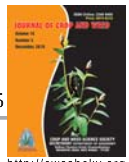
Journal of Crop and Weed, 15(3): 01-06 (2019)

ISSN- O : 2349 9400 ; P : 0974 6315



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A study on genetic variability for yield and its attributes in sacred basil (*Ocimum tenuiflorum* L.)

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Received : 12.11.2019 ; Revised : 29.11.2019 ; Accepted : 01.12.2019

DOI : 10.22271/09746315.2019.v15.i3.1227

ABSTRACT

Variability studyconceded out using six genotypes of sacred basil in lieu of twenty-four characters. The assessmentsof variance showed greater phenotypic variance than genotypic variance because of impact of environment in the manifestation of all the studied characters. High range variation coefficients at genotypic and phenotypic levels for fresh herbage yield $plant^{-1}$ (24.04%; 24.56%), fresh leaf (25.59%; 27.02%) yield $plant^{-1}$, leaf oil yield (30.03%; 31.63%)signifying more variation manifested for these traits thus, more prospect for selection. Broad sense heritability assessments were high in conjunction through high genetic advancement on % mean basis for fresh herbage (95.59%; 48.37%) and fresh leaf (89.64%; 49.90%) yield $plant^{-1}$ and leaf oil yield (90.15%; 58.73%) thus indicating the dominanceaction of additive genes prevailing in the inheritance and thus reliefs improvement over could done with simple selection techniques in sacred basil.

***Keywords* :** GAM, GCV, heritability, PCV, sacred basil, variability

One of the imperative genus of Lamiaceae is *Ocimum*, which comprises diverse species of which *Ocimum tenuiflorum* L. (Holy or Sacred basil) is cultivated in large scale in India.Sacred basil is basically herb worshiped by Indians. The sacred basil is used from ancient times in Indian system of medicines alike Ayurveda and Unani as herbal drug for health ailments. Leaf extracts is having anti-inflammatory activity and also used to cure cardiac related problems, cold, headache and Malaria too (Singh and Kumar, 2010). It is also having diaphoretic, antiperiodic, stimulating, expectorant and antipyretic properties. Root powder helps in spermatorrhoea treatment. Mucilaginous seeds heal genito-urinary complications (Farooqi and Sreeramu, 2004).

The cultivating area and yield of sacred basil is least, foremost cause behind this is due to lack of genotypes suited to a particular region. In basil selection is made on the basis of yield and quality of herb and oil beside with other correlating characters which substantiate in increasing yield. Performance study of the genotypes from corner to corner of different agro-climatic regions is crucial to recognize best yielding genotypes with varying attributes persuading yield. Based on this, promising genotypes can be identified and they can be used further in breeding programme. Variability pursuing at genetic level is akey factor for any improvement in traits which are heritable. Acquaintance of genetic variability, its nature and degree is worthwhile for desirable genotypes assortment from a germplasm (Ojo *et al.*, 2012). Number of accessions is not a sole rule in assessing value of germplasm collection, but it depends predominantly on the magnitude and heritable portion of genetic variability existing in those accessions. (Singh and Narayana, 1993). Availability of wide genetic variation among germplasm provides plentiful scope for advance improvement. Keeping above all in vision, we studied performance of holy basil to discern variability among different characters.

MATERIALS AND METHODS

A research was conceded out during *kharif* season, 2018-2019 at College of Horticulture, Venkataramanna-gudem, Andhra Pradesh, India on"Performance of basil (*Ocimum* spp.) genotypes" The experiment site falls at an altitude of 34 m above mean sea level. The geo-graphical situation is 16^{o} 63′120″ N latitude and 81^{o} 27′ 568″ E longitude under Agro-climatic zone-10, humid, East Coast Plain and Hills (Krishna-Godavari zone) with 900 mm of average annual rainfall. This location proficiencies hot humid summer and mild winter. Six sacred basil genotypes *viz*., Cim-Ayu sourced from CIMAP, Hyderabad, Anand Collection 1, Anand Collection 2 sourced from AAU, Gujarat, Mysore Local collected from Mysore, Karnataka, West Godavari Local collected from HRS-Venkataramannagudem, A.P. and IC75030 sourced from NBPGR, New Delhi were taken for study. RBD is used for experiment with four replications. Various observations on growth, yield and quality were documented. Essential oil percentage was recorded by using Clevenger apparatus (Clevenger, 1928) and expressed on dry weight basis from this oil

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yield was also computed by analyzing 100-gram fresh sample.

