Effect of spacings and nitrogen levels on herb and oil yield, oil concentration and composition in three selections of *Cymbopogon jwarancusa* (Jones) Schultz

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ABSTRACT

The performance of three selections of *Cymbopogon jwarancusa* (SL-7822, SL-7869 and SL-7896) was studied under five spacings and two levels of nitrogen. Though herbage and oil yield was higher in 4.0/m^2 stand density (50 x 50 cm spacing), 11.1/m^2 (30 x 30 cm spacing) stand density was preferred as the projected yield per ha was higher in the latter. Increase in nitrogen from 200 to 300 kg/ha did not result in higher herbage and oil concentration in the leaves. The composition of oil was also not affected by spacings or nitrogen levels.

Key words : camel grass, *Cymbopogon jwarancusa, khavi* grass, nitrogen, oil yield, spacing.

Introduction

Cymbopogon jwarancusa (Jones) Shultz (Poaceae) also known as *khavi* grass or camel grass grows wild in Kashmir and in the plains from Thar desert in the West to Assam in the East in India (Dhar, Thappa & Atal 1981). Hydrodistillation of the grass yields an essential oil rich in piperitone. Piperitone on conversion yields menthol/thymol of great pharmaceutical utility (Thappa *et al.* 1979). In an effort to increase the yield of the oil, 18 genotypes were selected by screening a wild population of *C. jwarancusa*. Further screening led to the isolation of five selections which had higher yield and other attributes that were advanced for domestication. In the absence of information on its cultivation, it was obligatory to know the response of these types to different agronomic practices. Studies on spacing are important for optimising the yield and in the present paper we report the performance of three selections under two levels of nitrogen and five spacings.

Materials and methods

Slips of camel grass of uniform size were grown in a propagation block at Regional Research Laboratory, Srinagar (Kashmir, India) and later transplanted to the experimental plot conforming to

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a split-split-plot design with three selections, namely, SL-7822, SL-7869 and SL-7896 as main plots, nitrogen @ 300 and 200 kg/ha as sub-plots and spacings at 30 x 30 cm, 35 x 35 cm, 40 x 40 cm, 45 x 45 cm and 50 x 50 cm as sub-sub plots. The stand densities under these spacings were 11.1, 8.1, 6.2, 4.9 and 4.0 per m^2, respectively. There were three replications and each plot consisted of three rows. The number of plants in each row varied with the stand density i.e., 15 in 11.1m^2, 14 in 8.1 m^2, 12 in 6.2 m^2, 10 in 4.9 m^2 and 9 in 4.0 m^2. The experiment was carried out for three seasons during 1985 to 1987. The schedule of harvesting dates for each year was May 15, June 18, July 24 and August 30, respectively.

Nitrogen was applied to soil in the form of urea @ 300 and 200 kg/ha in four equal split doses on May 18, June 21, July 27 and September 3, followed by a hoeing and an irrigation each year. The experimental field received phosphorous and potassium @ 100 kg/ha as a basal dressing each year.

The data was recorded from five plants selected at random from the middle row of each plot. The herbage from these plants was bulked and a composite sample was hydrodistilled for determining oil concentration in its leaves. Herbage at each harvest multiplied by oil concentration at that stage and summed up for all the harvests gave total oil yield which was expressed in ml on mean per plant basis.

A composite oil sample per treatment was analysed each year on a Amil Nucon Gas Liquid Chromatograph, Model 5700, Glass column, OV 17, 3 per cent on chromosorb W. The GLC was programmed from 45-24° C at 6°C/min. The percentage of Δ-2 carene, piperitone and elemol which constitute about 80% of the oil were studied for comparison. Statistical analysis of the data was performed according to the established methods of Gomez & Gomez (1984).

Results and discussion

The analysis of variance for mean oil concentration in leaves, fresh herbage yield and oil yield per plant for 1985, 1986 and 1987 growing seasons is given in Table 1. Due to non-homogeniety of data, it was not pooled. Selection effects were consistently significant for all the characters over all the years. For oil concentration, nitrogen effects were not significant, while the interaction of selection x spacing was significant for all the three years. Selection x nitrogen interaction was significant for 1985 only while selection x nitrogen x spacing effects were significant for 1985 and 1987.

Nitrogen effects were significant for herbage yield. Spacing effects and the interaction of selection x nitrogen x spacing was significant for both herbage and oil yield per plant for all the three years. Nitrogen applied to the soil did not increase oil concentration in the leaves (Table 2). However, the significant interaction of selection x spacing perhaps could be due to the relative proportion of young and upright leaves of different selections under different spacings. The change in microclimate of plants due to over crowding, affecting selectional response could not be also ruled out.

