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Variability, Correlation and Path Analysis Studies in Sesame (*Sesamum indicum* L.) Genotypes under Foothill Condition of Nagaland

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ABSTRACT

A total of 25 five genotypes of sesame were evaluated under foothill condition of Nagaland during *kharif*, 2017 using randomized block design with three replications at the experimental farm of School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema. Studies have been conducted on twelve quantitative characters. The analysis of variance indicated the existence of significant variations among the genotypes for all the characters except for plant height, stem height from base to first branch and number of locules per capsule. The highest genotypic coefficient of variation was observed for seed yield per plant, while the highest phenotypic coefficient of variation was recorded for stem height from base to first branch. The genotypic coefficients of variation for all the characters studied were lesser than the phenotypic coefficient of variation expressing the effect of the environment variance. The highest genetic advance as per cent of mean was observed for seed yield per plant. High heritability coupled with high genetic advance as per cent mean was observed for number of capsules per plant, seeds per capsule, 1000 seed weight, days to 50 per cent flowering and oil content indicating the influence of additive gene action, as such phenotypic selection would be effective for improvement of these traits. Correlation studies revealed that the character 1000 seed weight, number of locules per capsule and internodal length revealed positive association with seed yield. This indicated that simultaneous selection of all these characters was important for yield improvement. A critical analysis of the results by path analysis revealed that the traits positive direct effect on seed yield was contributed by internodal length, capsule length, oil content, seeds per capsule and number of capsules per plant. Hence, these characters were considered as important attributes in formulating selection criterion for achieving desired targets.

Introduction

Sesame (*Sesamum indicum* L.) is one of the oldest cultivated oilseed crops in the world. Sesamum belongs to Tubiflorae order and Pedaliaceae family (Nayar, 1984). It is also called as *til* and *gingelli* popularly known as “Queen of Oilseeds”. Sesame is a diploid (2n=26) dicotyledonous. The genus Sesame has about 36 species (Kobayashi, 1981), of which *Sesamum indicum* L. is the most dominant cultivated species. The seeds of the plant yield edible oil due to the presence of potent antioxidant sesame seeds are known as “the seed of immortality”.

India is considered to be the major centre of genetic diversity even though the crop originated in Africa (Maiti *et al.*, 2012). Two distinct types of sesame seeds are recognized, the white and the black. There are also intermediate seed coloured varieties varying from red to rose or from brown to grey. The brown seeds are used mainly for crushing. The white seeded variety has desirable taste and therefore primarily used for making sweets and confectionary products.

The global production of Sesame seeds was 6.2 million tonnes, led by Tanzania, India and Sudan (FAOSTAT, 2014), more than 6 million tons of sesame seeds have been produced under nearly 11 million ha classifying sesame at the ninth rank among the major oil crops (FAOSTAT, 2015). Distribution of most of the species occurs in three regions *viz*., Africa, India and the Far East (Kobayashi *et al*., 1991).

The composition of sesame possesses lipid contents 48g, carbohydrates 25.7 g, proteins 17 g, fiber 14 g and ash 6 g approximately with respect to 100 g of seeds. The seeds of sesame contains 40 to 63 per cent oil which is rich in antioxidants and has a significant amount of oleic and linoleic acids (Abate and Mekbib, 2015).

Sesame seeds are rich in minerals such as Calcium, Phosphorous, Magnesium, and Potassium in large amounts and also have vitamins such as Niacin, Thiamin, Riboflavin and vitamin B-6 (USDA Nutrient Database, 2015).

It is also used in pharmaceutical as well as cosmetic industries (Pornparn *et al.,* 2009). About 70 per cent of the World's Sesame seed is processed into oil and meal. Sesame has Bactericide and Insecticide activities and it also acts as an antioxidant which can inhibit the absorption of cholesterol and the production of cholesterol in the liver. Sesamolin also has insecticidal properties and is used as a synergist for pyrethrum insecticides (Simon *et al*., 1984).

