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Correlation and path coefficient analysis in mid-altitude sesame (*Sesamum indicum* L.) germplasm collection of Ethiopia

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The current investigation was aimed to study the genetic association of seed yield and its components in 81 mid-altitude sesame accessions based on morphological traits. The genotypes were evaluated in 9 × 9 simple lattice design at Melkassa Agricultural Research Center, Ethiopia, during the 2014 cropping season. The study mainly focused on determining the nature and extent of phenotypic and genotypic correlation and path coefficient analysis among 13 quantitative traits. Analysis of variance revealed significant difference among genotypes for all traits studied. Mean performance of genotypes revealed that the highest mean seed yield/plant (8.6 g) recorded for Oromia-22 and the lowest mean seed yield/plant (2.6g) for Oromia-9; with overall mean of 5.33 g/plant. Whereas, the highest mean oil content (52.15%) noted for Oromia-13 and the lowest (43.35%) mean oil content was recorded for Am-SW-7 genotypes, with overall mean of 47.1%. Characters viz., number of capsules, biomass yield, harvest index and 1000 seed weight showed highly significant and high positive correlation with seed yield. Plant height and number of seeds/capsule also showed highly significant but moderately positive significant association with seed yield; indicating that these traits are reliable yield components and seed yield can be improved through direct selection of these traits. Maximum positive direct effect on seed yield was exerted by number of capsules, biomass yield, days to maturity and harvest index; showing that these traits can be used for selection to improve the primary trait. Hence, the use of these traits in sesame improvement program would increase seed yield.

Key words: Correlation coefficient, mid-altitude, quantitative traits, path coefficient analysis.

INTRODUCTION

Sesame (*Sesamum indicum* L.) is an annual plant of Pedaliaceae family considered to be the oldest oilseed crop cultivated by man, having been grown in the Near East and Africa for over 5,000 years for cooking and medicinal purposes (Sharma et al., 2014). Generally, 65% of world sesame production is used for edible oil extraction and 35% for confectionary purpose (Pham et al., 2011). The fatty acid composition is rather attractive,

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due to the high level of unsaturated fatty acids. Sesame seed is the single readily available source of protein high in sulfur containing amino acids (Bradley, 2002). It is the major cash crop for smallholder farmers and a valuable foreign exchange revenue commodity for different countries. The remaining cakes of sesame are used as a source of crude protein for animal feed.

In Ethiopia, sesame is used as cash crop, export commodity, raw material for oil industries and as source of employment opportunity. Now a day, it becomes the primary export oil crop playing a role in the agricultural Gross Domestic Product (GDP) of the country. A sizable proportion of the population, therefore, generates income from oilseed farming, trade and processing (Abate et al., 2015). However, production and extension in Ethiopia is quite limited, particularly because of its low yield. One of the major problems facing sesame production in Ethiopia has been growing of inferior sesame varieties with low yield and poor quality. To overcome the problems of low productivity of sesame, there must be a sound procedure for selection of high yielding varieties adapted to the local environment (Tadele, 2005).

Seed yield in sesame like other field crops is a multifacet character and direct selection for this trait may often be misleading. The components that determine the yield are best indices for selection. Therefore, knowledge of relationship between important yield traits and seed yield may help the researchers to identify suitable donors for a potential and successful breeding program (Kumaresan and Nadrajan, 2002). Estimation of character associations could identify the relative importance of independent traits contributing to dependent ones and suggest upon the traits that may be useful as indicator for other traits. In other words, character associations between yield components can be used as the best guide for successful yield improvement by indirect selection. Achievement of such success depends upon sort and accuracy of estimated correlation coefficient, plant materials, environmental conditions and their interaction. Among several factors, yield related traits highly influence the amount of grain yield that can be obtained (Salah et al., 2013). Some of the yield related traits in sesame include: days to flower, days to maturity, plant height, number of branches, capsules per plant, capsule length, number of seeds per capsule, thousand-seed weight and seed yield per plant. These traits affect yield positively and/or negatively and their effect on yield depends on the influence of environment on them.

