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Genetic studies among sesame (*Sesamum indicum* L.) genotypes

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Abstract
In the present investigation, 20 genotypes of sesame were evaluated under foothill conditions of Nagaland between the months of August to November 2019 incorporating Randomized Block Design with three replications. Eleven traits were studied. Analysis of variance revealed significant differences among the genotypes under study for all characters suggesting the presence of variability among them. Seed yield exhibited the highest genotypic coefficient of variation (GCV) followed by stem height from base to first branch with similar result in phenotypic coefficient of variation with seed yield showing the highest value. For heritability in broad sense and genetic advance as per cent of mean, plant height was found to be the highest followed by number of capsules. For this, a simple approach of selection can be emphasized. At genotypic level, characters like plant height, stem height from base to first branch, seeds per capsule, number of capsules and capsule length exhibited significant positive correlation to seed yield. Path analysis showed that no of capsules had the highest positive direct effect followed by seeds per capsule. Thus, consideration of characters like number of capsules, seeds per capsule and plant height in selection can improved the overall seed yield.

Keywords: Sesame, genetic variability, correlation coefficient and path analysis

Introduction
Sesame (*Sesamum indicum* L.) is an oilseed crop that is extensively grown in India. It is grown over a wide variation of environments from semi- arid tropics to temperate regions. It has an ample number of cultivars grown across the globe. Sesame belongs to Tubiflorae order and Pedaliaceae family (Nayar, 1984) [23]. The genus Sesame has around 36 species (Kobayashi, 1981) [19]. It is a dicotyledonous diploid crop with chromosome number 2n= 26. India being the largest producer of sesame in the world, ranks 5th in terms of area for growing sesame (24%). India produced 6.6 lakh tonnes in the year 2017-18 (Anonymous, 2018) [3]
In the Hindi language it is called *til* and in Ao (Naga) dialect it is called *Azu*. Sesame in India is grown in *kharif* season generally but in some states (Maharashtra, Madhya Pradesh, Gujarat, Orissa); it is grown in more than one season *i.e. kharif* and *rabi*. India is considered to be a major centre of genetic diversity even though the crop originated in Africa. Distribution of most of the species occurs in three regions *viz.*, Africa, India and the Far East (Kobayashi *et al.*, 1991) [20].
Sesame seed is an excellent source of edible oil with oil content lying between 46 to 52% and protein content between 20 to 26%. Sesame seed contains 50% oil, 23% protein and 15% carbohydrate (Ranganatha *et al.*, 2012) [30]. Sesame is one of the earliest and vital oil seed crops (Mabberly, 1997) [21]. Among the major oilseed crops that are grown in the world *viz.*, rapeseed, peanut, soybean, sunflower and sesame (*Sesamum indicum* L.): til gives one of the highest and richest edible oils (Pathak *et al.*, 2014) [14]. Sesame seed oil has long shelf life due to the presence of lignans (sesamin, sesamol, sesamolin), which have remarkable antioxidant function and hence it is also regarded as the 'Queen of oilseeds'. Sesame seed is abundant in nutrition (oil 50 per cent, protein 25 per cent) and its oil contains an anti-oxidant called sesamol which transmit to it a high degree of resistance to counter oxidative rancidity (Ashri, 1989) [5]. It finds its use in pharmaceuticals, religious practices (for anointing) and also for manufacturing perfumes. Sesame cake, which is nutritious and rich in protein and carbohydrates is also used as feed for cattle.
The advantages of breeding sesame include high genetic variability, convenient production of F1 generation, small area requirement and the prospect of raising interspecific hybrids. Having said that, there are certain drawbacks they accompany the breeding of sesame like its susceptibility to low or high pH of soil, diseases and water logging.

The current experiment was taken in order to estimate the genetic variability for various characters present among the different genotypes of sesame selected for study. An effort to estimate the correlation and path coefficient pertaining to yield and yield contributing traits in sesame was also taken into consideration which is the pre requisite for any plant breeding programme.

Materials and Methods

The present investigation on "Variability studies in Sesame (*Sesamum indicum* L.) genotypes under foothill condition of Nagaland" was conducted on the experimental farm of department of Genetics and Plant Breeding, School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema during August to December in the year 2019. The experimental farm is located at SASRD, Medziphema in the foot hill of Nagaland having an altitude of 305 meters above mean sea level with geographical location of 25°45' 43 "N latitude and 93^{0}53'04" E longitude.

