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Original Research

Genetic Variability, Heritability and Genetic Advance for the Phenotypic Traits in Sesame (*Sesamum indicum* L.) Populations from Ethiopia

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Abstract

Sesame (*Sesamum indicum L.*) is an important crop produced in Ethiopia for oilseed production and it ranks first in total production from oil crops. A study was conducted to determine the extent of genetic variability, heritability and genetic advance among 64 sesame populations from Ethiopia. The populations were grown in 8 x 8 simple lattice design in Jima Arjo District, East Wollega Zone, Ethiopia during 2013. Data were collected for 11 morpho-agronomic traits and analyzed using SAS software version 9.0. The results showed that there were highly significant differences among the populations for all characters studied. High estimates for GCV and PCV were observed in the populations for NPB, BPP, SY, BY and HI which could indicate the populations are variable. High to very high estimates for heritability values were observed for all traits except TSW which indicated that the populations are useful for breeding activities and can be utilized in subsequent selections based on phenotypic expressions of individual plants for specific traits. And it further indicates the limited influence of the environment on the phenotypic expressions of the traits. Further computation for GAM indicated that high estimates were found for NPB, BPP, BY, SY and HI which could further confirm the easy of selections based on phenotypic traits after cycle of selection using 5 % selection intensity. This study generally indicated that there were significance genetic variations among the populations. Thus, there is enormous opportunity of using the germplasm in the improvement program for employing different breeding techniques for selection of varieties for significant increment in economic trait like seed yield and percent oil content.

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INTRODUCTION

Sesame (*Sesamum indicum* L.) is a diploid with 2n=2X= 26 chromosomes; a self pollinated crop which belongs to the family of pedaliaceae. Though its origin is believed to be in Indian subcontinent (Bedigian and Harlan, 1986); it has high genetic diversity in east Africa, Ethiopia. The presence of weedy or wild forms of sesame (*S. alatum*; 2n=26 and *S. latifolium,* 2n=32) in Ethiopia shows that it is indigenous to this country. Sesame production was recorded in the Middle East and India during 3050-3500 BC (Bedigian and Harlan, 1986). Currently, about 60% of the world's sesame production is from Myanmar, India, China, Ethiopia and Nigeria during 2011(http://www.factfish.com/statistic/sesame%20seed,%20production%20quantity); and Ethiopia is among the top 5 world's producers of sesame seed, linseed and also an important producer of Niger seed (Wijnands *et al.,* 2007; http://www.epospeaeth.org/index.php/ethiopian-sesame-and-oilseeds: accessed date December 14/2013). Sesame ranks first in total area and production from oil crops during 2013 in Ethiopia. The total area, production and productivity were 0.299 million ha, 0.220 million tonnes and 0.735 t ha^{-1}, respectively (CSA, 2014). It is a small farmer's crop in the developing countries and it is majorly grown in the small plots (Gulhan *et al.*, 2004). In Ethiopia, the production of sesame is both by small and large scale farmers; and it is an important export commodity. Due to its importance the area coverage and production has increased in the last consecutive years in Ethiopia. In spite of the growing demand for sesame seeds and oil in Ethiopia, the productivity, production and oil extractions methods are traditional.

The production of sesame is for oil and margarines. It is often called the 'queen of oil crops'. Sesame seeds are used whole or processed to produce oil and meal while in Africa the seeds are made into porridges and soups (Gooding *et al*., 2000). The quality of oil is determined by the fatty acid compositions of the total oil. Its oil is used for salad and cooking dishes. Sesame seed is used for confectionery purpose and an important source of edible oil and is also widely used as a spice. In addition, it is used for pharmaceutical and skin care products and as a synergist for insecticides (Salunkhe and Desai, 1986). The seed contains 50 to 60% oil which has excellent stability due to the presence of natural antioxidants such as sesamolin, sesamin and sesamol (Brar and Ahuja, 1979).The fatty acid composition of sesame oil varies considerably among the different cultivars worldwide (Yermanos *et al*., 1972).

