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Selection index and genetic variability for morpho-phenological traits in sesame (*Sesamum indicum* L.)

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Abstract
Twenty-six advanced breeding lines of sesame were evaluated in a randomized block design with two replications for fifteen traits during summer 2022 at AICRP on Sesame and Niger, MARS, UAS, Dharwad along with four checks *viz.*, DS-5, DSS-9, JTS-8 and TKG-22 to study the genetic parameters and selection index for yield and its component traits in sesame. Among the various quantitative characters studied, number of secondary branches per plant exhibited highest genotypic and phenotypic coefficient of variation. The number of primary branches per plant showed the highest heritability coupled with genetic advance over the mean, indicating additive gene action underlying these traits and useful in selection. Thirty-one selection indices involving five traits *i.e.*, seed yield per plant (A_1), days to maturity (A_2), number of productive capsules per plant (A_3), thousand seed weight (A_4) and oil content (A_5) were constructed using the discriminant function technique. Among thirty-one different selection index, highest expected genetic advance and relative efficiency was observed for the selection index consisting of all the component characters *viz.*, A_1, A_2, A_3, A_4 and A_5.

Keywords: sesame, relative efficiency, selection index, discriminant function and expected genetic advance

Introduction
Sesamum indicum L. is an important and perhaps the ancient edible oil seed crops cultivated extensively from tropical regions to temperate zones in the world. Being admired as "Queen of oilseeds" due to its plethora of nutritive substance (Iqbal *et al.* 2016) [5]. It contains high amounts of unsaturated fatty acid *viz.*, linoleic acid and oleic acid and saturated fatty acid *viz.*, palmitic acid and stearic acid with 25 percent protein (Weiss, 1971) [9]. Sesame seeds contain lignans *viz.*, sesamin (8.80%), sesamolin (4.50%), sesamol (1.20%) and sesaminol (1.40%) with remarkable antioxidation function. Sesame oil is renowned for its long shelf life due to resistance to oxidative rancidity after prolonged air exposure (Global Agri Systems, 2010) [3].
Sesame is a plant breeder's dream because it has high variability. Variability assessment is the foundation of any crop improvement programme and is determined by the type and magnitude of variability in the crop. However, while carrying out selection for a highly variable character like seed yield, direct selection may not always be efficient. At such stage, a selection index technique in which selection is based upon more than one variable simultaneously may prove useful. Seed yield per plant (A_1) along with four components *viz.*, days to maturity (A_2), number of productive capsules per plant (A_3), thousand seed weight (A_4) and oil content (A_5) were identified and considered. For computing selection indices, seed yield per plant was considered as the dependent variable with the relative efficiency of 100 percent. A total of 31 selection indices based on five characters constructed in all possible combinations revealed that when selection was based on individual components, selection efficiency was higher than straight selection.

Materials and Method
The experiment was conducted during summer 2022 at AICRP on Sesame and Niger, MARS, UAS, Dharwad. Twenty-six advanced breeding lines (F_6 generation) derived from cross DS-5 × DS-28 along with checks *viz.*, DS-5, DSS-9, JTS-8 and TKG-22 (Table 1) were evaluated in RCBD with two replications. Genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2) in broad sense and genetic advance as percent of mean (GAM) were estimated (Johnson *et al.* 1955).

Discriminant function analysis was used to construct the selection indices involving five characters *viz.*, seed yield per plant (A_1), days to maturity (A_2), number of productive capsules per plant (A_3), 1000 seed weight (A_4) and oil content (A_5). For computing selection indices, seed yield per plant was considered as the dependent variable with the relative efficiency of 100 percent. The expected genetic advance and relative efficiency of index selection were calculated according to Robinson *et al.* (1951) [8].

Results and Discussion

The Analysis of variance for different traits exhibit highly significant different among the genotypes (Table 2) revealed the presence of a wide spectrum of variability in the material. The coefficients of variation at the phenotypic and genotypic levels were high for the number of secondary branches per plant, number of seeds per capsule and seed yield (kg/ha) indicating the presence of considerable variation for these traits (Table 3). Hence, these traits can be relied upon and simple selection can be practiced for further improvement. Heritability estimates revealed that the heritable portion of variability present in different traits. High heritability coupled with high genetic advance over mean observed for the traits *viz.*, number of primary branches per plant, number of secondary branches per plant, number of productive branches per plant, number of productive capsules per plant, number of capsules on main stem, number of seeds per capsule, seed yield per plant (g) and seed yield (kg/ha) indicating that these characters are under the control of additive gene action and phenotypic selection for these traits will be effective. Plant height (cm), thousand seed weight (g) and oil content (%) showed high heritability with moderate genetic advance as a percentage of the mean, indicating that these traits were controlled by both additive and non-additive gene action rather than by the environment. Days to 50% flowering and days to maturity were associated with high heritability with low genetic advance over mean, indicating a reduced environmental influence but a high prevalence of non-additive gene action for which selection will be less successful.

