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ESTIMATION OF GENETIC AND PHENOTIPIC COFFICIENT OF VARIATION OF YIELD AND ITS CONTRIBUTING TRAITS OF ETHIOPIAN MUSTARD (*Brasica carinata* A.Braun) LANDRACES

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Abstract: **The experiment was executed to estimate genetic and phenotypic coefficient of variations of yield and its contribution traits of Ethiopian mustard (Brasica carinata A. Braun) landraces at Holetta agricultural research center, Ethiopia. Forty nine genotypes of Ethiopian mustard were analyzed using seed yield and its contributing traits that exist in these materials. The experiment was carried out in a simple lattice design. The analysis of variance showed that there were significant differences among genotypes for all traits studied. The significant difference indicates the existence of genetic variability among the landraces which is important for improvement. For yield component traits, high genotypic and phenotypic coefficients of variations were observed in seed yield kg/ha and oil yield. This shows that selection of these traits based on phenotype may be useful for yield improvement. The highest heritability in broad sense was recorded for thousand seed weight(68.80%) followed by days to flowering (65.91%), stand percent (63.14%), days to maturity(60.43%), plant height (59.63%),oil content(50.33%),oil yield(44.84%), seed yield kg/ha(42.99%), and primary branches(34.20%). This suggests that large proportion of the total variance was due to the high genotypic and less environmental variance. Hence, a good progress can be made if some of these traits are considered as selection criteria for the improvement of yield and its contributing traits. In the correlation coefficient analysis, seed yield kg/ha showed positive correlation with oil content, oil yield, plant height and seed yield per plant. In this study, seed yield kg/ha, oil content, oil yield and primary branches were found to be the most important components for the improvement of seed and oil. The present study revealed the presence of considerable variability among genotypes for all traits. These results indicate that there is good opportunity to improve these traits using the tested genotypes.**

Keywords: **Ethiopian mustard, Genetic, phenotypic, heritability, correlation.**

1. INTRODUCTION

The genus *Brassica* of *Brassicaceae* family as a whole is believed to have originated around the Mediterranean, Eastern Afghanistan and the adjoining portion of Pakistan and North-Eastern Africa (Hemigway, 1976). The genus includes six economically important species, namely, *Brassica rapa*, *B. oleracea*, *B. nigra*, *B. juncea*, *B. napus*, and *B. carinata* (Doweny and Röbbelen, 1989). Ethiopian mustard is believed to be originated in the highlands of the Ethiopian plateau and the adjoining portion of East Africa and the Mediterranean coast (Gomez-Campo and Prakash, 1999). It evolved as a natural cross between *B. nigra* (BB) (n=8) and *B. oleracea* (CC) (n=9) and underwent further chromosomal doubling (2n=34; UN, 1935). It is partially amphidiploids.

In Ethiopia, among the highland oilseeds, Ethiopian mustard stands third next to niger seed and linseed in total production and areas coverage (CSA, 2013/2014). Its area and production are estimated to 44041.34 hectares and 62450.266 tons, respectively, at private peasants holdings level, with an average productivity of 1.418 tons/ha (CSA, 2013/14). It is often grown on well-drained and organic matter rich soils close to homesteads but the trend of growing far from their home is started by using inorganic fertilizer. Ethiopian mustard is well adapted to cool, long growing season and high rainfall areas at elevation between 2200 and 2800 meters. In these areas, the temperature and rainfall range from 12 to 18°C and 500 to 1200 mm, respectively during the growing season. It grows well in either a heavy sandy loam or light clay soils with a good drainage system (Getinet and Nigussie, 1997). The crop is traditionally used for many purposes, such as greasing traditional bread-baking clay pan, curing certain diseases and as a source of vegetable relish (Nigussie, 2001). For the small-scale farmers, it is a security crop, because it is a source of food and income at the time of acute food and income shortage that mostly occurs at the middle of the main rainy season. In many parts of the country, boiled and chopped leaves along with very delicate young stems are mixed with butter, and served along with cheese and '*kitifo*' (slightly cooked, heavily chopped, and buttered beef).

