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Research Note

Genetic variability and association studies in Palmarosa *(Cymbopogon martinii)*

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Abstract
Analysis of variance for 14 quantitative characters in 16 accessions of palmarosa showed significant variability for all the traits. High estimate of heritability coupled with high genetic advance were observed for number of spikes per plant, oil yield and oil content. Hence these traits would respond to selection. Oil yield had positive association with oil content, herbage yield, number of spikes per plant, number of panicles per plant and number of internodes on main axis at genotypic and phenotypic level. These traits could be considered as selection indices for oil yield improvement programme in palarosa.

Key words: Palmarosa, *Cymbopogon martini*, oil yield, variability, correlation.

Palmarosa is an aromatic perennial grass referred to a variety of *Cymbopogon viz Cymbopogon martinii* (Roxb) Wats. var. *motia* belonging to the family Poaceae. It is an essential oil bearing perennial but multicut grass.This grass referred as ‘Rosha grass’ or ‘Russa grass’ and is also called East India geranium oil or Russa oil. Oil of Palmarosa is used in perfumery, particularly for flavouring tobacco and for blending of soaps due to the lasting rose-note it imparts to the blend. It also serves as a source for very high grade geraniol. Geraniol is highly valued as a perfume and as a starting material for large chemicals, viz., geranyl esters that have permanent rose-like; this oil is very rich in geraniol (75-90%) content, presents both in free and bound form, in esters combination with acetic acid and caproic acids (Wealth of India, (1950). The herb containing flowering tops and foliage, on distillation, yield a colourless pale (greenish) yellow essential oil, emitting a sweet scented rose-like aroma (Sadgopal, 1959). The oil has a large demand in perfumery, soap, cosmetics and blending of tobacco products. Variability in the population, especially for the characters where improvement is sought for, is important for successful crop improvement programme, whereas, character association will help in simultaneous selection of two or more characters at a time. Therefore, present investigations were undertaken to study variation and character association in palmarosa.

Sixteen accessions of palmarosa were grown in Randomized Block Design (RBD) with three replications at Research farm, Department of Genetics and Plant Breeding, C.C.S. University campus, Meerut during *Kharif* season of 2006-07 under rainfed situation. Plot length was kept 4 meter and row to row and plant to plant spacing were maintained 60 cm and 30 cm, respectively. Observations were recorded on 10 randomly selected competitive plants and data was recorded for 14 quantitative characters. Mean data was subjected to statistical analysis. The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were computed according to the method suggested by Burton (1953). Heritability in broad sense (h^2), expected genetic advance as per cent of mean (GA as % of mean) and genotypic and phenotypic correlation coefficient were estimated according to Johnson *et al*. (1955 a, b).

The statistical analysis of variance (Table 1) indicated highly significant differences amongst the genotypes for all the attributes under study indicating sufficient variability in genetic material under study. The recorded maximum and minimum (Range) values for each character and estimated of genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^{2}), Genetic Advance (GA (as per cent of mean) for characters studied are given in (Table 2). GCV and PCV were high for spikes per plant and oil yield .These results are in agreement with those reported by Sahoo and Dutta. (1982).

Heritability estimates were high for plant height(97.30%) followed by number of spikes per plant, oil yield,width of leaf, oil content and number of internodes on main axis, indicating that they are highly heritable character. High expected genetic advance as per cent of mean for number of spikes per plant, oil yield and oil content. High estimate of heritability coupled with high genetic advance were observed for number of spikes per plant, oil yield and oil content, thereby indicating the possibility of maximizing genetic gain through selection for these characters. Johanson *et al*. (1955) suggest that characters with high heritability coupled with high genetic advance would respond to selection better than those with high heritability and low genetic advance.

Genotypic and phenotypic correlation coefficients among various characters are presented in (Table 3). Oil yield showed positive association with oil content, herbage yield, number of spikes per plant, number of panicles per plant and number of internodes on main axis at genotypic and phenotypic level. Herbage yield per plant showed strongest positive association with number of internodes on main axis followed by number of panicle per plant at genotypic and phenotypic levels. The correlation of herbage yield with plant height and number of spikes per plant were positive but significant only at genotypic level.