Nitrogen fertilization in the soil had a direct impact on herbage yield. The response of selections to nitrogen differed both within and between years. The vigour of the plant was equally affected by spacing. The plants pro-

Table 1. Analysis of variance for oil concentration in leaves, fresh herbage yield and oil yield per plant in *Cymbopogon jwarancusa*

Source of variation	Degrees of freedom	Mean Square								
		Oil concentration in leaves			Fresh herbage per plant			Oil yield per plant		
		1985	1986	1987	1985	1986	1987	1985	1986	1987
Selection	2	0.778**	0.769**	0.148**	9105.6**	101069.6**	318331.1**	0.452*	11.467**	38.13**
Replication	2	0.003	0.003	0.007	536.6	275.8	46.8	0.042	0.064	0.000
Error (a)	4	0.004	0.005	0.001	305.5	232.2	45.4	0.052	0.054	0.008
Nitrogen	1	0.000	0.000	0.000	1895.9**	2270.0*	3519.3**	0.352**	0.790*	0.039
Selection x Nitrogen	2	0.026**	0.000	0.005	960.9**	1987.0*	778.0	0.145**	0.063	0.227*
Error (b)	6	0.000	0.004	0.003	88.3	300.2	178.1	0.014	0.118	0.043
Spacing	4	0.011	0.009	0.017**	13768.0**	31806.0**	28274.6**	1.901**	11.488**	5.908**
Selection x Spacing	8	0.027**	0.037**	0.032**	2513.3**	11335.8**	10911.0**	0.554**	3.428**	1.450**
Nitrogen x Spacing	4	0.003	0.001	0.012	537.3	242.1	4125.7**	0.059**	0.067	0.844**
Selection x Nitrogen x Spacing	8	0.084**	0.003	0.016**	563.9*	640.1*	1162.1**	0.117**	0.215*	0.132*

duced less herbage under closer spacings than under wider spacings (Table 3). These factors exerted their influence individually or in combination and resulted in the complex interactions.

Oil yield, which is a summation over all the harvests, the relative oil concentration produced by the plant multiplied by its herbage at that harvest was highest (7 ml) in the selected genotype SL-7869

Table 2. Effect of spacings and nitrogen levels on concentration of oil in three selections of *Cymbopogon jwarancusa*

Spacing (cm)	SL-7822			SL-7869			SL-7896		
	1985	1986	1987	1985	1986	1987	1985	1986	1987
30 x 30	1.33	1.52	1.26	1.39	1.44	1.36	1.52	1.62	1.41
35 x 35	1.46	1.70	1.39	1.20	1.27	1.20	1.60	1.62	1.33
40 x 40	1.38	1.56	1.29	1.19	1.33	1.20	1.52	1.68	1.30
45 x 45	1.40	1.61	1.42	1.24	1.39	1.19	1.64	1.70	1.34
50 x 50	1.30	1.53	1.42	1.23	1.40	1.19	1.57	1.77	1.36
LSD (P=0.05)	0.008	0.037	0.032	0.008	0.037	0.032	0.008	0.037	0.032
N (300kg/ha)	1.45	1.58	1.37	1.22	1.36	1.22	1.57	1.68	1.34
N (200kg/ha)	1.36	1.58	1.34	1.28	1.37	1.23	1.57	1.68	1.36
LSD (P=0.05)	0.057	-	-	-	-	-	-	-	-

Values indicate oil concentration in %

Table 3. Effect of spacings and nitrogen levels on fresh herbage yield in three selections of *Cymbopogon jwarancusa*

Spacing (cm)	SL-7822			SL-7869			SL-7896		
	1985	1986	1987	1985	1986	1987	1985	1986	1987
30 x 30	116	190	150	164	239	229	164	202	130
35 x 35	128	192	194	173	255	282	151	223	141
40 x 40	159	235	212	180	309	341	137	218	121
45 x 45	180	232	200	204	367	401	147	200	146
50 x 50	237	318	236	225	432	437	182	2.07	146
LSD (P=0.05)	5.94	10.95	8.43	5.94	10.95	8.43	5.94	10.95	8.43
N (300kg/ha)	155	232	192	183	313	336	153	204	125
N (200kg/ha)	173	236	204	196	328	340	159	216	148
LSD (P=0.05)	12.41	-	11.79	12.41	12.69	-	-	-	11.79