Major production constraints of the Ethiopian mustard are: lack of high yielding, early maturing varieties, high erucic acid (C22: 1) content in seed oil and high glucosinolate content in the meal (EARO, 2000). Before Ethiopian mustard can be used as a major food crop, the quality of both the seed oil and the meal characteristics must be improved to meet Canola quality standards (Getinet *et al*., 1994).

Crop improvement through plant breeding, thus, occurs through selection operating on genetic variability. Selection by plant breeders or by farmers can be intense and has resulted in major improvements. However, continued success in plant breeding can only be realized in so far as new variability is available for selection (Copper *et al.*, 2001). Such variability provides adaptability, which is the capacity for genetic change in response to selection (Sigmmonds, 1962). Genetic variability is therefore essential for crop improvement. Despite research efforts carried out one of the major production constraint is shortage of high yielding genotypes, due to this and nature of the crop the national average yield of Ethiopian mustard is still low. Hence, research efforts to improve seed yield of Ethiopian mustard using suitable selection criteria is indispensable. Therefore the present study was, executed with the following objectives:

To estimate the variability, heritability and genetic advance for yield and its contributing related traits;

To estimate the extent of genotypic and phenotypic correlation among traits

2. MATERIALS AND METHODS

Experimental Site

The experiment was conducted at Holetta Agricultural Research Center (HARC) in 2013/2014 cropping season from June to December 2013. Holetta (West Shewa Zone of Oromia Region) is located at latitude 9^o N and longitude 38^o E, altitude of 2400 m a.s.l situated 30km West of Addis Ababa. It is one of the representatives of oil seed *Brassica* growing areas in the central highlands of Ethiopia (Nigussie and Mesfin, 1994). The area has mean annual rainfall of 1059 mm and temperatures of 23^{o}C (maximum) and 8^{o}C (minimum). The soil type is Nitisols with soil ph in the range of 6.0 - 7.5(Nigussie and Mesfin, 1994).

Description of Test Materials

A total of forty-nine mustard land races that include one local check and one standard check were used in this study. The majority of the accessions represent the national collection from different major mustard growing regions of the country and that are maintained at HARC. The landraces were obtained kindly from Holetta agricultural research center of highland oil crops improvement project. The details of the landraces used in the experiment are given in Table 1.

Table 1: List of 49 Ethiopian mustard genotypes used in the study and their origin

No.	Landrace number	Area of collection	Altitude(m)	Latitude	Longitude
1	PGRC/E20001	West Wollega/Arjo	2420	08-44-00N	36-40.00E
2	" 20002	Bale Zone/Kitu	2500	06-.59.00N	39-12-00E
3	" 20004	South Gonder/Liba	1980	12-.05-00N	37-44-00E
4	" 20005	SouthGonder/Debretabor	1830	11-57-00N	37-37-00E