The knowledge of nature and magnitude of genetic variability is of immense value for planning efficient breeding programme to improve the yield potential of crop species. Likewise, information on genetic association of plant traits with seed yield has great importance to breeder in selecting desirable genotypes (Parameshwarappa et al., 2009). Phenotypic selection of parents based on their performance alone may not always be reliable procedure since phenotypic expression is highly influenced by environmental factors, which are non-heritable. It is therefore, essential to select genotypes on the basis of their genetic worth (Salah et al., 2013). Thus, correlation helps in selection of superior genotype from diverse genetic populations (Jogdhande et al., 2017). However, in correlation studies indirect associations become more complex and confusing but path analysis can avoid this complication by measuring the direct influence of one trait on other as well as permits the partitioning of a given correlation coefficients into its components of direct and indirect effects (Manisha et al*.*, 2018; Jogdhande et al*.*, 2017). The path coefficient analysis is an effective means of analyzing direct and indirect causes of association and permits critical examination of the specific traits that produce a given correlation. It provides information about magnitude and direction of direct and indirect effect of the yield components (Chaudhary et al*.*, 2005; Bizeti et al*.*, 2004).

However, lack of information (particularly agro-ecological based) on character association of yield and its contributing traits, believed to limit the genetic improvement of sesame in Ethiopia. Hence, the present investigation was focused to gather adequate information on genetic association of yield and yield related traits in sesame accessions collected from mid-altitude areas of Ethiopia.

MATERIALS AND METHODS

Description of the study site

The experiment was conducted at Melkassa Agricultural Research Center (MARC), Ethiopia, during the 2014 cropping season. Melkassa is located along the Upper Awash valley between 8° 33' N and 39° 17' E. The altitude of the Center is 1550 m.a.s.l. and the minimum and maximum annual temperature ranges from 14.35 to 28.22°C, respectively. The mean annual rain fall in the area is 704.8 mm with verti-cambisol soil type of pH = 7.6.

Experimental materials and design

The materials for the study comprised 81 sesame accessions (including three released varieties as standard checks) representing the mid-altitude areas of Ethiopia (Table 1) that were obtained from Ethiopian Biodiversity Institute (EBI) and Werer Agricultural Research Center (WARC). The experiment was laid out in 9 × 9 simple lattice designs with two replications and each genotype was planted in a plot consisting of four rows of 2.5 m long at a distance of 40 cm between rows and 10 cm between plants. All cultural practices were applied as required throughout the season.

Data collection

Morphological data *viz*., days to 50% flowering (DF), days to 75% maturity (DM), number of primary branch/plant (PBPL), number of capsules/plant (CPPL), number of seeds/capsule (SDPC), capsule length (CL) (cm), plant height (PH) (cm), biomass/plant (BMPL) (g),

Table 1. List of sesame accessions collected from mid-altitude areas of Ethiopia used in the experiment.

S/N	Genotype	Altitude	/ District	S/N	Genotype	Altitude	Region/ District
1.	Am-NSh-1	1395	Amhara North Shoa	42.	SNNP-2	1300	North Omo
2.	Oromia-1	1500	East Wollega	43.	SNNP-3	1290	Bench-Maji
3.	Oromia-2	1395	East Wollega	44.	SNNP-4	1310	North Omo
4.	Oromia-3	1640	West Wellega	45.	Am-NG-2	1460	Amhara North Gonder
5.	Oromia-4	1520	West Wellega	46.	Oromia-13	1610	Bale Zone
6.	Am-NG-1	1635	Amhara North Gonder	47.	Oromia-14	1560	Jimma Zone
7.	Am-SW-1	1590	Amhara South Wollo	48.	Oromia-15	1500	Jimma Zone
8.	Oromia-5	1580	Bale	49.	Am-NG-3	1440	Amhara North Gondr GGGonder
9.	Oromia-6	1680	Bale	50.	Am-NG-4	1440	"
10.	Oromia-7	1565	Arsi	51.	Am-NW-16	1630	Amhara North Wollo
11.	Oromia-8	1560	Arsi	52.	Tigray-1	1400	Debubawit
12.	Am-SW-2	1673	Amhara South Wollo	53.	Am-SW-9	1570	Amhara South Wollo
13.	Am-SW-3	1565	"	54.	Am-NG-5	1530	Amhara North Gonder
14.	Am-SW-4	1440	"	55.	Oromia-16	1600	East Wollega
15.	Am-SW-5	1462	"	56.	Oromia-17	1690	Arsi Zone
16.	Am-SW-6	1624	"	57.	Oromia-18	1700	East Harrarge
17.	Am-NW-1	1522	Amhara North Wollo	58.	Oromia-19	1630	East Harrarge
18.	Am-NW-2	1270	"	59.	Tigray-2	1650	Debubawit
19.	Am-NW-3	1400	"	60.	Tigray-3	1640	Debubawit
20.	Am-NW-4	1450	"	61.	Oromia-20	1560	East Wollega
21.	Am-NW-5	1430	"	62.	Am-SW-10	1540	Amhara South Wollo
22.	Am-NW-6	1700	"	63.	Am-SW-11	1500	"
23.	Am-NW-7	1550	"	64.	Am-SW-12	1660	"
24.	Am-NW-8	1580	"	65.	Oromia-21	1570	West Wellega
25.	Am-NW-9	1645	"	66.	Oromia-22	1435	West Harrarge
26.	Am-NW-10	1555	"	67.	Oromia-23	1450	West Harrarge
27.	Am-NW-11	1490	"	68.	Oromia-24	1500	West Harrarge
28.	Am-NW-12	1460	"	69.	Oromia-25	1380	Illubabor
29.	Am-NW-13	1500	"	70.	Oromia-26	1380	Illubabor
30.	Am-NSh-2	1395	Amhara North Shoa	71.	Oromia-27	1462	Illubabor
31.	Am-NW-14	1640	Amhara North Wollo	72.	Am-NG-6	1335	Amhara North Gonder
32.	SNNP-1	1520	Gurage Zone	73.	Am-NG-7	1360	"
33.	Oromia-9	1635	Jimma	74.	Am-NG-8	1360	"
34.	Oromia-10	1590	East Wollega	75.	Am-NG-9	1445	"
35.	Oromia-11	1680	East Harrarge	76.	Am-NG-10	1470	"
36.	Oromia-12	1580	East Wollega	77.	Tigray-4	1534	Mirabawit
37.	Am-NSh-3	1565	Amhara North Shoa	78.	Tigray-5	1545	Mirabawit
38.	Am-NSh-4	1560	"	79.	T-85	-	Check variety
39.	Am-SW-7	1673	Amhara South Wollo	80.	E	-	"
40.	Am-SW-8	1565	"	81.	Tate	-	"
41.	Am-NW-15	1440	Amhara North Wollo				

