

Genetic Variability, Correlation and Path Coefficient Studies in *Perilla* (*Perilla frutescens* [(L.) Britton]) Landraces of Nagaland

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ABSTRACT

The analysis of variance revealed significant variation for all the character except for petiole length and plant height, indicating significant variability in the material. The highest GCV and PCV were recorded for seed yield per plant, number of inflorescence, number of leaves and test weight indicating the ample variation present for these traits in the present material. In the present study, high estimates of heritability and genetic advance were obtained for seed yield per plant, test weight, number of leaves, length of main inflorescence and number of primary branches. Thus, selection for these traits is likely to accumulate more additive genes leading to further improvement of their performance and these traits may be used as selection criteria in breeding programme. Studies on character associations and their casual relationships revealed that plant height, number of inflorescence per plant and number of primary branches per plant were found to be significantly and positively correlated with seed yield per plant. However, path coefficient analysis revealed that that leaf breadth followed by test weight and oil content contributed high and positive direct effect on seed yield per plant, hence, emphasis should be given on indirect selection of these traits for improvement in seed yield.

1. Introduction

In India, *Perilla* (*Perilla frutescens* [(L.) Britton]) is an underutilized crop which comes under the category of minor oil seed crop. It is cultivated majority in the northeastern hill region, Kumaon, Garhwal and Himachal Pradesh. It is also reported to have medicinal values. Asian herbalists prescribe *perilla* for cough and lung afflictions, influenza prevention, restless fetus, seafood poisoning, incorrect energy balance, etc (Brenner, 1993). Along with the other Northeastern states, Nagaland state is endowed many landraces of its own; however, exploitation of germplasm has not been done so far. In any crop, germplasm is a valuable source of base population and provides the scope for wider variability. In general, diverse landraces traditionally are considered important for future food security due to their ability to sustain in changing climate (Huang *et al.*, 2012; Pusadee *et al.*, 2009 and Doebley *et al.*, 2006). Therefore, the present study was undertaken to assess the nature and magnitude of genetic variability present in different indigenous collections of *Perilla*. An attempt has also been made to study the correlation and path coefficient which are helpful in selecting the desirable traits.

2. Materials and Methods:

The present investigation was undertaken during the kharif season of 2016 with 15 landraces from 10 districts of Nagaland. The experiment was laid out in randomized block design with three replication in the experimental farm of School of Agricultural Sciences and Rural Development, Medziphema campus, Nagaland University. The period of crop growth cycle was for seven months *i.e.* from May to November 2016. Seeds were sown on 8th May in line sowing with a depth of 1-1.5 cm. All the cultural practices were followed for raising a good crop. Data were recorded on five randomly sampled plants from each plot leaving all the border plants. The data collected were

on the thirteen quantitative traits of the crop *viz.*, days to 50% flowering, plant height, number of leaves per plant, leaf length, leaf breadth, petiole length, number of primary branches per plant, number of inflorescence per plant, length of main inflorescence, days to 80% maturity, test weight, oil content and seed yield per plant. The mean values were subjected to statistical analysis to work out analysis of variance for all the characters as suggested Panse and Sukhatme (1957). The phenotypic, genotypic and environmental coefficient of variation was calculated according to Burton and De Vane (1953). Heritability and genetic advance were calculated according to Allard (1960) and genetic gain was estimated using the method of Johanson *et al.* (1955). Phenotypic and genotypic correlation coefficients were worked out to study the interrelationship between various pairs of characters as suggested by Al-Jibouriet *al.* (1958). The path coefficient analysis was carried out by the formula apply by the Dewey and Lu (1959).

