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Effect of Nitrogen and Phosphorus Levels on Herbage and Oil Yield of Palmarosa (*Cympogon martinii*)

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ABSTRACT

A field experiment was carried out during 2007-08 at Nagarjun Medicinal and Aromatic Plants Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. There were four levels of nitrogen *viz.,* 0 kg (N_0), 40 kg (N_1), 60 kg (N_2), 80 kg (N_3) and three levels of phosphorus 0 kg (P_0), 20 kg (P_1), 40 kg (P_2) ha^{-1}, tried in factorial randomized block design with three replications. The experimental findings revealed that maximum plant height and number of tillers were recorded by the application of 80 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1}. Similarly maximum fresh herbage and oil yield were noticed with the application of 80 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1}

Key words : Palmarosa, Oil yield.

Cymbopogan grasses are important for their essential oils and twenty seven species are found in India. However, only *C. nardus*, *C. citratus*, *C. winterianus* and *C. motia* found are cultivated, *C. flexuosus, C. martinii* and *C. pendulus* are found in both cultivated and in wild state while the rest of the species occur in wild state only (Gupta, 1983). *Cympogon martinii* commonly known as Palmarosa or Rosha grass was selected for the study. it is a tall perennial tufted hedge native of most parts of sub tropical India. The species occurs in patches in open shrub forests in parts of Madhya Pradesh, Maharashtra and Andhra Pradesh where it is commercially collected and distilled for its oil. The total area under the crops ranges between 30,000 to 40,000 ha.

Palmarosa oil is very rich in geraniol (75-90 %) present both in free and bound form and oil is thus source of high grade geraniol for cosmetics and perfumery industry. Considering the importance of this crop every effort is made to increase the oil production of the crop by using improved nutrient management practices.

MATERIAL AND METHODS

A field experiment to study "The effect of nitrogen and phosphorus levels on herbage and oil yield of Palmarosa" was conducted at Nagarjun Medicinal and Aromatic Plants Garden, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *kharif* 2007-2008. The soil site selected for the experiment was a medium black. Typic Haplustert with medium fertility status and good drainage. There were twelve treatments combinations, laid in factorial randomized block design with three replications. The treatment include four levels of nitrogen *viz.,* 0 kg (N_0), 40 kg (N_1), 60 kg (N_2), 80 kg (N_3) and three levels of phosphorus 0 kg (P_0), 20 kg (P_1), 40 kg (P_2) ha^{-1},

The seed was mixed in 1:6 ratio with sand, and beaten to detach them from the accompanying glumes to ensure good germination. Four weeks age seedlings were planted at the spacing of 45 x 30 cm. Protective irrigations were given at timely interval as and when required. Nitrogen was applied through urea in three split doses as per 2:1:1 basal dose, after 1st cutting and after 2nd cutting, respectively. Phosphorus was applied as per the treatment as basal dose at the time of planting through single super phosphate. Potassium was applied as basal dose @ 40 kg ha^{-1} through muriate of potash to all the treatments.

The first cutting was done after 110 days of plating *i.e.* at flowering stage, subsequently second and third cuttings were undertaken after 90 and 170 days after 1st cutting, respectively. The second cutting was delayed as the growth of the Palmarosa was adversely affected due to cold wave during December and January.

Ten plants were selected randomly from each treatment per plot for recording observations. The observations on number of tillers at every harvesting were recorded. The plant height was recorded at every harvest and average height was

calculated. Yield per plant was recorded from observational plants randomly under each treatment and averages were worked out per plant. The plant taken for of fresh was subjected to drying for recording the dry weight of dry herbage and averages were calculated per plant.

On the basis of weight of fresh herbage per plant at each cutting was recorded and added to work out total fresh herbage yield per hectare in tones. Oil content in fresh herb was estimated at each cutting. The oil yield was calculated by multiplying herb yield with oil content.