Genetic diversity studies were done by different researchers for Ethiopian sesame collections in different times (Endale and Parzies, 2011; Alemu *et al*., 2013, Desawi *et al*., 2014, Hika *et al*., 2014) and the researchers reported that phenotypical and genetic variations have been detected in the specific populations studied. Endale and Parzies (2011) studied 50 populations of Ethiopian sesame using SSR markers and ample amount of genetic variations were reported. Alemu *et al*. (2013) reported that significant genetic variation were detected using ISSR markers among six farmers' varieties of sesame from Northern Ethiopia indicating that Ethiopia has ample genetic resources of sesame which could be utilized for improvement programs. Knowledge on the extent and pattern of genetic variability present in a specific breeding population is absolutely essential for further improvement of the crop. Besides, knowledge of the naturally occurring diversity in a population helps to identify diverse groups of populations that can be useful for the breeding program. Sesame breeding programs started before three decades in Ethiopia and so far 18 varieties were released for different agro-ecologies in the country based on the moisture, temperature and soil requirements , however only three varieties were produced for export purpose (Wijinands *et al*., 2007; Geremew *et al*., 2012;) while the others are out of production due to different reasons. Hence the objectives of the study were to determine the magnitude of phenotypic variations for yield and yield related traits in sesame populations; and to estimate broad sense heritability and genetic advance for different traits of sesame populations.

MATERIALS AND METHODS

Description of Experimental Site

The experiment was carried out at Jimma Arjo district, Eastern Wollega Zone, Western Ethiopia. The test location, Jimma Arjo district is 378 km to the west of Addis Ababa, the capital city of Ethiopia. The district is located at an altitudinal ranges from 1200-1816 meters above sea level; and it receives an average annual rainfall that ranges from 824-2616 mm. The average annual temperature ranges from 18-26^{0}C (Unpublished data of Jima Arjo Agricultural Office).

Experimental Materials and Design

The experimental materials consisted of 64 sesame populations which were collected from different parts of the country (Tigray, Amhara, Oromia, Beneshangul Gumuz and others region) and conserved at the Institute of Biodiversity Conservation (IBC) and the population code, region and altitude of original collection sites were reported in Hika *et al.* (2014). The trial was laid out using 8 x 8 simple lattice design. Seeds of each population was sown in rows by hand on a separate plot size of 6.4m^2 (4 rows x 4m row length x 40cm between rows and 10cm between plants within row spacing respectively). Weeding was done as required uniformly.

Data Collection

The measurements and other protocol for data collections were dome according to sesame crop descriptors (IPGRI, 2004). Data were collected for days to 50% flowering, days to 90 % maturity, capsule filling period, plant height, number of branches per plant, number of primary branches per plant, number of capsules per plant, thousand seed weight, biomass yield, seed yield and harvest index.

Data Analysis

Analysis of variance (ANOVA) was done following the procedure for statically computation for Gomez and Gomez (1984) and it was analyzed using Statistical Analysis System (SAS) Computer software program following SAS statement for simple lattice design (SAS, 2002, version 9.0, USA). The phenotypic and genotypic coefficients of variation were estimated according to the method suggested by Burton and de Vane (1953). Broad sense heritability (h^2) expressed as the percentage of the ratio of the genotypic variance (σ^2g) to the phenotypic variance (σ^2p) was computed as described by Allard (1960). Genetic advance in absolute unit (GA) and percent of the mean (GAM), assuming selection of superior 5% of the populations was estimated according to the method illustrated by Johnson *et al*. (1955).

RESULTS

Analysis of Variance

The analysis of variance showed that all the studied characters showed highly significant differences (P<0.01) among the tested sesame populations. This indicates the presence of adequate variability which can be exploited through selection for improving specific traits (Table 1).

