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Leaf Agro Morphological Genetic Variability, Heritability Genetic Advance, Genetic Advance as Percent Mean of Ethiopian Mustard (*Brasica Carinata* A. Braun) Landraces

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ABSTRACT

Field experiment was conducted to estimate leaf agro morphological genetic variability, heritability, genetic advance, genetic advance as a percent mean of forty nine genotypes of Ethiopian mustards collected from different agro ecologies. The experiment was carried out in a simple lattice design The analysis of variance showed that there were significant differences among genotypes for seed yield per plant, thousand seed weight, petiole length, leaf length, leaf width and leaf area traits but seed yield per plant, leaf weight per plant topped at 40, 50 and 60 days of topping and number of intact leaves at flowering stage showed non-significant differences. The significant difference indicates the existence of genetic variability among the accessions which is important for the leaves agro morphological traits improvement. High genotypic and phenotypic coefficients of variations were observed in number of leaves intact at vegetative stage, petiole length and seed yield per plant. This shows that selection of these traits based on phenotype may be useful for useful agro morphological leave traits improvement. The highest heritability in broad sense was recorded for thousand seed weight(68.80%) followed by petiole length (56.03%), leaf area(52..09%), leaf width(48.29%),leaf length(46.28%),leaf weight at 50 days of topping(43.40%),number of leaves at vegetative stage (40.48%),seed yield per plant (39.18%), seed yield of 50 days growth stage topped plants (38.85%) and leaf weight at 40 days of topping(38.91%). 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 leaves agro morphological vegetative traits. In genotypic correlation coefficients of the leaf topped plants of vegetative related traits seed yield per topped plants of 40 days growth stage of plants showed positive correlation with 50 and 60 days of growth stage of leaves topped plants (0.220) and (0.305), respectively. Similarly, positive correlation was shown in leaf biomass among plants topped at 40 days (0.004) and 60 days (0.141) and 50 days (0.307). These results indicate that there is good opportunity to improve leave agro morphological traits using the tested genotypes.

Keywords: *Ethiopian mustard, variability, Genetic advance, heritability, leaf agro morphological traits, correlation*

INTRODUCTION

The genus *Brassica* of *Brassicaceae* family as a whole is believed to have originated around the Mediterranean, Eastern Afghanistan and the adjoing 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 amphidiploid.

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. In characterization of

Ethiopian mustard lines for vegetative agro-morphological traits Jane Muthoni, (2010) reported as great variation was seen in leaf number per plant, leaf bloom and leaf blade blistering. As Muhamad *et.al*. 2013 reported .similar assessment of genetic variation in this crop was done for 33 agro-morphological characters. Hence, research efforts to improve leaf agro morphological character of Ethiopian mustard using suitable selection criteria is indispensable. Information on the leaf agro morphological traits of Ethiopian mustard as a leafy vegetable crop is lacking.. Therefore the study was, executed with the objectives of estimating leaf agro morphological genetic variability, heritability, genetic advance, genetic advance as percent mean and estimating the extent of correlation of its related traits.

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 Holetta agricultural research center. The details of the accessions used in the experiment are given in Table 1.

Table1. *List of 49 Ethiopian mustard genotypes used in the study and their origin*

No.	Accession number	Area of collection	Altitude(m)	Latitude	Longitude
1	PGRC/E 20001	West Wellega/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/Wogera/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 from June 2013 to December 2013. The experiment was laid out in 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).

Analysis of Variance

The data collected for leave agro morphological 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). Analysis of variance (Table 2) for the considered traits was done using the model for lattice design as follows:

$$Yil(j) = u + ti + rj + (b/r)l(j) + eil(j)$$

Where, $Yil(j)$ is the observation of the treatment $i(i = 1,....V, k^2)$, in the block $l(l = 1,...k)$ of the replication $j(j = 1,...,m)$;

μ is a constant common to all observations;

t_i is the effect of the treatment i;

rj is the effect of the replication j;

$(b|r)_{l(j)}$ is the effect of the block l of the replication j;

$e_{il(j)}$ is the error associated to the observation $Y_{il(j)}$, where $e_{il(j)}$ ~N(0,s) independent.

