Stability Analysis for Biomass and Essential Oil Yield in Basil (*Ocimum basilicum*) Germplasm

NS Panwar[1], A Kumar[1], SS Malik[1], VK Dwivedi[2], PB Singh[1] and G Kumar[1]

[1]*National Bureau of Plant Genetic Resources, New Delhi-110012*

[2]*Janta Vedic College, Baraut, Baghpat-250611, Uttar Pradesh*

(Received: 20 December 2010; Revised: 24 October 2011; Accepted: 14 November 2011)

The essential oil of basil (*Ocimum basilicum* L.) is used for flavoring foods, dental and oral products. Stability analysis was conducted on 30 accessions of basil germplasm (exotic as well as indigenous). These accessions were augmented from different countries namely, India (10), USA (10), USSR (7), Germany (1), Hungary (1) and Poland (1). These were evaluated under four diverse environments comprising two locations and two years (2004 and 2005). The mean performance and stability parameters of 30 accessions were analyzed under four environments for nine characters, namely, number of primary branches/plant, lamina length (cm), lamina width (cm), leaf-stem ratio, plant height (cm), fresh herbage yield/plant (g), dry herbage yield/plant (g), essential oil content (%) and essential oil yield/plant (ml). All 30 genotypes had squared deviation equivalent to zero (S^2 di=0) showing consistent performance of the genotypes among all the environments. Essential oil is the economic product of basil. Five genotypes *viz.* EC388788, IC333332, IC336833, IC388891 and EC338773 were identified as desirable and stable in relation to essential oil yield per plant. Two genotypes (EC388788 and IC333332) were found superior for essential oil yield, fresh herbage yield and dry herbage yield/plant over the four environments. Hence, these genotypes could be recommended for their direct utilization across the environments.

Key Words: Accession, Adaptability, Basil, Environment, Essential oil, Herbage yield, Stability

Introduction

The genus *Ocimum* is an annual aromatic herb, having 160 species and belongs to family Lamiaceae (Balyan and Pushpangadan, 1988). It is widely distributed and cultivated throughout India (Pushpangadan and Bradu 1995; Verma *et. al.*, 1989 and Pandey and Chowdhary, 2002). The diversity in this genus is observed in the tropical rain forests of Africa with the largest 59 reported species followed by the subtropical regions of Africa (19 species), Arabia and Brazil (11 species each), India, Ethiopia and Madagascar with 9, 8 and 7 species, respectively (Pushpangadan and Bradu, 1995). Its aromatic leaves are used fresh and dried as salad dressing, vegetables, flavouring in sauces, vinegar and confectionary products. The essential oil of basil is used to flavour foods, dental and oral products, in fragrances and in traditional rituals and medicines (Guenther, 1949 and Simon *et al.*, 1984). The variable performance of the genotypes under varying environments creates problem in the adaptation and spread of a crop/varieties for large scale cultivation. Realizing the importance of this new crop, the efforts have been made to generate information on influence of environment, adaptability and stability of genotypes.

Materials and Methods

The experimental materials comprised of 30 accessions of basil, augmented from different indigenous as well as exotic sources through National Bureau of Plant Genetic Resources (NBPGR), New Delhi. These accessions were grown under four diverse environments at two locations during *kharif* 2004 and 2005. These environments were created through different locations and years. The NBPGR Experimental Farm, Issapur, New Delhi (latitude 28°36'N, longitude 76°50'E) is of semi-arid climate with average annual rainfall/400 mm. The ground water is highly saline having EC of over 4m mhos/cm. The soil varies from sandy loam to loamy sand having pH around 8.0. The Research Farm, JV College Baraut, District Baghpat, Uttar Pradesh (latitude 29°06'N, longitude 77°15'E) is of sub-tropical nature having loamy humus rich soil and average annual rainfall over 600 mm. It has good irrigated water condition. All the accessions were sown in nursery and transplanted after 30 days of sowing. In each environment, these accessions were planted in Randomized Block Design (RBD) with three replications. Each entry was allotted a plot of three rows (3m) with spacing 45 x 30 cm. Before transplanting, a dose of 10 tones of FYM, 80 kg N, 40 kg P and 40 kg K/ha was applied. Half of the N and whole of P and K were applied as basal dose. The remaining half of the nitrogen was mixed in two equal doses as top dressing after 30 and 45 days of transplanting between the rows in wet soil by hand-hoeing. Irrigation and weeding were done regularly. Observations on five randomly selected plants

***Author for Correspondence:** *E-mail: nspanwar2002@yahoo.co.uk*

in each genotype for nine characters *viz.* number of primary branches/plant, lamina length (cm), lamina width (cm), leaf-stem ratio, plant height (cm), fresh herbage yield/plant (g), dry herbage yield/plant (g), essential oil content (%), essential oil yield/plant (ml) were recorded at full-bloom stage. The stability analysis was carried out on mean performances of four environments accomplished by two locations and two years for nine characters following the Eberhart and Russell Model (1966) and variability parameters were estimated as per standard procedures.