5	"	20006	South Gonder/Debretabor	1980	11-50-00N	37-37_00E
6	"	20007	North Gonder/Woger/Dabat	2500	*	*
7	"	20017	West Gojiam /Awi /Dangila	1980	11-.20-00N	36-58-00E
8	"	20056	West Shewa/Jibatenamecha	2200	09-01-00N	38.-20-00E
9	"	20065	West Shewa/Jibatena mecha	2200	08-58-00N	37-30.00E
10	"	20066	West Shewa/Ambo	1950	08-.59.00N	37-48-00E
11	"	20067	West Shewa/Ambo	2010	08-.58-00N	37-52-00E
12	"	20076	SNNP/Wenago	1853	06-23-00N	38-20-00E
13	"	20077	South East Tigray/Inderta	2000	13-29-00N	39-30.00E
14	"	20112	West Gojam/JabiTehnan	1980	10-.39.00N	37-24-00E
15	"	20117	West Shewa/Jibatnamecha	2050	08-.58-00N	38-01-00E
16	"	20127	West Shewa/chelia	1700	09-03-00N	37-10-00E
17	"	20133	West Shewa/Menagesha	2600	09-11-00N	39-09.00E
18	"	20134	West Shewa/Jibat	2200	08-.58.00N	37-30-00E
19	"	20146	West Gojam/Bahirdarzuria	1980	11-.25-00N	37-12-00E
20	"	20165	West Gojiam/Awi/Dangila	1980	11-20-00N	36-58-00E
21	"	20166	West Gojiam/Awi/Dangila	1980	11-20-00N	36-58.00E
22	"	21008	Arsi/Gedeb	2380	07-.12.00N	38-09-00E
23	"	21012	West shewa/Dendi	2900	09-.14-00N	38-53-00E
24	"	21017	West Shewa/Gendbert	2470	09-43-00N	37-46-00E
25	"	21026	West Gojiam Awi/Dangila	2000	11-18-00N	36-58.00E
26	"	21035	West Gojam/Sekela	2540	10-.50-00N	37-04-00E
27	"	21037	West Gojiam/Awi/Dangila	2165	11-.14-00N	36-51-00E
28	"	21068	Bale/Adaba	2500	07-01-00N	39-25-00E
29	"	21157	SNNP /South omo	2830	06-19-00N	38-52-00E
30	"	21225	East Gojam/Enemay	2000	10-.32-00N	38-09-00E
31	"	208411	West Gonder/Debretabor	2150	11-.50-00N	37-35-00E
32	"	229665	West Gojam/Burie	2050	10-33-00N	37-34-00E
33	"	237048	Arsie-Robe	2350	07-08-00N	40-00.00E
34	"	241907	South Gonder/Fogera	1825	12-.01-00N	37-43-00E
35	"	241910	South Gonder/Farta	2289	11-.49-00N	38-00-00E
36	"	242856	Arsi zone /Sherka	2360	07-32-64N	39-37-87E
37	"	242858	Arsi zone /Sherka	2360	07-34-27N	39-31-24E
38	"	243738	South Wollo/Desiezuria	2928	11-08-00N	39-13-00E
39	"	243739	South Wollo/Tenta	2950	11-.14-00N	39-15-00E
40	"	21256	West Gojam/Bahirdarzuria	1940	11-16-00N	36-59-00E
41	"	243750	Wollo/kalu	2020	11-45-00N	39-47.00E
42	"	2243756	South Gonder/ Debark	3115	11-.08.00N	37-56-00E
43	"	243761	Gonder Zuria	2050	12-.19-00N	37-33-00E
44	"	243763	South Gonder/Kemkem	2070	11-57-00N	37-37-00E
45	"	208556	West Shewa/Adis Alem	2200	*	*
46	"	208585	East Shewa/yerer	1600	*	*
47	Yellow dodolla		Bale/Dodolla	2500	06-.59-00N	39-12-00E
48	(ZemX Yellow Dodolla)		Cross	2400	09-00-00N	38-00-00E
49	Local check		Holetta area	2400	09-00-00N	38-00-00E

Source: Holetta highland oil crops research program,*=information not found

Experimental Design, Management and Season

The experiment was executed in 2013 using simple lattice design with two replications. A plot of four central rows each three-meter long and 30cm spacing between rows were used for data collection. Each replication had seven blocks and each block was represented by seven plots. The path between blocks was 2 m and the spacing between plots with in sub-blocks was also 0.6 m. Each entry was manually drilled, a rate of 10 kg/ha and urea and phosphorous fertilizers were applied at the rates of 46/69 kg/ha N/P_2O_5, respectively following the national recommendations. All other recommended agronomic and cultural practices were carried out following practices described by Adefris(2005).

Data Collected

I. data collected on plot basis

1. **Days to flowering (Df)**: The numbers of days from date of sowing to a stage at which 50% of the plants in a plot open flowers.

2. **Days to maturity (Dm)**: The number of days from date of sowing to a stage at which 50% of the plants have reached physiological maturity. It is the time when 50% of the capsules change their color into brown.

3. **Seed yield per plot (SYPP)**: Seed yield per plot measured in grams after moisture of the seed was adjusted to 7 percent.

4. **Oil content (Oc)**: The proportion of oil in the seed to total oven dried seed weight measured by nuclear magnetic resonance spectroscope as described by Oregon State University seed laboratory. WWW.Seed lab oregonstate.ed/node/158.

5. **Thousand seed weight (Tsw)**: The weight (g) of 1000 seeds from randomly sampled grains.

6. **Oil yield (Oy)**: The amount of oil in grams obtained by multiplying seed yield per plot by corresponding oil percent.

