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GENETIC VARIABILITY, HERITABILITY AND GENETIC ADVANCE IN SEGREGATING GENERATIONS OF BASIL (*Ocimum basilicum* L.)

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ABSTRACT

F_2, BC_1 and BC_2 segregating generations of seven diverse crosses were studied for genotypic and phenotypic coefficient of variation, heritability and genetic advance as per cent of mean on Ocimum. The magnitude of phenotypic coefficient variation was observed higher than genotypic coefficient of variation, indicating the greater influence of environment. Highly significant differences were recorded among the genotypes for the characters indicating high genetic diversity. In F_2 generation high range of phenotypic coefficient of variation was observed for dry herb yield, fresh herb yield per plant, leaf area, and number of branches. In BC_1 generation the highest estimates of phenotypic coefficient of variation was followed by dry herb yield and fresh herb yield whereas in BC_2 generation the high estimates of phenotypic coefficient of variation was observed for dry herb yield and plant height. The estimates of high genotypic coefficient of variation was noticed for number of branches, leaf area, fresh herb yield and dry herb yield in F_2, BC_1 and BC_2 segregating generation. High values of genetic advance with high heritability for these traits such as fresh herb yield per plant, dry herb yield per plant, per plant indicating the involvement of additive gene action in the inheritance of these traits. It could be exploited by resorting to simple selection.

Key word : *Ocimum basilicum L., genetic variability, segregating generation.*

Basil (*Ocimum basilicum* L.) is a globally cultivated plant since times immemorial due to its medicinal, Culinary and other properties. The genus Ocimum belongs to family Lamiaceae having around 160 species widely distributed throughout the country from tropical area to 1800 m in the Himalayas region (1). The Ocimum genus belonging to the Lamiaceae family is characterized by a great variability of both morphology and chemo types (2). The case of cross-pollination leads to a large number of subspecies, varieties, and forms (3). Among all the species, Ocimum basilicum (basil or sweet basil) has the most economic importance and is cultivated and utilized throughout the world. The maximum diversity of species in this genus is met in the tropical rain forests of Africa with 59 species, the largest number of species in the genus so far reported from any region. Tropical Africa is followed by the subtropical regions of Africa (South Africa) with 19 species, Arabia and Brazil with 11 species each, India, Ethiopia and Madagascar with 9, 8 and 7 species, respectively (4). In India, it is grown in about 400 ha (Gujarat, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan and Uttar Pradesh). Genus Ocimum (family Lamiaceae) is widely distributed in the warmer regions of both hemispheres. About 160 species of Ocimum are reported (1). *Ocimum basilicum* L. (French basil) has originated in Central Asia and cultivated throughout the World. Among Indian species, *O. basilicum* and *O. sanctum* have the widest distribution and covers the entire Indian subcontinent. The species *O. americanum* and *O. canum* have their range of distribution mainly in the north-western part of India which includes Jammu and Kashmir, Punjab, Himachal Pradesh, Delhi and Uttar Pradesh. On the other hand, *O. suave*, *O. viride* and *O. carnosum* species were introduced in India only in 1972 and are found in cultivated condition mainly in the whole of Deccan plateau and the coastal region of southern or eastern parts of the Indian Peninsula. The distribution of *O. gratissimum* is found mostly in southern and eastern parts of India and the specimens found in other regions are mostly introduced recently. Genetic variability of medicinal plant is generally very important (5). The role of genetic variability is well documented in crop improvement. Genotypic and phenotypic coefficient of variability helps to access the magnitude of variability in populations. Selection would be more effective for the traits which exhibit high variability and heritability along with moderate to high genetic advance.

MATERIALS AND METHODS

Experimental material of this study was generated from thirteen accessions of Basil (*Ocimum basilicum* L.) obtained from NBPGR, New Delhi. The F_2, BC_1 and