In Nagaland, it is also called as "*Chützi"* in Angami (Naga) the cultivated area of Sesame is 370 ha, production is 240 tonnes and Productivity is 648 kg/ha (ICAR, 2015). State like Nagaland where agriculture production system creates jeopardy owing to problems like soil acidity, loss of nutrient through soil erosion, lower availability and greater fixation of nutrients coupled with little use of external, judicious integration of all resources available at hand seems to be the only option. Estimates of various genetic parameters for seed yield and yield components are essential for an efficient breeding program. Therefore, the present study was carried out to estimate genetic variability, heritability and genetic advance for yield and yield components in sesame. An attempt has also been made to study the correlation and path coefficient which are helpful in selecting the desirable traits.

Materials and Methods

The field experiment entitled Genetic evaluation of Sesame (*Sesamum indicum* L.) genotypes under foothill condition of Nagaland was conducted at the experimental farm of Department of Genetics and Plant Breeding, School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema Campus, during *kharif* 2017. The experiment farm was located at Medziphema, in the foothill of Nagaland at an altitude of 310 meters above mean sea level with the geographical location of 25°45'43'' North Latitude and 95°53'04'' East Longitude.

The experiment was conducted in the following Randomized Block Design in three replications with twenty-five genotypes. The experimental material comprises of 25 sesame genotypes which were collected from diverse places of India, out of which four genotypes have been procured from Nagaland, one genotype from Meghalaya, six genotypes from AAU Experimental Centre, Diphu, Assam, which are recent released varieties and 14 genotypes were collected from The Project Coordinator, AICRP on sesame & Niger, J.N. Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, of which the variety TKG-21 is a national variety and has been used as check variety. The experimental field was ploughed, harrowed and cleaned. Manure vermicompost has been applied @ 10 kg/ha before sowing. A total of 75 plots (1m x 1.5m) were prepared with 25 plots in its replication. A distance of 0.5 m x 1.0 m was maintained between plots and replications. The seeds were treated with Thiram @ 10g/kg of seeds before sowing. The analysis of variance was analysed according to Panse and Sukhatme (1957) by using the mean performance of the genotypes. The phenotypic, genotypic and environmental coefficient of variation was calculated according to Burton and De Vane (1953). Genetic advance possible through selection was calculated according to Johnson *et al.*, (1950). Phenotypic and genotypic correlation coefficients were worked out to study the interrelationship between various pairs of characters as suggested by Al-Jibouri *et al.*, (1958). The path coefficient analysis was carried out by the formula apply by the Dewey and Lu (1959).

Results and Discussion

Genetic variability

In the present investigation, 25 genotypes of sesame were evaluated to assess their genetic potential. All the genotypes showed considerable amount of variations in their mean performance with respect to all the characters studied. The analysis of variance showed significant differences among genotypes for all the character studied except for plant height and stem height from base to first branch, indicating high degree of variability in the genotypes. The studies on genotypic coefficient of variation (GCV) and phenotypic coefficient (PCV) values greater than 20% are considered as high, whereas value less than 10% are regarded to be low and values between 10% and 20% to be medium (Deshmukh *et al*., 1986). The PCV value for days to 50 per cent flowering, internodal length, stem height from base to first branch, number of capsules per plant, seeds per capsule, 1000 seed weight, oil content and seed yield are high. Plant height and capsule length had medium PCV. Days to 80% maturity and number of locules per capsules are found to be low.

The studies showed that the PCV were higher than the GCV for all the characters (Table 1), indicating the effect of environmental variance in rest of the variance studied. Similar findings were reported by Bharathi *et al.*, (2014). Narayanan and Murughan (2013), Sumathi and Muralidharan (2010) for days to 50% flowering, capsule length, seed yield per plant and 1000 seed weight. Bharathi *et al.*, (2014) and Narayanan and Murughan (2013) have also reported similar findings for number of seeds per capsule. The character number of capsules per plant with higher values of PCV have been reported by Narayanan and Murugan (2013) and Sumathi and Muralidharan (2010). Barathi *et al.*, (2014) and Sumathi and Muralidharan (2010) reported similar findings for the trait days to maturity.

