Int.J.Curr.Microbiol.App.Sci (2018) Special Issue-6: 2452-2458

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7692 **Special Issue-6 pp. 2452-2458**
Journal homepage: http://www.ijcmas.com

Original Research Article

Performance of Palmarosa Cultivars under Saline Condition

V. G. Takankhar*, P. N. Karanjikar, V. V. Tayde and R. G. Patil

Soil and Water Management Research Unit, N. M. College of Agriculture, Navsari Agricultural University, Navsari - 396 450, Gujarat, India
**Corresponding author*

A B S T R A C T

A pot experiment consisting of two varieties (V_1: PRC-1 and V_2: ODP-1) and six levels of irrigation water salinity (S_1: BAW, S_2: 2, S_3: 4, S_4: 8, S_5: 12 and S_6: 16 dS/m.) in FCRD with three repetitions in net house of Soil and Water Management Research Unit, Navsari Agricultural University, Navsari. In all three cuttings were taken during the course of field as well as pot experiments. The results of pot study revealed that, the palmarosa variety PRC-1 performed better than the ODP-1 in respect of all the growth and yield parameters. Significantly higher number of tillers, taller plants and longer inflorescence were observed with PRC-1 as compared to ODP-1. Herbage, dry matter and oil yields of PRC-1 were also more by 14.3, 16.5 and 21.2 per cent, respectively than ODP-1. Irrigation water salinity significantly influenced all the growth parameters and yield. The results indicated that the use of saline water up to 8 dS/m did not show much reduction in number of tillers, plant height and length of inflorescence at first cutting in comparison to lower levels of salinity. However, increase in water salinity above 8 dS/m. resulted in drastic reduction of these properties. Herbage, dry matter (shoot and root) and essential oil yield were not reduced significantly even up to irrigation water salinity level of 8 dS/m at first cutting and up to 4 dS/m at second cutting, further increase in level of salinity decreased the yield considerably. The results of present studies proved that palmarosa is remunerative crop under South Gujarat conditions. Similarly, it can tolerate irrigation water salinity up to 4.0 dS/m without adversely affecting herbage yield.

Keywords

Salinity, tillers, inflorescence, essential oil and herbage

Introduction

The essences and aroma are closely linked with the ecosystem. The traditional aesthetic use has a significant bearing on scientific development of aromatic crops in India. During last few decades, the aromatic industry demand for quality products of international standards triggered the concerned scientific organizations to exploit, conserve and improve natural resources.

Palmarosa (*Cymbopogon martinii*) is a tall perennial grass belongs to the family gramineae (Poaceae). 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 can be cultivated in a wide range of agro climatic conditions. Hot and humid conditions are most favorable for plant growth. 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 (Anonymous, 2004). 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.,* 2000b). Timely and adequate irrigation with minimum losses are to be aimed for efficient and economic utilization of water resulting in high and economic yields.

The increasing salinization of thousands of hectares of cultivated lands with raising water table in many areas is a serious threat and needs at most attention. In India, Gujarat state is having highest salt affected area of 16.49 lakh hectares (Sen, 2003). In many areas underground water available for irrigation have high salt content. Their indiscriminate use causes excessive accumulation of salts and led to rapid salinization and sodication of soil profile which adversely affect the crop growth and productivity. This is one of the reason for low productivity of agricultural crops in South Gujarat. In view of this there is need to identify new crops for the South Gujarat region. Palmarosa is one such crop which can tolerate salinity and seems to be remunerative. Prasad *et al.,* (2001) reported that the herbage yield of palmarosa was not reduced significantly with salinity of irrigation water (EC 18.8 dS/m.) at first and second cutting but decreased significantly in third cutting on sandy loam soil of Lucknow. These results revealed that there is scope of using poor quality waters for irrigating salt tolerant crop like palmarosa.