3. Results and Discussion

Genetic variability

The analysis of variance revealed presence of significant variations for all the characters except for petiole length and plant height indicating the presence of sufficient amount of genetic variability among the landraces for seed yield per plant and other yield contributing traits. Hence, it can be noted that systematic crossing among selected landraces will generate variability in subsequent generation. The experimental finding showed a wide range of variation for number of leaves per plant, number of inflorescence per plant, plant height, days to 80% maturity and seed yield per plant (Table- 1). Similar results were reported by Bahuguna and Prasad (2014). Landraces Pe-2(30.27g), Pe-10(20.65g), Pe-15(15.76) and Pe-12(12.34g) were recorded with high seed yield per plant. Pe-

12, Pe-3, Pe-5, Pe-2, Pe-8, Pe-13, Pe-14, Pe-9, Pe-10 and Pe-15 were recorded with high number of inflorescence per plant. Pe-7, Pe-12, Pe-2 and Pe-10 were recorded with high length of main inflorescence. Therefore these landraces could be utilized in further breeding improvement programme for the yield improvement.

Phenotypic coefficient of variation was found to be higher than those of genotypic coefficient of variance for all the characters under study (Table-2) indicating the role of

environmental variance in the total variance. High PCV and GCV were recorded for seed yield per plant (73.65% and 73.01%), number of inflorescence (35.44% and 21.42%), number of leaves (32.85% and 31.72%) and test weight (28.59% and 27.74%) indicating presence of ample variation for these traits in the present material. Moderate PCV and GCV were recorded for length of main inflorescence (21.72% and 19.54%), number of primary branches (20.65% and 16.57%) and oil content (16.74% and 12.79%). Similar results were reported by Hussain *et al* (2013).

Table- 1. Mean value of fifteen (15) genotypes of *Perilla frutescens* [(L.) Britton] for thirteen (13) characters

Genotypes	Characters												
	Days to 50% flowering	Plant height (cm)	No. of leaves/plant	Leaf length (cm)	Leaf breadth (cm)	Petiole length (cm)	No. of primary branches/Plant	No. of inflorescence/plant	Length of main inflorescence (cm)	Days to 80% Maturity	Test weight (g)	Oil content (%)	Seed yield/plant (g)
Pe1	152.00	139.00	310.00	10.67	10.07	5.47	15.67	120.00	9.97	192.00	1.20	29.75	7.46
Pe2	146.67	155.00	243.00	14.00	12.30	7.37	19.00	183.33	10.60	192.00	1.80	30.30	30.27
Pe3	146.67	155.00	253.00	14.60	11.83	7.00	17.33	200.00	11.53	190.00	1.27	44.80	10.32
Pe4	166.00	157.67	143.00	13.43	11.53	6.17	14.00	113.33	8.90	199.00	1.30	42.00	3.98
Pe5	146.67	180.67	137.67	13.33	10.47	5.57	21.67	200.00	9.63	200.33	1.23	37.30	11.09
Pe6	155.67	135.00	239.67	13.50	11.27	6.30	11.67	100.00	8.20	190.00	1.43	35.30	4.03
Pe7	154.33	126.67	146.67	15.97	12.93	7.00	14.00	90.00	14.50	203.33	1.83	32.30	4.09
Pe8	160.00	173.33	190.67	14.93	12.77	7.53	17.67	180.00	10.20	211.67	1.63	37.90	4.14
Pe9	160.00	133.33	275.33	17.03	13.87	8.07	16.67	173.33	8.30	196.33	2.03	29.25	4.20
Pe10	145.33	169.67	169.67	14.17	11.53	6.70	15.33	166.67	10.47	192.00	1.60	33.25	20.65
Pe11	148.67	150.00	145.33	13.37	11.23	7.57	22.33	93.33	10.83	190.00	1.23	34.00	8.16
Pe12	145.33	172.67	232.67	14.13	14.73	7.90	21.33	220.00	14.50	177.33	1.57	27.25	12.34
Pe13	154.33	151.00	141.67	13.40	12.50	6.93	17.00	173.33	10.53	186.00	0.57	34.25	12.08
Pe14	168.67	128.00	245.67	11.97	9.70	5.27	15.00	173.33	6.77	194.33	1.13	38.20	4.56
Pe15	154.33	145.00	362.33	12.77	11.60	6.90	19.67	163.33	9.60	190.00	2.23	30.85	15.76
Grand Mean	153.64	151.47	215.76	13.82	11.89	6.78	17.22	156.67	10.30	193.62	1.47	34.45	10.21
CD at 5%	7.96	53.18	30.81	2.60	2.62	2.34	3.55	73.98	1.63	12.48	0.17	6.22	1.65
CV	3.10	20.99	8.54	11.23	13.18	20.65	12.33	28.23	9.48	3.85	6.94	10.80	9.68

Table- 2. Estimates of variances and other related parameters for thirteen (13) characters in 15 landraces of *Perilla*.