Note: Region = Administrative Zone, SNNP = Southern Nation Nationality people.

harvest index/plant (HIPL) (%), 1000 seed weight (TSW) (g), seed yield/plant (SYPL) (g) and seed yield/ha (SYH) (kg) were collected for each plot by selecting 5 plants at random from the central rows leaving aside rows from the top and bottom to take care of boarder effects. Finally, oil content OC (%) was determined for each genotype from 5 g of seeds using Nuclear Magnetic Resonance Spectroscope; as the proportion of oil in the seed to the total oven dried seed weight × (100).

Data analysis

Analysis of variance was carried out for the data with SAS statistical software (9.2); to test for significant differences among the genotypes according to the standard statistical procedure described by Gomez and Gomez (1984). Phenotypic and genotypic correlations between agro-morphological traits were estimated using the method described by Miller et al. (1958) as follows:

Table 2. Mean squares from analysis of variance for 13 agro-morphological traits in 81 sesame genotypes.

Trait	Rep (1)	Block (8)	Gen (72)	Error (72)	CV (%)	SE
Days to Flowering	4.17	19.88	17.57*	7.87	2.76	2.03
Days to Maturity	1.04	14.70	12.72*	5.83	1.57	1.91
No. of Pr. Branches	3.56	4.17	8.53*	5.27	25.25	2.29
No. of Capsules/plant	0.01	79.53	428.83*	184.03	13.74	10.55
No. of Seeds/capsule	111.50	18.44	17.46*	6.98	6.50	2.08
Capsule Length (cm)	0.04	0.10	0.08*	0.07	10.60	0.27
Plant Height (cm)	1063.12	262.38	242.88**	115.17	8.78	10.73
Biomass/plant (g)	9.18	1.05	3.12**	1.51	19.67	1.17
Harvest Index (%)	235.45	41.34	83.26**	29.96	6.29	4.77
1000 Seed weight (g)	0.57	0.07	0.13*	0.06	11.29	0.21
Seed Yield/plant (g)	9.98	1.05	3.13**	1.46	24.63	1.14
Seed Yield/ha (kg)	24545.89	2575.81	7846.69**	3651.85	24.65	57.06
Oil Content (%)	0.83	11.71	8.11*	3.35	2.54	1.20

**, * significance at P < 0.01 and P < 0.05 level, respectively; figures in parenthesis refer to degrees of freedom; CV= coefficient of variation, Gen= genotypes, SE= standard error.