Results and Discussion

The analysis of variance (Table 1) revealed that all the genotypes differed significantly for all the characters indicating the presence of genetic variability in the genotypes. Environmental variance was significant for all the characters except leaf-stem ratio, lamina length, lamina width, essential oil content and oil yield suggesting the influence of the environment. However, G x E interaction was significant for plant height, fresh herbage yield/plant and dry herbage yield/plant. Environment (linear) was significantly pronounced for all the characters whereas Environment and G x E interaction (linear) were significant for number of primary branches, fresh herbage yield and dry herbage yield/plant. The traits having significant G x E interaction namely plant height, fresh herbage yield/plant and dry herbage yield per plant were considered for analysis of stability parameters (Table 2). For plant height, the mean performance of the different genotypes ranged from 44.95 (EC387837) to 81.70 (EC338785) with population mean 54.14. Out of 30 genotypes, thirteen genotypes have shown regression coefficient (bi#1) showing better adaptation to favorable environments and 16 genotypes had shown regression coefficient (bi#1) showing poor response to the environments. In respect of fresh herbage yield/plant, the results indicated that the mean performance ranged from 223.58 g (EC388896) to 346.92 g (IC333332) with population mean 290.97. Four genotypes namely IC110267, EC388788, EC388891 and EC338794 had b_i values closer to unity and these genotypes are stable and can be suggested for all the environments. Similarly, four genotypes, namely, IC110267, EC388788, EC388891 and EC338794 had higher values of regression coefficient (b_i <1.0) may be suitable for favourable environment. Similarly, in case of dry herbage yield/plant, the mean performance of different genotypes ranged from 49.16 g (IC201233) to 75.78 g (IC333332) with population mean 63.39 g. Three genotypes (EC338893, EC388788 and EC338794) had b_i values closer to unity and favorable for all kind of environments. Nine genotypes had higher values of regression coefficient (b_i <1.0) and suitable for favourable environment.

Stability is an important parameter to decide the suitability of a genotype under vide range of environments. In the present study on basil, almost all the characters except lamina length, lamina width, leaf-stem ratio, essential oil content and essential oil yield influenced by the environment. It showed the sensitivity of the crop toward environments. However, genotype and environment (G x E) interaction was significant on plant height, fresh herbage yield/plant and dry herbage yield/plant. Environment (linear) was significantly pronounced for all the nine characters studied, whereas E+(G x E) were significant for number of primary branches/plant, number of spikes/plant, fresh herbage yield/plant, dry herbage yield /plant and seed yield/plant. The stability parameters like population mean, regression coefficient (bi) and squared deviation from regression (S^2di) for plant height, fresh herbage yield/plant and dry herbage yield/plant where the G x E interaction was significant.

In respect of plant height, four genotypes namely IC110267, EC388788, EC388891 and EC338794 best suited for all the environments. For fresh herbage yield/plant, four genotypes namely IC110267, EC388788, EC388891 and EC338794 had b_i values closer to unity

Table 1. Analysis of variance (ANOVA) for stability in basil germplasm for nine characters under four environments

Source of variance	d.f.	No. of primary branches/plant	Lamina length (cm)	Lamina width (cm)	Leaf stem ratio	Plant height (cm)	Fresh herbage yield/plant (g)	Dry herbage yield/plant (g)	Essential oil content (%)	Essential oil yield/ plant (ml)
Genotype (G)	29	1.06	0.49	0.11	0.350	197.67 **	5041.17 **	232.79 **	0.0022	0.024
Environments (E)	3	11.57 **	0.46	1.19	0.005	41.15 **	19653.23 **	1136.76 **	0.0004	0.083
G x E	87	0.45	0.09	0.04	0.005	4.99 **	576.15 **	28.81 **	0.0004	0.005
Pooled error	232	0.41	0.09	0.02	0.002	11.09	298.25	20.03	0.0007	0.006
E + (G x E)	90	0.83	0.10	0.08	0.005	6.20 **	1212.05 **	65.74 **	0.0004	0.008
Environment (linear)	1	34.72 **	1.39	3.58	0.014	123.38 **	58960.44 **	3410.39 **	0.0013	0.249
(G x E) (linear)	29	0.56	0.10	0.05	0.006	10.99	916.88	51.74	0.0004	0.009
Pooled deviation	60	0.39	0.08	0.03	0.004	1.93	392.24	16.76	0.0004	0.003

*** Significant at 5% and 1%, respectively

Table 2. Estimates of stability parameters basil germplasm during *kharif* 2004 and 2005 at New Delhi and Baraut locations