Oil content recovery by Clevengers apparatus

The oil content as influenced by each of treatment is estimated by using clevengers apparatus. However for determination of quality parameters the oil was distilled by a small hydro steam distillation lab unit having capacity of 15 kg biomass per batch and quality parameters were determined as per procedures described in Training Manual of FFDC, Kannauj (U.P.).

Clevengers appratus is used for the determinations of the percentage of volatile oils present in the oil bearing material.

$$\% \text{ Oil} = \frac{Weight\ of\ the\ oil}{\text{Weight of meterial taken}} X\ 100$$

RESULTS AND DISCUSSION

Effect of nitrogen on plant height

Significantly maximum plant height at 1st, 2nd, 3rd cuttings (213.22, 210.25 and 227.79 cm respectively) was observed under the treatment N_3 (80 kg N ha^{-1}) followed by treatment N_2 (60 kg N ha^{-1}) (Table 1). Maximum plant height attained by Palmarosa due to optimum proportion of nitrogen and carbohydrates compounds achieved with in the plants under treatment 80 kg N ha^{-1}. Significantly lowest plant height (190.62, 186.89 and 193.06 cm at 1st, 2nd and 3rd cutting, respectively) was recorded under treatment N_0 (0 kg N ha^{-1}). Low height is due to disturbed relationship between nitrogen and carbohydrate compound. This data was in agreement with Maheswari *et al.* (1984) who also reported that plant height and fresh herbage yield were significantly increased over control upto application of 60 kg N + 30 kg P + 30 kg K per ha yield.

Effect of phosphorus on plant height

Phosphorus application at various levels had significant effect on plant height at 1st, 2nd, 3rd cuttings and significantly maximum plant height (203.31, 199.50, 207.05 cm at 1st, 2nd and 3rd cuttings respectively) was recorded, under treatment P_2 (40 kg P_2O_5 ha^{-1}) followed by P_1 (Table 1). Phosphorus is an important growth promoting element and therefore, resultions is an increase in growth. Singh *et al.* (1991) reported plant height, and tiller production at each cutting with the simalar application of P levels up to 35 kg ha^{-1}

Interaction effect on plant height

Interaction effect of nitrogen and phosphorus on plant height was found significant in all the cuttings.

Maximum plant height at each cutting was recorded with the treatment combination of $N_3 + P_2$ i.e. 80 kg N + 40 kg P_2O_5 ha^{-1} followed by the treatment combination of $N_3 + P_1$ i.e. 80 kg N + 20 kg P_2O_5 ha^{-1}. Indicating that the importance of P for the growth of Palmarosa (Table 1).

Effect of nitrogen on Number of tillers

Significantly maximum number of tillers at 1st, 2nd and 3rd cutting (28, 28.1, 28.44 respectively) was observed under treatment N_3 (80 kg N ha^{-1}) followed by treatment N_2 (60 kg N ha^{-1}) (Table 1). Significantly lowest number of tillers at 1st, 2nd and 3rd cuttings (13.30, 14.11 and 20.30 respectively) was recorded under treatment N_0 (0 kg N ha^{-1}). Formation of plant parts above the soil represent photosynthesis apparatus in conversion of solar energy into chemical energy totally depends on the utilization of carbohydrates and other metabolites in roots accelerated by nitrogen uptake which ultimately gives more number of tillers. These results are supported by Bommegowada *et al.* (1980a) who also revealed that application of 75 to 100 kg N ha^{-1} significantly increase tiller number and leaf area.

Effect of phosphorus on Number of tillers

Favourable effect of various phosphorus levels was noticed on the number of tillers per plant at each cutting. Significantly maximum number of tillers at 1st, 2nd and 3rd cuttings (22.32, 23.08, 25.49, respectively) was observed under treatment P_2 (40 kg P ha^{-1}) followed by treatment N_2 (20 kg P ha^{-1}). The lowest number of tillers (19.40, 20.50 and 22.33 1st, 2nd and 3rd cuttings respectively) was recorded under treatment P_0 (0 kg P_2O_5 ha^{-1}).