Table2. *Simple Lattice analysis of variance and expected mean squares*

Source of variation	Df PGRC/E	SS	MS	F-value
Replication(r)	r-1	SSr	MSr	MSr/MSe
Genotype(g)	g-1	SSg	MSg	MSg/MSe
Block within replication	r(b-1)	SSb	MSb	MSb/MSe
Intra-block error	(b-1)(rb-b-1)	SSe	MSe	
Total	rb2-1	SST		

Where, Df = degree of freedom, SS sum of squares; MS: mean of squares, SSr and MSr sum of squares and mean of replication, respectively: SSg and MSg are sum of squares and mean of genotypes, respectively: SSb and MSb are sum of squares and mean of blocks within replication respectively. SSe and MSe are sum of squares and mean of intera-block error.

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

$\delta^2 e$ = 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.

Correlation Coefficient

Genotypic Correlation Coefficients

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

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.

Results and Discussion

Analysis of Variance

The analysis of variance for the 13 traits studied is given in Table 3.The analysis of variance showed that there were significant differences among genotypes for seed yield per plant, thousand seed weight, petiole length, leaf length, leaf width and leaf area traits but leaf weight per plant topped at 40, 50 and 60 days of topping and number of intact leaves at flowering stage showed non-significant differences. The significant difference indicates the existence of genetic variability among the accessions which is important for leave agro morphological traits improvement. Similarly Yared,(2010) studied thirty six genotypes of mustard for number of seed per plant and thousand seed weight of traits found the same result. In the same manner Muthoni (2010) studied 33 agro morphological traits of Ethiopian mustard and reported similar genetic variability for number leaf per plants, leaf bloom and leaf blade blistering.

Table3. *Mean squares for different sources of variations for thirteen leave agro morphological traits of 49 Ethiopian mustard*

Characters	Genotype (48)	Block (12)	Replication(1)	Intera-block error (36)
Seed yield per plant	18.2377*	15.9527	88.2551	9.6692
Thousand seed weight	0.1939**	0.06957	0.1111	0.06942
Seed yield at 40 date of topping	0.2544ns	0.1951	3.530	0.17997
Seed yield at 50 date of topping	0.245ns	0.2628	1.9715	0.1314
Seed yield at 60 date of topping	0.3633ns	0.1902	5.7315	0.3056
Petiole length	11.6242**	2.7005	32.229	2.6565
Leaf length	6.1553**	2.072	22.6368	2.4629
Leaf width	5.8638**	1.8471	22.5408	2.1336
Leaf area	7.3403**	2.0052	25.0026	2.1764
Number of leaf intact at flowering	354.12ns	185.86	969.26	179.31
Leaf biomass at 40 date of topping	2092.69ns	32923.9	9601.02	1120.07
Leaf biomass at 50 date of topping	4322.45ns	3934.41	5683.46	1957.18
Leaf biomass at 60 date of topping	3599.61ns	7416.95	29440	3129.77

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

Analysis of Genetic Parameters

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 Table4.

Estimated genetic variance ranged from 0.02892% for seed yield harvested from 60 days of topped to 1182.6% for leaf biomass at 50days topping/ defoliation (Table4). Likewise phenotypic variance ranged from 0.131% for thousand seed weight to 6729.63% for leaf biomass at 50days topping. Phenotypic coefficients of variation ranged from 2.09% for thousand seed weight to 67.95 % leaf biomass at 50 days topping. Genotypic coefficients of variation ranged from 1.07% for seed yield from harvested 60 days of topped to 29.49 % for leaf biomass of 50 days topping and leaf biomass of 40 days (3212.76, 486.31), of 50 days (6279.63, 1182.6) and of 60 days (6729.38, 234.92) of topping 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.

Low genotypic variance as compared to environmental variance was recorded for traits such as thousand seed weight(0.062), seed yield of 40(0.037),of 50(0.059) and of 60(0.029) days of growth stage of topped, petiole length(4.483), leaf length(1.846),leaf width(1.865), leaf area (2.582), However, high genotypic coefficients of variation (GCV) and phenotypic coefficients of variation (PCV) were shown in traits such as leaf biomass 50 days topped (29.48, 67.95) and leaf biomass of 60 days topping (12.68,67.89) respectively, which means selection of these traits based on phenotype characteristics may be useful for leave agro morphological traits improvement.