The recorded data inreverence to plant height (cm), spread (cm^2), number of branches (primary and secondary), leaves count, leaf area plant^{-1} (cm^2), total herbage yield (fresh and dry) of plant (g), fresh leaf herbage and spikes yield plant (g), dry matter content (%) of leaf and spike, dry leaf herbage and spikes yield plant^{-1} (g), number of days to 50% flowering, spike counts plant^{-1}, length of spike (cm), oil percentage from leaves and spikes (DWB), Leaf oil yield and spikes plant^{-1} (g), seed counts spike^{-1}, seeds test weight (g) and yield of seeds plant^{-1} (g) were imperiled to the following statistical analysis. To find out the connotation effect of genotypes,the mean values of 5 random plants in plots were analyzed using Panse and Sukhatme (1985) method. Coefficients of variation at genotypic and phenotypic levels were assessed bestowing to Burton and Devane (1953), and its categorization was based on the ranges of variation as described by Sivasubramanian and Menon (1973). Allard (1960) formula was used to estimate broad sense heritability. Formula suggested by Lush (1940) and Johnson *et al.* (1955) second hand to assessment of genetic advance and its per cent over mean was gotten by dividing genetic advance with general mean of the character. The ranges of h^2_b and GAM were classified as recommended by Johnson *et al.* (1955).

RESULTS AND DISCUSSION

The population genotypic and phenotypic coefficients of variation (GCV& PCV), heritability, genetic advancement its per cent of mean (GAM) for important quantitative characters were analysed to record the degree of variability of sacred basil genotypes and presented in table 2.

The variance assessments at phenotypic level were higher than those at genotypic level for all the traits (Table 1), thus representing the impact of environment in the countenance of these traits. Meanwhile the appraisals of variances merely do not provide resources to judge the nature of genetic variability, therefore coefficients of variation were also figured. Significant higher PCV was noticed for maximum number of traits than GCV under study confirming the environmental intervention.

Coefficient of variation at genotypic level (%)

Higher range of GCV was found in secondary branches plant^{-1} (28.28%), leaf counts plant^{-1} (22.08%), leaf area plant^{-1} (34.33%), total fresh herbage yield of plant (24.02%), total dry herbage yield of plant (24.93%), fresh leaf herbage plant^{-1} (25.59%), dry leaf herbage plant^{-1} (26.82%), spike counts plant^{-1} (40.09%), fresh spike yield plant^{-1} (34.89%), dry spike yield plant^{-1} (36.06%), leaf oil yield plant^{-1}(30.03%), spike oil yield plant^{-1} (53.87%) and yield of seed plant^{-1} (60.17%).

The values were in moderate range for plant spread (14.57%), primary branches plant^{-1} (17.49%), spike oil% (18.96%), seeds count spike^{-1} (12.55%) and seeds test weight (14.82%). Whereas, plant height (7.99%), dry matter content of leaf (8.12%), days to 50% flowering (6.20%), length of spike (8.93%), dry matter content of spike (9.08%), and per cent oil from leaf (9.67%) showed lesser GCV range.

Coefficient of variation at phenotypic level (%)

In this experiment, high PCV range was intended for plant spread (21.22%), secondary branches number plant^{-1} (29.22%), leaf counts plant^{-1} (23.37%), leaf area plant^{-1} (36.50%), total fresh herbage yield of plant (24.56%), total dry herbage yield of plant (25.75%), fresh leaf herbage plant^{-1} (27.02%), dry leaf herbage plant^{-1} (30.39%), spikes count plant^{-1} (41.61%), fresh spike yield plant^{-1} (38.20%), dry spike yield plant^{-1} (41.63%), leaves oil yield plant^{-1} (31.63%), spike oil% (22.18%), spikes oil yield plant^{-1} (56.32%) and yield of seeds plant^{-1} (61.83%).

Moderate records of PCV range were obtained for Primary branches plant^{-1} (19.56%), dry matter content of leaf (14.38%), length of spike (14.62%), per cent oil from leaf (17.91%), seed counts spike^{-1} (13.05%) and seeds test weight (15.12%) whereas, low range of PCV was exhibited for plant height (8.42%), days to 50% flowering (6.23%) and dry matter of spike (9.60%).

The appraisals of variability at both genotypic and phenotypic levels were higher for secondary branches plant^{-1}, leaf counts plant^{-1}, leaf area plant^{-1}, total fresh herbage yield of plant, total dry herbage yield of plant, fresh leaf herbage plant^{-1}, dry leaf herbage plant^{-1}, spike counts plant^{-1}, fresh spike yield plant^{-1}, dry spike yield plant^{-1}, leaf oil yield plant^{-1}, spike oil yield plant-^{1} and yield of seeds plant^{-1}demonstrating larger variability presence in lieu of these traits among the genotypes as a result of which more scope for selection. These outcomes stay in agreement with the verdicts of Verma *et al.* (1998a) for fresh herb and oil yield, Kassahum *et al.* (2018) for leaf and oil yield in rosemary, Smita and Kishori (2018) for fresh herb yield in basil.

