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Comparative Efficiency of Single Capsule Descent and Bulk Methods in Sesame

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ABSTRACT

Bulk and single capsule descent (SCD) breeding procedures were evaluated for their relative efficiency in the F_6 generation of six crosses of sesame for seed yield and yield contributing characters. Bulk method of breeding exhibited marginal superiority over SCD procedure for yield and some yield attributes when compared across the crosses. However, a crosswise analysis for retention of superior lines indicated the effectivenesss of bulk procedure for crosses of greater parental diversity viz., RCR-2 x AT-2, RCR-4 x AT-6, PDP 1-2 x JLT-8 and (GS-12 x TC-25) x AT-1 while SCD procedure was observed to be superior for crosses of low parental diversity viz., PDP 1-2 x JLT-9 and PDP 1-2 x JLT-2. The SCD procedure also exhibited greater level of variability retention.

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INTRODUCTION

Selection of superior genotypes is the primary objective of any crop improvement programme. Commonly adopted procedures for selection of desirable genotypes in segregating populations of autogamous species are pedigree and bulk methods. The single seed descent (SSD) method of breeding is also becoming popular because of its economy in advancing the generations. The main drawback with SSD however, lies in the strict population control which may result in the loss of potential genotypes, while bulk method suffers from genetic drift due to inadequate sampling and natural selection which affects the competitive ability of the genotypes. Considering the above aspects, the single capsule descent (SCD) breeding procedure was formulated to combine the beneficial features of both bulk and SSD methods of breeding and evaluated for its relative efficiency with bulk method in six crosses of sesame.

MATERIALS AND METHODS

The experimental material in the present investigation comprised of 25 F_6 lines, each developd by bulk and SCD procedures for each of the six crosses od sesame viz., PDP 1-2 x JLT-9, RCR-2 x AT-2, RCR-4 x AT-6, PDP 1-2 x JLT-8, (GS-12 x TC-25) x AT-1 and PDP 1-2 x JLT-2. In the F_2 generation of each cross at harvest, bulk and SCD populations were constituted. The SCD population was constituted from seeds of a single random capsule from each of the F_2 plants and the bulk population, from the F_2 plants harvested *en masse*. These

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populations were advanced by the respective procedures and in the F_5 generation, 25 plants were selected from each of the six crosses. This material was raised in the F_6 generation as plant to row progenies and evaluated in a double split plot design with crosses as main, breeding methods as sub and the progenies as sub-sub plots in three replications at the College Farm, A. P. Agricultural University, Rajendranagar, Hyderabad, during *kharif* 1989-90. A plot consisted of a single row of 4 m length of which a net plot of 3 m was fixed for recording the observations. The spacing adopted was 30 x 10 cm. Data on seed yield per plant, days to maturity, plant height, number of primary and secondary branches, productive capsules, abortive capsules and oil content were recorded on five random plants and the mean values were computed. The bulk and SCD procedures were compared on the basis of mean and variance values across crosses. The cross-wise variance of 25 lines and mean of top 20 per cent lines for bulk and SCD procedures were computed and the variances were compared using two-tailed F-test. For days to maturity and number of abortive capsules, lines with lower values were considered for inclusion in the top 20 per cent lines.

RESULTS AND DISCUSSION

The mean and variance values for methods over crosses for seed yield and yield attributed are presente in Table-1, while the mean of top 20 per cent lines and variance of 25 lines are presented cross- wise in Table-2. Bulk breeding procedure exhibited significant superiority over SCD method when considered across crosses for mean seed yield and other important yield attributes such as plant height, secondary branches, productive and abortive capsules, while, SCD procedure recorded significant superiority for days to maturity,

TABLE 1

Mean and variance values for bulk and SCD methods across the crosses, for yield and yield components in sesame.

Character	*Mean*			*Variance*		
	Bulk	*SCD*	± *SE*	*Bulk*	*SCD*	*Fcal*
Seed yield (g) per plant	3.8372	3.7378	.0050*	2.1000	2.1900	1.0428*
Days to maturity	93.2926	92.1099	.1508*	20.8617	23.0633	1.1055*
Plant height (cm)	136.7502	131.9165	.1833*	231.1083	244.4850	1.0579*
Primary branches	3.7281	3.8681	.0149*	1.4850	1.3550	1.0959*
Secondary branches	0.8831	0.7684	.0094*	0.8083	0.6583	1.2278*
Productive capsules	37.5480	36.9350	.0795*	141.3267	188.4967	1.3377*
Abortive capsules	6.0512	6.3987	.0240*	6.4117	8.5467	1.3330*
Oil content (%)	53.9980	54.3689	.0105*	7.8850	8.0200	1.0771*

* Significant at 0.05 level of significance.

