

Research Article

Correlation and Path Analysis of Seed Yield and Yield Components in Some Sesame (*Sesamum indicum* L.) Genotypes

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Abstract

Due to hereditary causes of correlations through pleiotropic action or developmental interactions of genes, associations of traits are crucial in breeding and genetic studies. These associations also yield trustworthy information about the type, degree, and directions of selection. The experiment was conducted in 8 x 8 simple lattice design during the 2021 main cropping season at Assosa Agricultural Research Center, western Ethiopia to determine the interrelationship among the traits and know the direct and indirect effects on the yield of 64 sesame genotypes based on 15 quantitative traits. For the majority of the traits under study, the results indicated a large variation in genotypes. This suggests that there is enough variation among various genotypes for the majority of the significant traits. Except for internode length and capsule length, the correlation result showed that seed yield had highly significant positive correlations with 12 quantitative traits and negative correlations with the bacterial blight disease severity. The number of capsules per plant, days to maturity, and seeds per plant all revealed a strong direct impact on seed yield. These traits also had indirect or direct effects on oil content, so increasing seed yield also increased oil content through those traits.

Keywords

Sesame, Correlation, Path Coefficient

1. Introduction

Sesame is the queen of oilseeds due to its high oil content, delicious nutty aroma, flavor, and high-quality polyunsaturated stable fatty acid, which restrains oxidative rancidity [1]. Understanding the genetic relationships between yield and yield-related traits can lead to an increase in yield and yield components in genetic resources. Given that selection on seed yield is frequently ineffective and that seed yield is a polygenic controlled complex character that depends on multiple quantitatively inherited component traits [2]. It is neces-

sary to use indirect selection through component traits by focusing on important traits and hybridization [3]. Correlation analysis can provide breeder to know the strengths and direction of the relationships of various traits with the targeted traits but correlation measures only the mutual association between two characters without considering causation [4] for that path coefficient analysis specifies the cause and measures the relative importance of characters such as between yield and yield components and recognizing the im-

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pacts of multi-collinearity [5]. Therefore, essential to assess the degree of association of various quantitative traits in an effective selection program targeted to the genetic improvement of seed yield.

2. Materials and Methods

In the present study, 64 sesame genotypes were used. From these materials 23 genotypes were exotic and the remaining 40 genotypes were local land races collected from different parts of the country. Along with the tested genotypes recently released sesame variety, Gida Ayana was used as a check. The experiment was conducted at the testing site of Assosa Agricultural Research Center which is located 683 km west of Addis Ababa located at 10°04' North 34°31' East at an altitude of 1383 meter above sea level. The experiment was conducted in 8 x 8 simple lattice

design with 40 cm inter and 10 cm intra-row spacing. All field trial management practices including fertilizer application, weed management, thinning, and other important practices were implemented with strict close supervision and as per the recommendations. Data were recorded on days to 50% flowering (DF), bacterial blight disease severity (%) (BBDS), days to 90% maturity (DM), oil content (%) taken on plot-based; plant height (PH) in cm, plant height to the first branch (PHTFC) in cm, length of capsule bearing zone (LCBZ) in cm, internode length (IL) in cm, capsule length (CL) in mm, number of primary branches per plant (NPB), number of secondary branches per plant (NSB), number of seed per capsule (SPC), number of capsules per plant (NCP), thousand seed weight (TSW) in g, seed yield per plant (SYPP) in g with taken on five randomly selected plant.

Table 1. List and description of sesame genotypes used in the experiment.

No	Genotype	Locality	No	Genotype	Locality
1	9027	BG	33	227884	EGY
2	9686	TIG	34	X - 30/40 # 403	Israel
3	9688	TIG	35	205189	HVO
4	9691	TIG	36	227936	EGY
5	9692	TIG	37	203610	ZIM
6	9693	TIG	38	SSBS - (9 - 2) -3	Kenya
7	9696	TIG	39	227875	EGY
8	17693	ORO	40	227938	EGY
9	17703	ORO	41	Acc - 210 - 991 - 4	Sudan
10	17704	ORO	42	227944	EGY
11	17711	ORO	43	203639	Kenya
12	USR - 82 # 171 NS	Israel	44	205186	HVO
13	203633	ZAM	45	222876	GAM
14	23546	BG	46	235404	AMH
15	28300	AMH	47	235905	TIG
16	28317	AMH	48	241321	AMH
17	28319	AMH	49	241324	TIG
18	28321	AMH	50	241325	TIG
19	28322	AMH	51	241330	AMH
20	28323	AMH	52	241332	AMH
21	28324	AMH	53	241334	AMH
22	28325	AMH	54	241338	AMH
23	28326	AMH	55	241340	AMH