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 4. In this study, heritability values were found to be sufficiently high for most important yield component characters. Dabholkar (1992) generally classified heritability estimates as low (5-10%), medium (10-30%) and high (30-60%). Based on this classification,1000-seed weight (68.80%), petiole length(56.03%), leaf area (52.09%), leaf width(48.29),leaf length (46.28%), leaf biomass at 50 days of topping (43.40%), number of intact leafs (40.48%), leaf biomass of topped at 50 days of growth stage(38.91)and seed yield 50 days growth stage topped plants (38.85%) 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 petiole length 56.03%. 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 improvement program. Similar findings had been reported by Yared (2010) for thousand seed weight and seed yield per plant. High heritability value for thousand seed weight and seed yield per plant 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 character 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 seed yield obtained from 40 days and 60 days topped leaves (29.27,20.77) respectively and leaf biomass at 60 days of growth stage topped (18.83%)exhibit medium heritability estimates.

Genetic Advance

Concerning the genetic advance at 5% intensity the highest genetic gain was predicted for leaf biomass at 50 days defoliation (74.93%) followed leaf biomass at 60 days defoliation (50.89%) and while the lowest genetic advance was predicted for thousand seed weight (0.43%). Genetic advance as a percent mean ranged from 4.12% for leaf area to 57.18% for petiole length (Table 4). Within this range, a relatively high genetic advance as a percent mean was observed for petiole length (57.18%) and seed yield per plants (56.65%) followed by leaf biomass at 50 days defoliation (55.09%). On the other side high genetic advance with high heritability was shown for leaf biomass at 50 days defoliation, for leaf biomass at 60 days defoliation and leaf biomass at 40 days defoliation which may be because of the presence of both additive and non-additive gene action (Liang *et al.*, 1972). On the other hand, the lowest genetic gain as percent of means was observed for leaf area 4.12% thousand seed weight 14.36 % followed by seed yield 50 days topped plants 20.33%. Low genetic advance as percent means observations in this study indicates that characters probably were under environmental influence than the genotypic expression and that selection based on these traits would be ineffective.

Table4. *Components of variance, coefficients of variability, heritability and genetic advance and Genetic advance as percent of mean of studied traits*

Character	δ^2g	δ^2e	δ^2ph	GCV	PCV	h^2b	GA k = 5%	GA/Grand mean *100 k 5%
Seed yield per plant	4.2843	23.62	27.9069	7.15	18.25	39.18	4.75	56.65
Thousand seed weight	0.062	0.07	0.131	1.44	2.09	68.80	0.43	14.36
Seed yield at 40 date of topping	0.0372	0.40	0.4344	1.10	3.74	29.27	0.51	16.51
Seed yield at 50 date of topping	0.0599	0.30	0.3622	1.45	3.73	38.85	0.55	20.33
Seed yield at 60 date of topping	0.0289	0.64	0.6689	1.07	5.17	20.77	0.53	21.40
Petiole length	4.4839	9.80	14.2807	7.95	14.18	56.03	4.06	57.18
Leaf length	1.8462	6.77	8.6182	4.66	10.07	46.28	2.87	33.72
Leaf width	1.8651	6.13	7.9974	5.67	11.74	48.29	2.82	48.63
Leaf area	2.582	6.93	9.5167	1.82	3.50	52.09	3.20	4.12
Number of leaf intact at flowering	87.405	446.03	533.43	11.10	27.41	40.48	21.09	29.70
Leaf biomass at 40 date of topping	486.31	2726.45	3212.76	22.05	56.68	38.91	50.74	50.74
Leaf biomass at 50 date of topping	1182.6	5097	6279.63	29.49	67.95	43.40	74.93	55.09
Leaf biomass at 60 date of topping	234.92	6494.46	6729.38	12.68	67.89	18.68	50.89	34.86

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.

Character Associations

Improvement for a target character can be achieved by indirect selection via other characters that are more heritable and easy to select. This selection strategy requires understanding of the interrelationship of the characters among themselves and with the target character.