The experiment was carried out in a randomized block design (RBD) with three replications and 20 treatments. All the 20 treatments were placed randomly in each replication. The experimental comprised of 20 genotypes of sesame of which three genotypes have been procured from Project Coordinator, AICRP on sesame & Niger, J. N. Krishi Vishwa Vidyalaya, Jabalpur, 11 genotypes have been procured from various parts of Assam, Meghalaya and Nagaland, two from Odisha and West Bengal each and one genotype each from Maharashtra and Andhra Pradesh were also included. The experimental field was ploughed, harrowed and cleaned. FYM was applied @5 tons per hectare before sowing. The experimental field was divided into three replications and each replication consisted of twenty plots with an overall 60 plots in total. A distance of 0.5 m × 0.5m was maintained between plots and replications respectively. The Analysis of Variance technique was performed on the basis of model proposed by Panse and Sukhatme (1978) [24] by using the mean performance values of the genotypes. The genotypic (GCV) and phenotypic (PCV) and environmental (ECV) coefficients of variation were calculated as per the formulae given by Burton (1952) [9]. Phenotypic and genotypic correlation coefficients were worked out to study the inter-relationship between various pairs of characters as suggested by Al-Jibouri *et al.* (1958). The path coefficient was analyzed according to the formula given by Dewey and Lu (1959) [13].

Results And Discussions

The present investigation was carried out after consideration of 20 genotypes of sesame for study under foothill condition of Nagaland to determine their genetic potential. The data on the quantitative characters were recorded and the analysis of variance for the 11 characters *viz.*, days to 50 per cent flowering, days to 80 per cent flowering, plant height, inter-nodal length, stem height, number of capsules per plant, capsule length, seeds per capsule, seed yield, 1000 seed weight and oil content (per cent) showed significant differences which proved existence of variability among the characters selected. Also, all of the 20 genotypes showed observable variations in their mean performances for the different traits studied.

The highest GCV (genotypic coefficient of variation) was observed for seed yield followed by stem height from base to first branch while the highest PCV (phenotypic coefficient of variation) was also observed for seed yield followed by stem height from base to first branch. In the study of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV), it was noticed that PCV was always slightly or distinctively higher than their respective GCV values for all the characters under evaluation which indicated the effect and influence of environmental variance in the study of the variance of each character (table 1). This discussion comes into agreement with reports given by Bharathi *et al.* (2014) [8].

The traits that showed the high GCV and PCV were stem height from base to first branch, plant height and number of capsules. These traits also showed the highest values of heritability and genetic advance per cent. These data are in consonance to researches reported by Chowdhury *et al.* (2010) [10] and Aristya *et al.* (2017) [4] Dash *et al.* (2018) [11], Gokulakrishnan *et al.* (2018) [16] and Ramachandran *et al.* (2019) [29].

Moderate values of GCV and PCV with high value of heritability and low genetic advance as per cent mean were seen in the traits like capsule length, seeds per capsule, 1000 seed weight and oil content all. These results came into close agreement with reports from researches of Gidey *et al.* (2012) [15], Bamrotiya *et al.* (2016) [6] Kiruthika *et al.* (2018) [18], Umamaheswari *et al.* (2019) [34], Patidar *et al.* (2020) [26] and Pavani *et al.* (2020) [28].

High heritability and genetic advance per cent of mean with moderate to low GCV and PCV were seen in traits of days to 50 per cent flowering and days to 80 per cent flowering. The conclusion came into proximity with results from researches of Desawi *et al.* (2017) [12] and Patil and Lokesha (2018) [27].