Mean, Range and Coefficient of Variation

The mean seed yield was 511 kg ha^{-1} and about 40.63% of the populations gave seed yield above the mean yield. The maximum yield was obtained from populations Acc-215816 (902 kg ha^{-1}). Regarding BY and HI, 41 and 70 % respectively of the populations had higher values as compared to the mean. For TSW, 52 % of the population had more than the mean values and the maximum was 2.99 g. About 59 % and 50 % of the populations gave flower and mature late respectively as compared to the mean of the populations. NPB and PH had maximum values of 9.0 and 127 cm respectively and 36 % and 45 % of the populations respectively had more than the mean values. The 64 populations studied showed wide range of variability for most of the characters (Tables 2, 3 and 4). Mean ranges in the populations were higher (> 20) for DF, DM, PH, CPP, BY, and SY, while medium mean ranges (10 to 20) were observed for BPP and CFP. However, the mean ranges were low (< 10) for TSW and NPB. There was high coefficient of variation in the characters for NPB and BPP.

Estimates of Genetic Parameters

Number of primary branches per plant, the number of branches per plant, seed yield, harvest index and biomass yield had high values (> 18 %) of genotypic and phenotypic coefficients of variation (Table 5). Estimates for genotypic and phenotypic coefficients of variation were low (<18 %) for days to 50 % flowering, days to 90 % maturity, capsule filling period, plant height, and thousand seed weight. The high GCV value of characters suggest that the possibility of improving these trait through selection**.** The difference between GCV and PCV values was low for days to 50 % flowering, days to 90 % maturity and thousand seed weight; suggesting minimal influence of environment on the expression of the characters so that it is easy to select based on the phenotypes. Heritability in broad sense was greater than 80% for all traits except for

Table 1: Mean square values for different morpho-agronomic traits in 64 sesame populations

Traits	Replication (Df=1)	Blocks with in rep (adj) (Df=14)	Populations (unadj.) (Df=63)	Intra block error (Df=49)
Days to 50 % flowering	3.13	1.03	59.38**	1.37
Days to 95 % maturity	1.76	2.02	98.93**	2.28
Capsules filling period	1.13	1.36	29.69**	1.49
Primary branches per plant	0.07	0.13	3.74**	0.175
Number of branches per plant	5.69	0.24	4.97**	0.34
Plant height, cm	4.5	2.61	146.88**	2.71
Number of capsules per plant	15.82	10.48	198.25**	7.31
Biological yield (kg ha^{-1})	208334.34	47807.07	867461.23**	48057.15
Seed yield (kg ha^{-1})	21.72	9.81	18794.57**	17.07
Harvest index	0.002	0.00	0.005**	0.00
Thousand seed weight, (g)	0.001	0.061	1282.83**	0.037

Df = degrees of freedom; ** means significant at 1% probability level

Table 2: Estimates of mean values, range and coefficient variation for morphological traits in sesame populations

Characters	Mean	Range	CV (%)
Days to 50 % flowering	60.48	45.0-70.0	1.88
Days to 90 % maturity	133.00	116.0-146.0	1.12
Plant height, cm	104.55	87.0-127.0	1.57
Capsule filling period	46.46	39-56.0.0	2.59
Number of primary branches	2.49	1.0-9.0	16.33
Number of branches per plant	2.97	1.0-11.0	17.63
Number of capsules per plant	90.66	68.0-116.0	3.08
Biological yield (kg ha^{-1})	2991.00	1563.0-3916.0	7.32
Seed yield (kg ha^{-1})	510.75	328.0-625.0	0.77
Harvest index	0.18	0.1-0.31	10.20
Thousand seed yield (g)	2.40	2.0-3.41	4.27

TSW (45.13%) (Table 5). Estimates of genetic advance as percent of the mean (GAM) were greater than 30% for PB, BPP, SY, BY and HI.

DISCUSSION

The 64 sesame populations were significantly different for the 11 morphological characters studied. The variations could be attributed to the genetic and phenotypic. The genetic components are useful and can be exploited for breeding programs since it can be transferred to the offspring. Different researchers have reported that genetic diversity exists among the Ethiopian sesame collections (Endale and Parzies, 2011; Gidey *et al*., 2012; Alemu *et al*., 2013). Hika *et al*. (2014) previously reported for the same populations for morphological divergence and correlations among seed yield and other traits. And the same authors reported that the 64 populations were grouped or clustered in to 4 major groups and each group had its own characteristics. In the present study phenotypic variations were observed for the 11 studied traits among the 64 sesame populations but the extent of variation varies with the traits. For instance; mean ranges in the populations were higher (> 20) for DF, DM, PH, CPP, BY, and SY, while medium mean ranges (10 to 20) were observed for BPP and CFP. However, the mean ranges were low (<10) for TSW and NPB.