7. **Stand percent (SP)**: The proportion of plants at vegetative stage and at harvest as visually assessed in percentage.

II. On plant basis

These data was collected from five plants randomly selected from the central rows of each plot and averaged for statistical analysis.

1. **Number of Primary branches per plant (PB)**: The average number of primary branches per plant was counted from five randomly selected plants.

2. **Number of Secondary branches per plant (SB)**: The average number of secondary branches per plant was counted from five randomly selected plants.

3. **Plant height (PHT)**: The average height of five randomly selected plants was measured in centimeters from the ground surface to the top of the main stem at maturity.

4. **Seeds yield per plant (SYPPL)**: The weight of the seeds of the five randomly selected plants measured in grams that are divided by five.

Statistical Analysis

The data collected for seed yields and its contributing traits were subjected to analysis of variance (ANOVA) for simple lattice design. Analysis of variance was done using Proc lattice and Proc GLM procedures of SAS version 9.2, (SAS Institute, 2008).

Estimation of phenotypic and genotypic variability

The variability present in the population was estimated by simple measures, namely range, mean, standard error, and phenotypic and genotypic variances and coefficients of variations. The phenotypic and genotypic variance and coefficients of variation was also estimated as per the procedure suggested by Burton and De Vane (1953) as follows:

$$\delta^2 p = \delta^2 g + \delta^2 e$$

$$\delta^2 g = \frac{MSg - MSe}{r}$$

Where, $\delta^2 g$ =Genotypic variance

$\delta^2 P$ = Phenotypic variance

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$\delta^2 e$ = Environmental (error) variance or Error mean square

MSg = mean sum square due to genotypes (accessions)

MSe =mean sum square of error (environmental variance)

r = number of replications

Phenotypic Coefficient of Variation (PCV), $$PCV = \frac{\sqrt{\delta^2 p}}{\bar{x}} x100$$

Genotypic coefficient of Variation (GCV), $$GCV = \frac{\sqrt{\delta^2 g}}{\bar{x}} x100$$

$\bar{x}$ = Population mean of the character being evaluated

Heritability in broad sense

Heritability in the broad sense for quantitative characters was computed using the formula suggested by Singh and Chaudhary (1985):

$$H = \frac{\delta^2 g}{\delta^2 p} x100$$

Where, H= heritability in the broad sense.

$(\delta^2 g)$ = Genotypic variance and

$(\delta^2 p)$ = Phenotypic variance.

Expected genetic advance (GA)

The genetic advance (GA) for selection intensity (K) at 5% was calculated by the formula suggested by Allard (1999) as:

$$GA = K * \delta_P * H$$

Where, GA = expected genetic advance, δ_p =phenotypic standard deviation on mean basis, H= Heritability in broad sense, K =selection differential (k=2.06 at 5% selection intensity)

Genetic advance (as percent of mean) (GA) was computed to compare the extent of predicted genetic advance of different traits under selection using the formula:

$$GAM = \frac{GA}{\bar{X}} * 100$$

Where, $\bar{x}$ =population mean of the quantitative character, GAM =genetic advance as percent of mean.

Genotypic correlation coefficients

Estimation of genotypic correlation coefficients was done based on the procedure of Dabholkar (1992).

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Genotypic correlation coefficient (r_g) = COV_g (xy)/ σ_g (x) * σ_g (y)

Where, COV_g (xy) is the genotypic co-variances of two variables (X and Y), respectively. σ_g (x) and σ_g (y) are the genotypic standard deviations for variables, X and Y, respectively.

3. RESULTS AND DISCUSSION

The analysis of variance for the 11 traits studied is given in Table 2.The analysis of variance showed that there were significant differences among genotypes for all traits compared .The significant difference indicates the existence of genetic variability among the accessions that is important for selection and breeding. Similarly Yared,(2010) studied thirty six genotypes of mustard for date of flowering, date of maturity, seed yield per plot, oil content, oil yield, number of seed per plant, thousand seed weight, number of primary branches, number of secondary branches and plant height of traits found the same result. Besides, genetic variability of Ethiopian mustard for days to flowering and plant height has been reported by Getahun (1988) and Erena (2001) as well as days to maturity by Erena (2001).