BC_2 segregating generation of seven crosses namely: (I) EC-388788 x IC-333322, (ii) EC-387893 x IC-326711, (iii) EC-388896 x IC-369247, (iv) EC-388887 x IC-386833, (v) EC-387837 x EC-338785, (vi) IC-369247 x IC-370846 and (vii) IC-344681 x IC-326735 were sown in strips of 4 M length. A spacing of 60 cm row to row between 50 cm plant to plant was followed. The experiment was conducted at the research farm of Department of Genetics and Plant Breeding, Ch. Charan Singh University, Meerut in a Randomized Block Design with three replications. The data on the following quantitative and qualitative traits were recorded on 15 randomly selected plants each of BC_1 and BC_2 and 30 randomly selected plants of F_2 generations. Detailed observations were recorded on randomly selected plants from each cross for each trait. Observations were recorded on six traits viz., number of branches, leaf area, Chlorophyll content, fresh herb yield, dry herb yield and oil content (%). The genotypic and phenotypic coefficient of variances was calculated according to (6). Heritability in broad sense was calculated as ratio between genotypic variance to the total phenotypic variance and expected genetic advance was defined as the difference between mean of the progeny of selected individuals and base population as suggested by (7). The essential oil was extracted from the air dried herb by hydro-distillation using Clevenger's apparatus and estimation of chlorophyll content by (8).

RESULTS AND DISCUSSION

Data on estimates of PCV and GCV, heritability and genetic advance as per cent of mean performance for various traits of different crosses of F_2, BC_1 and BC_2 segregating generation are presented in Table-1. Highly significant differences were recorded among the genotype for all the traits indicating diversity among the genotype. Among the F_2 high range of PCV was observed for dry herb yield, fresh herb yield per plant, leaf area, and number of branches. In BC_1 generation the highest estimates of PCV was followed by dry herb yield and fresh herb yield and B_2 generation the highest estimates of PCV were followed by dry herb yield. The findings are also supported by (9) for different morphological traits such as plant height, fresh herb yield, oil content, oil yield, number of branches, leaf area. Similar to above the large variability occurred for different traits like- leaf area, number of racemes per plant, plant height, days to maturity days to flowering, leaf length, leaf width oil content, oil percent reported by (10).

Thus, it is expected that phenotypic selection for fresh herb yield, dry herb yield per plant and oil content would be more effective. The estimates of high genotypic coefficient variation was noticed for number of branches, leaf area, fresh herb yield and dry herb yield in F_2, BC_1 and BC_2 segregating generation which suggested greater genotypic variability among the segregation and responsiveness of the attributes to making further improvement of the trait by selection. The effectiveness of selection for any traits depend not only the amount of variability present, but also on the extent to which variability in transmitted to the next generation. Thus the traits with high heritability are less influenced environment and therefore, direct selection for the traits would be effective.

High heritability (broad sense) estimates were recorded for F_2 of number of branches in cross EC-388788 x IC-333322 and BC_1 of cross EC-388887 x IC-386833 for oil content and BC_2 of cross IC-369247 x IC--370846 for oil content. For majority of traits in all F_2, BC_1, and BC_2, the estimates of heritability (bs) were adequately higher for above traits and rests of traits were showed low values of broad sense heritability. These results are in agreement with the findings of broad-sense heritability in some quantitative and qualitative trait such as leaf length, leaf width, leaf area, fresh herb yield per plants, dry herb per plants, number of branches, oil content and chlorophyll content earlier reported by (11). The difference between highest and lowest values of heritability due to less and great environment. The estimates of essential oil content in leaves earlier reported by (12) and found that essential oil content increased with plant development reported by (9).

The magnitude of EGA in segregating population especially in F_2 population was higher than that in other population for some traits such as fresh herb yield in cross IC-344681 x IC-326735, dry herb yield in cross IC-369247 x IC-370846, and oil content in cross IC-369247 x IC-370846, in the present study. It seems that larger variability in F_2 population have provided traits selection for promising segregates. Similar results were observed in some earlier study involving different species of Ocimum of genetic advance for

Table 1: Genetic parameter in Basil (*Ocimum basilicum* L.).

