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Studies on Identification of Stable Genotypes of Lemongrass for Semi-Arid Regions

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ABSTRACT

The present research work was carried out for identification of stable genotypes of lemongrass for different characters over different spacing environments (60x60, 60x45 and 45x45) at Research area of MAP Section (GPB), CCS HAU, Hisar in RBD. The ANOVA for the stability revealed presence of both linear and non - linear G X E interactions. The results on oil content % (FWB) revealed that, out of all the thirty three genotypes / varieties, only twelve genotypes exhibited stable performance with high mean. NLG-4, Krishna, NLG-5, NLG-118, OD-58, NLG-84, HL-11, RRL-16 and CKP-25 were found best genotypes for oil content % (FWB) viewing high mean performance with above average (b_i>1) responsiveness; and genotype, OD-19, OD-23, and OD-388 were suitable for favourable environments, none were suitable for poor environments.

Keywords: *Cymbopogon* spp., stability, G X E, herbage yield, oil content

Introduction

The Indian subcontinent prospers in many aromatic plants. Chiefly three kinds of Lemongrasses are in cultivation, i.e. (i) East Indian / Malabar or Cochin Lemongrass (*Cymbopogon flexuosus*), (ii) West Indian Lemongrass (*C. citratus*) and (iii) North Indian Lemongrass (*C. pendulus*). East Indian Lemongrass is mainly cultivated in Kerala, A.P., Karnataa, T.N., Maharastra and U.P. In addition to this, Java citronella (*C. winterianus*) and Ceylon-citronella (*C. nardus*) mainly cultivated in Ceylon, Indonesia, India, and Sumatra, respectively. Lemongrass oil is used for making perfumes, cosmetics, creams and soaps. The bioactive compound, 'Citral' extracted from the oil, is a flavouring agent for soft drinks, scenting soaps and detergents, which has germicidal properties (Arya et al., 2021). After oil extraction, spent lemongrass may be utilized as raw material for paper making, or manure/ compositing and also as a fuel. Being a medicinal herb, lemongrass is found as a good carminative and antimicrobial. *C. nardus* is considered as an excellent source of citronella oil. This oil is an insect repellent and useful in ridding off dogs and cats parasites. Moreover, its oil also found helpful to clear the mind with a general toning as it has a very good tonic effect on human body. It also seems helpful to relieve cold and flu, and has antiseptic and deodorizing properties (Arya et al., 2021).

The genotypes - environments interaction, significantly contributed to the non realization of expected gain in relation to selection (Comstock and Moll, 1963). This condition imparts a serious hitch to the crop breeder in appropriate evaluation of genotype/ variety under different growing environments. Therefore, such a situation is complicated by the relationship of several environmental factors which vitiate the expression of the genotype/variety, when same are assessed over different environments. To overcome this difficulty, two types of schemes, statistical (Finlay and Wilkinson, 1963; Eberhart and Russell, 1966) and the other genetical (Perkins and Jinks, 1968 a, b and Breeze, 1969) are utilized by different research workers, which could be useful to give reliable estimation of these g x e interactions. From the research of these scientists, the most valuable finding which has came out is that the bulk of g x e interaction is often a linear function played a major part in building of total genotype-environment interaction. The range of genotypes/varieties could give a capable tool to measure and grade a progression of environments. Eberhart and Russell (1966) has been pointed out that in order to get unbiased estimates of stability parameters, the genotypes/varieties must be grown in an adequate number of environments.

Good stability and wider adaptability is a significant criterion to improve the herbage yield, oil yield, quality of oil and active compounds over a wide range of environments. It is always pleasing that a good yielding clone/genotype must be stable over different locations. Keeping in view the above discussion and increasing demand o essential oils produced from lemongrass, present investigation was carried out with the objective to identify the stable genotypes for different characters.