As phosphorus having close relationship in cell division and development, it stimulates early root development and growth. So, it might be the reason to improve tiller number due to increased application of phosphorus. This data also supported by the findings of Singh *et al.* (1991).

Table 1. Effect of nitrogen and phosphorus on plant height (cm), number of tillers and fresh herbage yield (tonne ha^{-1}) at various cuttings.

	Plant height			No. of tillers			Fresh herbage yield		
	1st cutting	2nd cutting	3rd cutting	1st cutting	2nd cutting	3rd cutting	1st cutting	2nd cutting	3rd cutting
Nitrogen levels (kg ha^{-1})									
N_0 – 0	190.62	186.89	193.06	13.30	14.11	20.30	3.52	3.84	4.13
N_1 – 40	191.40	187.16	193.35	19.10	21.00	22.00	4.16	4.81	5.03
N_2 – 60	196.54	192.82	197.79	23.00	24.11	25.33	4.65	5.38	5.66
N_3 – 80	213.22	210.25	222.79	28.00	28.11	28.44	5.21	5.92	6.13
'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (m) ±	0.48	0.34	0.35	0.55	0.52	0.44	0.08	0.05	0.06
CD at 5 %	1.33	0.95	0.97	1.53	1.46	1.23	0.24	0.16	0.19
Phosphorus levels (kg ha^{-1})									
P_0 – 0	193.02	189.36	196.98	19.40	20.50	22.33	4.39	4.70	5.00
P_1 – 20	198.05	194.78	201.22	20.80	21.91	24.25	4.43	5.05	5.30
P_2 – 40	203.31	199.50	207.05	22.32	23.08	25.49	4.53	5.17	5.40
'F' test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
SE (m) ±	0.41	0.29	0.30	0.47	0.45	0.38	0.07	0.05	0.05
CD at 5 %	1.15	0.82	0.84	1.32	1.26	1.06	0.21	0.13	0.16
Interaction									
SE (m) ±	0.24	0.17	0.17	0.27	0.26	0.22	0.04	0.02	0.03
CD at 5 %	0.66	0.47	0.48	NS	0.73	NS	NS	NS	NS

Table 2. Interaction effect of nitrogen and phosphorus on plant height (cm) at various cuttings.

	1st cutting				2nd cutting				3rd cutting			
	P_0	P_1	P_2	Mean(N)	P_0	P_1	P_2	Mean(N)	P_0	P_1	P_2	Mean(N)
N_0	189.46	190.90	191.50	190.62	179.33	190.00	191.36	186.89	190.83	193.16	195.20	193.06
N_1	187.83	192.66	193.76	191.4	185.66	186.83	189.00	187.16	192.36	194.43	193.26	193.35
N_2	193.96	196.66	199.00	196.54	190.16	193.33	195.00	192.82	195.13	198.76	199.50	197.79
N_3	201.00	209.66	229.00	213.22	199.13	208.96	222.66	210.25	209.60	218.53	240.26	222.79
Mean(P)	193.02	198.05	203.31		189.36	194.78	199.50	-	196.98	201.22	207.05	-
'F' test	Sig.				Sig.				Sig.			
SE(m) ±	0.24				0.17				0.17			
CD at %	0.66				0.47				0.45			