Both levels of variation intended for primary branches plant^{-1}, seed countsspike^{-1} and seeds test weightwas moderate thus signposted the incidence of moderately less genetic variation. Analogousoutcomes were established by Singh and Kumar (2010), Anyaoha (2013) and Simtha and Kishori (2018) in basil.

Approximations of variability at phenotypic and genotypic levels were distant to each other for plant

Table 1: Mean, range, genotypic, phenotypic and environment variance among different characters in sacred basil (*Ocimum tenuiflorum* L.) genotypes

Character	Mean	Range	GV	PV	EV
Plant height (cm)	77.19	66.56-82.59	38.01	42.25	4.24
Plant spread (cm^2)	4118.83	2900.00-4880.00	3603347	764227.75	403880.64
Number of primary branches plant^{-1}	19.10	15.19-23.08	11.16	13.95	2.79
Number of secondary branches plant^{-1}	135.14	79.49-187.31	1460.78	1559.28	98.50
Leaf countsplant^{-1}	2198.85	1444.47-2959.42	235725.50	264174.35	28448.81
Leaf area plant^{-1} (cm^2)	9186.47	5548.37-12789.02	9952115.19	11249696.13	1297580.94
Total fresh herbage yield of plant (g)	514.85	344.28-677.44	15290.06	15994.63	704.57
Total dry herbage yield of plant (g)	118.23	76.61-156.35	868.85	927.17	58.28
Fresh leaf herbage plant^{-1} (g)	197.13	133.08-255.23	2543.77	2837.72	293.95
Dry matter content of leaf (%)	15.17	13.18-17.01	1.52	4.76	3.24
Dry leaf herbageplant^{-1} (g)	29.95	18.79-42.48	64.53	82.86	18.32
Days to 50% flowering	67.63	61.65-73.72	17.60	17.75	0.15
Spike countsplant^{-1}	374.19	164.44-563.03	22505.38	24240.71	1735.33
Length of spike (cm)	9.39	8.44-11.22	0.70	1.88	1.18
Fresh spike yield plant^{-1} (g)	119.35	70.27-178.70	1733.84	2078.30	344.46
Dry matter content of spike (%)	22.5	18.73-24.86	4.17	4.66	0.49
Dry spike yield plant^{-1} (g)	27.22	15.85-41.91	96.32	128.40	32.08
Leaf oil percentage (DWB)	3.00	2.63-3.70	0.08	0.29	0.20
Leaf oil yield plant^{-1} (g)	0.88	0.56-1.19	0.07	0.08	0.01
Spike oil percentage (DWB)	2.20	1.60-2.68	0.17	0.24	0.06
Spike oil yield plant^{-1} (g)	0.63	0.25-1.11	0.11	0.12	0.01
Seed counts spike^{-1}	136.46	108.00-153.00	293.52	317.09	23.58
Seeds test weight (g)	0.43	0.34-0.52	0.009	0.009	0.00
Yield of seeds plant^{-1} (g)	23.83	9.26-44.84	209.35	217.14	7.80

spread, dry matter content of leaf, length of spike, leaf and spike oil% which point out that this attributes were much swayed by external climatic factors. The fallouts were in agreement with Verma *et al.* (1998b) reported moderate GCV meant for oil content and moderate PCV for plant height in mint, Anyaoha (2013) for plant spread in basil, Kasshum *et al.* (2015) in sage and Simta and Kishori (2018) for oil content in basil.

Height of plant, days taken to 50% flowering and dry matter content of spike showed lower range of phenotypic and genotypic coefficients of variation since less genetic variation, which in-turn yields less/ nopossibility for selection. These results were in conformity with conclusions put forth by Singh *et al.* (1999) in mint, Smita and Kishori (2018) in basil.

Broad sense heritability (h_b^2)

The analysed per cent h_b^2 for important quantitative characters among sacred basil genotypes were portrayed in table 2. This information withdraws the virtual magnitude of variation on performance of genotypes at both genetic and environmental levels.