Table 2: Mean squares for different sources of variations of seed yield and its contributing traits of 49 Ethiopian mustard landraces

Traits	Genotype (48)	Block (12)	Replication(1)	Intera-block error (36)
Date of flowering	141.98**	6.39	0.91	9.96
Date of maturity	284.69**	45.67	84.5	44.36
Seed yield kg /ha	503441*	925530	7543862	231667
Seed yield per plant	18.2377*	15.9527	88.2551	9.6692
Oil content	3.4446**	1.3825	217.51	1.1283
Oil yield	108661*	167934	2098030	46331
Thousand seed weight	0.1939**	0.06957	0.1111	0.06942
Stand percent	208.34**	721.28	4676.83	23.4813
Number of primary branches	9.8346*	6.07095	24.7004	6.1063
Number of primary branches	0.3389*	4.0816	4.0816	0.2421
Plant height	1004.12**	1102.13	2812.5	169.46

*, ** significant at p = 0.05 and 0.01 significance level, respectively; ns= non-significant

Genotypic and phenotypic coefficient of variation

Estimates of genotypic and phenotypic variances, genotypic coefficient of variation (GCV), phenotypic coefficients of variation (PCV), heritability in broad sense, expected genetic advances and genetic advances as percent mean are given in Table3.

Estimated genetic variance ranged from 0.0484% for number of secondary branches to 135887 for seed yield (Table3). Likewise phenotypic variance ranged from 0.131% for thousand seed weight to 735108% for seed yield kg/ha. Phenotypic coefficients of variation ranged from 2.09% for thousand seed weight to 191.78% for seed yield kg/ha. Genotypic coefficients of variation ranged from 1.21% for number of secondary branches to 82.46 % for seed yield kg/ha. Days to flowering (151.94, 66.01), Days to maturity (329.05, 120.16), seed yield kg/ha (735108, 135887), stand percent (231.82, 92.42), plant height (1173.58, 417.33) and oil yield (154992, 31165) showed high phenotypic and genotypic variances, respectively indicating that the genotypes could be reflected by the phenotype and the effectiveness of selection based on the phenotypic performance for these traits. Likewise, Yared(2010) reported high genotypic and phenotypic variance for days to flowering, days to maturity, plant height and oil content in 36 genotypes of Ethiopian mustard. Low genotypic variance as compared to environmental variance was recorded for traits such as thousand seed weight (0.062), number of secondary branches per plant (0.0484), and oil content (1.158). However, high genotypic coefficients of variation (GCV) and phenotypic coefficients of variation (PCV) were shown in traits such as seed yield kg/ha(82.46, 191.78) and oil yield kg/ha(60.00,133.81) respectively, which means selection of these traits based on phenotype traits may be useful for seed yield and oil yield improvement. This result agrees with the findings of Abebe (2006) and Aytac and Kinaci (2009).

Heritability in the broad sense

Breeders can make rapid progress where heritability is high by using selection methods that are dependant solely on phenotypic characteristics (e.g. mass selection). However, where heritability is low methods of selection based on families and progeny testing are more effective and efficient. Heritability estimated using the total genetic variance is called broad sense heritability .Heritability in the broad sense of the traits is presented in Table 3. In this study, heritability values were found to be sufficiently high for most important yield component traits. Dabholkar (1992) generally classified heritability estimates as low (5-10%), medium (10-30%) and high (30-60%). Based on this classification, thousand seed weight (68.80%), days to flowering (65.91%), stand percent (63.14%), days to maturity (60.43%), plant height(59.63%), oil content(50.53%), oil yield kg/ha(44.84%), seed yield kg/ha(42.99%) and number of primary branches per plants (34.20%) exhibited high heritability estimates. Thousand seed weight was found to be the most heritable trait in the genotype, with heritability of 68.80%, followed by days to maturity (65.91%) and stand percent (63.14%). This indicates that selection for these traits in the genotype would be most effective for the expression of these traits in the succeeding generations.