Phenotypic correlation coefficient $(rp_{xy}) = \frac{Covpxy}{\sqrt{(\sigma^2 px)(\sigma^2 py)}}$

Genotypic correlation coefficient $(rg_{xy}) = \frac{Covgxy}{\sqrt{(\sigma^2 gx)(\sigma^2 gy)}}$

Where, r_{pxy} is phenotypic correlation coefficient and genotypic correlation coefficient (rg_{xy}) between character x and y; Cov_{pxy} and Cov_{gxy} are phenotypic covariance and genotypic covariance between character x and y; σ^2_{gx} and σ^2_{gy} are genotypic variances traits x and y; σ^2_{px} and σ^2_{py} are phenotypic variances of traits x and y, respectively.

The correlation coefficient was analyzed based on the tabulated data, using META-R Version- 6. 01 (Alvarado et al., 2017). The path coefficient analysis was computed for 12 yield related traits using the phenotypic and genotypic correlation results following the procedure suggested by Dewey and Lu (1959). Seed yield per plant was used as dependent character in path coefficient analysis and the remaining traits were used as independent variables.

$\mathbf{R_{ij} = P_ij + \sum_{rik} P_{kj}}$

Where, r_{ij} is mutual association between the independent character (i) and dependent traits (j) as measured by correlation coefficients, p_{ij} is components of direct effects of the independent traits (i) on the dependent traits (j), $\sum_{rik} P_{kj}$ = summation of components of indirect effect of a given independent character (i) on the dependent traits (j) via all other independent traits (k).

The residual effect (R) was computed using the formula suggested by Dewey and Lu (1959) as:

$R = \sqrt{1\text{-}R^2}$ Where, $R^2 = \sum r_{ij}\, p_{ij}$

RESULTS AND DISCUSSION

Analysis of variance and mean performance of accessions

The analysis of variance revealed significant difference among the genotypes for all traits, indicating the presence of sufficient variability among the tested accessions for the traits under consideration (Table 2). This result was in agreement with the previous results reported by, Parameshwarappa et al. (2009), Salah et al. (2013) and Ahmed and Ahmed (2013). Mean performance of 81 sesame genotypes for 13 traits (data not shown) showed that seed yield per plant was ranged from 2.6 g (Oromia-9) to 8.6 g (Oromia-22) with overall mean of 5.33 g/plant. Generally, 44% of the genotypes had greater mean seed yield than the overall mean of genotypes. The highest mean seed yield/plant was recorded for Oromia-22 (8.66 g) followed by Am-NW-13 (8.41 g), Am-SW-5 (8.23), Oromia-25 (7.62 g), Am-NW-14 (7.60 g), Am-SW-10 (7.53) and Oromia-1 (7.51 g). These genotypes were found to be superior even to the released varieties. The highest (52.15%) and lowest (43.35%) mean oil content was recorded for Oromia-13 and Am-SW-7 genotypes, respectively, with overall genotypes mean of 47.1%. The genotypes Oromia-13 (52.15%) and Am-NSh-2 (51.20%) had the highest mean oil content and were found to be superior as compared to the standard checks. A high variation in number of capsules/plant, primary branches/plant and plant height was found among the studied genotypes. Similarly, high variation in number of primary branches, plant height and 1000 seed weight was reported by Gidey et al. (2013).

Correlation coefficient

Phenotypic and genotypic correlation coefficients of the various traits are presented in Table 3. The phenotypic and genotypic correlations in general were higher than the environmental correlation for the studied traits.

Table 3. Genotypic correlation above diagonal and phenotypic correlation below diagonal among 13 traits in 81 sesame accessions.

