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RESEARCH ARTICLE

IRRIGATION AND NITROGEN MANAGEMENT IN PALMAROSA

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ABSTRACT

Field experiment was conducted with 16 treatment combinations consisting of four levels of irrigation (0.4, 0.6, 0.8 and 1.0 IW/CPE ratio) at 60 mm depth and four levels of N (0, 50, 100 and 150 kg N/ha/yr). It was conducted in split plot design with four replications at Soil and Water Management Farm, Navsari Agricultural University, Navsari. In all three cuttings were under taken during the course of field experiment. The results of field study indicated that the herbage yield and essential oil yield of palmarosa were significantly influenced by irrigation and N levels. Among the four levels of irrigation, the treatment 0.6 IW/CPE ratio recorded significantly higher herbage yield (58.2 t/ha/yr) and essential oil yield (256 kg/ha/yr)of palmarosa. Among the different N levels, application of 100 kg N/ha/yr resulted significantly higher herbage and essential oil yield over rest of the treatments. An increase in oil yield under N_{100} was of the order of 64, 21 and 3.5 per cent over N_0, N_{50} and N_{150}, respectively.

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INTRODUCTION

Among the aromatic grasses, the genus *Cymbopogon* consists of about 100 species, distributed mainly in the tropical region of Africa and South East India. It was an indigenous plant found in large tracts in open dry scrub forests of *peninsular* India. In recent times, its cultivation has been commercially taken up in the states of Madhya Pradesh, Karnataka, Maharashtra, Uttar Pradesh and Bihar. Palmarosa oil is rich in geraniol and possess a rose like odour which is used in perfumery, particularly for flavouring tobacco and for blending of soaps due to the lasting rose-note it imparts to the blend**.** India ranks first among the palmarosa oil producing countries and is the major supplier to the world market. The annual production of palmarosa in India is estimated to be 70-80 tonnes which are mostly obtained from wild sources (*i.e.* forests). Successful cultivation of palmarosa can also be done on problematic soils such as saline and alkali soils, poor fertile soils, sloppy lands and soils with high proportions of gravels and coarse sand. Palmarosa is cultivated both as rain fed and irrigated crop in several tropical and subtropical parts of India. It has been observed that there is 23 and 27 % increase in herbage and oil yield of palmarosa due to 2 irrigations over unirrigated (rain fed) crop, respectively (Maheshwari *et al.,* 1992). Although palmarosa is tolerant to soil moisture stress, irrigation during post rainy season has been found to favorably influence herbage and essential oil yields of palmarosa (Singh *et al.,* 2000). Palmarosa being a member of gramineae family and a perennial grass tend to remove large quantity of nutrients from the soil over long period of time to produce large biomass of herbage .It is observed that increasing the rate of N application up to 150 kg N/ha/yr on sandy loam soils significantly increased the herbage and essential oil yield of palmarosa (Yadav *et al.* 1985). Rajeswara Rao (2001) also reported that addition of N @ 80 kg/ha/yr enhanced the total biomass yield by 57.6 per cent and oil yield 60.3 per cent over no N application in palmarosa. Recently, in India, farmers have started commercial cultivation of aromatic crops like palmarosa, mint, lemongrass *etc.* due to increased demand from cosmetic industries and getting more profit than the traditional crops like paddy, soybean, *etc*.

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MATERIALS AND METHODS

The present experiment was conducted at plot no. E-14 of Soil and Water Management Research Farm, Navsari Agricultural University, Navsari, The experimental soil is classified as *Vertic ustochrepts* at subgroup level and it belongs to Jalalpor soil series. It is deep and moderately drained, predominantly containing smectite clay mineral. The soil is clayey in texture and having 61.33 per cent clay, high moisture retentive capacity of 35.1 per cent. It is low in available N, medium in organic carbon and available P and high in Fe, Mn and Cu and fairly rich in available potash. It is not having any problem of sodicity or salinity.

A field experiment with 16 treatment combinations consisting of four levels of irrigation (0.4, 0.6, 0.8 and 1.0 IW/CPE ratio) at 60 mm depth and four levels of N (0, 50, 100 and 150 kg N/ha/yr) was conducted in split plot design with four replications. Well rooted healthy two slips (Variety PRC-1) per hill were planted at specified distance on the ridge. Well decomposed FYM @ 10 t/ha and whole quantity of P_2O_5, K_2O and $ZnSO_4$ @ 60: 40 and 10 kg/ha/yr were applied at the time of planting. Nitrogen was applied in six splits as per the treatments. For irrigation purpose cumulative pan evaporation values were calculated from daily USWB class A pan evaporimeter installed at Soil and Water Management Research Farm, NAU, Navsari. Tube well water was used to irrigate the individual plot based on IW: CPE ratio. The parshall flume was fixed in channel for measuring the quantity of irrigation water. The time required for irrigating each plot at 60 mm depth was worked out and required quantity of water was applied by maintaining discharge of water through Parshall flume. From each plot ten clumps were selected randomly and 200 g fresh material was collected for estimation of essential oil. It was estimated by distillation of herbage using Clevenger's method. Per cent weight of oil was calculated by multiplying volume of oil with sp. gravity of oil *i.e.* 0.9 gm/cc.The oil yield was computed by using following formulae,

