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Genetic variability studies for quantitative traits in germplasm collections of sesame (*Sesamum indicum* L.).

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Abstract: One hundred and thirty one sesame genotypes were evaluated during *kharif* 2014 for genetic variability and other related parameters in respect of thirteen quantitative characters. Analysis of variance revealed highly significant differences among genotypes for all the thirteen characters studied. 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, number of capsules on the main stem and number seeds per capsules while it was moderate for plant height, plant height to first capsule, number of branches per plant, capsule breadth, 1000 seed weight. On the other hand, oil content, days to 50 per cent flowering, day to maturity and capsule length showed low genotypic and phenotypic coefficient of variation. High heritability and genetic advance as per cent mean was observed for seed yield per plant, number of capsules on main stem, number of capsules per plant, plant height and number of seeds per capsule where as moderate heritability with high genetic advance as per cent over mean was observed for plant height to first capsule and number of branches per plant. Characters such as days to 50 per cent flowering, days to maturity, 1000 seed weight and oil content showed high heritability and low genetic advance as per cent over mean. Moderate heritability with moderate genetic advance as per cent over mean for capsule breadth and moderate heritability with low genetic advance as per cent over mean for capsule length was observed.

Key words: Genetic advance, Genetic variability, Heritability, Sesame

Introduction

Sesame (*Sesamum indicum* L.), commonly known as gingelly, til, benniseed, simsim, is a member of the order Tubiflorae and family pedaliaceae. It is the most ancient oilseed known and used by man whose domestication is lost in the mists of antiquity (Weiss, 1983). It has been under cultivation in Asia for over 5000 years. The genus Sesamum consists of 36 species and the most cultivated one is *Sesamum indicum* L. (2n=26). Bedigian (1981) argues that owing to the wide genetic diversity Africa is the primary centre of origin and India is the secondary centre of origin. But the cultivated sesame originated in India. Sesame is the short day erect herbaceous annual plant which is self pollinated, although cross pollination ranging from 5-10 per cent. It has two growth characteristics *i.e.,* indeterminate and determinate with the plant height reaching upto 2 m and its growth period ranges from 70-150 days. Sesame is described as "queen of oil seeds" because of its high oil content ranging from 34-63 per cent (Uzun *et al.,* 2008), protein (18-25%), calcium, phosphorus, oxalic acid and excellent qualities of the seed oil and meal (Prasad, 2002). Sesame seed oil has long shelf life due to the presence of lignans (sesamin and sesamolin), which has remarkable antioxidant function, resisting oxidation. The seeds of sesame are used either decorticated or whole in buns, bread and confection. The grains may be eaten fried, mixed with sugar or in the form of sweetmeats. Seeds are crushed for a high grade edible oil, or an oily paste (tahini). Oil is also used for anointing the body, for manufacturing perfumed oils, cosmetics and for medicinal purposes.

Sesame is an important oil seed crop cultivated both in tropical and subtropical region, mostly between the latitudes of 40^0 N to 40^0 S. In the world sesame is grown in an area of 7.8 million hectare with a production of 3.8 million tonnes with a productivity of 470 kg/ha. Among the sesame growing countries in the world, India ranks first in area (18.9 lakh hectares) and production (7.3 lakh tonnes). However, the productivity is 386 kg/ha (Anon., 2012). In Karnataka sesame is grown during *kharif* in an area of 0.60 lakh hectare with a production of 0.31 lakh tonnes. The average productivity of sesame is low as compared to other oilseed crops due to the lack of variability in developing high yielding cultivars, resistance to major diseases and insect pests and shattering problem. Knowledge on the extent and pattern of genetic and phenotypic variability present in a population and heritability of characters is absolutely essential for genetic improvement of the crop. Hence, the present investigation was carried out to study the variability, heritability, genetic advance and other related parameters for yield and its attributes in the germplasm collections of sesame.