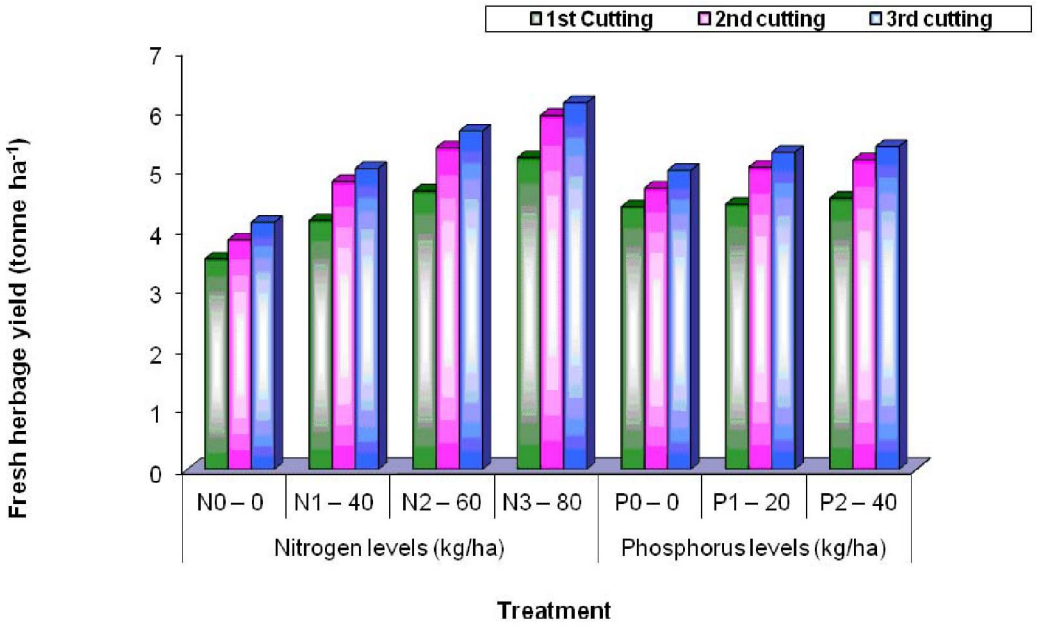
Table 3. Interaction effect of nitrogen and phosphorus on number of tillers at 2nd cutting.

Treatments	Phosphorus levels kg ha^{-1}			
	P_0	P_1	P_2	Mean (N)
Nitrogen levels (kg ha^{-1})				
N_0	13.00	14.00	15.33	14.11
N_1	20.00	21.00	22.00	21.00
N_2	23.00	24.33	25.00	24.11
N_3	26.00	28.33	30.00	28.11
Mean (P)	20.50	21.91	23.08	-
SE (m) ±	0.26			
CD at 5 %	0.73			

Table 4. Effect of nitrogen and phosphorus on oil content and oil yield at various cuttings.

	Oil content (%)			Oil yield (kg ha^{-1})		
	1st cutting	2nd cutting	3rd cutting	1st cutting	2nd cutting	3rd cutting
Nitrogen levels (kg ha^{-1})						
N_0 – 0	0.50	0.45	0.50	16.55	20.80	20.85
N_1 – 40	0.55	0.50	0.55	22.84	26.68	28.38
N_2 – 60	0.60	0.57	0.60	30.86	33.05	37.16
N_3 – 80	0.66	0.69	0.65	37.88	43.54	45.86
SE (m) ±	0.01	0.04	0.01	0.52	0.64	0.88
CD at 5 %	0.04	0.00	0.04	1.44	1.78	2.45
Phosphorus levels (kg ha^{-1})						
P_0 – 0	0.58	0.60	0.62	24.27	27.63	30.12
P_1 – 20	0.63	0.65	0.66	28.12	31.76	33.61
P_2 – 40	0.66	0.67	0.68	28.65	33.66	35.46
SE (m) ±	0.009	0.0363	0.0243	0.45	0.55	0.76
CD at 5 %	0.03	NS	NS	1.25	1.54	2.12
Interaction						
SE (m) ±	0.0144	0.0209	0.0141	0.26	0.32	0.44
CD at 5 %	NS	NS	NS	0.72	0.89	1.22

Figure 1. Effect of nitrogen and phosphorus on fresh herbage yield at various cuttings.



Interaction effect of nitrogen and phosphorus on number of tillers

Interaction effect of nitrogen and phosphorus on number of tillers was found significant at 2nd cutting, however in 1st and 2nd cutting it was found non significant.