In the present study, the mean seed yield was 511 kg ha^{-1} and about 40.63 % of the populations gave seed yield above the mean yield. The maximum yield was obtained from populations Acc-215816 (902 kg ha^{-1}), and this genotype gave the maximum thousand seed weight (2.99 g). The present mean seed yield reported is inferior to the mean seed yield reported by Desawi *et al*. (2014) for other Ethiopian sesame populations evaluated for seed yield and other agronomic traits. This might be due to environmental variations in addition to the genetic differences that influence the performances of quantitative traits. Desawi *et al*. (2014) conducted the field experiment in the Northern lowland areas of Ethiopia with low and erratic annual rainfall distribution which varies between 850 mm and 1140 mm and mean annual temperature of 28 degree Celsius, while the present study was carried out in western lowlands with humid climate and better rainfall distribution but low annual temperature (Hika *et al*., 2014) and soil physical and chemical properties differs from the former. The soil physico-chemical characteristic of the latter is majorly acidic in nature and not useful for crop production especially for oil crops like sesame (Deressa, 2013). Number of primary branches per plant, the number of branches per plant, seed yield, harvest index and biomass yield had high values (> 18 %) of genotypic and phenotypic coefficients of variation. Similar results were reported by other researchers (Gangarde *et al*., 2009; Deswai *et al*., 2014) for BPP, CPP, NPB and SY. As yield contributing factor, number of primary braches per plant had significant positive correlation and high direct effect on seed yield (Hika *et al*., 2014). Hence, the average number of primary branches per plant observed for the present populations was less value that contributed to the low average seed yield.

Table 3: Mean values of phenologic and vegetative parameters in 64 sesame populations

No.	Populations	DF	DM	CFP	PH	PB	BPP
1	Acc- 249212	60	125	46	95	3	4
2	Acc-202289	63	132	43	105	2	2
3	Acc-202374	67	122	41	111	2	2
4	Acc-202376	63	120	44	107	2	3
5	Acc-241305	55	137	51	97	2	2
6	Acc-202356	61	140	46	118	1	2
7	Acc- 241320	58	130	49	101	2	3
8	Acc-202309	60	132	50	120	2	2
9	Acc-241301	70	133	46	118	2	3
10	Acc-202308	69	140	47	108	1	2
11	Acc-241304	58	136	43	95	2	2
12	Acc-202312	68	119	47	103	7	8
13	Acc-202335	63	137	47	93	3	3
14	Acc-202353	66	145	51	91	2	2
15	Acc-241300	69	122	39	106	1	1
16	Acc-228816	59	143	53	110	2	2
17	Acc-202287	67	136	47	127	2	2
18	Acc-241328	64	131	49	109	3	3
19	Acc-211921	63	128	51	101	2	3
20	Acc-202339	66	136	43	104	2	2
21	Acc-202329	56	129	47	98	1	2
22	Acc-202315	53	134	51	116	2	3
23	Acc-203099	51	131	43	98	2	2
24	Acc-202320	57	140	47	101	2	3
25	Acc-212995	49	126	49	105	3	3
26	Acc-202345	54	141	51	107	2	2
27	Acc-9242	61	137	43	113	1	2
28	Acc-241294	52	143	52	104	1	2
29	Acc-202330	58	141	44	116	1	1
30	Acc-241297	61	131	51	113	2	2
31	Acc-212633	47	143	53	98	2	2
32	Acc-215816	62	146	43	92	9	11
33	Acc-216896	57	131	47	97	1	2
34	Acc-202323	61	142	43	96	1	1
35	Acc-202313	52	125	44	118	2	2
36	Acc-241298	49	137	51	117	7	9
37	Acc-202332	63	141	41	104	1	2
38	Acc-202288	61	123	44	106	2	3
39	Acc-241296	51	116	41	115	1	2
40	Acc-202511	60	127	47	121	2	3
41	Acc-202343	54	123	41	114	2	2
42	Acc-241293	61	124	46	107	2	2
43	Acc-241347	61	127	49	98	2	2
44	Acc-203104	70	145	51	104	3	3
45	Acc-241299	54	122	43	91	3	3
46	Acc-202327	61	134	41	104	2	3
47	Acc-241291	69	140	47	98	3	3
48	Acc-241314	62	136	51	107	4	5
49	Acc-235405	59	141	42	104	3	4
50	Acc-202364	64	126	47	98	3	3
51	Acc-202306	68	131	39	101	3	3
52	Acc-241303	64	127	41	98	2	2
53	Acc-202286	62	131	56	104	3	3
54	Acc-212994	58	136	43	111	4	4
55	Acc-202317	61	144	47	93	3	3
56	Acc-202286	64	134	50	88	2	3
57	Acc-241329	69	137	49	96	3	3
58	Acc-202373	63	135	43	104	2	4
59	Acc-241295	58	141	44	113	3	4
60	Acc-202318	61	140	50	107	4	4
61	Acc-241302	67	132	49	116	3	4
62	Acc-202370	58	131	51	96	3	3
63	Acc-202360	64	126	47	88	2	3
64	Acc-212632	65	133	48	97	4	5
	Mean	**60.48**	**133.07**	**46.47**	**104.36**	**2.49**	**3.18**
	LSD (5%)	**2.35**	**3.01**	**2.44**	**2.29**	**0.84**	**1.18**