Material and methods

One hundred thirty one germplasm along with two checks (DS-5 and DS-1) were evaluated at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad (Karantaka) during *kharif*, 2014 in a Randomized Complete Block Design with two replications. Each genotype was sown in a single row of 3 m length at a distance of 30 cm between the rows and 15 cm between the plants within the rows. Five plants in each row were selected at random and the data on thirteen characters *viz.,* days to 50 per cent flowering, days to maturity, plant height (cm), plant height to first capsule (cm), number of branches per plant, number of capsules on main stem, number of capsules per plant, capsule length (cm), capsule breadth (cm), number of seeds per capsule, 1000 seed weight (g), oil content (%) and seed yield per plant (g)were analyzed based on the formula given by Lush (1940)for heritability. Heritability in the broad sense was derived based on the formula given by Hansan *et al.* (1956). Genetic advance was obtained by the formula prescribed by Johnson *et al.* (1955). The method adopted by Burton and Devane (1953) was used to calculate phenotypic and genotypic co-efficient of variation. Analysis was done using Indostat statistical package.

Results and discussion

The analysis of variance revealed highly significant differences among the genotypes for seed yield and component characters in the material under study (Table 1). The variability present in different characters can be attributed due to the differential breeding procedures and also to the geo-ecological differences from which they originated. The variation of different traits under study revealed the measure of free variability in the population of different genotypes, which would reflect the unforeseen impact of potential variability on yield. Thus the genotypes exhibited considerable amount of variation for yield and its component traits studied indicating the scope for selection of suitable genotypes as initial material in breeding program for further improvement (Table 2).

The phenotypic and genotypic coefficient of variation were highest for seed yield per plant, followed by number of capsules per plant, number of capsules on the main stem and number seeds per capsules suggesting the existence of the substantial variability in these characters and these traits are mainly under genetic control which is less influenced by the environment. Hence these characters can be relied upon and simple selection can be practiced for further improvement. Similar results were reported for these traits by Sudhakar *et al.* (2007), Parameshwarappa *et al.* (2009), Jadhav and Mohrir (2012); Shadakshari *et al.* (1995) and Tripathi *et al.* (2014) reported for seed yield per plant. The phenotypic and genotypic coefficient of variation were moderate for plant height, plant height to first capsule, number of branches per plant, capsule breadth and 1000 seed weight. These result are in agreement with those of Reddy *et al.* (2001) for plant height and plant height to first capsule; Jadhav and Mohrir (2012) for plant height and 1000 seed weight; Sudhakar *et al.* (2007), Parameshwarappa *et al.* (2009) for plant height and Tripathi *et al.* (2014) for plant height. On the contrary high GCV and PCV estimate was reported for 1000 seed weight by Shadakshari *et al*. (1995). Oil content, days to 50 per cent flowering, day to maturity and capsule length showed low genotypic and phenotypic coefficient of variation suggesting that there is considerably less amount of variability in the material under study and these traits are highly under the influence of environment. These results are in conformity with the findings of Jadhav and Mohrir (2012) for days to maturity, capsule length and oil content; Sudhakar *et al.* (2007) for days to maturity and oil content; Shadakshari *et al.* (1995) and Parameshwarappa *et al.* (2009) for oil content and Tripathi *et al.* (2014) for days to maturity and capsule length. On the contrary Parameshwarappa *et al.* (2009) reported moderate GCV and PCV estimate for days to 50 per cent flowering and capsule length, Tripathi *et al*. (2014) reported moderate GCV and PCV for days to 50 per cent flowering and oil content. Genotypic coefficient of variability (GCV) would be more useful for the assessment of inherent or real variability as it exhibits the heritable portion only (Allard, 1960). The estimated GCV for different characters were almost the same as that of PCV except for plant height, plant height to first capsule, number of branches per plant, capsule length, capsule breadth and number of seeds per capsule. It is therefore evident that apart from the above mentioned characters for all the other characters influence of environment is invariably low, so at least for these characters phenotypic variability as such can be utilized in making selection.