Selection indices for seed yield per plant and other traits were constructed and examined to identify their relative efficiency in the selection of superior genotypes. The data on selection indices, discriminant functions, expected genetic gain and relative efficiency are presented in Table 4. The maximum relative efficiency (RI) in single character discriminant function was 123.45% for seed yield per plant (A_1). However, it increased up to 125.53% in two-character combinations seed yield per plant (A_1) and thousand seed weight (A_4). Further in three characters combinations *viz.*, seed yield per plant (A_1), 1000 seed weight (A_4) and oil content (A_5) exhibited 127.39% of RI. Whereas, 127.68% in four characters combinations *viz.*, seed yield per plant (g), days to maturity, 1000 seed weight and oil content. In five-character combinations, the highest RI (128.73%) was observed by combinations of characters such as seed yield per plant (A_1), days to maturity (A_2), number of productive capsules per plant (A_3), thousand seed weight (A_4) and oil content (A_5) in table 5. Thus, there was an increase in relative efficiency with an increase in the character combinations. As the number of characters under selection increases, selection based on index becomes more advantageous (Hazel and Lush 1943) [4]. Adsul and Monpara (2014) [1], Kachhadia *et al*. (2014) [7], and Bizari *et al*. (2017) [2] were reported that an increase in characters led to an increase in genetic gain and that the selection indices improve the efficiency than the straight selection for seed yield alone. Further, it was observed that the straight selection for seed yield per plant was not that much rewarding as it was through its component traits.

Among the combination involving two component characters, seed yield per plant and thousand seed weight (A_1+ A_4) with the 276.74 g genetic advance and 125.53% RI. The selection index based on three-character combinations indicated that a discriminant function with seed yield per plant, thousand seed weight and oil content (A_1 + A_4 + A_5) possessed 280.84 g genetic advance with RI of 127.39%. The selection index of four characters *viz.*, seed yield per plant, days to maturity, thousand seed weight and oil content (A_1+ A_2 + A_4 + A_5) with the 281.47 g genetic advance and 127.68% RI. The maximum efficiency in selection for seed yield was exhibited by a discriminant function involving seed yield per plant, days to maturity, number of productive capsules per plant, thousand seed weight and oil content (A_1- A_2 + A_3 + A_4 + A_5) which had a genetic advance and RI of 283.96 g and 128.73.

Table 1: List of advanced breeding lines of sesame of cross DS-5 × DS-28

SL. No	Genotypes	SL. No	Genotypes
1	(DS-5 × DS-28)-1-2-1-2	16	(DS-5 × DS-28)-4-1-1-2
2	(DS-5 × DS-28)-1-2-2-1	17	(DS-5 × DS-28)-4-1-2-2
3	(DS-5 × DS-28)-2-1-2-2	18	(DS-5 × DS-28)-4-1-3-2
4	(DS-5 × DS-28)-2-1-1-2	19	(DS-5 × DS-28)-4-2-1-2
5	(DS-5 × DS-28)-2-1-3-1	20	(DS-5 × DS-28)-4-3-1-2
6	(DS-5 × DS-28)-2-2-1-1	21	(DS-5 × DS-28)-4-3-2-1
7	(DS-5 × DS-28)-2-2-2-2	22	(DS-5 × DS-28)-4-3-3-2
8	(DS-5 × DS-28)-2-2-3-1	23	(DS-5 × DS-28)-5-1-1-1
9	(DS-5 × DS-28)-3-1-1-1	24	(DS-5 × DS-28)-5-3-1-2
10	(DS-5 × DS-28)-3-1-2-1	25	(DS-5 × DS-28)-5-3-1-3
11	(DS-5 × DS-28)-3-2-1-1	26	(DS-5 × DS-28)-5-3-2-1
12	(DS-5 × DS-28)-3-2-2-2	27	DS-5(local check)
13	(DS-5 × DS-28)-3-2-3-2	28	DSS-9(local check)
14	(DS-5 × DS-28)-3-2-3-3	29	JTS-8(zonal check)
15	(DS-5 × DS-28)-4-1-1-1	30	TKG-22(national check)