Materials and Methods

For this pot experiment, 36 earthen pots of 10 kg capacity were selected and lined with polythene to avoid leaching of salts from the pots. The treatments consisting of two varieties (V_1: PRC-1 and V_2: ODP-1) and six levels of irrigation water salinity (S_1: BAW, S_2: 2, S_3: 4, S_4: 8, S_5: 12 and S_6: 16 dS/m.) were used in FCRD with three replications. Irrigation water of desired salinity level was prepared by mixing canal water with sea water

Bulk surface soil samples were collected from different places of block E-14 of Soil and Water Management Research Farm. The soil was mixed well, ground and passed through 2 mm sieve. Well rooted healthy two slips of each variety were planted per pot. After establishment of slips in pot, palmarosa crop was grown for three cuttings. The nutrients were supplied @ 100: 60: 40: 10 ppm of N, P, K, and $ZnSO_4$ through inorganic fertilizers viz.

Urea, SSP, muriate of potash and $ZnSO_4$ respectively. Before planting full dose of P_2O_5, K_2O and Zn along with FYM were thoroughly mixed in soils of each pot. The pots were irrigated with different salinity waters as per the treatments in such a way that soil moisture was maintained at field capacity throughout the experiment. It was achieved by adding required quantity of water equal to the loss of weight from the respective treatment. Biometric observations *viz.*plant height, number of tillers, length of inflorescence and fresh weight were recorded at every cutting of palmarosa grass.

Results and Discussion

The results obtained on biometric observations and yield of palmarosa, are described as under with following heads.

Number of tillers

The data regarding number of tillers per pot are presented in table 1. It is revealed from the data that the number of tillers per pot were influenced significantly by different levels of water salinity and varieties of palmarosa.

Significantly the higher number of tillers per pot were observed in variety V_1 as compared to V_2 in all the three cuttings. In case of salinity levels, S_1 recorded significantly higher number of tillers per pot (15, 28 and 32) at all the three cuttings but it remained at par with S_2 and S_3 at first and second cuttings and with S_2 only, at third cutting. Significantly lower number of tillers per pot were observed with S_6 level followed by S_5 and S_4. The interaction effect (V x S) on tillering was found to be non-significant at all the cuttings.

Plant height

The results pertaining to plant height recorded at three cuttings are presented in table1. In all the cases, treatment effects were significant on plant height of palmarosa. The tallest plant was recorded with the variety V_1 (116, 84 and 76 cm) which was significantly superior over V_2 at all the cuttings.

The quality of water had also significant influence on plant height. Among the salinity levels, S_1 produced significantly taller plant (32, 128 and 114 cm) than the rest levels but was found at par with S_2 level at all the three cuttings. Similarly S_2 and S_3 waters were at par with each other at first and second cuttings only. The treatment S_6 recorded significantly dwarfish plant than rest of the treatments. The combined effect of variety and salinity was to be found non-significant on plant height.

Length of inflorescence

The data in respect of length of inflorescence of palmarosa as influenced by varieties and salinity levels of irrigation water presented in table1. It is evident from the data that the length of inflorescence was significantly affected by different treatments. The results revealed that the variety PRC-1 produced longer inflorescence than the ODP-1 at all the cuttings. With respect to water salinity, S_1 (BAW) recorded significantly longer inflorescence (36, 30 and 26 cm) than rest of the treatments at all the three cuttings. However, it was at par with S_2 and S_3 at first and with S_2 at second and third cuttings. The significantly shorter inflorescence was observed in S_6 which was followed by S_5 and S_4. The treatment S_2 and S_3, S_3 and S_4 were found at par with each other at first cutting. However, at third cutting each salinity level (except S_1 and S_2) recorded significantly longer inflorescence than its respective lower level of salinity. The interaction effect was not significant on length of inflorescence of palmarosa.

The differences in growth characters, herbage and oil yield between two varieties of palmarosa observed in present study might be due to differences in inherent capacity of salt tolerance and osmotic adjustment of each variety under saline conditions. Such significant differences were also observed by Suhayda *et al.*, (1992) in case of shoot and root growth of cultivated and wild barley species, Kumar and Gill (1995) and Tomar and Minhas (2004) in case of root biomass of various cultivars of Vetiver.

Fresh weight

The results regarding fresh weight of shoot per pot of palmarosa are presented in table2.