Therefore, good improvement can be made if some of these traits are considered as selection criteria in future breeding program. Similar findings had been reported by Yared (2010) for thousand seed weight, date of flowering, date of maturity and plant height. High heritability value for thousand seed weight, date to flowering, days to maturity and plant height, recorded in the current study was also recorded by Yared(2010)and Abebe(2006).According to Singh(1993), if the heritability of a character is high, selection for such character is fairly easy as selected traits will be transmitted to its progeny. This is because there would be a close correspondence between the genotype and phenotype due to a relatively similar contribution of the environment to the genotype. At the same time secondary branches per plant (28.86%) exhibit medium heritability estimate.

Genetic advance

Concerning the genetic advance at 5% intensity the highest genetic gain was predicted for seed yield (806.89kg/ha) followed by seed oil yield (378.38kg/ha)and while the lowest genetic advance was predicted for thousand seed weight(0.43gm).Genetic advance as a percent mean ranged 5.08% for oil content to 56.65% for seed yield per plant (Table 3). Within this range, a relatively high genetic advance as a percent mean was observed for seed yield per plant (56.65%) and oil yield (43.71%)followed by seed yield kg/ha(40.37). On the other side high genetic advance with high heritability was shown for seed yield kg/ha and seed oil yield which may be because of the presence of both additive and non-additive gene action (Liang *et al.*, 1972).Those traits having medium heritability along with high genetic advance could be improved using breeding procedure such as pedigree method. On the other hand, the lowest genetic gain as percent of means was observed for oil content 5.08 % followed by day to maturity%. Low genetic advance as percent means observations in this study indicates that traits probably were under environmental influence than the genotypic expression and that selection based on these traits would be ineffective.

Table 3: Components of variance, coefficients of variability, heritability and genetic advance and Genetic advance as percent of mean of studied traits

Traits	δ^2g	δ^2e	δ^2ph	GCV	PCV	h^2b	GA k = 5%	GA/Grand mean *100 k 5%
Date of flowering	66.01	85.93	151.94	8.41	12.76	65.91	14.36	15.39
Date of maturity	120.16	208.89	329.051	8.18	13.53	60.43	20.24	11.26
Seed yield kg/ha	135887	599221	735108	82.46	191.78	42.99	806.89	40.37
Seed yield per plant	4.2843	23.62	27.9069	7.15	18.25	39.18	4.75	56.65
Oil yield kg/ha	31165	123827	154992	60.00	133.81	44.84	378.38	43.71
Oil content percent	1.1582	3.41	4.5729	1.64	3.27	50.33	2.18	5.08
Thousand seed weight	0.062	0.07	0.131	1.44	2.09	68.80	0.43	14.36
Stand percent	92.429	139.39	231.821	10.38	16.43	63.14	17.36	20.23
Number of primary branch	1.8642	14.08	15.9409	4.09	11.97	34.20	3.35	30.10
Number of secondary branch	0.0484	0.53	0.581	1.21	4.20	28.86	0.59	17.81
Plant height	417.33	756.25	1173.58	15.18	25.45	59.63	37.97	20.96

δ^2g = Genotypic variance, δ^2e = Error variance, δ^2ph = Phenotypic variance, GCV = Genotypic coefficient of variability, PCV = Phenotypic coefficient of variability, h2b = Broad sense heritability, GA = Genetic advance and K = Selection intensity