DF = Days to 50% flowering, DM = Days to 90 % maturity, CFP = Capsule filling period,
PH = Plant height (cm), PB, Number of primary branches per plant, BPP = Number of branches per plant

Table 4: Mean values for yield components in 64 sesame populations

No.	Populations	CPP	TSW (g)	SY (kg ha^{-1})	BY (kg ha^{-1})	HI
1	Acc- 249212	81	2.29	378.00	3012.50	0.13
2	Acc-202289	74	2.04	588.00	1990.63	0.30
3	Acc-202374	68	2.75	469.00	3003.13	0.16
4	Acc-202376	84	2.50	454.69	1615.63	0.28
5	Acc-241305	103	2.34	488.00	3046.88	0.16
6	Acc-202356	83	2.07	445.94	3078.13	0.19
7	Acc- 241320	87	2.31	563.00	2993.75	0.19
8	Acc-202309	97	2.78	603.13	3046.88	0.20
9	Acc-241301	91	2.06	472.00	1618.75	0.29
10	Acc-202308	107	2.22	478.13	1562.50	0.31
11	Acc-241304	98	2.19	481.00	3029.13	0.16
12	Acc-202312	90	2.88	753.13	2971.88	0.25
13	Acc-202335	105	2.25	497.00	2025.00	0.25
14	Acc-202353	101	2.13	518.75	1987.50	0.26
15	Acc-241300	98	2.23	491.00	3096.88	0.16
16	Acc-228816	110	2.44	446.88	3756.25	0.12
17	Acc-202287	95	2.43	628.00	3068.75	0.20
18	Acc-241328	86	2.65	443.75	3059.38	0.15
19	Acc-211921	91	2.45	384.00	3018.75	0.13
20	Acc-202339	87	2.56	615.63	3012.50	0.20
21	Acc-202329	69	2.34	463.00	1603.13	0.29
22	Acc-202315	77	2.75	675.00	3771.88	0.18
23	Acc-203099	88	2.05	473.00	1953.13	0.24
24	Acc-202320	77	2.54	581.25	1984.38	0.29
25	Acc-212995	69	2.45	503.00	3028.13	0.17
26	Acc-202345	74	2.18	509.38	3800.00	0.13
27	Acc-9242	99	2.41	550.00	3075.00	0.18
28	Acc-241294	100	2.30	566.88	3053.13	0.19
29	Acc-202330	103	2.01	380.00	2021.88	0.19
30	Acc-241297	84	2.45	510.94	3050.00	0.17
31	Acc-212633	96	2.56	388.00	753.13	0.10
32	Acc-215816	104	2.99	901.56	3784.38	0.24
33	Acc-216896	116	2.57	470.00	121.88	0.15
34	Acc-202323	101	2.01	550.00	2000.00	0.28
35	Acc-202313	98	2.43	595.00	3068.75	0.19
36	Acc-241298	79	2.78	746.88	3118.75	0.24
37	Acc-202332	89	2.10	516.00	2021.88	0.26
38	Acc-202288	84	2.43	596.88	3818.75	0.16
39	Acc-241296	79	2.01	456.00	2003.13	0.23
40	Acc-202511	101	2.45	553.13	3103.13	0.18
41	Acc-202343	104	2.31	570.00	3056.25	0.19