The positive significant association was obtained between plant height and number of spikes per plant at genotypic levels. However, number of internodes on main axis and herbage yield traits positive correlations with plant height was significant only at genotypic level. These results indicate that tall plant had more number of internodes, panicle and herbage yield. Number of internodes on main axis had positive and significant association with number of tillers, number of panicle per plant, number of spikes per plant, herbage yield, oil yield and oil content both at genotypic and phenotypic levels indicating that plant with more number of internodes led to produce more tillers, spikes, panicles, herbage and oil yield per plant. Inflorescence length of plant showed significant positive associations with herbage yield at genotypic level. Thus, this showed that with the increase in inflorescence length, herbage yield increased.

Leaf blade length had positive correlations with days to flowering and significant only at genotypic level. It indicates that leaf blade length increase with late types. Leaf width had positive and significant correlations at genotypic and phenotypic level. Number of tillers showed significant positive association with number with number of panicles and number of spikes indicating that with more number of tillers led to produce more number of panicles as well as spikes per plant. Number of panicles had positive significant genotypic and phenotypic correlations with number of spikes per plant, herbage yield, oil yield but length of spike showed positive and significant association with oil yield and content.

It was interesting to note that genotypic correlation of length of spike with oil yield and oil content content was positive and significant. Thus with the increase in length of spikes, the yield of oil and content increased. Herbage yield of plant was positively and significantly correlated with oil yield at genotypic and phenotypic level and oil content at genotypic level shows more herbage gave more oil yield and content.

In the present investigation higher GCV, heritability and expected genetic gains were observed for characters *viz.*, number of spikes per plant, oil yield, leaf blade width, number of panicle per plant, number of internodes on main axis indicating selection for these traits will reward in improvement of these traits .Gupta *et al.*, (1980); Sahu *et al*., (2000); Pareek *et al*., (1980, 1985) and Sethi *et al*., (1986) also observed similar results in rosa grass. The traits plant height, number of internodes on main axis, leaf blade width, leaf blade length, number of spikes per plant, oil yield exhibited positive and significant genotypic and phenotypic correlations with herbage yield. Hence, direct selection of individual plant for these traits can be made for the improvement in yield.

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Table 1: Analysis of variance (ANOVA) for quantitative traits in Palmarosa accessions

Source of variance	d.f.	Plant height in (cm)	No. of internodes on main axis	Inflorescence Length	Leaf blade length	Leaf blade width	No. of tillers/plant	No. of panical/ plant	Length of panicales	No. of spikes/ plant	Length of spike	Days to flowering	Herbage yield/plant (g)	Essential oil yield (ml)	Essential oil content (%)
Replication	2	118.50	14.87	4.29	15.79	0.14	23.78	17.83	31.90	12.02	0.12	59.61	29.84	0.38	0.25
Treatment	15	370.16**	13.96**	32.20**	11.33**	0.15**	8.96**	3.93**	1.93**	165.12**	0.05**	8.18**	99.72**	3.90**	2.16**
Error	30	3.33	0.58	3.40	0.82	0.01	0.44	0.34	0.46	2.66	0.01	1.75	29.75	0.10	0.09