Sumathi and Muralidharan (2010) observed higher value of PCV for oil content. The PCV were found to be greater than the GCV value for all the characters, it was observed that there were least difference between PCV and GCV for the characters such as days to 50% flowering, days to 80% maturity, number of seeds per capsule and 1000 seed weight. Jadhav and Mohrir (2012) also find similar result for seed yield per plant, number of capsules per plant. The least difference between PCV and GCV for, days to 50% flowering, days to 80% maturity, plant height, number of seeds per capsule and 1000 seed weight was also reported by Solomon and Peter (2012). Sexena and Bisen (2016) also present similar findings for days to 50% flowering, days to maturity, plant height, oil content and seed yield. The traits *viz*., capsules per plant and 1000 seed weight showed high values of GCV in the present investigation. Similar findings have also been observed by Jadhav and Mohrir (2012).

The highest GCV and PCV values were observed for number of seeds per capsule expressing the presence of wide extent of variability for this character. It also showed that the GCV and PCV result were also high in days to 50% flowering, stem height from base to first branch, number of capsules per plant, number of seeds per capsules, 1000 seed weight, and oil content. These findings were also reported by Ahadu (2012), Bamorotiya *et al.,* (2016) and Sexena and Bisen (2016) for seed yield per plant and number of capsules per plant.

In the present investigation, high genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were observed for seed yield per plant followed by number of capsules per plant, and number seeds per capsules Prithviraj and Parameshwarappa (2017) have also observed high phenotypic and genotypic coefficient of variability for these characters. The estimated GCV for different characters were almost the same as that of PCV in most of the characters. It is evident therefore, that the influence of environment on the expression of these characters was invariably low in the study. It may be assumed that the phenotypic variability as such can be utilized in making selection.

Heritability and Genetic Advance

Heritability estimates revealed the heritable portion of variability present in different characters. Heritability is generally considered to be low if it is less than 30%, moderate if it is between 30-60% and high if it is more than 60%. The range genetic advance as percent of mean is classified as low if it is less than 10%, moderate if it is between 10-20% and high if more than 20% (Johnson *et al.,* 1955).

High estimates of heritability was observed in all the character, whereas number of days to 50% flowering exhibited high heritability accompanied with genetic advance as per cent of mean which revealed the selection could be more effective for these characters. These finding are in consonance with Parameshwarappa *et al.*, (2009). Number of capsules per plant exerted high heritability with genetic advance as per cent of mean. This findings is in agreement with Kumar *et al.*, (2008), Prameshwarappa *et al.,* (2009), Ismaila and Usman (2014), Vanishree *et al.,* (2013), Chandra Mohan (2014) and Bharati *et al.*, (2014). High heritability coupled with genetic advance as per cent of mean was exhibited by seeds per capsule. Similar observations were reported by Prameshwarappa *et al.,* (2009) and Vanishree *et al.*, (2013). 1000 seed weight expressed high heritability accompanied with genetic advance as per cent of mean which is in accordance with Kumar *et al.,* (2012) and Vanishree *et al.,* (2013). Oil content exhibited high heritability coupled with high genetic advance as per cent of mean. The same results have been reported by Jadhav and Mohrir (2012). Expression of high heritability accompanied with high genetic advance as per cent of mean by various trait indicating lesser influence of environment and presence of additive gene action, hence amenable for simple selection.