Table.1 Effect of varieties of palmarosa and irrigation water salinity on number of tillers, plant height and length of inflorescence

Treatment	No. of tillers per pot			Plant height (cm)			Length of inflorescence (cm)		
	I Cut	II Cut	III Cut	I Cut	II Cut	III Cut	I Cut	II Cut	III Cut
Variety (V)									
V_1	12.33	21.50	19.44	116.00	84.13	75.66	33.18	26.91	8.11
V_2	11.56	20.22	17.72	100.65	75.59	69.10	29.70	23.64	16.85
S.Em±	0.208	0.351	0.245	1.202	0.909	0.827	0.501	0.310	0.251
CD at 5 %	0.62	1.03	0.72	3.51	2.65	2.41	1.46	0.91	0.73
Salinity level (S)									
S_1	14.67	27.50	31.50	128.29	113.71	118.17	35.81	30.3	26.4
S_2	14.17	27.17	30.67	124.63	109.49	114.19	34.44	29.8	25.4
S_3	13.67	26.17	20.83	120.34	105.39	92.59	33.44	28.5	21.6
S_4	12.67	21.00	16.00	117.07	67.36	64.50	32.33	24.6	16.0
S_5	9.67	14.33	9.83	85.09	51.77	30.10	28.72	21.3	9.4
S_6	6.83	9.00	2.67	75.05	31.45	14.68	23.93	17.1	6.0
S.Em±	0.360	0.609	0.425	2.081	1.580	14.33	0.667	0.538	0.434
CD at 5 %	1.05	1.78	1.24	6.08	4.60	4.18	2.53	1.57	1.27
Interaction (Vx S)									
S.Em±	0.509	0.861	0.601	2.944	2.227	2.026	1.226	0.760	0.614
CD at 5 %	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	7.38	7.15	5.60	4.70	4.83	4.85	6.75	5.21	6.09

Table.2 Effect of varieties of palmarosa and irrigation water salinity on fresh weight and dry matter yields of shoot and root

Treatment	Fresh weight (g/pot)			Dry matter yield (g/pot)			Root length (cm)	Root weight (g/pot)
	Shoot				Shoot			
	I Cut	II Cut	III Cut	I Cut	II Cut	III Cut		
Variety (V)								
V_1	47.81	73.58	66.08	21.28	34.08	32.3	25.61	15.96
V_2	37.43	63.38	59.81	16.65	29.25	29.3	22.28	13.11
S.Em±	0.430	0.696	0.664	0.19	0.33	0.32	0.47	0.30
CD at 5 %	1.26	2.04	1.94	0.56	0.96	0.96	1.37	0.88
Salinity level (S)								
S_1	54.08	106.36	110.89	23.19	47.75	53.12	32.67	21.55
S_2	53.22	103.25	108.19	23.12	46.92	52.42	30.67	20.13
S_3	52.22	100.12	79.48	23.05	46.48	38.86	28.83	18.82
S_4	50.60	47.19	43.96	23.11	22.49	22.27	23.67	13.08
S_5	25.31	39.68	27.10	11.77	19.25	13.96	18.00	8.73
S_6	19.99	14.26	8.05	9.53	7.09	4.24	9.83	4.88
S.Em±	0.745	1.209	1.150	0.33	0.57	0.57	0.81	0.52
CD at 5 %	2.17	3.53	3.36	0.97	1.66	1.65	2.37	1.52
Interaction (Vx S)								
S.Em±	1.054	1.710	1.627	0.47	0.80	0.81	1.15	0.74
CD at 5 %	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	4.28	4.32	4.48	4.29	4.36	4.39	4.53	8.79

Table.3 Effect of varieties of palmarosa and irrigation water salinity on essential oil content (%) and oil yield (mg/pot)

Treatment	Essential oil content		Essential oil yield	
	I Cut	II Cut	I Cut	II Cut
Variety (V)				
V_1	0.44	0.47	213	346
V_2	0.44	0.46	166	295
S.Em±	0.003	0.003	2	4
CD at 5 %	NS	NS	7	12
Salinity level (S)				
S_1	0.45	0.47	243	504
S_2	0.45	0.47	240	487
S_3	0.44	0.47	232	471
S_4	0.44	0.46	224	216
S_5	0.44	0.46	111	181
S_6	0.43	0.45	87	65
S.Em±	0.005	0.006	4	7
CD at 5 %	NS	NS	12	20
Interaction (Vx S)				
S.Em±	0.007	0.008	6	10
CD at 5 %	NS	NS	NS	NS
CV (%)	3	3	5	5

Note: Oil content in palmarosa at third cutting could not be determined because of very less herbage yield recorded with higher levels of irrigation water salinity.