Sl. No.	Characters	Parameters								
		Mean values \pm SEM	Range	σ^2_g	σ^2_p	GCV (%)	PCV (%)	h ² (broad sense)	Genetic advance	GA as percent of mean
1.	Days to 50% flowering	153.64 \pm 2.75	145.33-168.67	47.91	70.54	4.50	5.47	67.92	11.75	7.65
2.	Plant height	151.47 \pm 18.36	126.67-180.67	-41.29	969.77	-4.24	20.56	-4.26	-2.73	-5.11
3.	No. of leaves	215.76 \pm 10.64	137.67-362.33	4684.36	5023.78	31.72	32.85	93.24	136.15	63.10
4.	Leaf length	13.82 \pm 0.90	10.67-17.03	1.51	3.92	8.90	14.33	38.55	1.57	11.38
5.	Leaf breadth	11.89 \pm 0.90	9.70-14.73	1.02	3.47	8.48	15.68	29.27	1.12	9.45
6.	Petiole length	6.78 \pm 0.81	5.27-8.07	0.11	2.07	4.86	21.21	5.25	0.16	2.30
7.	No. of primary branches/plant	17.22 \pm 1.23	11.67-22.33	8.14	12.65	16.57	20.65	64.34	4.71	30.44
8.	No. of inflorescence/plant	156.67 \pm 25.54	90.00-220.00	1125.63	3082.06	21.42	35.44	36.52	41.77	26.66
9.	Length of main inflorescence	10.30 \pm 0.56	6.77-14.50	4.05	5.01	19.54	21.72	80.93	3.73	36.20
10.	Days to 80% maturity	193.62 \pm 4.31	177.33-211.67	44.68	100.39	3.45	5.17	44.51	9.19	4.75
11.	Test weight	1.47 \pm 0.06	0.57-2.23	0.17	0.18	27.74	28.59	94.11	0.82	55.43
12.	Oil content	34.45 \pm 2.15	27.25-44.80	19.41	33.26	12.79	16.74	58.36	6.93	20.13
13.	Seed yield/ plant	10.21 \pm 0.57	3.98-30.27	55.56	56.53	73.01	73.65	98.27	15.22	149.10

Table- 3. Estimates of genotypic correlation coefficients (r_g) among different characters in perilla.

Characters	Days to 50% flowering	Plant height (cm)	No. of leaves/ plant	Leaf length (cm)	Leaf breadth (cm)	Petiole length (cm)	No. of primary branches/ Plant	No. of inflorescence/ plant	Length of main inflorescence (cm)	Days to 80% maturity	Test weight (g)	Oil content (%)	Seed yield/ plant (g)
Days to 50% flowering	1.000	-0.180	0.055	-0.096	-0.310	-0.971**	-0.657**	-0.338	-0.668**	0.379	-0.029	0.367	-0.687**
Plant height (cm)		1.000	-0.450*	-0.376	-0.041	-0.702**	0.653**	0.089	0.339	-0.333	-0.098	-0.078	0.601**
No. of leaves / plant			1.000	-0.301	-0.069	0.015	-0.008	0.170	-0.257	-0.335	0.487*	-0.376	0.129
Leaf length (cm)				1.000	0.653**	0.992**	-0.185	0.055	0.394	0.385	0.588*	-0.029	-0.121
Leaf breadth (cm)					1.000	0.152	0.144	0.263	0.809**	-0.259	0.524*	-0.531*	0.079
Petiole length(cm)						1.000	0.633**	0.087	0.217	-0.500*	0.117	-0.909**	0.429
No. of primary branches/ plant							1.000	0.486*	0.292	-0.500*	0.013	-0.390	0.449*
No. of inflorescence/ plant								1.000	0.013	-0.232	-0.007	-0.034	0.505*
Length of main inflorescence (cm)									1.000	-0.254	0.123	-0.377	0.195
Days to 80% maturity										1.000	0.259	0.505*	-0.445*
Test weight (g)											1.000	-0.454*	0.196
Oil content (%)												1.000	-0.361
Seed yield/plant (g)													1.000