TABLE 2

Mean of top 20 per cent lines (MTL) and variance of 25 lines for yield and yield components in six crosses of sesame.

Cross-Method	Seed yield per plant (g)		Days to maturity		Plant height (cm)		Primary branches		Secondary branches		Productive capsules		Abortive capsules		Oil content (%)	
	MTL	Variance	MTL	Variance	MTL	Variance	MTL	Variance	MTL	Variance	MTL	Variance	MTL	Variance	MTL	Variance
PDP 1-2 X JLT-9																
Bulk	4.06	1.19	88.40	12.33	155.74	271.46	5.44	1.38	2.02	0.64	46.10	108.51	5.18	5.89	53.14	4.56
SCD	4.84	1.18	84.20	15.40	162.78	313.61	4.64	1.74	0.90	0.03	53.34	209.42	4.36	8.10	54.46	5.46
SE and (F_{cal})	±0.01*	(1.00)	±0.37*	(1.25)	±0.45*	(1.16)	±0.04*	(1.26)	±0.03*	(21.33)*	±0.20*	(1.93)*	±0.06*	(1.38)*	±0.03*	(1.20)
RCR-2 X AT-2																
Bulk	6.42	2.89	80.40	16.36	143.16	96.54	4.88	1.65	1.86	0.36	51.84	123.75	1.14	6.66	55.12	9.57
SCD	5.68	2.79	83.60	19.12	141.18	245.84	5.74	2.11	2.78	1.00	49.36	90.46	1.38	7.48	54.40	6.95
SE and (F_{cal})	±0.01*	(1.03)	±0.37*	(1.17)	±0.45*	(2.55)*	±0.04*	(1.28)	±0.03*	(2.78)*	±0.20*	(1.37)*	±0.06*	(1.12)	±0.03*	(1.38)*
RCR-4 X AT-6																
Bulk	5.94	1.64	87.20	40.84	167.54	426.46	5.96	1.51	1.78	0.52	70.00	93.74	2.20	2.01	52.70	5.50
SCD	5.92	2.02	84.40	54.65	152.88	268.25	6.08	1.59	1.74	0.47	55.94	344.63	3.20	18.28	54.36	4.81
SE and (F_{cal})	±0.01*	(1.23)	±0.37*	(1.34)*	±0.45*	(1.59)*	±0.04*	(1.05)	±0.03	(1.11)	±0.20*	(3.68)*	±0.06*	(9.09)*	±0.03*	(1.14)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
PDP 1-2 X JLT-8																
Bulk	7.20	2.77	86.63	10.73	159.10	156.34	4.90	1.17	0.98	0.08	60.36	219.00	1.80	5.37	53.64	6.89
SCD	5.78	1.86	86.80	10.90	150.32	201.80	5.12	1.01	1.56	0.27	52.50	117.23	2.40	6.31	53.36	2.43
SE and (F_{cal})	±0.01*	(1.49)*	± 0.37*	(1.02)	±0.45*	(1.29)	±0.04*	(1.16)	±0.03	(3.37)*	±0.20*	(1.87)*	±0.06*	(1.18)	±0.05*	(2.84)*
(GS-12 X TC-25) X AT-1																
Bulk	6.96	2.74	85.40	18.34	147.00	151.46	6.14	1.76	4.58	1.76	61.46	165.50	3.06	14.04	54.14	9.30
SCD	5.68	1.81	84.80	9.71	156.02	260.17	4.92	0.93	1.52	0.87	59.34	176.19	3.72	6.24	53.88	8.07
SE and (F_{cal})	±0.01*	(1.51)*	±0.37*	(1.89)*	±0.45*	(1.72)*	±0.04*	(1.89)*	±0.03*	(2.02)	±0.20*	(1.06)	±0.06*	(2.25)*	±0.03*	(1.15)
PDP 1-2 X JLT-2																
Bulk	5.20	1.37	94.00	26.57	172.48	284.39	4.88	1.44	2.56	1.49	46.14	137.46	5.24	4.50	53.22	11.49
SCD	5.60	3.53	91.00	28.60	147.22	177.24	4.90	0.75	2.54	1.31	49.42	193.05	5.12	4.87	53.06	20.40
SE and (F_{cal})	±0.01*	(2.51)*	± 0.37*	(1.08)	±0.45*	(1.60)*	±0.04*	(1.92)*	±0.03	(1.14)	±0.20*	(1.40)*	±0.06*	(1.08)	±0.03*	(1.78*)

* Significant at 0.05 level of significance.