Trait	DF	DM	PBPL	CPPL	SDCP	CL	PH	BMPL	HIPL	TSW	SYPL	SYP	OC
DF		0.69***	0.05	-0.02	-0.04	-0.13*	-0.03	-0.01	0.01	0.09	-0.01	-0.01	-0.05
DM	0.70***		0.05	0.03	0.00	-0.09	0.02	0.02	0.03	0.04	0.02	0.02	-0.02
PBPL	0.06	0.10		0.35***	-0.04	0.01	0.25***	0.27***	0.21***	0.06	0.27***	0.27***	-0.04
CPPL	-0.02	0.04	0.42***		0.13*	0.15**	0.33***	0.79***	0.73***	0.11	0.79***	0.79***	0.01
SDCP	0.00	0.08	-0.01	0.24*		0.00	0.08	0.48***	0.53***	0.22***	0.48***	0.48***	-0.07
CL	-0.08	-0.09	0.04	0.22	0.03		0.00	0.13*	0.16**	-0.01	0.13*	0.13*	-0.04
PH	0.01	0.03	0.38**	0.46***	0.30*	0.00		0.28***	0.22***	0.03	0.28***	0.28***	0.00
BMPL	0.02	0.05	0.31*	0.83***	0.53***	0.21	0.43***		0.94***	0.60***	1.00***	1.00***	-0.11*
HIPL	0.05	0.05	0.25*	0.78***	0.57***	0.24	0.37**	0.96***		0.62***	0.94***	0.94***	-0.13*
TSW	0.17	0.06	0.07	0.21	0.24*	-0.01	0.06	0.65***	0.62***		0.60***	0.60***	-0.21*
SYPL	0.02	0.05	0.31*	0.83***	0.53***	0.21	0.43***	0.99***	0.96***	0.65***		1.00***	-0.11*
SYP	0.02	0.05	0.31*	0.83***	0.52***	0.22	0.42***	0.98***	0.96***	0.65***	1.00***		-0.11*
OC	-0.02	-0.01	0.06	0.16	-0.06	-0.02	0.03	-0.08	-0.12	-0.06	-0.08	-0.08	

***, **, *= significant at P < 0.001, < 0.01 and < 0.05 respectively. DF = Days to flowering, DM= Days to maturity, PBPL= Number of primary branches per plant, CPPL= Number of capsules per plant, SDPC= Number of seeds per capsule, CL= capsules length, PH= Plant height, BMP= Biomass per plant, HIPL= Harvest index per plant, TSW= 1000 seed weight, SYPL= Seed yield per plant, SYP= Seed yield per hectare, and OC= Oil content.

Number of capsules/plant, biomass/plant, harvest index and 1000 seed weight exhibited highly significant (<0.001) and high positive association with seed yield/plant at both phenotypic and genotypic level, indicating that these traits are reliable yield components and seed yield can be improved through direct selection of these traits. Similar results were reported by Muhamman et al. (2010) and Haruna et al. (2012), who found highly significant correlation of sesame seed yield with number of capsules/plant, biomass/plant and 1000 seed weight. Plant height and number of seeds/capsule showed highly significant and moderate positive correlation with seed yield/plant at both phenotypic and genotypic level. Number of primary branch/plant showed significant (<0.05) and low positive genotypic association with plant height, biomass/plant, harvest index and seed yield/plant. Hence, indirect selection in favor of these traits can improve seed yield in sesame. Similar results were reported by Sumathi et al. (2007) and Sumathi and Muralidharan (2010) for plant height, number of branches, number of capsules, days to 50% flowering, days to maturity and 1000 seed weight. However, oil content showed significant (<0.05) negative genotypic correlation with most of the yield traits (Table 3). This implies that indirect selection for high oil content would reduce seed yield/plant. Hence, simultaneous improvement for seed yield and oil content is difficult in the studied germplasm. Similar result was found by Daniya et al. (2013). In the contrary, Onginjo and Ayiecho (2009) found insignificant positive correlation of oil content with seed yield and suggested that selection for oil content had no any effect on seed yield.

Generally, correlation analysis revealed the presence of highly significant positive association between seed yield and the yield related traits such as number of capsules, biomass/plant, harvest index, 1000 seed weight and number of seeds/capsule. This finding is in line with Muhamman et al. (2010), Tamina and Tapash (2011), Haruna et al. (2012) and Daniya et al. (2013) who reported significant positive correlations between yield traits and final seed yield in sesame.

Path coefficient analyses

According to Bhatt (1973), correlation analysis may not be sufficient to explain the extent of associations in a manner that will enable one to decide on either a direct or an indirect selection strategy. Because of this, path coefficients

Table 4. Direct (diagonal) and indirect effect (off diagonal) of quantitative traits on seed yield/plant at phenotypic level in 81 sesame genotypes.