Characters	Crosses	Genetic parameters				
		Generation	PCV	GCV	h^2	EGA as % of mean
1. Number of branches	EC-388788 IC-333322	F_2	13.52	13.48	99.40	46.18
		B_1	11.97	11.48	92.00	22.27
		B_2	7.92	7.36	86.40	14.17
	EC-387893 IC-326711	F_2	18.48	17.85	58.20	17.43
		B_1	17.50	16.05	83.30	30.17
		B_2	14.56	11.11	93.30	11.54
	EC-388896 IC-369247	F_2	19.17	11.71	37.30	12.90
		B_1	7.92	7.36	86.40	14.07
		B_2	16.95	16.07	89.90	31.35
	EC-388887 IC-386833	F_2	20.63	19.54	72.20	31.87
		B_1	17.30	16.18	87.50	27.30
		B_2	16.68	15.97	91.70	18.03
	EC-387837 EC-338785	F_2	23.69	19.13	80.17	25.20
		B_1	20.59	19.56	90.30	27.08
		B_2	12.22	11.43	87.50	31.77
	IC-369247 IC-370846	F_2	24.85	23.55	89.80	45.54
		B_1	15.41	14.87	93.20	27.99
		B_2	12.22	11.43	87.50	23.59
	IC-344681 IC-326735	F_2	18.74	15.69	70.10	36.26
		B_1	15.41	14.87	93.20	29.62
		B_2	15.62	15.52	98.70	31.81
2. Leaf area	EC-388788 IC-333322	F_2	29.04	28.78	78.90	18.98
		B_1	15.39	11.91	98.30	58.85
		B_2	18.54	18.12	95.50	36.50
	EC-387893 IC-326711	F_2	25.61	25.33	85.40	33.26
		B_1	10.91	8.98	67.70	15.24
		B_2	18.90	17.47	97.90	51.16
	EC-388896 IC-369247	F_2	24.90	23.85	77.50	25.79
		B_1	18.54	18.12	94.40	36.50
		B_2	21.03	18.15	91.70	47.09
	EC-388887 IC-386833	F_2	24.83	22.29	80.60	41.23
		B_1	20.72	20.22	95.70	40.88
		B_2	16.03	12.64	62.20	20.56
	EC-387837 EC-338785	F_2	25.27	24.71	93.90	17.61
		B_1	23.24	23.02	98.10	47.04
		B_2	10.73	10.33	92.80	20.53
	IC-369247 IC-370846	F_2	29.21	29.02	95.60	10.03
		B_1	17.70	17.39	96.50	35.17
		B_2	13.63	8.13	98.70	59.46
	IC-344681 IC-326735	F_2	26.93	26.65	97.20	51.91
		B_1	20.72	20.22	95.70	40.88
		B_2	25.90	25.33	98.00	54.37
3. Chlorophyll content	EC-388788 x IC-333322	F_2	9.19	9.02	97.60	4.10
		B_1	3.65	2.80	96.40	18.84
		B_2	2.40	2.26	94.10	10.81
	EC-387893 x IC-326711	F_2	7.13	6.33	92.90	2.73
		B_1	4.37	4.73	93.63	76.92
		B_2	4.15	2.89	48.80	4.22
	EC-388896 x IC-369247	F_2	5.30	4.89	86.80	2.70
		B_1	2.40	2.26	94.10	10.81
		B_2	4.82	4.18	75.10	6.94
	EC-388887 x IC-386833	F_2	8.10	7.14	91.30	7.04
		B_1	2.16	2.06	97.80	22.22
		B_2	5.38	4.62	73.60	8.33
	EC-387837 x EC-338785	F_2	11.62	11.31	42.80	5.47
		B_1	2.67	2.61	74.00	6.84
		B_2	9.67	5.01	94.70	22.97
	IC-369247 x IC-370846	F_2	8.13	7.38	96.10	5.40
		B_1	5.58	5.39	85.30	13.04
		B_2	3.50	4.95	82.40	14.28
	IC-344681 x IC-326735	F_2	4.82	4.18	95.00	12.50
		B_1	2.16	2.06	97.80	22.22
		B_2	2.35	1.25	75.10	34.72

Table-1: Contd......