The data from Table 3 revealed that significantly maximum number of tillers was recorded at the treatment combination N_3+P_2 (80 kg N + 40 kg P_2O_5 ha^{-1}) followed by treatment combination N_3+P_1 (80 kg N + 20 kg P_2O_5 ha^{-1}). N and P interaction had significant effect on growth (plant height, number of tillers). The detail study of above data revealed that the beneficial effect of nitrogen on vegetative growth was increased by higher level of phosphorus fertilization and vice-versa. It thus appears that the nitrogen and phosphorus on growth of Palmarosa is complimentary to each other.

Effect of nitrogen on fresh herbage yield

Nitrogen had significant effect on fresh herbage yield at each cutting under study. Significantly highest fresh herbage yield at 1st, 2nd and 3rd cuttings and total yield (5.21, 5.92, 6.13, 17.26 t ha^{-1} respectively) was observed under treatment N_3 (80 kg N ha^{-1}) followed by treatment N_2 (60 kg N ha^{-1}). Whereas lowest fresh herbage yield (3.52, 3.84, 4.13, 11.49 t ha^{-1}) respectively was recorded under treatment N_0 (0 kg N ha^{-1}) (Table 1).

In general each level of nitrogen was significantly superior to the preceding level. This is to be expected as nitrogen being a known growth promoting factor its application would naturally increase the vegetative growth and hence fresh herbage yield. These results were in agreement with findings of Singh and Singh (1992) who have also reported increased fresh herbage and oil yield with the application of 150 kg N ha^{-1}.

Effect of phosphorus on fresh herbage yield

Phosphorus application had significant effect on fresh herbage yield at each cutting. Significantly highest fresh herbage yield (4.53, 5.17, 5.4, 15.1 t ha^{-1} respectively) was recorded at 1st, 2nd and 3rd cuttings and total yield under treatment P_2 (40 kg P_2O_5 ha^{-1}). However, treatment P_1 (20 kg P_2O_5 ha^{-1}) was statistically at par with treatment P_2 (40 kg P_2O_5 ha^{-1}) at all three cuttings. As phosphorus stimulates vegetative growth and flowering, it might be the reason for increased fresh herbage yield due to phosphorus application (Figure 1).

Interaction effect on fresh herbage yield

The interaction effect between nitrogen and phosphorus on fresh herbage yield was found non significant. However, it may be observed that with higher dose of phosphorus, beneficial effect of nitrogen on fresh herbage yield was fairly enhanced.

Similarly with the higher dose of nitrogen, phosphorus increased the herbage yield to a greater extent than with lower doses of nitrogen. Therefore, both nitrogen and phosphorus growth promoting factors and complimentary to each other.

Effect of nitrogen on oil content and yield of Palmarosa oil

Nitrogen had significant effect on oil content at each cutting. Significantly highest oil content (0.66%, 0.69%, 0.65%, respectively) at 1st, 2nd and 3rd cuttings was recorded due to the application of 80 kg N ha^{-1} (N_3), which found superior over all other treatment levels (Table 4).

The maximum oil content found under treatment N_3 (80 kg N ha^{-1}) may be due to optimum level of nitrogen achieved by plant. This might be due to the fact that nitrogen is an essential constituent of protein and chlorophyll in many compounds in plant metabolism such as nucleotides, Phosphotodies, alcohol and aldehyde enzymes, *etc.* The results are in agreement with Bommegowada *et al.* (1980[b]).

Effect of phosphorus on the content and yield of Palmarosa oil

No significant effect of phosphorus application was recorded on the oil content of Palmarosa expect that of oil content observed at 1st cutting and the maximum oil content (0.68%) was obtained with P_2 (40 kg P_2O_5 ha^{-1}) level, however it was at par with P_1 (20 kg P_2O_5 ha^{-1}) (Table 4).

Interaction effect on the content and yield of Palmarosa oil

The interaction between nitrogen and phosphorus on oil content was found to be non significant. Profitability of the cultivation of any aromatic plant solely depends upon the yield of oil. Therefore, in any fertilizer experiment the effect of experimental treatment on the yield of oil could naturally extract maximum attention.

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