Trait	DF	DM	PBPL	CPPL	SDCP	CL	PH	BMPL	HIPL	TSW	OC	pr
DF	**0.02**	0.00	0.00	0.01	0.00	0.00	0.00	0.03	0.01	-0.04	0.00	0.02
DM	0.01	**0.00**	0.00	-0.02	-0.01	0.00	0.00	0.07	0.01	-0.02	0.00	0.05
PBPL	0.00	0.00	**0.01**	-0.17	0.00	0.00	-0.00	0.43	0.05	-0.02	0.01	0.31
CPPL	0.00	0.00	0.00	**0.53**	-0.1	-0.02	-0.37	0.85	0.17	-0.25	0.02	0.83
SDCP	0.00	0.00	0.00	-0.10	**-0.16**	0.00	-0.00	0.73	0.12	-0.06	-0.01	0.53
CL	0.00	0.00	0.00	-0.09	0.00	**-0.04**	-0.00	0.29	0.05	0.00	0.00	0.21
PH	0.00	0.00	0.00	-0.19	-0.05	0.00	**-0.00**	0.59	0.08	-0.02	0.00	0.43
BMPL	0.00	0.00	0.00	-0.04	-0.09	-0.01	-0.00	**1.08**	0.21	-0.17	-0.01	0.99
HIPL	0.00	0.00	0.00	-0.31	-0.09	-0.01	-0.00	0.80	**0.75**	-0.16	-0.01	0.96
TSW	0.00	0.00	0.00	-0.08	-0.04	0.00	0.00	0.90	0.13	**-0.26**	-0.01	0.65
OC	0.00	0.00	0.00	-0.06	0.01	0.00	0.00	-0.11	-0.03	0.02	**0.10**	-0.1

DF= Days to flowering, DM= Days to maturity, PBPL= Number of primary branches/plant, CPPL= Number of capsules/plant, SDPC= Number of seeds/capsule, CL= Capsules length, PH= Plant height, BMPL= Biomass/plant, HIPL= Harvest index/plant, TSW= 1000 seed weight, SYPL= Seed yield/plant and OC= Oil content. Residual = 0.15.

Table 5. Direct (diagonal) and indirect effect (off diagonal) of quantitative traits on seed yield/plant at genotypic level in 81 sesame genotypes.

Trait	DF	DM	PBPL	CPPL	SDCP	CL	PH	BMPL	HIPL	TSW	OC	gr
DF	**-0.01**	0.00	0.00	-0.01	-0.01	0.00	0.00	-0.01	0.00	0.02	0.00	-0.01
DM	0.00	**0.00**	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.02
PBPL	0.00	0.00	**0.00**	0.10	-0.01	0.00	0.00	0.17	-0.02	0.01	0.00	0.27
CPPL	0.00	0.00	0.00	**0.60**	0.02	0.00	0.00	0.20	-0.05	0.02	0.00	0.79
SDCP	0.00	0.00	0.00	0.04	**0.13**	0.00	0.00	0.31	-0.04	0.04	0.00	0.48
CL	0.00	0.00	0.00	0.04	0.00	**0.02**	0.00	0.08	-0.01	0.00	0.00	0.13
PH	0.00	0.00	0.00	0.10	0.01	0.00	**0.00**	0.18	-0.02	0.01	0.00	0.28
BMPL	0.00	0.00	0.00	0.23	0.06	0.00	0.00	**0.64**	-0.07	0.12	0.00	0.99
HIPL	0.00	0.00	0.00	0.22	0.07	0.00	0.00	0.20	**0.34**	0.12	0.00	0.94
TSW	0.00	0.00	0.00	0.03	0.03	0.00	0.00	0.27	-0.05	**0.31**	0.00	0.60
OC	0.00	0.00	0.00	0.00	-0.01	0.00	0.00	-0.07	0.01	-0.04	**0.00**	-0.11

DF= Days to flowering, DM= Days to maturity, PBPL= Number of primary branches/plant, CPPL= Number of capsules/plant, SDPC= Number of seeds/capsule, CL= Capsules length, PH= Plant height, BMPL= Biomass/plant, HIPL= Harvest index/plant, TSW= 1000 seed weight, SYPL= Seed yield/plant and OC= Oil content. Residual = 0.13.

analysis was carried out between the different traits at both phenotypic and genotypic levels to partition correlation coefficients into direct and indirect effects; permitting a critical examination of the specific forces acting to produce a given correlation and measuring the relative importance of the causal factors. The result of phenotypic path analysis (Table 4) revealed that biomass/plant (1.08) had maximum positive direct effect on seed yield/plant followed by harvest index (0.75) and capsules/plant (0.53). Similarly, at genotypic level (Table 5), biomass/plant (0.64), capsules/plant (0.60) and harvest index (0.34) imposed highest direct effect on seed yield/plant. These traits also had strong positive correlation with seed yield at both phenotypic and genotypic level. Therefore, these traits can be considered as the principal traits while selecting for seed yield. In other words, selection indices may be formed by considering all these traits for improvement of seed yield. This result was in agreement with previous studies on association of traits in sesame accessions of different countries (Mothilal, 2005; Ahadu, 2008; Goudappagoudra et al., 2011; Ibrahim and Khidir, 2012).