primary branches and oil content (Table-1). However, when the breeding procedures were studied cross-wise for retention of superior lines, bulk procedure exhibited a clear superiority in crosses, RCR-2 x AT-2, RCR-4 x AT-6, PDP 1-2 x JLT-8 and (GS-12 x TC-25) x AT-1. The superiority of bulk method over SSD procedure was also reported by Ndoni (1986) in wheat and by Ranganatha (1986) in sesame. The superiority of bulk method may be due to, an increase in population mean yield over generations resulting from natural selection (Palmer, 1952), shifting of gene frequencies for yield in a positive direction (Raeber and Weber, 1953), shift towards types adapted to the location (Taylor and Atkins, 1954), elimination of low seed number individuals through competition (Muehlbauer, *et al.*, 1981) or through retention of superior genotypes (Ranganatha, 1986). On contrary, the effectiveness of natural selection in bulk method of breeding was questioned by Sandfaer (1970).

The SCD procedure retained higher variability for majority of the characters studied in the present investigation. This may be because of representation of each genotype in the consecutive generations of modified SSD. The disadvantage of narrowing genetic base in SSD through loss of plants from generation to generation due to occassional inviability of the single seed used to propagate each individual (Muehlbauer *et al.*, 1981) might have been overcome in the present investigation by the use of single capsules. Similarly Jensen (1988) used single head descent (SHD) procedure in wheat to counter the loss of plants in SSD populations. The low variability noticed in bulk populations may be attributed to stabilized selection occuring naturally in bulk populations (Khalifa and Qualset, 1975) and losses in genetic variability during generation advance as reported by Muehlbauer *et al.*, (1981).

A cross-wise analysis of variability across the traits in general (Table-2) indicated higher level of variability in SCD procedure for PDP 1-2 x JLT-9, RCR-2 x At-2, RCR-4 x AT-6 and PDP 1-2 x JLT-2 while, bulk procedure retained higher level in case of (GS-12 x TC-25) x AT-1 and PDP 1-2 x JLT-8. The bulk and SCD breeding procedures exhibited significantly different levels of variability for seed yield, days to naturity, plant height, primary branches and abortive capsules in (GS-12 x TC-25) x AT-1; for seed yield, plant height, primary branches, productive capsules and oil content in PDP 1-2 x JLT-2; for seed yield, secondary branches, productive capsules and oil content in PDP 1- 2 x JLT-8; for plant height, secondary branches, productive capsules and oil content in RCR-2 x AT-2; for days to maturity, plant height, productive capsules and abortive capsules in RCR-4 x AT-6 and for secondary branches, productive capsules and abortive capsules in PDP 1-2 x JLT-9. Thus retention of variability by the breeding procedures varied with the cross and character involved, similar to the findings of Tee and Qualset (1975). The present study indicates the favourable response of sesame to bulk procedure in general. However SCD was observed to be effective for crosses of low parental diversity and for retention of higher level of variability. Hence, a better understanding of crosses and parents regarding genetic diversity and recombination potential would be advantageous in handling segregating generations.

REFERENCES

Jensen, N. F. (1988). Plant Breeding Methodology; Wiley Interscience Publication, New york, pp 115-296.

Khalifa, M. A. and Qualset, C. O. (1975). Intergenotypic competition between tall and dwarf wheats II : In Hybrid bulks; *Crop Sci.* **15** : 640-644.

Muehlbauer, F. J., Burnell, D. G., Bogyo, T. and Bogyo, M. T. (1981) Simulated comparisons of SSD and bulk population breeding methods; *Crop Sci,* **21** : 572-577.

Ndoni, R. V. (1986). Comparison of the single seed descent (SSD) method the multiple seed descent (MSD) and the bulk population method for yield and protein improvement in wheat; *Pl. Breed. Abst.* **56**, 10, 8457.

Palmer, T. P. (1952). Population and selection studies in a *Triticum* cross; *Heredity*, **6** : 171-185.

Raeber, J. G. and Weber, C. R. (1953). Effectiveness of selection for yield in soybean crosses by bulk and pedigree systems of breeding; *Agron. J.* **45** : 362-366.

Ranganatha, A. R. G. (1986). Comparison of breeding methods for their relative efficiency in sesame (*Sesamum indicum* L.); Ph. D. thesis, U.A.S., Bangalore, India.

Sandfaer, J. (1970). An analysis of the competition between some barley varieties; Danish Atomic Energy Commission, Riso Report No. **230** : 114.

Taylor, L. H. and Atkins, R. E. (1954). Effects of natural selection in segregating generations of bulk populations of barley; *IOWA State J. of Sci.* **39** : 147-162.

Tee, T. S. and Qualset, C. O. (1975). Bulk populations in wheat breeding; Comparison of single seed descent and random bulk methods; Euphytica. **24** : 393-403.