Correlation

Seed yield showed significant positive correlation to plant height (0.794), stem height from base to first branch (0.759), no of capsules (0.868), capsule length (0.0707) and seeds per capsule (0.791). Plant height gave similar correlation with significant positive correlation towards stem height from base to first branch, no of capsules, capsule length, seeds per capsule and seed yield. Days to 50 per cent flowering gave the significant positive correlation in days to 80 per cent flowering (0.578), number of capsules (0.316) and capsule length (0.258). Similar traits were also positively correlated in terms of phenotypic correlation to seed yield *viz.* plant height (0.760), stem height from base to first branch (0.719), no of capsules (0.847), capsule length (0.675) and seeds per capsule (0.771). Results of researches by Singh *et al.* (2018) have close proximity to the data collected. Similar results were also reported by Ismaila and Usman (2014) [17], Fazal *et al.*, (2015) [14], Bharathi *et al.*, (2015) [7], Abate and Mekbib (2015) [1] and Singh *et al.* (2018) [32]. This shows that the selection of such traits and their improvement will altogether increase and improve the yield of the crop.

Path Coefficient Analysis

Path coefficient analysis was carried out to determine and identify the traits that are useful and should be put into consideration for selection referencing on their effect towards seed yield as well as the indirect effect of traits that might impact in higher seed yield. Traits like days to 80 per cent flowering, plant height, internodal length, no capsules, seeds per capsule and 1000 seed weight gave direct positive effect and consideration of such traits will positively improve the yield of the crop. The maximum positive direct effect was shown by no of capsules (0.8692). Subashini *et al.* (2008) [33], Roy and Pal (2019) [31] and Navaneetha and Murugan (2019)

gave similar findings in terms of traits that directly affected positively seed yield. The residual effect was 6.1 per cent which is far below 50 per cent. Hence, the considered characters for estimating path coefficient are satisfactory for the cause-and-effect relationship on the grain yield. Hence, there is no need to consider some other additional factors.

Table 1: Genetic parameters of yield and its related traits in Sesame

Characters	Grand mean	Range		Co-variance			Co-efficient of variation			Heritability (h^2bs)	Genetic advance as percent of mean
		Min.	Max.	σ^2g	σ^2p	σ^2 e	GCV	PCV	ECV		
Days to 50 per cent flowering	52.82	42.67	76	29.95	32.61	2.66	10.36	10.81	3.09	91.84	10.8
Days to 80 per cent flowering	85.70	71	94.67	56.61	58.99	2.38	8.78	8.96	1.80	95.97	15.18
Plant height (cm)	81.94	40.15	125.7	688.59	696.32	7.73	32.03	32.21	3.39	98.89	53.76
Internodal length(cm)	4.01	2.153	5.446	0.62	0.64	0.02	19.58	19.94	3.75	96.47	1.59
Stem height (cm)	34.57	13.17	54.64	124.07	131.47	7.40	32.22	33.17	7.87	94.37	22.29
Number of capsules	37.14	22.53	58.8	129.53	132.15	2.63	30.64	30.95	4.37	98.01	23.21
Capsule length(cm)	2.06	1.2	2.94	0.14	0.14	0.01	17.95	18.35	3.77	95.77	0.74
Seeds per capsule	54.49	41.2	73.33	102.21	104.36	2.15	18.55	18.75	2.69	97.94	20.61
Seed yield(g)	4.66	2.34	9.19	3.8	4.08	0.28	41.80	43.33	11.41	93.06	3.87
1000 seed weight(g)	2.3	1.67	3.05	0.15	0.18	0.03	16.61	18.37	7.84	81.78	0.71
Oil content (per cent)	30.75	21.68	40.78	18.16	19.30	1.15	13.86	14.29	3.48	94.06	8.51

Table 2: Genotypic correlation of 11 characters of Sesame

Characters	Days to 50 per cent flowering	Days to 80 per cent flowering	Plant height (cm)	Internodal length (cm)	Stem height from base to first branch(cm)	Number of capsules	Capsule length (cm)	Seeds per capsule	1000 seed weight (g)	Oil content (percent)	Seed yield (g)
Days to 50 per cent flowering	1	0.578**	0.1237	-0.0076	-0.0465	0.316*	0.258*	0.1852	-0.611**	-0.293*	0.065
Days to 80 per cent flowering		1	0.0687	-0.1053	0.0556	0.162	0.1943	0.1437	-0.322*	-0.48**	0.0605
Plant height (cm)			1	0.2432	0.861**	0.587**	0.624**	0.740**	-0.0479	-0.285*	0.794**
Internodal length(cm)				1	0.462**	0.1821	0.411**	-0.1439	0.318*	0.0144	0.1627
Stem height from base to first branch(cm)					1	0.598**	0.592**	0.545**	0.0747	-0.2002	0.759**
Number of capsules						1	0.809**	0.605**	-0.424**	-0.0232	0.868**
Capsule length(cm)							1	0.593**	-0.341**	-0.0502	0.707**
Seeds per capsule								1	-0.417**	-0.284*	0.791**
1000 seed weight9g)									1	0.293*	-0.1314
Oil content (per cent)										1	-0.0994
Seed yield(g)											1