The traits viz., 1000 seed weight (0.90), capsules/plant (0.85), harvest index (0.80) and number of seeds/capsule (0.73) showed maximum indirect effects on seed yield at phenotypic level. Thousand seed weight and seeds/capsule also showed high indirect effect at genotypic level (Table 5). Therefore, this finding strongly emphasized that these two traits (1000 seed weight and seeds/capsule) made the greatest indirect contribution to seed yield. However, both these traits had negative direct effect to seed yield/plant at phenotypic level, suggesting that direct selection in favor of these traits can affect seed yield. This result agreed with those of Azeez and Morakinyo (2011), Ibrahim and Khidir (2012).

Conclusion

The analysis of variance revealed significant difference among the sesame accessions for all traits considered, indicating the presence of sufficient variability among the tested genotypes. Mean performance of 81 sesame genotypes for 13 traits generally showed that 44% of the genotypes had greater mean seed yield than the overall mean of genotypes. Genotypes Oromia-22, Am-NW-13, Am-SW-5, Oromia-25 and Am-NW-14, exhibited the highest mean seed yield and were superior even to the check varieties. Whereas, the genotypes Oromia-13 and Am-NSh2 had the highest mean oil content and were found to be superior as compared to the checks. Hence, these genotypes should be given emphasis while intending to improve sesame yield (seed and oil) in mid-altitude areas of Ethiopia. The phenotypic and genotypic correlations in general were higher than the environmental correlation for the studied traits. Number of capsules/plant, biomass/plant, harvest index and 1000 seed weight exhibited highly significant and high positive association with seed yield at both phenotypic and genotypic level, suggesting that these traits are reliable yield components and seed yield can be improved through direct selection of these traits. On the other hand, Plant height and number of seeds/capsule showed highly significant and moderate positive correlation with seed yield/plant at both phenotypic and genotypic level; hence, indirect selection in favor of these traits can improve seed yield in sesame. Number of capsules/plant, biomass/plant, days to maturity and harvest index imposed maximum positive direct effect on seed yield. Hence, they can be considered as the principal traits while selecting for seed yield. In other words, selection indices may be formed by considering all these traits for improvement of sesame seed yield.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

REFERENCES

Abate M, Mekbib F, Ayana A, Negussie M (2015). Genetic Variability and Association of Traits in Mid-altitude Sesame (*Sesamum indicum* L.) Germplasm of Ethiopia. American Journal of Experimental Agriculture 9(3):1-14.

Ahadu M (2008). Genetic Variability and Association of Characters in Sesame (*sesamum indicum* L.) Genotypes. MSc. Thesis Submitted to the Department of Plant Sciences, Haramaya University pp. 20-43.

Ahmed BMS, Ahmed FA (2013). Variability of yield and some morphological traits in some sesame (*Sesamum indicum* L.) genotypes under rain-fed conditions. International Journal of Agricultural Science Research 2(2):054-059.

Alvarado G, Lopez M, Vargas M, Pacheco A, Rodríguez F, Burgueno J, Crossa J (2017). Multi Environment Trail Analysis with R for Windows (META-R. Version 6.01). CIMMYT, Mexico.

Azeez MA, Morakinyo JA (2011). Path analysis of the relationships between single plant seed yield and some morphological traits in sesame. International Journal of Plant Breeding and Genetics 5:358-368.

Bhatt GM (1973). Path coefficient analysis in determining the nature of character association. Euphytica 22:383-393.

Bizeti HS, de Carvalho CGP, de Souza JRP, Destro D (2004). Path Analysis under Multicollinearity in Soybean. Agronomy Journal 47(5):669-676.

Bradley JM (2002). Food, industrial, nutraceutical, and pharmaceutical uses of sesame genetic resources. Trends in New Crops and New Uses. Janick J. in Whipkey A. (eds.). ASHS Press, Alexandria, VA. Kindly provide link or source

Chaudhary RR, Joshi BK (2005). Correlation and Path Coefficient Analyses in Sugarcane. Nepal Agriculture Research Journal 6:24-28.

Daniya E, Dadari SA, Ndahi WB, Kuchinda NC, Babaji BA (2013). Correlation and Path Analysis between Seed Yield and some Weed and Quantitative Components in Two Sesame (*Sesamum indicum* L.) Varieties as influenced by Seed Rate and Nitrogen Fertilizer. Journal of Biology, Agriculture and Healthcare 3(15):12-16.