*significant at 5% (0.441) ; ** significant at 1% (0.592)

Table- 4. Estimates of Phenotypic correlation coefficient (r_p) among different characters in perilla.

Characters	Days to 50% flowering	Plant height (cm)	No. of leaves/ plant	Leaf length (cm)	Leaf breadth (cm)	Petiole length (cm)	No. of primary branches/ Plant	No. of inflorescence/ plant	Length of main inflorescence (cm)	Days to 80% maturity	Test weight (g)	Oil content (%)	Seed yield/ plant (g)
Days to 50% flowering	1.000	-0.184	0.040	0.013	-0.085	-0.086	-0.471*	-0.215	-0.490*	0.500*	-0.071	0.214	-0.530*
Plant height (cm)		1.000	-0.114	0.205	0.226	0.297	0.335	0.304	0.226	0.102	-0.051	0.072	0.258
No. of leaves / plant			1.000	-0.169	-0.024	-0.009	0.036	0.217	-0.203	-0.229	0.462*	-0.287	0.136
Leaf length (cm)				1.000	0.813**	0.728**	0.016	0.176	0.256	0.212	0.346	-0.075	-0.051
Leaf breadth (cm)					1.000	0.863**	0.124	0.321	0.414	-0.087	0.282	-0.309	0.069
Petiole length(cm)						1.000	0.224	0.237	0.313	-0.051	0.287	-0.237	0.140
No. of primary branches/ plant							1.000	0.361	0.314	-0.306	0.048	-0.149	0.399
No. of inflorescence/ plant								1.000	0.129	-0.204	0.053	0.026	0.323
Length of main inflorescence (cm)									1.000	-0.150	0.137	-0.173	0.178
Days to 80% maturity										1.000	0.134	0.222	-0.269
Test weight (g)											1.000	-0.379	0.187
Oil content (%)												1.000	-0.263
Seed yield/plant (g)													1.000

*significant at 5% (0.441) ; ** significant at 1% (0.592)

Table- 5. Estimates of direct and indirect effects of different characters on seed yield/plant at genotypic level

Characters	Days to 50% flowering	Plant height (cm)	No. of leaves / plant	Leaf length (cm)	Leaf breadth (cm)	Petiole length (cm)	No. of primary branches / plant	No. of inflorescence / plant	Length of main inflorescence (cm)	Days to 80% maturity	Test weight (g)	Oil content (%)	Total (r _g)
Days to 50% flowering	-1.36	-0.47	-0.04	0.08	-0.39	0.11	0.30	0.15	1.04	-0.27	-0.03	0.19	-0.687
Plant height (cm)	1.61	-0.40	0.29	0.29	-0.05	0.08	-0.30	-0.49	-0.53	0.22	-0.11	-0.04	0.601
No. of leaves / plant	-0.07	-0.18	-0.65	0.24	-0.09	-0.002	0.004	-0.08	0.40	0.24	0.52	-0.20	0.129
Leaf length (cm)	0.13	-0.15	0.20	-0.78	0.82	-0.11	0.08	-0.03	-0.61	-0.28	0.62	-0.02	-0.121
Leaf breadth (cm)	0.42	-0.02	0.05	-0.51	1.25	-0.13	-0.07	-0.12	-1.26	0.19	0.56	-0.28	0.079
Petiole length (cm)	1.32	-0.28	-0.01	-0.77	1.44	-0.11	-0.29	-0.04	-1.89	0.36	1.19	-0.48	0.429
No. of primary branches / plant	0.90	0.26	0.01	0.14	0.18	-0.07	-0.45	-0.22	-0.45	0.36	0.01	-0.21	0.449
No. of inflorescence / plant	0.46	0.43	-0.11	-0.04	0.33	-0.01	-0.22	-0.45	-0.02	0.17	-0.01	-0.02	0.505
Length of main inflorescence (cm)	0.91	0.13	0.17	-0.31	1.01	-0.12	-0.13	-0.01	-1.56	0.18	0.13	-0.20	0.195
Days to 80% maturity	-0.52	-0.13	0.22	-0.30	-0.32	0.06	0.23	0.11	0.40	-0.72	0.28	0.27	-0.445
Test weight (g)	0.04	-0.04	-0.32	-0.46	0.65	-0.13	-0.01	0.003	-0.19	-0.19	1.06	-0.24	0.196
Oil content (%)	-0.50	-0.03	0.24	0.02	-0.66	0.10	0.18	0.02	0.59	-0.36	-0.48	0.53	-0.361