Correlation of Seed Yield and Its Contributing Traits

Genotypic correlation coefficients of the seed yield and its contributing traits of Ethiopian mustard land races are presented in Table 4. Seed yield kg/ha showed highly significant and positive correlation with oil content (0.613),oil yield (0.993), plant height (0.543) seed yield per plants (0.295), Taking into account seed yield per plant, oil content, oil yield and plant height as selection parameter will be an effective way to increase seed, oil content and oil yield. This result is in agreement with the findings of Abebe (2006), Aytac and Kinaci (2009) and Jeromela *et al*. (2007) who reported positive correlation of seed yield kg/ha with oil yield kg/ha and seed yield per plant. Seed yield of kg/ha also showed positive associations between the stand percent and thousand seed weight. Days to maturity showed significant positive correlation between number of primary branches (0.074) and thousand seed weight (0.135) while highly significant but negative correlation was found with seed yield per plant(-0.412) and negative correlation with seed yield per plot (-0.228), oil content (-0.042),oil yield (-0.213), stand percent (-0.069), number of secondary branches per plant (-0.410) and plant height (-0.066).Hence making simultaneous increase for these traits with yield kg/ha is difficult. From these results, we may extract that indirect selection for earliness for days to maturity; shortness of plant height will be worthwhile in improvement of the seed and oil yield. Result of positive correlation of days to flowering with days to maturity as well as negative correlation of these two traits with seed yield per plant and oil yield are in agreement with the result of Abebe (2006) and Yared(2010). Association of plant height with seed yield kg/ha (0.543), oil content percent (0.450), oil yield (0.701), stand percent (0.711) was significant and positive, while its association with date of maturity (-0.066) was found negative. Number of primary branches per plant showed positive correlation with number of secondary branches per plant (0.299).Relationship between secondary branches per plant and thousand seed weight was positive. Seed yield per plant showed positive correlation with stand percent (0.092), primary branches (0.239), secondary branches (0.517), plant height (0.326) and thousand seed weight (0.101).

Table 4: Genotypic correlation coefficients among 11 agronomic traits in 49 Ethiopian mustard genotypes tested at Holetta, 2013

Traits	Date of flowering	Date of maturity	Seed yield per plot	Oil content	Oil yield	Seed yield per plant	Stand percent	Number of primary branch	Number of secondary branch	Plant height	Thousand seed weight
Date of flowering		0.828**	-0.095	0.068	-0.076	-0.157	0.081	0.235	-0.101	0.109	0.087
Date of maturity			-0.228	-0.042	-0.213	-0.412**	-0.069	0.074	-0.410	-0.066	0.135
Seed yield kg/ha				0.613**	0.993**	0.295 *	0.627	-0.047	0.075	0.543**	0.415
Oil content percent					0.659**	0.322*	0.521**	0.056	0.057	0.450**	0.331*
Oil yield kg/ha						0.309*	0.642*	-0.046	0.049	0.701**7	0.162
Seed yield per plant							0.092	0.239	0.517	0.326	0.101
Stand percent								0.008	0.049	0.701*	0.162
Number of primary branch									0.299*	0.155	-0.141
Number of secondary branch										0.174	0.053
Plant height											-0.001
Thousand seed weight											

*, ** Indicate significance at 0.05 and 0.01 probability levels, respectively.

4. CONCLUSION

In this study, 49 Ethiopian mustard genotypes acquired from diverse zones/regions of Ethiopia were evaluated in simple lattice design with two replications at Holetta Agricultural Research Center, West Shewa zone, with the objectives of estimating the variability, heritability, genetic advance for yield and its contributing related traits, to estimate the extent of genetic and phenotypic correlation among traits

The analysis of variance showed the presence of highly significant differences among the tested genotypes for all of traits considered, indicating the existence of variability among the tested genotypes for these traits. High phenotypic coefficient of variation (PCV) was recorded for seed yield kg/ha and oil yield. But low PCV was detected for thousand seed weight. Generally, the magnitudes of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were high for seed yield kg/ha and oil yield.

Heritability in broad sense estimates were high for thousand seed weight, days to flowering, stand percent, days to maturity and plant height. Similarly, the heritability values of secondary branches were also medium. Genetic advance as percent of the mean (GAM) was high for seed yield per plants where as the rest shows low GAM below 50%.

Seed yield kg/ha showed significant positive correlation with oil yield, plant height, seed yield per plants, which indicates that taking in to account seed yield per plant, oil yield and plant height as selection criteria will be an effective way to increase seed and oil yield.

Traits associations in this study have revealed that considering of seed yield per plant, oil content, oil yield and plant height as selection criteria will be effective in improvement of seed and oil of Ethiopian mustard genotypes. The positive correlation of oil content with oil yield which is also expressed by its direct effect indicates that breeding strategies which focus on raising the percentage of oil content in seeds will be worthwhile. Improvement of oil content can be achieved through selection of early flowering genotypes.

The present study revealed the presence of considerable variability among genotypes for all traits compared. These conditions indicate that there is good opportunity to improve these traits using the tested genotypes.

Further similar study on variability of metric characters using biotechnological tools would also help in substantiating the result obtained.

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