while the minimum oil yield (4.48 ml/kg) was obtained from

Nitrogen of 0 kg/ha and Potassium of 0kg/ha (N₁K₁).

Application of nitrogen at 200 kg ha⁻¹ year⁻¹ increased total essential oil yield of Palmarosa (*Cymbopogon martini*) by 102.6% over control (no added N) under semi-arid tropical climate (Munnu singh, 2008). Yadav *et al.*, (1984) studied the fertilizer nitrogen recovery and growth of Java citronella as influenced by nitrogen and concluded that the herbage, citronella oil yields and nitrogen uptake by the crop increased with the increased rate of nitrogen from 0 to 180 kg ha⁻¹ in all cuttings. Total herbage production increased by 28.40 and 53 % and Citronella oil by 26, 38 and 49 to due 60, 120 and kg N ha⁻¹ respectively over control. Prakasha Rao *et al.*, (1983) conducted a two year experiment (1979-81) to study the effect of N, P and K fertilizers on growth and yield of Java citronella in a sandy loam soil. Application of 200 kg N ha⁻¹ yr⁻¹ resulted in significantly high yields of herb and essential oil and uptake of N, P and K.

In conclusion from this investigation, the highest fresh herbage and oil yield was recorded in the treatment combination of Nitrogen of 200 kg/ha and Potassium of 123 kg/ha (N₃K₃). It can be concluded that the herbage yield, oil yields of nitrogen uptake by the crop increased with the increased rate of nitrogen from 0 to 200 kg ha⁻¹.

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How to cite this article:

Cheena, J., V. Krishna Veni, M. Padma and Sreenivas, M. 2020. Studies on the Effect of Nitrogen and Potassium Fertilizers on Growth, Herbage and Oil Yield of Palmarosa in Irrigation Condition (*Cymbopogon martini* [Roxb.] Will. Watson). *Int.J.Curr.Microbiol.App.Sci.* 9(12): 3538-3544. doi: <https://doi.org/10.20546/ijcmas.2020.912.420>