Table.1 Genetic parameters of yield and its related traits in sesame

Characters	Grand mean	Range	Variance			Coefficient of variance			Heritability h^2bs (percent)	Genetic advance as percentage of mean
			$\sigma^2 g$	$\sigma^2 p$	$\sigma^2 e$	GCV	PCV	ECV		
Days to 50% flowering	51.10	33.33-85.33	185.11	189.24	4.13	26.62	26.91	3.97	97.82	54.23
Days to 80% maturity	93.61	90.66-100	5.42	6.97	1.55	2.48	2.82	1.33	77.70	4.51
Plant height	97.90	79.96-123.43	27.14	216.14	189.14	5.321	15.01	14.02	12.56	3.88
Internodal length (cm)	5.43	3.56-6.61	0.37	1.34	0.96	11.25	21.29	18.07	27.93	12.24
Stem height from base to first branch (cm)	5.03	2.36-14.50	1.77	15.32	13.54	26.49	77.75	73.09	11.61	18.59
No. of capsule/plant	50.97	13.30-76.56	255.58	338.35	82.77	31.36	36.08	17.84	75.54	56.15
No. of locules /capsules	4.09	4-5	0.06	0.08	0.02	6.03	7.19	3.90	70.51	10.44
Capsules length (mm)	26.51	23.66-31.20	3.12	7368	4.55	6.67	10.45	8.05	40.74	8.77
Seeds/capsules	52.18	19.23-81.50	298.84	307.45	8.61	33.12	33.60	5.62	97.20	67.27
1000-seed weight	2.46	1.10-3.53	0.54	0.57	0.20	30.07	30.75	6.41	95.64	60.59
Oil content	29.51	10.16-40.90	39.46	43.29	3.82	21.28	22.29	6.62	91.16	41.85
Seed yield	30.97	8.89-78.98	276.09	291.44	15.35	53.65	55.12	12.65	94.73	107.57

Table.2 Genotypic correlation coefficient between 12 characters in sesame

Characters	Days to 50% Flowering	Days to 80% Maturity	Plant height	Internodal length	Stem height from base to 1st branch	No. Of capsules/ Plant	No. Of locules/ Capsule	Capsule Length	Seeds/ Capsule	1000-seed weight	Oil content	Seed yield /plant
Days to 50% Flowering	1	0.292	0.478**	-0.167	0.318	0.008	-0.277	-0.371*	0.012	-0.635**	-0.235	-0.101
Days to 80% Maturity		1	-0.777**	-0.530**	0.611**	-0.234	-0.062	-0.057	-0.261	-0.737**	0.315	-0.259
Plant height			1	-0.391*	0.721**	0.612**	-0.221	-0.215	0.757**	0.262	-0.575**	-0.262
Internodal length (cm)				1	0.601**	0.516**	0.196	-0.052	0.416*	0.497**	0.067	0.094
Stem height from base to first branch (cm)					1	-0.058	0.329	0.534**	-0.124	-0.761**	0.234	-0.614**
No. Of capsule/plant						1	0.349*	-0.271	0.562**	0.272	-0.151	-0.092
No. Of locules /capsules							1	0.129	0.299	0.273	-0.179	0.144
Capsules length (mm)								1	0.310	0.110	0.114	0.057
Seeds/capsules									1	0.224	-0.222	-0.135
Oil content										1	0.077	0.168
1000-seed weight											1	0.0913

Table.3 Phenotypic correlation coefficient between 14 characters in sesame

Characters	Days to 50% Flowering	Days to 80% maturity	Plant height	Internodal length	Stem Height from base to 1st branch	No. Of capsules/ plant	No. Of locules/ Capsule	Capsule Length	Seeds/ Capsule	1000-seed weight	Oil content
Days to 50% Flowering	1	0.242	-0.015	-0.113	0.098	0.003	-0.195	-0.255*	0.009	-0.619**	-0.216
Days to 80% Maturity		1	-0.168	-0.157	0.173	-0.192	-0.047	-0.052	-0.231*	-0.619**	0.262*
Plant height			1	0.340**	-0.009	0.270*	-0.153	-0.016	0.282*	0.146	-0.262*
Internodal length (cm)				1	-0.020	0.210	0.052	-0.023	0.197	0.259*	0.010
Stem height from base to 1st branch (cm)					1	-0.009	-0.008	0.058	-0.022	-0.237*	0.071
No. Of capsule/plant						1	0.264*	-0.161	0.884**	0.250*	-0.123
No. Of locules /capsules							1	0.081	0.247*	0.204	-0.131
Capsules length (mm)								1	-0.173	0.070	-0.098
Seeds/capsules									1	0.212	-0.219
1000-seed weight										1	0.080
Oil content											1