Materials and Methods

The present research work was carried out during *spring-summer-rainy* seasons for identification of stable genotypes of *Cymbopogon flexuosus* for different characters under three different environments created by planting the genotypes in different spacing, i.e. environment E_1 (60x60 cm), E_2 (60x45 cm) and E_3 (45x45 cm) at Research area of MAP Section (GPB), CCS Haryana Agricultural University, Hisar in randomized block design. Each genotype was accommodated in two rows of three meter length in each environment. For present study 33 genotypes of lemongrass viz., GRL-1, Krishna, NLG-1, Chirharit, NLG-2, NLG-3, NLG-5, NLG-4, NLG-6,NLG-7, NLG-9, NLG-8, NLG-118, NLG-10, NLG-84, OD-388, OD-23, OD-58, OD-19, RRL-16, HL-1, HL-2, HL-4, HL-3, HL-5, HL-7, HL-6, HL-8, HL-9, CKP-25, HL-10, HL-11 and HL-12. The observations were recorded on ten randomly selected planted in each genotype in each replication in each environment. Data recorded on plant height (cm), tillers per plant, fresh herb yield per plant (g) and oil content (%) FWB was subjected to analysis of variance as per standard procedure. The stability parameters were estimated as per procedure suggested by Eberhart and Russell, 1966.

Results and Discussion

The results on mean sum of squares due to g x e interaction revealed that genotypes/varieties have differential response to the change in environmental conditions. The performance of genotypes/varieties was found different under different environmental conditions. This pointed about the presence of g x e interaction for oil yield per plant and its related characters. Similar finding were also reported by Arya et al., (2022). It was also observed that both linear and non linear parameters extensively contributed to the total G x E interaction for all the traits but their magnitude varied (Table 1). There was preponderance of linear components for all the traits. This revealed that there is no association or complex relationship between the genotypes/varieties and environmental effects and in such a situation prediction is not possible. The results on the basis of the present investigation in relation to the stability parameters of individual genotype/variety are given in Table 2. The proportion of genotypes/varieties indicating predictable performance was high for all the traits. Linear components exhibited preponderance for yield per plant in analysis of variance here escaped in this analysis of stability parameters for individual genotypes/varieties, and oil content (FWB) came into notice in present study. This incongruity might be due to the discrepancy testing procedures in the two analyses.

As per stability model of Eberhart and Russell (1966), regression coefficient b_1, represents the linear component of G x E interaction and is a suitable measure of response of a variety/genotype to the alteration in the environment. A genotype / variety which reflect above average response ($b_1 \geq 1$) has b_1 value significantly greater than unity; such a genotype/ variety suitable for the better environment because improvement in the environment could only enhance the yield of such genotypes/varieties. Opposite to this, genotype with below average response ($b_1 \leq 1$) has b_1 value significantly less than unity; such a genotype/variety does not exhibit significant decrease with the decline of the environment. A genotype, which is relatively indifferent toward the change in the environment is believed to be average responsive ($b_1 = 1$) and will have regression coefficient value do not differ significantly from unity. Such genotypes/varieties are valuable for all the environments (Abhay et al., 2013, Arya et al., 2022).

In stability study, s main question comes in the mind of breeder that which type of linear regression is to be selected. The selection in crop plants for the type of response would differ with the alteration in the environmental conditions. The required level of interaction should be as low as possible to give maximum uniformity of presentation. But, according to Allard and Bradshaw, (1964) for inhibited factors like date of sowing, the desired level of interaction could be as high as possible to increase the yield. It is always looked-for to select genotype/variety with high mean performance and above unity response because only such genotypes are going to make the use of superior environmental conditions. The difficulties arise in evaluating the required level of responsiveness when the two types of environment variables i.e. controllable and uncontrollable, are functioning at the same time. In such situation, it will be desirable to have a universal level of interaction, so that genotypes/varieties can be selected which combine low level of interaction with controllable variables. For such a condition, the genotypes/varieties could be chosen having, high average yield, regression of unity one (b_1=1) and least deviation from regression (S^2_{di}=0). Such genotypes designated as ideal genotypes.

Stability analysis in present investigation identified based on 33 genotypes/varieties which could be suitable for different kinds of environments are presented in Table 3. None of the genotype /variety conferred stable for all the traits under investigation. Out of 33 genotypes/varieties, six genotypes for plant height, four for number of tillers per plant, and nine for oil content % (FWB) were found stable. Out of 33 genotypes, tall genotypes were 19, of which six genotypes/ varieties viz., OD-19, OD-23, NLG-3, GRL-1, NLG-5, and NLG-6 were stable in performance (S^{-2}_{di}=0) and found suitable for wide range of environmental conditions (b_1=1). Fourteen genotypes/varieties revealed above average mean performance for number of tillers per plant, out of which only six genotypes/varieties exhibited stable performance. Most of them were fit for general adaptability (b_1=1) viz., NLG-118, NLG-8, NLG-3 and NLG-10. Only NLG-1 and NLG-9 revealed suitability for favourable environmental conditions and no genotypes was suitable for unfavourable conditions.