No	Genotype	Locality	No	Genotype	Locality
24	28327	AMH	56	Shelela-03	TIG
25	227945	EGY	57	Ass-acc-36	BG
26	227881	EGY	58	ACC-EW-017(4)	ORO
27	215013	ZAM	59	ACC ?031	TIG
28	203640	ZIM	60	NAJOO-69 (GABAA KAMISA)	ORO
29	205186	HVO	61	238269	TIG
30	227874	EGY	62	215816	ORO
31	227888	EGY	63	23565	BG
32	203637	ZAM	64	GIDA AYANA	Improved variety

Note: ORO = Oromia; BG = Benishangul Gumuz; AMH = Amhara; GAM = Gambella; TIG = Tigray; EYG=Egypt; ZIM=Zimbabwe; and ZAM=Zambia

3. Result and Discussion

3.1. Analysis of Variance

The result indicates the mean squares of genotypes were highly significant ($P \leq 0.01$) for days to flowering, days to maturity, plant height, plant height to first branching, number of primary branches, number primary of branches, number of capsules/plant, number of

seeds/capsule, bacterial blight severity, thousand seeds weight, seed yield/plant and oil content(%). In addition, mean squares of genotype for the length of capsule bearing zone and capsule length showed significant ($P \leq 0.05$) variation (Table 2), indicating variation among tested 64 genotypes and the possibility of improving through selection. Similarly, the existence of variation among sesame genotypes had been reported for different traits by previous authors [6-8].

Table 2. Analysis of Variance and mean performance for 15 quantitative traits in 64 sesame genotypes.

Traits	MSG	MSR	block/rep	MSE	Mean	CV	R2
DF	108.575**	4.88 ^{ns}	164.4**	6.75	70.18	3.7	0.96
DM	38.31**	4.13 ^{ns}	85.58**	7.65	118.41	2.31	0.89
NPB	5.97**	4.06*	5.012**	0.62	4.73	16.63	0.92
NSB	1.387 ^{ns}	4.57*	1.83 ^{ns}	1.06	1.3	23.64	0.65
PH	418.59**	2723**	469.1**	72.21	87.13	9.75	0.89
BBDS	148.54**	190.85**	209.14**	15.58	57.25	6.9	0.93
HTFC	42.51**	95.9**	90.83**	8.28	15.31	18.8	0.89
IL	0.38 ^{ns}	1.8 ^{ns}	0.55 ^{ns}	0.5	4.19	16.99	0.52
LCBZ	91.63*	69.32 ^{ns}	189.4**	51.04	54.56	13.09	0.73
CL	5.786*	13.23 ^{ns}	2.73 ^{ns}	3.47	21.17	8.79	0.66
SPC	102.15**	9.35 ^{ns}	109.65*	49.34	45.12	15.57	0.72
NCP	755.65**	8511.86**	399.46**	161.328	41.58	30.55	0.86
TSW	0.165**	0.232 ^{ns}	0.089 ^{ns}	0.07234	1.69	15.91	0.73
SYPP	2.3**	21.25**	3.51**	0.95555	3.72	26.25	0.79

Traits	MSG	MSR	block/rep	MSE	Mean	CV	R2
OC	4.2**	0.57 ^{ns}	2.585**	0.18221	50.13	0.96	0.85

Note: MSG= mean square of genotype; MSE= mean square of error; MSR= mean square of replication CV= coefficient of variation; DF = days to flowering; BBDS = bacterial blight disease severity(%); DM = days to maturity; PH = plant height in cm; HTFC = plant height to first branch in cm; LCBZ = length of capsule bearing zone in cm; IL = internode length in cm; CL = capsule length in mm; NPB = number of primary branches per plant; NSB = number of secondary branches per plant; SPC= number of seed per capsule; NCPP= number of capsule per plant; TSW = thousand seed weight in g; SYPP= seed yield per plant in g; OC = oil content in (%); *=significance at 0.05 **; = significance at 0.01 probability levels; NS =Non-Significant