The fresh weight of shoot was significantly influenced due to individual effect of varieties and water salinity levels only. Between the varieties, V_1 (PRC-1) recorded significantly higher fresh weight of shoot (48, 74 and 66 g/pot) over V_2 at all the three cuttings. As regards to salinity effects, S_1 (BAW) registered significantly more fresh weight (54, 106 and 111 g/pot) than rest of the salinity levels. But it was at par with S_2 and S_3 at first cutting only and with S_2 at second and third cuttings. In general, with increase in irrigation water salinity, biomass yield of palmarosa at all the three cutting was found to decrease gradually.

Dry matter yield

Shoot

The results reported in table 2 are pertaining to the dry matter yield per pot for three cuttings. Between the varieties tried, V_1 (PRC-1) recorded significantly higher dry matter yield as compared to V_2 (ODP-1). The results further showed that the dry matter yield per pot was found to decrease significantly with increase in level of salinity. This is evident from the results that S_1 recorded significantly higher dry matter yield (23, 48 and 53 g/pot) as compare to rest of the salinity levels, but it remained at par with S_2, S_3 and S_4 at first cutting, S_2 and S_3 at second cutting and S_2 at third cutting. The interaction between variety and salinity was not significant at all the cuttings.

Root

The data regarding maximum root length and dry weight of roots are presented in table 2. The results indicated that the length and dry weight of root were influenced significantly due to varieties and different levels of water salinity. Significantly the higher length and dry weight of root were recorded with variety V_1 over V_2. Regarding salinity levels, S_1 recorded significantly higher length (33 cm) and dry weight of root (22 g/pot) of palmarosa. However, it remained at par with S_2. In general, it was observed that the growth of root was decreased significantly with increase in salinity of irrigation water. The interaction effect V x S was found to be non-significant.

Essential oil content and yield

The results regarding essential oil content and oil yield of palmarosa are presented in table 3. It is evident from the results that the per cent essential oil content in palmarosa shoot was not affected significantly due to individual as well as interaction effect of variety and salinity of irrigation water. Numerically higher oil content was observed in BAW and decreased with increase in level of irrigation water salinity at both the cuttings.

The results regarding essential oil yield of palmarosa was influenced significantly due to both, variety and salinity levels. The variety PRC-1 gave significantly higher essential oil yield of 213 and 346 mg/pot in comparison to ODP-1at first and second cutting, respectively. With respect to salinity levels, the treatment S_1 recorded significantly higher essential oil yield (243 and 504 mg/pot) as compared to rest of the treatments. But it was at par with S_2 and S_3 at first cuttings and S_2 only at second cutting. The interaction effect V x S was not significant.

The results further revealed that the detrimental effect of saline water on herbage, root biomass and oil yield were more pronounced at second and third cuttings than at first cutting. As the extent of reduction in herbage, root and oil yield with S_4 over S_1 level at first cutting was less than

10 per cent but which was more than 50 per cent at second and third cuttings. This suggests that palmarosa survives initially, but with progress of time, accumulation of salts in root zone due to irrigation with saline water inhibit the plant growth. Such adverse effects are supposed to be more pronounced with clay soil and that too under pot conditions. The reasons generally quoted by the earlier researchers are: adverse effect on osmotic pressure of soil solution on water and nutrient absorption, decrease in cell elongation and division, specific ion effects and decrease in availability of some of the essential plant nutrients (Singh *et al.*, 1994, Singh and Pal, 2000 and Aishwath and Pal, 2004). These reasons are equally applicable for explaining the results of present study as well.

Looking to the set-up of pot study, the adverse effect of irrigation water salinity seems to be evident at slightly lower salinity level *i.e.*, up to 4 dS/m these levels are bound to change under field conditions where natural drainage is available and more so in light textured soils.

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