Table.4 Direct (diagonal) and indirect effect of yield components on seed yield at genotypic level in sesame genotypes

Characters	Days to 50% Flowering	Days to 80% Maturity	Plant Height	Internodal Length	Stem Height from base to 1st branch	No. Of Capsule/ Plant	No. Of Locules/ Capsule	Capsule Length	Seeds/ Capsule	1000-seed Weight	Oil content	Seed yield/plant
Days to 50% Flowering	**-0.192**	-0.056	-0.009	0.032	-0.061	-0.001	0.053	0.071	-0.002	0.122	0.045	0.101
Days to 80% Maturity	-0.033	**-0.620**	0.620	0.602	-0.694	0.266	0.071	0.064	0.296	0.837	-0.358	-0.259
Plant height	-0.030	0.497	**-0.640**	-0.250	-0.731	-0.392	0.141	0.137	-0.485	-0.168	0.368	-0.262
Internodal length (cm)	-0.063	-0.201	0.148	**0.380**	0.229	0.196	0.074	-0.020	0.158	0.189	0.025	0.094
Stem height from base to first branch (cm)	-0.107	-0.206	-0.385	-0.203	**-0.337**	0.019	-0.111	-0.180	0.042	0.256	-0.080	-0.614
No. Of capsule/plant	0.016	-0.022	0.058	0.048	-0.005	**0.094**	0.033	-0.025	0.095	0.025	-0.014	-0.092
No. Of locules /capsules	0.038	0.008	0.030	-0.027	-0.045	-0.048	**-0.138**	-0.017	-0.041	-0.037	0.024	-0.144
Capsules length (mm)	-0.088	-0.013	-0.051	-0.012	0.127	-0.064	0.030	**0.238**	-0.074	0.026	-0.027	0.057
Seeds/capsules	0.002	-0.048	0.140	0.077	-0.023	0.185	0.055	-0.057	**0.184**	0.041	-0.041	-0.135
1000-seed weight	0.727	0.084	-0.300	-0.569	0.870	-0.312	-0.312	-0.126	-0.257	**-0.526**	-0.088	0.168
Oil content	-0.056	0.075	-0.137	0.016	0.057	-0.036	-0.042	-0.027	-0.053	0.018	**0.238**	0.091

Correlation coefficient

The correlation coefficients between seed yield and yield components were worked out at genotypic and phenotypic level (Table 2 and 3). Days to 50 per cent flowering exhibited significant positive correlation with plant height at the genotypic level. Similar findings have been reported by Vidhyavathi *et al.,* (2005). Capsule length exhibited positive association with seed yield. Sankar and Kumar (2003) and Parameshwarappa *et al.*, (2009) also find the same result. 1000 seed weight and oil content exerted positive correlation association with seed yield. The results are in accordance with that reported by Bharathi and Vivekanandan (2009).

Path coefficient analysis

The present investigation on path analysis (Table 4) revealed that internodal length, capsule length, oil content, seeds per capsule and number of capsules per plant have positive direct effect on seed yield, while plant height, days to 80 per cent maturity, 1000 seed weight, stem height from base to first branch, days to 50 per cent flowering and number of locules per capsule have negative direct effect on seed yield. The maximum direct effect on yield was contributed by internodal length, capsule length and oil content.

Therefore these traits may be given primary focus while selecting for improvement of seed yield. Capsule length revealed positive direct effect on seed yield. Parameshwarappa *et al.*, (2009) also reported similar results. Seeds per capsule exhibited positive direct effect on seed yield. Goudappagoudra *et al.*, (2011) also reported that number of seeds per capsule had direct positive effect on seed yield. 1000 seed weight and 80 per cent days to maturity exhibited negative direct effect on seed yield. The result is in consonance with Meenakumari and Ganesamurthi (2015) and Gangadhara *et al.*, (2012). The residual effect estimated was 0.566 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, chlorophyll content could be considered important in order to derive a much clear picture of casual relationship.

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