Genotype	Fresh herbage yield/plant (g)			Dry herbage yield/plant (g)			Plant height (cm)		
	Mean	b_i	S^2d_i	Mean	Mean	S^2d_i	Mean	b_i	S^2d_i
IC110267	321.76	0.96	356.91	46.41	46.41	13.35	0.71	1.37	0.00
EC338785	344.92	1.27	11.89	81.70	81.70	-3.25	0.50	0.13	0.00
EC388890	326.92	0.29	83.48	58.65	58.65	-6.62	0.70	0.27	0.00
EC388895	298.92	2.48	644.16	57.90	57.90	38.96	0.50	2.09	0.00
EC388893	238.83	1.18	208.51	55.07	55.07	0.88	0.53	1.29	0.00
EC387838	320.00	1.42	446.95	54.28	54.28	29.96	0.46	2.71	0.00
EC388788	335.00	1.01	-82.94	56.53	56.53	-6.44	0.53	0.78	0.00
EC338794	330.58	1.03	38.26	50.98	50.98	-4.84	0.57	1.65	0.00
IC326735	255.33	0.43	189.47	53.45	53.45	-5.37	0.46	0.61	0.00
IC333332	346.25	1.20	166.40	50.30	50.30	11.47	0.62	0.98	0.00
IC336833	287.00	0.83	50.22	46.06	46.06	3.44	0.54	0.54	0.00
EC312264	321.67	2.23	1171.98	53.28	53.28	36.76	0.55	2.39	0.00
EC388891	264.92	0.96	51.29	58.18	58.18	-6.36	0.56	1.23	0.00
EC338782	313.25	0.63	186.78	51.55	51.55	28.35	0.58	1.41	0.01
EC128730	341.25	2.24	952.66	56.16	56.16	-6.41	0.59	3.00	0.00
EC338772	297.75	2.15	1386.55	49.76	49.76	17.63	0.56	2.64	0.01
IC344638	281.33	1.38	349.04	50.38	50.38	2.12	0.50	-0.44	0.02
EC174527	293.17	1.39	483.38	50.43	50.43	22.67	0.49	2.08	0.00
EC387837	275.50	0.46	324.33	44.95	44.95	-4.23	0.58	-0.28	0.02
IC201233	224.42	0.18	231.55	47.71	47.71	-1.91	0.39	0.00	0.00
EC388896	223.58	0.42	309.67	51.87	51.87	1.90	0.47	1.32	0.00
EC338773	304.58	0.21	129.98	58.90	58.90	3.18	0.59	0.65	0.00
IC326711	232.17	0.09	-23.86	63.14	63.14	-3.97	0.49	-0.46	0.00
EC338775	297.75	0.29	-66.78	57.84	57.84	-0.39	0.54	0.42	0.00
EC338776	258.92	0.25	628.65	58.64	58.64	48.67	0.44	-0.08	0.00
IC211313	275.42	0.86	-90.60	52.38	52.38	-0.73	0.44	0.74	0.00
IC326732	275.75	0.77	68.06	46.48	46.48	10.43	0.63	-1.18	0.01
EC388887	296.58	0.47	-48.57	47.04	47.04	7.70	0.63	1.93	0.00
EC388889	277.83	2.06	705.47	54.83	54.83	66.74	0.45	1.40	0.00
IC338959	267.92	0.87	-78.09	59.22	59.22	8.81	0.44	0.81	0.00
Pop. (mean)	290.97			54.14	54.14		0.53		
S.E. (mean)	11.43			0.80	0.80		0.032		
S.E. of B	0.44			0.68	0.68		0.611		

and these genotypes are stable and can be suggested for all the environments. Similarly, three genotypes (EC338893, EC388788 and EC338794) identified for all kind of environments. The genotype EC388788 was found stable for most of the traits and got wider adaptability. Therefore, the genotype EC388788 could be recommended for direct utilization across the environments by farmers.

Acknowledgements

The authors are grateful to the Director, NBPGR; Head, Plant Exploration and Germplasm Collection and Head, Germplasm Evaluation Division, National Bureau of Plant Genetic Resources, New Delhi. Thanks are also due to the Principal, JV College Baraut, District Baghpat, Uttar Pradesh, for providing facilities and suggestions.

References

Balyan SS and P Pushpangadan (1988) A study on the taxonomical status and geographical distribution of genus *Ocimum*. *PAFAI J.* **10:** 13-19.

Eberhart, SA and Russell, WA (1966) Stability parameters for comparing varieties. *Crop Sci.* **61:** 36-40.

Guenther E (1949) In: The essential oils. VIII. Robert E. Krieger Publ. Co. Malabar, Florida. 399-433.

Pandey AK and AR Chowdhary (2002) Essential oil of Ocimum basilicum L. from Satura plateau of central India. *Indian Perfumer* **46:** 131-134.

Pushpangadan P and BL Bradu (1995) In: *K.L. Chadha and Rajendra Gupta* (eds.): Advances in Horticulture-Vol. 11-Medicinal and Aromatic Plants: Malhotra Publishing House, New Delhi, India, pp 627-657.

Simon JE, Craker LE and Chadwick A (1984) Herbs: an indexed bibliography, 1971-1980. The scientific literature on selected herbs and aromatic & medicinal plants of the temperate zone. Archon Books, Hamden, CT. 770.

Verma PK, Punia MS, Sharma GD and Talwar D (1989) Evaluation of different species of *Ocimum* for their herb and oil yield under Haryana conditions. *Indian Perfumer* **33:** 79-83.