*significant at 5% level and ** significant at 1% level

Table.2 Estimates of variability parameters

Characters	Range	SEm±	GCV (%)	PCV (%)	Heritability	Genetic advance	GA as % of mean
Plant height in (cm)	100.11-134.22	1.49	9.48	9.61	97.30	22.47	19.26
No. of internodes	8.89-16.11	0.62	15.40	16.37	88.40	4.09	29.82
Inflorescence length	31.00-41.89	1.50	8.42	9.80	73.90	5.49	14.92
Leaf blade length (cm)	16.89-23.67	0.74	9.18	10.20	81.00	3.47	17.02
Leaf blade width (cm)	1.34-2..02	0.058	13.47	14.18	90.20	0.42	26.16
No. of tillers/plant	8.22-15.67	0.54	12.80	13.77	86.50	3.23	24.54
No. of panical/plant	5.89-10.22	0.47	12.53	14.18	78.10	1.99	22.78
Length of panicale (cm)	12.03-14.81	0.56	5.16	7.21	51.30	1.03	7.61
No. of spikes/plant	10.55-34.00	1.33	29.02	29.73	95.30	14.80	58.38
Length of spike (cm)	1.48-1.91	0.08	6.97	8.92	61.00	0.20	11.35
Days to flowering	47.67-54.11	1.08	2.91	3.92	55.10	2.24	4.45
Herbage yield/plant (g)	103.00-122.67	4.45	4.25	6.41	43.90	6.59	5.80
Essential oil yield (ml)	3.39-7.11	0.26	20.94	21.77	92.60	2.23	41.51
Essential oil content (%)	3.31-5.98	0.24	17.67	18.78	88.60	1.61	34.25

Table 3: Genotypic and phenotypic correlation coefficient among various characters of Palmarosa.

Characters		No. of internodes on main axis	Inflores cence Length	Leaf blade length	Leaf blade width	No. of tillers/pl ant	No. of panical/ plant	Length of panicales	No. of spikes/ plant	Length of spike	Days to flowerin g	Herbage yield/pla nt (g)	Essentia l oil yield (ml)	Essentia l oil content (%)
Plant height in	P	0.530*	-0.111	0.410	0.449	0.122	0.323	0.744**	0.226	0.316	0.244	0.708**	0.150	0.054
(cm)	G	0.474	-0.088	0.372	0.430	0.120	0.298	0.540*	0.210	0.228	0.150	0.476	0.150	0.043
No. of	P		-0.184	0.283	0.576*	0.636**	0.835**	0.066	0.825**	-0.135	0.054	0.899**	0.730**	0.674**
internodes	G		-0.165	0.236	0.506*	0.539*	0.650**	-0.009	0.751**	-0.095	0.123	0.568*	0.647**	0.s576*
Inflorescence	P			0.308	0.155	-0.097	-0.183	0.224	-0.268	-0.250	0.074	-0.694**	-0.297	-0.184
length(cm)	G			0.227	0.109	-0.091	-0.115	0.110	-0.206	-0.197	0.113	-0.318	-0.269	-0.190
Leaf blade	P				0.399	-0.108	0.114	0.356	0.171	0.145	0.501*	0.095	-0.092	-0.102
length (cm.)	G				0.345	-0.063	0.133	0.093	0.146	0.121	0.350	0.047	-0.048	-0.050
Leaf blade	P					0.316	0.534*	-0.034	0.607*	0.182	0.299	0.436	0.321	0.301
width (cm.)	G					0.253	0.467	-0.008	0.563*	0.116	0.198	0.194	0.270	0.269
No. of	P						0.704**	-0.141	0.693**	-0.113	-0.105	0.415	0.454	0.453
tillers/plant	G						0.591*	-0.214	0.611*	-0.104	-0.095	0.357	0.443	0.399
No. of	P							-0.124	0.839**	-0.110	0.237	0.757**	0.684**	0.645**
panicales/plant	G							-0.161	0.748**	-0.075	0.044	0.503*	0.596*	0.534*
Length of	P								-0.425	0.095	0.275	0.286	-0.111	-0.192
panicales (cm)	G								-0.266	0.092	0.218	0.046	-0.154	-0.187
No. of	P									-0.117	0.256	0.672**	0.734**	0.723**
spikes/plant	G									-0.086	0.194	0.457	0.693**	0.661**
Length of spike	P										-0.215	0.042	-0.527*	-0.596*
(cm.)	G										-0.171	0.018	-0.375	-0.412
Days to	P											0.043	-0.007	-0.039
flowering	G											-0.041	-0.013	-0.019
Herbage	P												0.779**	0.711**
yield/plant (g)	G												0.553*	0.318
Essential oil	P													0.993**
yield (ml)	G													0.963**

*significant at 5% level and ** significant at 1% level