3.2. Genotypic Correlation of 15 Quantitative Traits with Seed Yields

The result of correlation coefficient analysis revealed that seed yield per plant had a positive and highly significant genotypic correlation with the number of capsules per plant (0.75), plant height (0.72), number of primary branches per plant (0.69), seeds per capsule (0.67), days to 50% flowering (0.57), height to the first capsule (0.62), length of pod bearing zone (0.58), days to maturity (0.67), number of secondary branches (0.45), thousand seed weight (0.42) and oil content (0.33) (Table 3). Such results indicates the existence of the inherited relationship between traits and improving these traits may result in the improvement of seed yield as the result of a positive and strong correlation. Similarly [6] reported number of capsules, and 1000 seed weight showed highly significant positive correlation with seed yield. Seed yield per plant showed a highly significant and negative correlation with bacterial blight disease severity (-0.77), implying that a high bacterial blight disease severity scale leads to a reduction of the seed yield per plant in the sesame genotype, therefore it is possible to increase seed yield in sesame by selecting low disease sever genotypes [9]. Seed yield per plant showed a non-significant genotypic correlation with internode length (0.18) and capsule length (0.12) (Table 3).

3.3. Genotypic Correlation Among Yield-Related Traits

Days to 50 % flowering had a highly positive and significant correlation with day to maturity (0.91), number of primary branch (0.86), number of secondary branch (0.47), plant height (0.73), height to first capsule (0.75), length of pod bearing zone (0.38), seed per capsule (0.53), number of capsule per

plant (0.60), seed yield per plant (0.57). Days to 50% flowering had a highly negative genotypic correlation with bacterial blight disease severity (-0.64) (Table 3). Days to maturity had a highly significant genotypic correlation with the number of primary branches (0.80), the number of secondary branches (0.47), plant height (0.72), height to the first capsule (0.71), length of capsule bearing zone (0.38), seed per capsule (0.53) and number of capsules per plant (0.64). In addition, days to maturity had a positive significant correlation with oil content (0.25) (Table 3). Bacterial blight disease severity showed negative correlations with all traits, his trait indicates the most negative contributor to the growth parameter of the sesame crop or shows how this disease genetically inherits together. So, selection based on this information will be most relevant. Plant height had positive and highly correlation with number of primary branches per plant (0.86), number of secondary branches per plant (0.55), height to the first capsule (0.78), length of capsule bearing zone (0.70), number of capsule per plant (0.86) and seed per capsule (0.68) (Table 3). The number of capsules per plant showed highly positive genotypic correlation with number of secondary branch (0.53), length of capsule bearing zone (0.61), height to first capsule (0.65), seed per capsule (0.65) (Table 3).

These findings were similar to those of [10] and [6], who reported that days to flowering had a positive correlation with the number of primary branches, plant height, seeds per capsule, number of capsules per plant, and seed yield per plant. A similar finding was reported by [11]: Plant height showed a highly positive genotypic and phenotypic correlation with the number of primary branches per plant, the number of capsules per plant, the number of seeds per capsule, and the seed yield per plant. [12] also reported that days to flowering had a high significant correlation with the number of primary branches and seed yield.

Table 3. Genotypic above diagonal correlation coefficient for 15 traits sesame genotypes.

Traits	DF	DM	BBS	NPB	NSB	PH	HTFC	IL	LPBZ	CL	SPC	NCPP	TSW	YPP	OC
DF	1	0.91**	-0.6	0.86**	0.47**	0.73**	0.75**	0.01 ^{ns}	0.38**	0.24 ^{ns}	0.53**	0.60**	0.06 ^{ns}	0.57**	0.20 ^{ns}
DM		1	-0.7	0.80**	0.47**	0.72**	0.71**	0.04 ^{ns}	0.48**	0.20 ^{ns}	0.56**	0.64**	0.06 ^{ns}	0.67**	0.25*