Oil yield (kg/ha) = Herbage t/ha x oil (%) x 10

RESULTS AND DISCUSSION

Herbage yield: The data on herbage yield (t/ha) of palmarosa as influenced by irrigation and N treatments are presented in Table 1. An appraisal of data indicated that the irrigation levels had significant effect on herbage yield of palmarosa, at first and second cutting as well as on herbage yield of total of three cuttings.

Table 1. Herbage yield (t/ha) of palmarosa as influenced by irrigation and N levels

Treatment	Herbage yield (t/ha)			
	I Cut	II Cut	III Cut	Total
Irrigation level (I)				
$I_{0.4}$	12.87	18.72	21.79	53.38
$I_{0.6}$	15.32	19.89	23.01	58.22
$I_{0.8}$	14.89	18.27	22.16	55.32
$I_{1.0}$	13.98	18.12	21.77	53.87
S.Em±	0.44	0.36	0.40	0.64
CD at 5 %	1.40	1.15	NS	2.06
CV (%)	12	8	7	5
Nitrogen levels (N)				
N_0	7.32	11.92	18.28	37.52
N_{50}	12.64	18.14	21.34	52.12
N_{100}	18.96	22.32	24.35	65.63
N_{150}	18.14	22.62	24.76	65.52
S.Em±	0.33	0.29	0.39	0.59
CD at 5 %	0.97	0.84	1.05	1.69
Interaction (I x N)				
S.Em±	0.67	0.59	0.73	1.18
CD at 5 %	1.94	1.59	NS	3.37
CV (%)	10	6	7	4

Significantly higher herbage yield was registered under treatment $I_{0.6}$ at first (15.32 t/ha) and second (19.89 t/ha) cutting as compared to rest of the treatments but remained at par with $I_{0.8}$ (14.89 t/ha) at first cutting. The treatments $I_{0.4}$, $I_{0.8}$ and $I_{1.0}$ remained at par with each other in second cutting.

The herbage yield of palmarosa was not affected significantly by irrigation levels at third cutting. However, total herbage yield of three cuttings was significantly affected due to irrigation levels. The treatment $I_{0.6}$ (58.22 t/ha) recorded maximum herbage yield as compared to $I_{0.8}$ (55.32 t/ha), $I_{1.0}$ (53.87 t/ha) and $I_{0.4}$ (53.38 t/ha) which were at par with each other. Under climatic conditions of New Delhi, Pareek and Maheshwari (1995) reported 0.6 IW/CPE as an optimum ratio for better growth and yield of palamarosa grown on sandy loam soil. Similarly, under subtropical conditions of Lucknow, Singh *et al.* (1997) also found that palmarosa need to be irrigated at 0.5 IW/CPE ratio. While under semi arid tropical conditions of Banglore, Singh (1999) found that lemongrass need to be irrigated at 0.75 IW/CPE ratio. The difference between optimum ratio for palmaroa by above workers and present study seems to be due to climatic and soil conditions.

Irrigating the palmarosa at 0.6 IW/CPE ratio gave 5, 7 and 9 per cent more yield than 0.8, 1.0 and 0.4 IW/CPE ratios respectively. The adverse effect of irrigation above 0.6 IW/CPE ratio on herbage yield of palmarosa could possibly due to poor aeration caused by excessive water application particularly on clay soil. Where as, lower yield recorded with 0.4 IW/CPE ratio seems to be due to moisture stress experienced by palmarosa. Herbage yield of palmarosa recorded at all the 3 cuttings were significantly influenced due to different rates of N application. At first cutting the treatment N_{100} (18.96 t/ha) recorded significantly higher herbage yield as compared to N_{50} and N_0 but it remained at par with N_{150}. The data of second and third cutting revealed that the treatments N_{150} and N_{100} recorded significantly higher herbage yield of palmarosa in comparison to N_{50} and N_0. However, these two treatments (N_{150} and N_{100}) remained at par with each other. Significantly lower herbage yield was noted under the treatment N_0 at all the three cuttings as well as total herbage yield of three cuttings than rest of the levels. The herbage yield of palmarosa was significantly influenced by interaction effect (I x N) (Table2) at first and second cutting while it remained unaffected in third cutting.