42	Acc-241293	106	2.51	506.25	3771.88	0.13
43	Acc-241347	98	2.45	488.00	3096.88	0.16
44	Acc-203104	92	2.06	440.63	2009.38	0.22
45	Acc-241299	88	2.34	403.00	3050.00	0.13
46	Acc-202327	86	2.40	500.00	3768.75	0.13
47	Acc-241291	94	2.79	544.00	3821.88	0.14
48	Acc-241314	83	2.01	368.75	2025.00	0.18
49	Acc-235405	92	2.45	406.00	3103.13	0.13
50	Acc-202364	101	2.65	503.13	3753.13	0.13
51	Acc-202306	88	2.41	459.00	3065.63	0.15
52	Acc-241303	94	2.31	525.88	3037.50	0.17
53	Acc-202286	96	2.11	403.00	3003.13	0.19
54	Acc-212994	84	2.30	540.66	3043.75	0.18
55	Acc-202317	91	2.01	334.00	2025.88	0.17
56	Acc-202286	87	2.60	396.88	3768.75	0.11
57	Acc-241329	89	2.55	463.00	3121.88	0.15
58	Acc-202373	96	2.66	596.88	3771.88	0.16
59	Acc-241295	101	2.74	553.00	3787.50	0.15
60	Acc-202318	89	2.12	456.25	3812.50	0.12
61	Acc-241302	99	2.44	534.00	3821.88	0.14
62	Acc-202370	90	2.32	503.13	3915.63	0.13
63	Acc-202360	74	2.11	525.00	3027.88	0.17
64	Acc-212632	80	2.41	459.38	3075.00	0.15
	Mean	**90.66**	**2.40**	**510.75**	**2991.34**	**0.18**
	LSD (5%)	**5.40**	**0.20**	**8.22**	**438.07**	**0.04**

CPP = Number Capsules per plant, SY= Seed yield (kg ha-1), BY = Biomass yield (kg ha^{-1}), TSW = 1000 seed weight (g), HI=Harvest index, LSD= Least Significant Difference.

Table 5: Estimates of genetic components of variance, heritability and genetic advance for different traits in sesame populations

Traits	σ^2g	σ^2p	σ^2e	GCV (%)	PCV (%)	h^2 (%)	GA	GAM (%)
DF	25.95	27.32	1.37	8.42	8.64	94.99	10.23	16.91
DM	45.67	47.91	2.24	6.48	6.63	95.32	13.59	13.02
CFP	13.17	14.62	1.45	7.81	8.23	90.08	7.10	15.27
PH	66.82	69.61	2.79	6.14	6.27	95.99	16.50	12.40
NPB	1.62	1.78	0.16	51.12	53.58	91.01	2.50	99.95
BPP	2.13	2.46	0.33	45.89	49.32	86.59	2.80	87.97
CPP	88.60	95.79	7.19	10.38	10.80	92.49	18.65	20.57
SY	8733.83	8750.09	16.26	18.30	18.31	99.81	192.34	37.66
TSW	0.03	0.07	0.04	7.57	11.26	45.21	0.25	10.48
BY	376557.20	428317.84	51760.64	20.52	21.88	87.92	1185.26	39.63
HI	0.0024	0.0028	0.0004	27.22	29.40	85.71	0.09	51.91