Heritability estimates reveals the heritable portion of variability present in different characters. The knowledge of

Table 1. Analysis of variance for thirteen quantitative characters in sesame

Sources of variation	d.f.	Mean sum of squares						
		Days to 50% flowering	Days to maturity	Plant height (cm)	Plant height to first capsule (cm)	Number of branches per plant	Number of capsule on main stem	Number of capsules per plant
Genotypes	130	12.16**	12.03**	699.65**	169.34**	1.49**	36.85**	313.15**
Replications	1	3.44	3.21	159.46	97.36	0.19	12.84	173.16
Error	130	1.27	0.93	126.66	65.98	0.74	3.99	18.70
C.D. at 5%		2.81	3.27	22.26	16.10	1.41	3.99	8.56
CV (%)		4.34	3.89	12.97	17.97	17.11	14.07	13.04

Sources of variation	d.f.	Mean sum of squares					
		Capsule length (cm)	Capsule breadth (cm)	Number of seeds per capsule	1000 seed weight (g)	Oil content (%)	Seed yield per plant (g)
Genotypes	130	0.12**	0.04**	528.38**	0.20**	4.58**	53.20**
Replications	1	0.09	0.01	240.46	0.01	0.22	10.44
Error	130	0.06	0.02	95.51	0.00	1858.00	3.31
C.D. at 5%		0.50	0.26	19.44	0.12	0.85	3.63
CV (%)		10.65	14.95	15.83	2.04	0.93	13.24

** - Significant at 1% level of probability heritability enables the plant breeder to decide the course of selection procedure to be followed under a given situation. However, heritability values coupled with genetic advance would be more reliable (Johnson *et al.,* 1955) and useful in formulating selection procedure. In the present study heritability in broad sense estimates were high for days to 50 per cent flowering, days to maturity, plant height, number of capsules on main stem, number of capsules per plant, number of seeds per capsule, seed yield per plant, 1000 seed weight and oil content. The estimates were moderate for plant height, plant height to first capsule, number of branches per plant, capsule length and capsule breadth. Genetic advance as per cent of mean (GAM) is more reliable index for understanding the effectiveness of selection in improving the traits because the estimates are derived by involvement of heritability, phenotypic standard deviation and intensity of selection. Thus, genetic advance along with heritability provides clear picture regarding the effectiveness of selection for improving the plant character. The estimates of genetic advance as per cent over mean (GAM) recorded high for plant height, plant height to first capsule, number of branches per plant, number of capsules on main stem, number of capsules per plant, number of seeds per capsule and seed yield per plant. Moderate genetic advance as per cent over mean was recorded for capsule breadth and low for days to 50 per cent flowering, days to maturity, capsule length, 1000 seed weight and oil per cent.

Noor *et al.* (2004) had cautioned that high heritability per se is no index of high genetic gain hence should be accompanied by high genetic advance as per cent over mean. In the present study high heritability accompanied with high genetic advance were recorded for seed yield per plant, number of capsules on main stem, number of capsules per plant, plant height and number of seeds per capsule. This indicates the lesser influence of environment in expression of character and prevalence of additive gene action in their inheritance, hence are amenable for simple selection. But yield being a complex character is influenced by many factors. In the present study, high heritability coupled with high genetic advance as per cent over mean was observed for seed yield per plant. This might be due to the low mean value observed for seed yield per plant. Though, *t*here was a maximum yield of 31.45 g per plant, most of the genotypes had minimum seed yield of less than 10 g per plant leading to low mean value and high genetic advance as per cent over mean (Table 2). High heritability coupled with high genetic advance as per cent over mean was observed for seed yield per plant reported by Shadakshari *et al.* (1995), Sudhakar *et al.* (2007), Parameshwarappa *et al.* (2009), Jadhav and Mohrir (2012), Narayanan and Murugan (2013) and Tripathi *et al.* (2014), for number of seeds per capsule by Sudhakar *et al.* (2007), Parameshwarappa *et al.* (2009) and Narayanan and Murugan (2013), for number of capsules per plant by Shadakshari *et al.* (1995), Sudhakar *et al.* (2007), Parameshwarappa *et al.* (2009), Jadhav and Mohrir (2012) and Narayanan and Murugan (2013) and for number of capsules on main stem by Jadhav and Mohrir (2012). Moderate heritability with high genetic advance as per cent over mean was observed for plant height to first capsule