Heritability assessments were at high range for most of the important characters considered like,height of plant (89.97%), primary branches plant^{-1} (79.98%), secondary branches plant^{-1} (93.68%), leaf counts plant^{-1} (89.23%), leaf area plant^{-1} (88.47%), total fresh herbage yield of plant (95.59%), total dry herbage yield of plant (93.71%), fresh leaf herbage plant^{-1} (89.64%), dry leaf herbage plant^{-1} (77.89%), days to 50% flowering (99.15%), spike counts plant^{-1} (92.84%), fresh spike yieldplant^{-1} (83.43%), dry matter content of spike (89.46%), dry spike yield plant^{-1} (75.02%), leaf oil yield plant^{-1} (90.15%), spike oil% (73.12%), spike oil yield plant^{-1} (91.46%), seed counts spike^{-1} (92.57%), seeds test weight (96.07%) and yield of seeds plant^{-1} (96.41%).

Moderate range of heritability estimates were witnessed by plant spread (47.17%), dry matter content of leaf (31.88%) and length of spike (37.34%) whereas, leaf oil% (29.16%) exhibited heritability estimate at lower range.

Genetic advancement by means of percentage

Percentage of mean of the genetic advance (GAM) remainedto be high on behalf of important quantitative characters premeditated, such are primary branches plant^{-1} (32.22%), secondary branches plant^{-1} (56.39%), leaf counts plant^{-1} (42.97%), leaf area plant^{-1} (66.52%),

Table 2: Genotypic and phenotypic coefficients of variation, heritability in broad sense, genetic advance and genetic advance as per cent mean in sacred basil (*Ocimum tenuiflorum* L.) genotypes

Character	GCV	PCV	h_b^2	GA	GAM
Plant height (cm)	7.99	8.42	89.97	12.05	15.61
Plant spread (cm^2)	14.57	21.22	47.17	849.14	20.62
Number of primary branches plant^{-1}	17.49	19.56	79.98	6.15	32.22
Number of secondary branches plant^{-1}	28.28	29.22	93.68	76.21	56.39
Leaf counts plant^{-1}	22.08	23.37	89.23	944.78	42.97
Leaf area plant^{-1} (cm^2)	34.33	36.50	88.47	6112.41	66.52
Total fresh herbage yield of plant (g)	24.02	24.56	95.59	249.05	48.37
Total dry herbage yield of plant (g)	24.93	25.75	93.71	58.78	49.72
Fresh leaf herbage plant^{-1} (g)	25.59	27.02	89.64	98.37	49.90
Dry matter content of leaf (%)	8.12	14.38	31.88	1.43	9.44
Dry leaf herbage plant^{-1} (g)	26.82	30.39	77.89	14.60	48.76
Days to 50% flowering	6.20	6.23	99.15	8.61	12.72
Spike counts plant^{-1}	40.09	41.61	92.84	297.77	79.58
Length of spike (cm)	8.93	14.62	37.34	1.06	11.25
Fresh spike yield plant^{-1} (g)	34.89	38.20	83.43	78.35	65.64
Dry matter content of spike (%)	9.08	9.60	89.46	3.98	17.69
Dry spike yield plant^{-1} (g)	36.06	41.63	75.02	17.51	64.33
Leaf oil percentage (DWB)	9.67	17.91	29.16	0.32	10.76
Leaf oil yield plant^{-1} (g)	30.03	31.63	90.15	0.52	58.73
Spike oil percentage (DWB)	18.96	22.18	73.12	0.73	33.41
Spike oil yield plant^{-1} (g)	53.87	56.32	91.46	0.66	106.12
Seed counts spike^{-1}	12.55	13.05	92.57	33.96	24.88
Seeds test weight (g)	14.82	15.12	96.07	0.13	29.92
Yield of seeds plant^{-1} (g)	60.17	61.83	96.41	29.27	122.79

Table 3: Fresh weight, oil yield and yield of seeds plant^{-1} in sacred basil (*Ocimum tenuiflorum* L.) genotypes

Genotype	Herbage yield plant^{-1} (g)				Oil yield plant^{-1} (g)			Yield of seeds plant^{-1} (g)
	Leaves	Spikes	Stem	Total	Leaves	Spikes	Total	
CIM-Ayu	216.67	110.08	175.42	502.17	0.98	0.51	1.48	26.54
Anand collection 1	251.17	178.70	247.58	677.44	1.17	1.11	2.28	44.84
Anand collection 2	255.25	156.01	226.83	638.08	1.19	0.94	2.13	36.44
Mysore Local	166.00	77.83	195.34	439.17	0.72	0.31	1.03	12.78
West Godavari Local	133.08	70.27	140.92	344.28	0.56	0.25	0.81	13.15
IC75030	160.58	123.24	204.13	487.94	0.69	0.64	1.33	9.26
Mean	**197.13**	**119.35**	**198.37**	**514.85**	**0.88**	**0.63**	**1.51**	**23.83**
SEm(±)	**8.57**	**9.28**	**11.18**	**13.27**	**0.04**	**0.05**	**0.05**	**1.40**
LSD (0.05)	**25.84**	**27.97**	**33.71**	**40.01**	**0.13**	**0.16**	**0.16**	**4.21**