Table 2. Interaction effect of irrigation and nitrogen on herbage yield (t/ha) of palmarosa

Irrigation level (I)	N levels			
	N_0	N_{50}	N_{100}	N_{150}
	First cutting			
$I_{0.4}$	6.58	10.32	19.4	15.18
$I_{0.6}$	8.05	14.48	20.3	18.69
$I_{0.8}$	7.80	13.62	18.67	19.48
$I_{1.0}$	6.86	12.15	17.69	19.21
S.Em±			6.76	
CD at 5 %			1.94	
CV (%)			10	
Irrigation level (I)	Second cutting			
$I_{0.4}$	12.29	17.77	22.47	22.35
$I_{0.6}$	12.97	19.79	23.65	23.13
$I_{0.8}$	10.39	18.88	21.55	22.24
$I_{1.0}$	11.99	16.12	21.58	22.77
S.Em±			0.59	
CD at 5 %			1.69	
CV (%)			6	
Irrigation level (I)	Total of three cutting			
$I_{0.4}$	37.4	49.1	65.0	61.1
$I_{0.6}$	39.7	56.2	68.8	68.1
$I_{0.8}$	36.7	53.8	64.3	66.5
$I_{1.0}$	36.3	49.4	63.3	66.4
Mean (N)	37.5	52.1	65.6	65.5
S.Em±			1.18	
CD at 5 %			3.37	
CV (%)			4	

Table 3. Oil yield (kg/ha) of palmarosa as influenced by irrigation and N levels

Treatment	Oil yield			Total oil yield
	I Cut	II Cut	III Cut	
Irrigation level (I)				
$I_{0.4}$	58.99	94.49	106.73	260.21
$I_{0.6}$	67.89	100.82	111.00	279.72
$I_{0.8}$	65.48	88.30	102.61	256.39
$I_{1.0}$	58.77	87.57	97.42	243.76
S.Em±	2.23	1.78	4.05	5.67
CD at 5 %	7.12	5.71	NS	18.15
CV (%)	14	8	16	9
Nitrogen level (N)				
N_0	34.50	61.93	90.08	186.51
N_{50}	56.63	92.37	102.18	251.18
N_{100}	83.11	109.45	113.83	306.39
N_{150}	76.89	107.45	111.66	296.00
S.Em±	2.11	2.17	3.25	4.32
CD at 5 %	6	6	9	12
Interaction (I x N)				
S.Em±	4.22	4.35	6.51	8.64
CD at 5 %	NS	NS	NS	NS
CV (%)	13	9	12	7

A combination $I_{0.6}N_{100}$ recorded significantly higher herbage yield as compared to rest of the combinations at both the cuttings but it was at par with $I_{0.4}N_{100}$, $I_{0.6}N_{150}$, $I_{0.8}N_{100}$ and $I_{0.8}N_{150}$ in first cutting and $I_{0.4}N_{100}$, $I_{0.8}N_{100}$, and $I_{1.0}N_{150}$ in second cutting. Lower yield values were recorded with $I_{0.4}N_0$ and $I_{1.0}$ x N_0 treatment combinations at first and second cuttings. The results of total herbage yield of three cuttings was also affected significantly due to interaction effect. The treatment combination $I_{0.6}N_{100}$ recorded significantly higher herbage yield (68.8 t/ha) over rest of the treatment combinations and but remained at par with $I_{0.6}N_{150}$ (68.1 t/ha). In contrast $I_{1.0}N_0$ and $I_{0.4}N_0$ recorded significantly lower herbage yield than remaining combinations. Similar positive response to applied N by palmarosa was also observed by Pareek and Maheshwari (1995), Chauhan *et al.* **(**2000) and Rajeswara Rao (2001).

Essential oil yield: The essential oil yield of palmarosa was affected significantly (Table 3) due to individual effect of irrigation at first two cuttings only.

At first cutting, $I_{0.6}$ and $I_{0.8}$ were at par with each other, but, at second cutting $I_{0.6}$ out classed rest of the levels. With respect to total yield of oil, $I_{0.6}$ (256 kg/ha) maintained its superiority over rest of the levels. The results further revealed that in most of the cases the remaining levels of irrigation were at par with each other.

Similarly, N effect was also pronounced on the oil yield recorded at each cutting as well as total yield. Among the N levels, application of N @ 100 kg/haproduced significantly higher oil yield (306 kg/ha) in comparison to rest of the levels. However, at second and third cuttings, it was at par with N_{150} level. Here also interaction effect was absent.

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