Table 3: Phenotypic correlation of 11 characters in Sesame

Characters	Days to 50 per cent flowering	Days to 80 per cent flowering	Plant height (cm)	Internodal length (cm)	Stem height from base to first branch(cm)	Number of capsules	Capsule length (cm)	Seeds per capsule	1000 seed weight (g)	Oil content (%)	Seed yield (g)
Days to 50 per cent flowering	1	0.5659***	0.1192	-0.0125	-0.0386	0.3107*	0.2602*	0.1754	-0.5266***	-0.2759*	0.0737
Days to 80 per cent flowering		1	0.0674	-0.1046	0.0541	0.1618	0.1994	0.1371	-0.2959*	-0.4645***	0.0597
Plant height (cm)			1	0.2378	0.8424***	0.5799***	0.6040***	0.7273***	-0.0463	-0.2708*	0.760**
Internodal length(cm)				1	0-4259***	0.1759	0.3973**	-0.1497	0.2799*	0.0034	0.1431
Stem height from base to first branch(cm)					1	0.5773***	0.5656***	0.5328***	0.0667	-0.1962	0.719**
Number of capsules						1	0.7863***	0.5981***	-0.3765**	-0.0318	0.847**
Capsule length(cm)							1	0.5804***	-0.2921*	-0.0555	0.675**
Seeds per capsule								1	-0.3653**	-0.2806*	0.771**
1000 seed weight (g)									1	0.253	-0.0261
Oil content (per cent)										1	-0.095
Seed yield (g)										1	1

Table 4: Direct and Indirect effects of yield components on seed yield at genotypic level in sesame genotypes

Characters	Days to 50 per cent flowering	Days to 80 per cent flowering	Plant height (cm)	Internodal length (cm)	Stem height from base to first branch (cm)	Number of capsules	Capsule length (cm)	Seeds per capsule	1000 seed weight (g)	Oil content (per cent)	Seed yield (g)
Days to 50 per cent flowering	-0.0971	-0.0561	-0.012	0.0007	0.0045	-0.0307	-0.025	-0.018	0.0593	0.0284	0.065
Days to 80 per cent flowering	0.0256	0.0442	0.003	-0.0047	0.0025	0.0072	0.0086	0.0064	-0.0142	-0.0212	0.0605
Plant height (cm)	0.0138	0.0077	0.1119	0.0272	0.0964	0.0657	0.0699	0.0828	-0.0054	-0.0319	0.794
Internodal length (cm)	-0.0006	-0.0089	0.0205	0.0844	0.039	0.0154	0.0346	-0.0121	0.0268	0.0012	0.1627
Stem height from base to first branch(cm)	0.0029	-0.0035	-0.0543	-0.0291	-0.0631	-0.0377	-0.0374	-0.0344	-0.0047	0.0126	0.759
Number of capsules	0.275	0.1408	0.5098	0.1583	0.5194	0.8692	0.7031	0.5262	-0.3686	-0.0202	0.868
Capsule length(cm)	-0.0626	-0.0471	-0.1514	-0.0996	-0.1437	-0.1962	-0.2425	-0.1438	0.0827	0.0122	0.707
Seeds per capsule	0.0938	0.0728	0.3747	-0.0729	0.2759	0.3068	0.3004	0.5067	-0.2111	-0.1438	0.791
1000 seed weight (g)	-0.1896	-0.1	-0.0149	0.0987	0.0232	-0.1316	-0.1058	-0.1293	0.3104	0.091	-0.1314
Oil content (per cent)	0.0066	0. 0109	0.0065	-0.0003	0.0045	0.0005	0.0011	0.0064	-0.0067	-0.0227	-0.0944
Seed yield (g)	0.068	0. .0608	0.7939	0.1627	0.7586	0.8684	0.707	0.7909	-0.1314	-0.0944	1

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