DF = Days to 50% flowering, DM = Days to 90 % maturity, CFP = Capsule filling period, PH = Plant height (cm), NBP= Number of primary branches per plant; BPP = Number of branches per plant, CPP = Number Capsules per plant, SY = Seed yield (kg ha^{-1}), BY = Biomass yield (kg ha^{-1}), phenotypic (σ^2p), genotypic (σ^2g) and environmental (σ^2e) components of variances, phenotypic (PCV) and genotypic (GCV) coefficients of variation, broad sense heritability (h^2), expected genetic advance (GA) and genetic advance as percent of the mean (GAM).

Heritability in broad sense was greater than 80% for all traits except TSW (45.13%). Estimates of genetic advance as percent of the mean (GAM) were greater than 30% for PB, BPP, SY, BY and HI. Desawi *et al*. (2014) also reported relatively higher estimates of heritability for DF, DM and CFP and higher estimates of GAM for CPP, NPB, TSW and SY. According to Singh (2001), heritability values greater than 80% are very high, values from 60 to 80% are high and values from 40 to 59% are medium and values less than 40% are low. High heritability value was reported by Sumathi and Muralidharan (2010) for days to maturity. High value of heritability indicates that there would be a close correspondence between the genotype and the phenotype due to the relative small contribution of the environment to the phenotype. But, for characters with low heritability, say 40% or less, selection may be considerably difficult or virtually impractical due to the masking effect of the environment. Considering this benchmark, heritability estimate was high (>80%) for the majority of studied characters in the present investigation. Dabholkar (1992) explained that whenever values are stated for heritability of a character, it refers to a particular population under particular environmental conditions.

High heritability values coupled with high genetic advance as percent of mean was observed for SY, NPB, BP, BY, and HI. This indicates the lesser influence of environment in expression of these characters and prevalence of additive gene action in their inheritance. Hence, they are amenable for simple selection. Similar findings were reported by Reddy *et al*. (2001) and Krishnaiah *et al*. (2002). According to Johnson *et al*. (1955), high heritability estimates along with the high genetic advance is usually more helpful in predicting gain under selection than heritability estimates alone. Genetic advance under selection (GA) refers to improvement of characters in genotypic value for the new population compared with the base population under one cycle of selection at a given selection intensity (Singh, 2001). This study showed higher heritability values but low genetic advance and genetic advance as percent of mean for PH, DF, DM, CFP, and CPP, which was inconsistent with high heritability and high genetic advance for PH as reported by Govidarasu *et al*. (1990). In this study thousand seed weight showed low heritability and genetic advance as percent of the mean. Rajaravindran *et al.* (2000) and Paramasivam (1980) reported that high heritability and genetic advance for the seed yield per hectare, plant height and days to maturity in sesame populations. Emphasis should be placed on those characters which had high heritability and genetic advance for formulating reliable selection indices for the development of high yielding sesame varieties.

CONCLUSION

Sesame (*Sesamum indicum* L.) is an important crop produced in Ethiopia for oilseed production and it ranks first in total production from oil crops. A study was conducted to determine the extent of genetic variability, heritability and genetic advance among 64 sesame populations from Ethiopia. The results for analysis of variance showed that there were highly significant differences among the 64 populations for all characters considered. High values for GCV and PCV were observed in the populations for NPB, BPP, SY, BY and HI which could indicate the populations are variable and could be used for breeding stock. High to very high estimates for heritability values were observed for all traits except TSW which indicated that selection based on the phenotypes for specific objectives/traits are effective. And it further indicates the limited influence of the environment on the phenotypic expressions of the traits. Further computation for GAM indicated that high estimates were found for NPB, BPP, BY, SY and HI which could further confirm the easy of selections based on phenotypes after cycle of selection using 5 % selection intensity. This study generally indicated that there were significance phenotypic variations among the populations. Thus, there is enormous opportunity of using the germplasm in the improvement program for employing different breeding techniques for selection of varieties with significant increase in economic trait like seed yield.

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Conflict of Interest

The authors declared no conflict of interest.

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