In the present investigation fresh herbage yield per plant is very important trait for which only 16 genotypes/varieties exhibited above average herbage yield per plant and remaining 17 genotypes/varieties revealed below average herbage yield per plant but none of the genotype/variety was found stable for this trait. More or less similar findings were also observed by Lal (2002) in citronella grass stability studies, where clones/ varieties were extremely unstable for elemol content (SFi=28.67) followed by herbage yield per plant (SFi=14.67). In present study environments were created by spacing, first environment E_1(60x60 cm) was most favourable due to availability of more nutrition and less compaction among plants, second environment E_2(60x45 cm) was moderate and environment E_3(45x45 cm) was least favourable due to more competition among plants.

Out of 33 genotypes/varieties, the findings on oil content % (FWB), showed only 12 genotypes with high mean and stability performance i.e. HL-11, NLG-4, Krishna, NLG-5, RRL-16, CKP-25, OD-58, NLG-84, and NLG-118 were found ideal genotypes/varieties. However, the genotypes, OD-19, OD-23, and OD-388 were found suitable for favourable conditions for oil content % (FWB) having high mean with above average (b_i>1) responsiveness. None of genotype was found suitable for poor environmental conditions. These results indicated that there was sufficient difference for mean performance among the genotypes / varieties under different environmental conditions. This revealed the incidence of high g x e interactions for oil yield in lemongrass genotypes / varieties. Above results were supported by Sharma et al., (1988), Lal (2012 and 2023), Kumar et al., (2022, 2023a,b).

Table 1. Magnitude of linear and non-linear components (%) of G x E in lemongrass.

Characters	Lemongrass	
	Linear (%)	Non linear (%)
Average Plant height (cm)	62.80	37.20
Tillers per plant	68.62	31.38
Fresh herbage yield per plant (g)	73.7	26.22
Oil content (%) FWB	50.00	50.00

Table 2. Distribution of different genotypes on the basis of different stability parameters in lemongrass.

Characters	Predictable		Unpredictable	
	Both bi and S^2_{di} Non-significant	Only bi significant	Both bi and S^2_{di} significant	Only S^2_{di} significant
Average Plant height (cm)	11	07	00	15
Tillers per plant	16	03	02	12
Fresh herbage yield per plant (g)	00	00	10	23
Oil content (%) FWB	27	05	00	01

Table 3. Stability parameters' estimates for different characters in lemongrass.