Values indicate fresh herbage yield in g/plant under 4 m^2 stand density during 1986. Oil yield was higher in 1986 compared to 1985 or 1987 and perhaps the yield of the preceeding year affected the yield of the next growing season (Table 4). Increase in nitrogen from 200 to 300 kg/ ha did not increase herbage yield. However, Sharma, Singh & Tripathy (1980) reported an increase in palmarosa oil yield with increase in nitrogen levels. Yadav *et al.* (1985) reported that the application of 150 kg/ha resulted in high total herbage and essential oil yield in palmarosa. However, the essential oil constituents decreased beyond 100 kg/ha. Prakasa Rao, Singh & Ganesha (1989) observed high herbage and essential oil yield in Java citronella under 60 x 45 cm spacing, though it was not significantly superior to 60 x 30 cm spacing. However, essential oil quality remained unaffected both by nitrogen application and plant spacing. The concentration of essential oil constituents, namely, Δ-2 carene, piperitone and elemol differred between the years but the quality remained unaffected by spacing and fertilizer application for the same year (Table 5). This could be attributed to environmental influences or a slight shift in balance between biosynthetic precursors and catabolic processes due to ageing.

In the present study, herbage and oil yield was invariably high at 4/m^2 stand density and the differenecs were statistically significant, but 11.1/m^2 stand density is preferred as the projected yield per hectare was more than other plant densities for all the three selections. Further, plant spacing and application of nitrogen did not cause significant variation in the quality of its essential oil (Table 5).

Table 4. Effect of spacings and nitrogen levels on oil yield in three selections of *Cymbopogon jwarancusa*

Spacing (cm)	SL-7822			SL-7869			SL-7896		
	1985	1986	1987	1985	1986	1987	1985	1986	1987
30 x 30	1.60	3.03	1.89	2.39	3.62	3.20	2.57	3.51	1.97
35 x 35	1.82	3.48	2.30	2.16	3.56	3.39	2.50	3.90	1.96
40 x 40	2.22	3.76	2.79	2.21	4.65	4.37	2.10	4.03	1.72
45 x 45	2.41	3.84	3.13	2.60	5.77	4.80	2.20	3.70	2.14
50 x 50	3.09	5.47	3.91	2.86	7.00	5.46	2.83	3.84	2.20
LSD (P=0.05)	0.075	0.216	0.130	0.075	0.216	0.130	0.075	0.216	0.130
N (300kg/ha)	2.28	3.96	3.00	2.57	5.05	4.24	2.45	3.69	2.12
N (200kg/ha)	2.17	3.87	2.88	2.31	4.79	4.24	2.45	3.69	2.12
LSD (P=0.05)	0.09	-	-	0.09	0.24	-	-	0.24	0.18

Values denote oil yield in tonnes/plant

Table 5. Effect of nitrogen levels on concentration of chemical constituents of total oil of three selections of *Cymbopogon jwarancusa*

Selection	Chemical constituent	Year	1st harvest a	1st harvest b	2nd harvest a	2nd harvest b	3rd harvest a	3rd harvest b	4th harvest a	4th harvest b
	Δ 2-carene	1986	17.22	19.79	17.53	18.61	16.70	20.23	19.53	19.66
		1987	10.17	14.04	18.43	19.32	13.52	13.56	19.33	17.00
SL-7822	Piperitone	1986	44.38	42.25	64.54	63.93	66.95	64.96	64.93	66.03
		1987	32.24	31.06	57.99	61.09	46.70	54.96	49.37	56.95
	Elemol	1986	26.30	25.56	10.63	9.16	4.98	3.43	4.47	4.67
		1987	15.80	18.69	11.89	8.49	18.45	9.68	9.80	7.18
	Δ 2-carene	1986	12.58	11.25	13.51	12.16	15.18	16.30	7.77	17.23
		1987	10.96	9.64	19.26	16.16	13.53	17.96	19.25	14.48
SL-7869	Piperitone	1986	31.41	30.84	45.85	41.48	49.85	50.09	57.19	54.95
		1987	23.44	22.53	43.25	47.53	40.70	38.02	44.26	60.08
	Elemol	1986	39.83	38.33	33.95	37.15	21.10	30.53	15.88	17.53
		1987	23.98	22.53	26.09	21.63	26.67	17.96	20.59	8.39
	Δ 2-carene	1986	13.48	13.70	14.17	14.32	12.82	12.60	19.45	16.44
		1987	9.85	16.28	12.83	14.71	26.85	11.77	13.36	11.12
SL-7896	Piperitone	1986	67.01	64.32	72.51	70.99	70.76	72.62	65.87	69.77
		1987	50.06	49.39	69.79	68.99	44.98	58.52	52.43	61.82
	Elemol	1986	9.00	9.85	2.62	3.16	2.59	2.49	3.82	3.32
		1987	15.10	10.64	4.20	4.55	9.51	5.21	6.38	2.35

Values indicate concentrations of chemical constituents in %
a = 300 kg/ha N; b= 200 kg/ha N

Acknowledgement

We wish to thank Mr. G M Dar for his help in field work.

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