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Characters	Crosses	Genetic parameters				
		Generation	PCV	GCV	h^2	EGA as % of mean
4. Fresh herb yield	EC-388788 x IC-333322	F_2	16.99	16.97	81.10	
		B_1	8.35	9.36	99.00	34.61
		B_2	5.67	5.50	89.90	30.11
	EC-387893 x IC-326711	F_2	28.43	28.34	93.70	9.68
		B_1	26.41	24.31	84.80	46.05
		B_2	6.42	5.40	99.40	58.21
	EC-388896 x IC-369247	F_2	9.50	8.30	93.50	13.58
		B_1	14.77	14.69	98.90	30.11
		B_2	5.38	4.62	99.20	46.95
	EC-388887 x IC-386833	F_2	24.31	24.23	87.10	20.51
		B_1	12.25	10.67	94.40	49.76
		B_2	5.38	4.62	99.20	46.95
	EC-387837 x EC-338785	F_2	25.35	25.27	77.00	18.17
		B_1	23.21	23.07	98.80	47.23
		B_2	10.00	8.50	99.40	51.91
	IC-369247 x IC-370846	F_2	39.07	38.50	93.40	75.50
		B_1	24.41	24.17	98.10	49.31
		B_2	13.32	13.25	99.20	27.13
	IC-344681 x IC-326735	F_2	22.50	25.59	94.80	51.30
		B_1	24.31	24.23	99.40	49.75
		B_2	20.93	20.85	88.85	42.78
5. Dry herb yield	EC-388788 x IC-333322	F_2	14.77	14.69	91.70	12.33
		B_1	12.20	11.50	98.80	34.67
		B_2	8.89	7.70	97.00	32.08
	EC-387893 x IC-326711	F_2	24.49	23.31	93.70	9.49
		B_1	22.70	21.17	87.00	72.25
		B_2	6.67	5.09	90.60	45.69
	EC-388896 x IC-369247	F_2	4.17	5.06	99.40	6.66
		B_1	16.06	15.82	97.00	32.08
		B_2	22.95	21.53	88.00	41.61
	EC-388887 x IC-386833	F_2	38.81	38.80	80.30	24.99
		B_1	11.03	10.13	98.00	56.80
		B_2	21.35	21.18	98.40	43.27
	EC-387837 x EC-338785	F_2	10.39	8.13	89.90	24.99
		B_1	19.39	18.91	91.10	36.39
		B_2	24.77	24.48	97.70	49.83
	IC-369247 x IC-370846	F_2	37.00	32.67	92.80	74.76
		B_1	28.13	27.85	98.00	56.80
		B_2	15.03	14.97	99.20	30.71
	IC-344681 x IC-326735	F_2	27.49	27.09	86.60	48.70
		B_1	23.50	25.57	97.00	54.96
		B_2	22.95	21.53	76.70	41.61
6. Oil content	EC-388788 x IC-333322	F_2	30.06	30.05	94.80	25.51
		B_1	12.50	15.36	94.90	11.47
		B_2	22.22	21.82	95.20	37.29
	EC-387893 x IC-326711	F_2	27.32	27.29	99.20	11.29
		B_1	6.25	4.00	99.70	77.27
		B_2	8.76	8.21	87.80	14.74
	EC-388896 x IC-369247	F_2	25.90	25.50	98.10	14.92
		B_1	24.88	24.82	94.82	22.68
		B_2	12.76	11.18	76.77	18.78
	EC-388887 x IC-386833	F_2	38.81	38.80	75.00	6.44
		B_1	12.67	10.59	99.90	76.16
		B_2	19.64	19.40	97.50	28.57
	EC-387837 x EC-338785	F_2	37.15	37.09	94.06	13.20
		B_1	14.71	13.53	84.60	21.65
		B_2	10.80	10.30	99.70	63.65

morphological traits such as leaf area, number of inflorescence per plant, length of inflorescences, plant height, leaf width, fresh herb yield, dry herb yield, oil content, chlorophyll content as reported by (11).

The heritable variation can be estimated with greater degree of accuracy when heritability is studied along with genetic advance. High heritability estimates coupled with high genetic advance is an effective criteria for selection (7). Heritability along with genetics advance would also be helpful in assessing the nature of gene action. In the present study, the values of genetic advance as percent of men were high for several traits in both non-segregating and segregating population. High values of genetic advance for these traits such as fresh herb yield per plant, dry herb yield per plant, plant height, number of inflorescence, shows that these traits are governed by additive gene action and selection will be rewarding for improvement of such traits in further generations. If the values of genetic advance low, it indicates that the traits are likely to be governed by non-additive gene action and the heterosis breeding may be useful for such traits. The highest values of genetic advance in associated with heritability showed traits additive gene effect were more important for these traits as well higher heritability revealed less environment and greater genetic effect. Low values of genetic advance for these traits indicated non-additive gene effect reported (13).

CONCLUSION

The magnitude of phenotypic coefficient variation was observed higher than genotypic coefficient of variation, indicating the greater influence of environment. Highly significant differences were recorded among the genotypes for the characters indicating high genetic diversity The estimates of high genotypic coefficient of variation was noticed for number of branches, leaf area, fresh herb yield and dry herb yield in F_2, BC_1 and BC_2 segregating generation. High values of genetic advance with high heritability for these traits such as fresh herb yield per plant, dry herb yield per plant, per plant indicating the involvement of additive gene action in the inheritance of these traits. It could be exploited by resorting to simple selection.

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