Residual effect: 0.407

Heritability and Genetic Advance

High values of heritability in broad sense are helpful in identifying the appropriate character for selection and enabling the breeder to select superior genotypes on the basis of phenotypic expression of quantitative traits. Heritability is considered low if it is less than 30%, moderate between (30-60%) and high if it is more than 60% (Johnson *et al*,1995). The maximum heritability (broad sense) was observed for seed yield per plant followed by test weight, number of leaves, length of main inflorescence, days to 50% flowering and number of primary branches (Table- 2). Thus selection for these traits is likely to accumulate more additive genes leading to further improvement of their performance and may also be used as selection criteria in perilla breeding program. Similar results were reported by Hussain *et al* (2013).

The estimates of genetic advance expressed as percentage of mean was found maximum for seed yield per plant followed by number of leaves, test weight, length of main inflorescence, number of primary branches per plant, number of inflorescence per plant and oil content (Table- 2). Heritability and genetic advance when considered together would be more reliable and useful in predicting the resultant effects of selection. In the present study, high heritability coupled with high genetic advance expressed as percentage of mean were observed for seed yield per plant, test weight, number of leaves, length of main inflorescence and number of primary branches which may be attributed to the preponderance of

additive gene action and possess high selective value and thus, selection pressure could profitably be applied on these characters for their rationale improvement.

Correlation coefficient

Seed yield is a complex character that is outcome of interaction between many plant traits, which are in turn influenced by their genetic makeup and the environment, where crop is grown. Therefore, the direct evaluation and improvement of seed yield itself may be misleading due to involvement of environmental component. Therefore, it is important to analyze the data for relative contribution of various components to yield performance. The simple correlation analysis is an important tool for this purpose. To have more precise information, it is further taken into genotypic and phenotypic level. In the present study, correlations between thirteen characters were studied in all possible combinations both at phenotypic and genotypic level.

In general, the values of genotypic correlation were higher than their corresponding phenotypic correlation in the present investigation for most of the characters (Table 3 and 4). This indicated that though there was high degree of association between two variables at genotypic level, its phenotypic expression was deflated by the influence of environment. Similar results were reported by Hussain *et al*. (2013). At genotypic level, plant height, number of inflorescence per plant and number of primary branches per plant were found to be

significantly and positively correlated with seed yield per plant. Thus, these traits were proved to be the outstanding characters influencing seed yield per plant in *Perilla* and needs to be given due importance in selection to achieve higher seed yield.

Path coefficient analysis

The genotypic path coefficient analysis revealed that leaf breadth(1.25) followed by test weight (1.06) and oil content (0.53) contributed high and positive direct effect on seed yield per plant (Table- 5) Similar results were reported by Hussain *et al.* (2013). However, these traits did not show significant

correlation with seed yield, hence, while selection emphasis should be given on indirect selection of these traits. The residual effect estimated was 0.407 indicating that the characters under study are not sufficient to account for variability and there might be a few more characters other than those studied in the present investigation and thus inclusion of some more characters is required. Inclusion of some characters like leaf area index, harvest index and chlorophyll content could be considered important in order to derive a much clear picture of casual relationship.

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