Dewey DR, Lu KH (1959). A correlation and path coefficient analysis of components of crested wheat grass seed production. Agronomy Journal 51:515-518.

Gidey YT, Kebede SA, Gashawbeza GT (2013). Assessment of genetic variability, genetic advance, correlation and path analysis for morphological traits in sesame genotypes. International Journal of Plant Breeding and Genetics 7(1):21-34.

Gomez KA, Gomez AA (1984). Statistical procedure for agricultural research 2nd Ed. John Weley and Sons. Inc., New York.

Goudappagoudra R, Lokesha R, Ranganatha ARG (2011). Trait association and path coefficient analysis for yield and yield attributing traits in sesame (*Sesamum indicum* L.). Electronic Journal of Plant Breeding 2:448-452.

Haruna IM, Aliyu L, Olufajo OO, Odion EC (2012). Contributions of some growth characters to seed yield of sesame (*Sesamum indicum* L.). ISABB Journal of Food and Agricultural Sciences 2:9-14.

Ibrahim SE, Khidir MO (2012). Genotypic correlation and path coefficient analysis of yield and some yield components in sesame (*Sesamum indicum* L.). International Journal of Applied Agricultural Sciences 2:664-670.

Jogdhande S, Vijay SK and Nagre K (2017). Correlation and Path Analysis Study in Cowpea (*Vigna unguiculata* L.) genotypes. International Journal of Current Microbiology and Applied Sciences 6(6):3305-3313.

Kumaresan D, Nadrajan N (2002). Association of yield with some biometrical and physiology characters over different environments in sesame (*Sesamum indicum* L.). Sesame and Safflower Newsletter 17:13-16.

Manisha RP, Vijay SK, Madhavi BB, Jadhav RD (2018). Correlation and path analysis study in F5 generation of cowpea. International Journal of Current Microbiology and Applied Sciences 6:1529-1537.

Miller PA, Williams JC, Robinson HF, Comstock RF (1958). Estimation of genotypic and environmental variances and covariances in upland cotton and their implications in selection. Agronomy Journal 50:126-131.

Mothilal A (2005). Correlation and path analysis in sesame (*Sesamum indicum* L.). Environmental Economics 233:478-480.

Muhamman MA, Mohammed SG, Lado A, Belel MD (2010). Interrelationship and path coefficient analysis of some growth and yield characteristics in sesame (*Sesamum indicum* L.). The Journal of Agricultural Science 2:100-105.

Onginjo EO, Ayiecho PO (2009). Genotypic Variability in Sesame Mutant Lines in Kenya. Department of Crop Science, University of Nairobi. Nairobi, Kenya. African Crop Science Journal 17(2):10-107

Parameshwarappa SG, Palakshappa MG, Salimath PM, Parameshwarappa KG (2009). Studies on genetic variability and character association in germplasm collection of sesame (*sesamum indicum*). Karnataka Journal of Agricultural Sciences 22:252-254.

Pham TD, Geleta M, Bui TM, Bui TC, Merker A, Carlsson AS (2011). Comparative analysis of genetic diversity of sesame (*Sesamum indicum* L.) from Vietnam and Cambodia using agro-morphological and molecular markers. Hereditas 148:28-35.

Salah B, Ahmed M, Abubakri FA (2013). Variability of yield and some morphological traits in some sesame (*Sesamum indicum* L.) genotypes under rain-fed conditions. International Journal of Agricultural Science Research 2:054-059.

Sharma E, Islam TS, Khan F (2014). A review enlightening genetic divergence in *Sesamum indicum* based on morphological and molecular studies. International Journal of Agriculture and Crop Sciences 7(1):1-9.

Sumathi P, Muralidharan V, Manivannan N (2007). Trait association and path coefficient analysis for yield and yield attributing traits in sesame (*Sesamum indicum* L). The Madras Agricultural Journal 94:174-178.

Sumathi P, Murlidharan V (2010). Analysis of genetic variability, association and path analysis in the hybrids of sesame (*Sesamum indicum* L.), Tropical Agricultural Research and Extension 13(3):63-67.

Tadele A (2005). Sesame (*Sesamum indicum* L.) Research in Ethiopia: a Review of Past Work and Potential and Future Prospects. Werer Agricultural Research Center, Ethiopian Institute of Agricultural Research, Addis Ababa, Ethiopia.

Tamina B, Tapash D (2011). Effect of mutagenes on character association in sesame (*Sesamum indicum* L.). Pakistan Journal of Botany 43:243-251.