Sr. No.	Genotypes	Plant height (cm)			Tillers per plant			Fresh herb yield per plant (g)			Oil content (%) EWB		
		Mean	b_1	S^{-2}_{di}	Mean	b_1	S^{-2}_{di}	Mean	b_1	S^{-2}_{di}	Mean	b_1	S^{-2}_{di}
1.	Krishna	139.59	1.49	0.87*	82.15	2.00	9.93**	804.67	0.81	0.37**	0.72	0.34	1.00
2.	Chirharit	136.96	1.56	2.51**	77.56	2.36	5.18**	907.11	0.94	0.60**	0.35	-0.15*	1.77
3.	GRL-1	123.89	1.24	0.24	79.41	2.25	4.39**	868.56	0.63*	0.20**	0.47	0.07	0.83**
4.	NLG-1	139.19	1.67	3.65**	77.74	2.24**	1.06	1230.56	1.63*	0.57**	0.34	0.14**	0.67
5.	NLG-2	123.04	0.48**	0.09	59.96	-0.65*	3.56**	575.41	0.38**	0.09**	0.35	2.33**	0.67
6.	NLG-3	126.67	0.67	0.33	69.07	0.88	0.63	807.82	0.79	0.18**	0.37	1.27	0.37
7.	NLG-4	113.89	1.20	0.25	31.30	0.93	0.54	692.22	0.75	0.43**	0.48	0.58	4.46
8.	NLG-5	134.78	1.35	0.32	66.19	1.12	0.49	936.48	0.84	0.09**	0.40	0.63	2.88
9.	NLG-6	129.96	0.87	0.22	60.48	1.65	1.88*	907.59	0.84	0.32**	0.28	0.74	0.98
10.	NLG-7	142.33	1.64**	0.33	53.44	1.30	1.41	857.70	0.35	0.73**	0.37	0.77	0.14
11.	NLG-8	133.04	1.57**	0.15	69.26	1.41	0.65	956.85	1.36	0.77**	0.29	1.04	2.15
12.	NLG-9	128.41	1.47**	0.16	71.11	1.61	0.88	990.70	0.75	0.37**	0.28	0.90	1.39
13.	NLG-10	136.26	1.55	0.91*	72.85	-0.77**	0.22	721.22	0.89	0.09**	0.33	1.03	0.30
14.	NLG-118	117.44	0.94	0.12	68.48	1.09	1.32	662.96	0.77	0.26**	0.43	1.66	1.56
15.	NLG-84	116.15	0.81	0.10	55.37	0.72	3.00*	646.78	0.47**	0.05**	0.46	1.18	1.40
16.	OD-23	126.89	0.98	0.61*	64.04	1.34	0.58	736.96	1.05	0.33**	0.43	1.99**	0.35
17.	OD-388	122.07	1.41	0.92*	57.78	1.07	0.92	811.56	0.98	0.37**	0.44	2.45*	2.27
18.	OD-19	123.74	1.12	0.32	65.33	1.22	0.97	733.30	1.08	0.44**	0.43	2.10*	1.84
19.	OD-58	130.07	1.78	2.49**	73.78	0.60	1.90*	837.89	1.67*	0.57**	0.40	0.66	1.52
20.	RRL-16	121.78	1.55	2.83**	67.37	1.06	3.67**	667.67	1.23	0.16**	0.43	0.97	2.40
21.	HL-1	125.52	0.07**	0.43	65.19	0.15	2.36*	864.04	0.57	1.18**	0.29	0.45	0.67
22.	HL-2	116.41	0.89	0.06	46.56	1.08	0.71	687.63	1.06	0.47**	0.33	1.06	1.33
23.	HL-3	120.22	0.89	0.61	54.41	1.51	1.03	724.82	0.79	0.40**	0.33	1.86	1.74
24.	HL-4	94.04	0.64	2.78**	52.89	1.28	0.35	664.82	1.20	0.19**	0.31	0.96	1.15
25.	HL-5	91.67	0.57	2.37**	60.07	0.99	1.13	689.33	1.22	0.20**	0.29	1.01	0.70
26.	HL-6	94.44	0.49	1.36**	57.78	0.93	0.73	686.59	1.53**	0.23**	0.32	0.55	1.05
27.	HL-7	110.59	0.53*	0.19	64.44	1.18	1.14	866.22	1.47**	0.06**	0.35	1.02	2.47
28.	HL-8	102.44	0.74	1.38**	81.44	-0.67**	1.93*	873.96	1.11	0.44**	0.34	0.22	2.32
29.	HL-9	125.48	0.36**	0.10	78.82	1.81	1.90*	994.33	1.49*	0.34**	0.31	0.69	0.58
30.	HL-10	101.56	0.22	2.17**	51.96	-0.08	2.03*	821.93	1.65	0.89**	0.31	1.18	2.25
31.	HL-11	130.67	1.19	1.04*	57.52	-0.02**	0.96	688.67	0.41*	0.39**	0.40	1.54	3.44
32.	HL-12	139.00	0.34	1.11**	88.82	0.45	3.12**	1244.96	1.59*	0.48**	0.30	0.27*	0.64
33.	CKP-25	111.00	0.70	0.52	136.15	0.98	6.62**	836.67	0.71	0.22**	0.63	1.50	2.14
	Pooled mean	122.09	1.00		67.23	1.00		818.12	1.00		0.38	1.00	
	SE_m+ (mean)	0.25	0.36		0.50	0.53		0.53	0.23		0.29	0.78	

*,**= Significant at 5% & 1%, respectively.

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