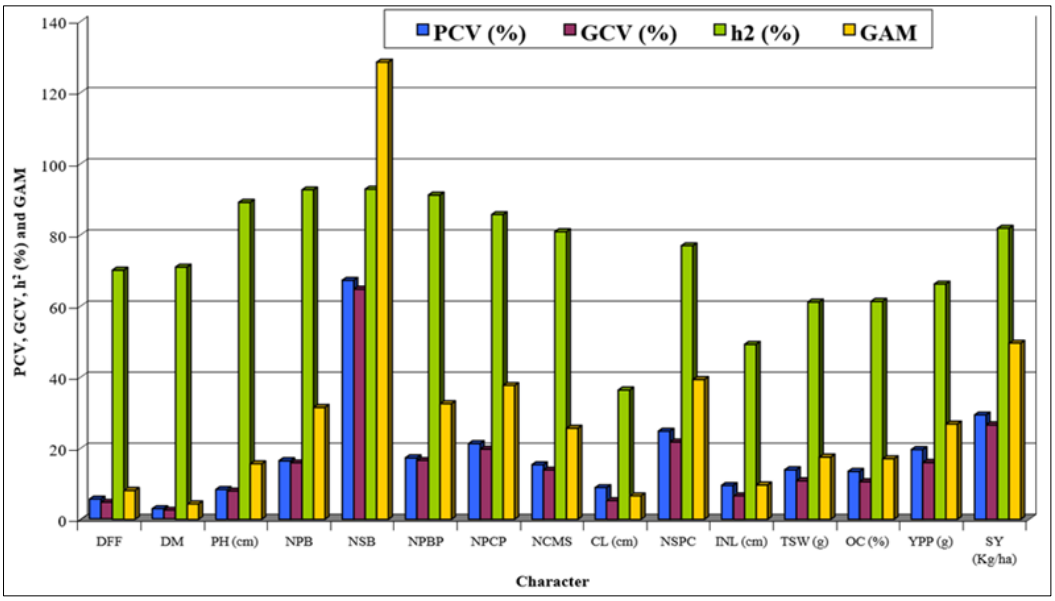

Fig 1: Genetic viability parameters for yield and yield related characters in advanced breeding lines of sesame cross D-5 × DS-28

Table 2: Genetic variability parameters for yield and yield related characters in advanced breeding lines of sesame cross DS-5 × DS-28

Character	Range		Mean	Coefficient of variation		h^2 (%)	GAM (%)
	Min.	Max.		PCV (%)	GCV (%)		
DFF	52.00	58.00	54.60	5.63	4.71	70.06	8.12
DM	101.00	107.00	103.72	2.95	2.49	70.95	4.32
PH (cm)	92.83	126.33	108.58	8.51	8.03	89.14	15.62
NPB	4.17	7.50	5.87	16.50	15.88	92.66	31.49
NSB	0.33	5.83	1.85	67.21	64.77	92.85	128.56
NPBP	3.17	6.17	4.51	17.30	16.53	91.22	32.52
NPCP	71.17	170.50	123.55	21.32	19.74	85.71	37.64
NCMS	23.83	42.33	31.64	15.39	13.84	80.89	25.64
CL (cm)	2.57	3.42	2.96	8.94	5.39	36.37	6.70
NSPC	24.33	57.67	37.55	24.81	21.76	76.96	39.32
INL (cm)	3.05	4.25	3.57	9.55	6.70	49.23	9.68
TSW (g)	2.32	3.76	2.99	13.94	10.89	61.12	17.54
OC (%)	27.68	45.63	33.54	13.51	10.58	61.30	17.06
YPP (g)	3.83	9.27	6.83	19.66	16.00	66.19	26.81
SY (Kg/ha)	296.83	927.33	522.89	29.38	26.58	81.85	49.54

DFF-Days to 50% flowering; **DM**- Days to maturity; **PH**: Plant height (cm); **NPB**- Number of primary branches; **NSB**- Number of secondary branches; **NPBP**- Number of productive branches per plant; **NPCP**- Number of productive Capsules per plant; **NCMS**- Number of capsules on main stem; **CL**- Capsule length (cm); **NSPC**- Number of seed per capsule; **INL**- Internodal length (cm); **TSW**-Thousand seed weight (g); **OC**- Oil content (%); **YPP**- Yield per plant (g); **SY**- Seed yield (Kg/ha).