Traits	DF	DM	BBS	NPB	NSB	PH	HTFC	IL	LPBZ	CL	SPC	NCPP	TSW	YPP	OC
BBS			1	-0.8**	-0.5**	-0.8**	-0.8**	-0.2 ^{ns}	-0.6**	-0.3*	-0.7**	-0.9**	-0.3*	-0.7**	-0.3*
NPB				1	0.55**	0.86**	0.78**	0.12 ^{ns}	0.47**	0.28*	0.68**	0.79**	0.03 ^{ns}	0.69**	0.32*
NSB					1	0.55**	0.39**	0.06 ^{ns}	0.46**	0.19 ^{ns}	0.34**	0.53**	0.10 ^{ns}	0.45**	0.32**
PH						1	0.78**	0.24 ^{ns}	0.70**	0.32	0.68**	0.86**	0.28*	0.72**	0.36**
HTFC							1	0.06 ^{ns}	0.33**	0.17 ^{ns}	0.55**	0.65**	0.04 ^{ns}	0.62**	0.24 ^{ns}
IL								1	0.20 ^{ns}	0.20 ^{ns}	0.30*	0.32*	0.25*	0.18 ^{ns}	0.16 ^{ns}
LPBZ									1	0.29*	0.53**	0.61**	0.48**	0.58**	0.33**
CL										1	0.42**	0.30*	0.04 ^{ns}	0.12 ^{ns}	0.30*
SPC											1	0.65**	0.17 ^{ns}	0.67**	0.46**
NCPP												1	0.31*	0.75**	0.27*
TSW													1	0.42**	0.11 ^{ns}
YPP														1	0.33**

Note; DF = days to flowering; BBDS = bacterial blight disease severity(%); DM days to maturity = plant height in cm; HTFC = plant height to first branch in cm; LCBZ=length capsule bearing zone in cm; IL = internode length in cm; CL = capsule length in mm; NPB = number of primary branches per plant; NSB = number of secondary branches per plant; SPC=number of seed per capsule; NCPP= number of capsule per plant; TSW = thousand seed weight in g; SYPP= seed yield per plant in g; OC = oil content in (%); *=significance at 0.05 **; = significance at 0.01 probability levels; NS =Non-Significant

3.4. Direct and Indirect effects of 13 Quantitative Traits on Seed Yield and Oil Content

Days to maturity (0.32), number of capsules/plant (0.25), seed per capsule (0.25), thousand seed weight (0.25), and number of primary branches per plant (0.25) were found to have significant direct effects on seed yield/plant based on genotypic path coefficient analysis results (Table 4). These traits exhibited positive and significant genotypic correlation with seed yield, thus, these traits may be considered as the most important yield contributing traits and due emphasis should be placed on these traits in order to improve seed yield through direct selection of such traits in further sesame breeding programs. A similar result were reported by [6] and [13] that number of capsules and days to maturity had maximum positive direct effect on seed yield and also this result line with [14] and [11] result by days to maturity, number of seeds per capsule, number of capsules per plant and thousand seed weight had a positive direct effect on seed yield. Similarly, [4] reported that number of primary branches, number of capsules per plant, number of seeds per capsule had positive direct effects on sesame seed yield.

Plant height ($R_g=0.722$), plant height to the first capsule

($R_g=0.622$), days to flowering ($R_g=0.573$), and length of the capsule bearing zone ($R_g=0.585$) all have a strong positive correlation with seed yield per plant. This is because there are significant indirect effects on seed yield per plant via the number of capsules per plant, days to maturity, number of primary branches, and seed per capsule. A positive correlation coefficient between seed yield per plant with oil content ($R_g=0.334$) was due to the indirect effect through seed per capsule. These results indicate the importance of these traits as indirect selection criteria for effective sesame seed yield improvement programs. Therefore, traits that showed considerable positive indirect effects via other traits should be considered simultaneously as indirect selection criteria for sesame seed yield improvement. [10] Reported that the number of primary branches per plant had a positive direct effect on seed yield and days to flowering and plant height had indirect effect on seed yield through days to maturity and number of capsule per plant. Seed yield is the resultant/dependent variable, and the genotypic path analysis residual effect shows how well the causal/independent variables account for it. With an estimated 0.23, it meant that 77% of the variability in seed yield could be explained by the causal variables, leaving only 23% of the variability unexplained.