total fresh herbage yield of plant (48.37%), total dry herbage yield of plant (49.72%), fresh leaf herbage plant^{-1} (49.90%), dry leaf herbage plant^{-1} (48.76%), spike counts plant^{-1} (79.58%), fresh spike yield plant^{-1} (65.64%), dry spike yield plant^{-1} (64.33%), leaf oil yield plant^{-1} (58.73%), spike oil% (33.41%), spike oil yield plant^{-1} (106.12%), seed counts spike^{-1} (24.88%), seeds test weight (29.92%) and yield of seeds plant^{-1} (122.79%).

GAM was in moderate range for plant height (15.61%), plant spread (20.62%), days to 50% flowering (12.72%), length of spike (11.25%) and dry matter content of spike (17.69%) whereas, dry matter content of leaf (9.44%) and leaf oil% (10.76%) unveiled low range of GAM.

Higher range of heritability perceived in juxtaposition with GAM at higher range was in lieu of the traits alike primary branches plant^{-1}, secondary branches plant^{-1}, leaf counts plant^{-1}, leaf area plant^{-1}, total fresh herbage yield of plant, total dry herbage yield of plant, fresh leaf herbage plant^{-1}, dry leaf herbage plant^{-1}, spike counts plant^{-1}, fresh spike yield plant^{-1}, dry spike yield plant^{-1}, leaf oil yield plant^{-1}, spike oil%, spike oil yield plant^{-1},seed counts spike^{-1}, seeds test weight and yield of seeds plant^{-1}as a consequence specifying the supremacy action of additive genes over riding the inheritance of these attributes and thus offers the paramount of simple and direct selection procedures on the basis of these attributes in diverse genetic materials with respect to desired crop improvement. These outcomes were found parallel with Pushpangadan *et al.* (1979) in lieu of fresh herbyield plant^{-1} and yield of oil plant^{-1} in basil, Sharma and Tyagi (1991) on behalf of herbage yield and %oil in mint, Singh *et al.* (1999) for oil content and oil yield from leaf and herb in mint. Singh and Kumar (2010) for basil plant fresh and dry weights, Anubha *et al.* (2013) intended for yield of seeds plant^{-1} in fenugreek.

GAM at medium range collective with medium to high range heritability signposts the together action of non-additive and additive genes as computed on behalf of height and spread of plant, days to 50% flowering, length of spike and dry matter content of spike and consequently selection grounded on these traits may not be of great advantage. High range appraisals of GAM united with moderate range heritability might be owing to camouflaging of additive gene action for a particular character by environmental stimulus. Conclusions drawn by, Singh and Kumar (2010), Pathak *et al.* (2014) and Smita and Kishori (2018) moreover indicated high rangefor this character besides GAM at moderate range.

Low GA as per cent of mean with moderate or low heritability intended for dry matter content of leaf, leaf oil% point towards the governance of inheritance of this character stands in association with non-additive gene action, however since the GAM is in low range the expected improvement could be lesser.

The appraisals of phenotypic variance stood greater than those of genotypic variance in lieu of all traits studied, thus specifying the stimulus of environment in their expression. In sacred basil, high heritability together with high GAM was perceived on behalf of the traits *viz*., primary and secondary branches number plant^{-1}, leaf counts plant^{-1}, leaf area plant^{-1}, total fresh herbage yield of plant, total dry herbage yield of plant, fresh leaf herbage plant^{-1}, dry leaf herbage plant^{-1}, spike counts plant^{-1}, fresh spike yield plant^{-1}, dry spike yield plant^{-1}, leaf oil yield plant^{-1}, spike oil%, spike oil yield plant^{-1},seed counts spike^{-1}, seeds test weight and yield of seeds plant^{-1} thus representing the preponderance of additive action of genes manifesting the inheritance of these traits by this means it consents best possibility of improving them through simple selection. On the basis of the study of genotypes Anand Collection 1 recorded highest herb (total fresh herbage yield of plant), yield of oil and seeds plant^{-1}, (herb – 677 g; oil – 2.28 g; seed – 44.84g) (Table 3).

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