Table 3: Selection index, discriminant function, expected genetic advance in yield and relative efficiency from the use of different selection indices in sesame

SL. No.	Selection index	Discriminant function	Expected genetic advance (g)	Relative efficiency (%)
1	A_1Seed yield per plant	0.83 A_1	272.15	123.45
2	A_2 Days to maturity	0.01 A_2	0.018	0.01
3	A_3 Number of productive capsules per plant	0.85 A_3	48.31	21.91
4	A_4 1000 seed weight	0.58 A_4	0.52	0.23
5	A_5 Oil content	0.64 A_5	6.14	2.78
6	A_1. A_2	0.81 A_1 - 7.78 A_2	272.62	123.67
7	A_1. A_3	0.82 A_1 + 0.59 A_3	265.97	120.64
8	A_1. A_4	0.76 A_1 + 59.38A_4	276.74	125.53
9	A_1. A_5	0.82 A_1 + 2.60 A_5	276.03	125.21
10	A_2. A_3	0.22 A_2 + 0.84 A_3	47.68	21.63
11	A_2. A_4	-0.03 A_2 - 0.07 A_4	0.13	0.06
12	A_2. A_5	0.21 A_2 + 0.71 A_5	6.92	3.14
13	A_3. A_4	0.85 A_3 + 4.14 A_4	48.39	21.95
14	A_3. A_5	0.78 A_3 + 0.03 A_5	44.59	20.22
15	A_4. A_5	3.11 A_4 + 0.63 A_5	6.99	3.17
16	A_1. A_2. A_3	0.79 A_1- 9.37 A_2 + 0.42 A_3	266.90	121.07

17	A_1. A_2. A_4	0.74 A_1- 6.97 A_2 + 57.20 A_4	276.90	125.60
18	A_1. A_2. A_5	0.78 A_1- 9.37 A_2+ 3.64 A_5	277.08	125.68
19	A_1. A_3. A_4	0.74 A_1+ 0.68 A_3 +63.90 A_4	271.26	123.05
20	A_1. A_3. A_5	0.81 A_1+ 0.62 A_3 + 1.68 A_5	268.79	121.93
21	A_1. A_4. A_5	0.75 A_1+ 61.35 A_4 + 2.49 A_5	280.84	127.39
22	A_2. A_3. A_4	0.34 A_2 + 0.85 A_3 + 3.64 A_4	47.73	21.65
23	A_2. A_3. A_5	0.52 A_2 + 0.78 A_3 + 0.07 A_5	44.00	19.96
24	A_2. A_4. A_5	0.27 A_2 + 2.53 A_4 + 0.70 A_5	7.52	3.41
25	A_3. A_4. A_5	0.79 A_3 + 7.16 A_4 - 0.01 A_5	44.97	20.40
26	A_1. A_2. A_3. A_4	0.72 A_1- 8.10 A_2 + 0.53 A_3 + 60.38 A_4	271.63	123.21
27	A_1. A_2. A_3. A_5	0.78 A_1- 9.94 A_2 + 0.49 A_3 + 2.50 A_5	269.93	122.44
28	A_1. A_2. A_4. A_5	0.72 A_1- 8.42 A_2 + 58.50 A_4 + 3.44 A_5	281.47	127.68
29	A_1. A_3. A_4. A_5	0.74 A_1+ 0.72 A_3 + 66.36 A_4 + 1.77 A_5	274.42	124.48
30	A_2. A_3. A_4. A_5	0.81 A_2 + 0.80 A_3 + 6.97 A_4 + 0.02 A_5	44.35	20.12
31	A_1. A_2. A_3. A_4. A_5	0.71 A_1- 8.62 A_2 + 0.60 A_3 + 62.71 A_4 + 2.49 A_5	283.96	128.73

Table 4: Average selection efficiency of different combination of characters in sesame

No. of characters in the index	Relative Efficiency (%)
One	29.68
Two	56.52
Three	81.01
Four	103.59
Five	128.73

Table 5: Highest Relative efficiency with character combinations in sesame

SL. No.	Character	Relative efficiency (%)
1	Seed yield per plant	123.45
2	Seed yield per plant+1000 seed weight	125.53
3	Seed yield per plant +Oil content	125.21
4	Seed yield per plant +1000 seed weight+ Oil content	127.39
5	Seed yield per plant + Days to maturity+ Oil content	125.68
6	Seed yield per plant + Days to maturity+1000 seed weight	125.60
7	Seed yield per plant + Days to maturity +1000 seed weight+ Oil content	127.68
8	Seed yield per plant + Number of productive capsules per plant +1000 seed weight+ Oil content	124.48
9	Seed yield per plant + Days to maturity+ Number of productive capsules per plant +1000 seed weight+ Oil content	128.73

Conclusion

From the 26 advanced breeding lines of sesame along with four checks *viz.*, DS-5, DSS-9, JTS-8 and TKG-22 have wide range variability indicating an ample scope for selection in crop improvement program. To save time and labor in a selection programme, the plant breeder may be interested in maximizing gain with the fewest characters possible. So maximum weightage should be given for components traits while making selection. The discriminant function method of making plant selections appears to be more useful than straight seed yield selection alone and thus due weightage should be given to the important selection indices when making selection for seed yield advancement in sesame crop.

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