Table 4. Genotypic direct (diagonal and bold) and indirect (off-diagonal) effects of 13 traits on seed yield per plant on 64 sesame genotypes.

Traits	DF	DM	BBDS	NPB	NSB	PH	HTFC	LPBZ	CL	SPC	NCPP	TSW	OC	Rg
DF	-0.194	0.294	0.089	0.204	0.016	-0.222	0.11	0.035	-0.038	0.132	0.153	-0.015	0.01	0.573**
DM	-0.178	0.321	0.093	0.191	0.016	-0.221	0.105	0.045	-0.033	0.139	0.16	0.016	0.013	0.666**
BBDS	0.125	-0.218	-0.138	-0.187	-0.016	0.262	-0.115	-0.053	0.042	-0.175	-0.214	-0.077	-0.014	-0.77**
NPB	-0.167	0.259	0.109	0.236	0.019	-0.264	0.114	0.044	-0.045	0.169	0.198	0.007	0.016	0.692**
NSB	-0.092	0.151	0.066	0.131	0.034	-0.167	0.057	0.043	-0.031	0.084	0.133	0.027	0.017	0.452
PH	-0.141	0.232	0.118	0.204	0.019	-0.306	0.115	0.066	-0.051	0.169	0.216	0.07	0.018	0.722**
HTFC	-0.146	0.229	0.108	0.184	0.013	-0.24	0.147	0.031	-0.027	0.136	0.163	0.011	0.012	0.622**
LPBZ	-0.073	0.154	0.078	0.111	0.016	-0.216	0.049	0.093	-0.046	0.132	0.155	0.122	0.017	0.585**
CL	-0.047	0.066	0.036	0.067	0.007	-0.098	0.025	0.027	-0.16	0.105	0.076	0.011	0.015	0.125
SPC	-0.103	0.179	0.097	0.161	0.012	-0.208	0.08	0.05	-0.067	0.249	0.163	0.043	0.024	0.669**
NCPP	-0.118	0.205	0.117	0.187	0.018	-0.263	0.096	0.057	-0.048	0.161	0.251	0.079	0.014	0.747**
TSW	0.012	0.02	0.042	0.007	0.004	-0.085	0.007	0.045	-0.007	0.043	0.079	0.252	0.006	0.417**
OC	-0.039	0.08	0.038	0.075	0.011	-0.109	0.036	0.03	-0.048	0.115	0.069	0.028	0.051	0.334**
Residual														0.23

Note; DF = days to flowering; BBDS = bacterial blight disease severity(%); DM = days to maturity; plant height in cm; PHTFC = plant height to first branch in cm; LCBZ = length of capsule bearing zone in cm; CL = capsule length in mm; NPB = number of primary branches per plant; NSB = number of secondary branches per plant; SPC=seed per capsule(no); NCPP= number of capsule per plant; TSW = thousand seed weight in g; OC = oil content in (%) and Rg=genotypic correlation coefficient

4. Conclusions

Based on the results in this study, it can be concluded that traits are interrelated with each other or seed yield is the total effects of several traits associated with them, and they affect sesame seed yield/plant directly or indirectly, positively or negatively, through each other therefore, seed yield of sesame can be improved through selection of genotypes underlying the positive direct magnitude of number of capsule per plant, days to maturity, number of primary branches, thousand seed weight and seeds per capsule and by indirect selection plant height, length of capsule bearing zone, plant height to first branch; bacterial blight disease severity has negative direct and indirect effects on seed yield of sesame genotypes. It also concluded that seed yield/plant appeared to be the highest contributor to the oil contents. Direct and indirect selection for higher seed yield is effective for improving oil contents. Therefore, selection for increasing seed yield through number of capsule per plant, days to maturity, number of primary branches, thousand seed weight and seeds per capsule might be more successful in improving its oil content in sesame genotypes so, it is input or base for researchers in the future sesame research program for improvement of genotypes instead of yield as well as oil contents.

Abbreviations

ANOVA	Analysis of Variance
ASRC	Assosa Agricultural Research Center
EIAR	Ethiopian Institute of Agricultural Research
CV	Coefficient of Variation
Rg	Genotypic Correlation Coefficient

Author Contributions

Askalech Bekele is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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