Table 2. Genetic parameters for thirteen quantitative characters in sesame

Characters	Range		Mean	Variance		Coefficient of variation		Broad sense heritability h^2 (%)	Genetic advance (GA)	Genetic advance mean (GAM) per cent
	Minimum	Maximum		Genotypic	Phenotypic	Genotypic (GCV)	Phenotypic (PCV)			
Days to 50% flowering	36.00	48.00	43.00	5.05	7.07	5.29	6.25	71.50	3.92	9.21
Days to maturity	81.00	98.00	88.00	4.70	7.43	2.48	3.11	63.30	3.55	4.06
Plant height (cm)	47.00	134.50	86.80	286.49	413.16	19.50	23.41	69.30	29.04	33.45
Plant height to first capsule (cm)	19.00	65.00	40.74	51.56	117.78	17.63	26.64	43.80	9.79	24.02
Number of branches per plant	3.00	8.00	4.00	0.49	1.00	16.81	23.99	49.10	1.01	24.28
Number of capsule on main stem	5.00	30.00	14.00	16.40	20.46	28.28	31.58	80.10	7.47	52.15
Number of capsules per plant	8.00	68.00	33.00	147.22	165.93	36.59	38.84	88.70	23.54	70.99
Capsule length (cm)	1.90	3.20	2.62	0.03	0.09	6.53	11.65	31.40	0.20	7.54
Capsule breadth (cm)	0.50	1.25	0.87	0.01	0.03	11.12	18.64	35.60	0.12	13.68
Number of seeds per capsule	22.00	152.00	62.00	215.88	312.50	23.66	28.47	69.10	25.16	40.51
1000 seed weight (g)	2.28	3.78	3.10	0.10	0.10	10.23	10.42	96.30	0.64	0.64
Oil content (%)	38.95	49.65	46.47	2.20	2.38	3.19	3.32	92.20	2.93	6.31
Seed yield per plant (g)	2.87	31.45	13.24	24.92	28.28	37.70	40.16	88.10	9.65	72.90

and number of branches per plant. Even though heritability for the above mentioned characters is moderate to high genetic advance as per cent over mean was observed depicting the influence of additive gene action thus these characters are also amenable for simple phenotypic selection. These results are in agreement with Shadakshari *et al*. (1995) and Narayanan and Murugan (2013) for number of branches per plant; Sudhakar *et al.* (2007), Parameshwarappa *et al*. (2009), Jadhav and Mohrir (2012) and Narayanan and Murugan (2013) for plant height and Jadhav and Mohrir (2012) for plant height to first capsule. Characters such as days to 50 per cent flowering, days to maturity, 1000 seed weight and oil content showed high heritability and low genetic advance as per cent over mean. This indicates less influence of environment but prevalence of non additive gene action for which simple selection will be less effective. These results are in agreement with the findings of Sudhakar *et al*. (2007), *Parameshwarappa et al.* (2009), Jadhav and Mohrir (2012) and Tripathi *et al*. (2014) for oil content; Babu *et al.* (2004) for days to maturity. But on the contrary high heritability with moderate genetic advance was observed for days to 50 per cent flowering by Parameshwarappa *et al.* (2009) and moderate heritability with moderate genetic advance for 1000 seed weight by Tripathi *et al.* (2014). Moderate heritability with moderate genetic advance as per cent over mean for capsule breadth and moderate heritability with low genetic advance as per cent over mean for capsule length was observed. Both additive and non additive gene action is prevailing in capsule breadth but in case of capsule length non additive gene action is prevailing and both the trait have considerable influence of environment and hence these two traits are not amenable for simple phenotypic selection. Moderate heritability with low genetic advance as per cent over mean for capsule length was reported by Tripathi *et al*. (2014) but high heritability coupled with moderate genetic advance was reported by Parameshwarappa *et al.* (2009) for capsule length.

In the present study substantial genetic variability and heritability was observed for seed yield per plant, number of capsules per plant, number of capsules on main stem and number of seeds per capsule among the material studied in sesame. The study concluded that, seed yield per plant, number of capsules per plant, number of capsules on main stem and number of seeds per capsules were governed by dominance genetic variance with the predominance of additive type of gene action. Pedigree breeding method with hybridization and selection at later generations could be followed for genetic improvement of these traits.

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