Genotypic Correlation of Leaf Topped Plants Seed Yield with Agro Morphological Traits

Genotypic correlation coefficients of the leaf topped plants of agro morphological traits are presented in Table 5. Seed yield per topped plants of 40 days growth stage of plants showed positive correlation with 50 and 60 days of growth stage of leafs topped plants (0.220) and (0.305), respectively. Similarly, positive correlation was shown in leaf biomass among plants topped at 40 days (0.004) and 60 days (0.141) and 50 days (0.307). This indicates that defoliation/topping of leaves enhances compensatory growth in mustard and the results in greater biomass accumulation. Seed yield per topped plants at 40 days growth showed negative correlation of number intact of leaves (-0.059) but seed yield per topped plants at 50 and 60 days growth showed a positive correlations(0.186) and (0.219) respectively. This is indicate that early topping decreases the number of intact leaves while late topping increases the number of intact leaves at vegetative stage of growth. Seed yields of all topped plants at the three stages growth and topping/defoliation showed negative correlation for petiole length, leaf length, leaf width and leaf area vegetative traits . Petiole length had highly significant positive correlation with leaf length (0.916), leaf width (0.939), leaf area (0.977) and significant level with leaf biomass of topped plants at 60 days(0.374) of growth. A highly significant correlation had been reported between leaf length and leaf width by Kennared *et al*, (1994). Similarly, leaf length showed significant positive correlation for leaf width (0.950), leaf area (0.972) and leaf biomass of topped plants at 60 days (0.312) of growth. Number of intact leaves at vegetative growth was negatively correlated with petiole length (-0.105), leaf length (-0.060), leaf width (-0.053) and leaf area (-0.079) that indicates the long and wide leaves have negative impact leaf area duration.

In this study defoliation was done at 40, 50 and 60 days (from five plants each) and leafy vegetative parameters for leaf petiole length, leaf length, leaf width, leaf area, leaf weight from defoliated plants and number of intact leaf was considered and analyzed to identify defoliation impact on seed yield and leaf biomass. Higher genotypic positive correlation was observed between 40 and60 days of topping seed yield indicating that early topping / defoliation has increased removal of early stage of the competition between organs and consequence the plant can make use of available, light, water and nutrient more efficiently and can have high seed yield. Thurling (1974a) has observed appreciably higher heritability values for, leaf area and leaf weight than for the yield. However, none of them were suitable criteria for yield selection, as the expected correlated responses to selection for these characters were lower than the direct response to selection for yield.

These results suggest the importance of additive gene action for their inheritance, and improvement could be brought about by a phenotypic selection. Analysis of genotypic diversity must be considered in plant breeding commonly based on simultaneous examination of large number of population for several characters of both morphological and physiological interest (Revilla and Tracy, 1995). Similarly**,** Jane Muthoni (2010) studied forty seven lines of Ethiopian Mustard Vegetative agro morphological traits in order to identify with useful traits that can be used as genitors for active breeding and based on vegetative agro morphological traits. His results indicated as there is a wide variation in Ethiopian mustard. In summary further work should consider agro morphological characterization at reproductive phase or molecular characterization in order to get a clearer picture of agro morphological diversity

Table5. *Genotypic Correlation of leaf toped plants among 11 characters of leaf vegetative related traits studied at Holetta during 2013/2014*

Traits	SYpl	SY40dt	SY50dt	SY60dt	PL	LL	LW	LA	LB40	LB50	LB60	NOL
Seed yield per plant(SYpl)		0.212	0.150	0.290	0.117	0.051	0.024	0.027	0.111	0.200	-0.137	0.652
Seed yield at 40 date of topping (SY40dt)			0.220	0.305	-0.134	-0.070	-0.161	-0.125	0.004	0.307*	0.141	-0.059
Seed yield at 50 date of topping (SY50dt)				0.169	-0.218	-0.151	-0.163	-0.023	0.122	0.267	-0.046	0.186
Seed yield at 60 date of topping (SY60dt)					-0.218	-0.151	-0.163	-0.185	0.045	0.309*	0.235	0.219
Petiole length (PL)						0.916**	0.939**	0.977**	0.159	0.020	0.374**	-0.105
Leaf length (LL)							0.950**	0.972**	0.199	0.113	0.312*	-0.060
Leaf width (LW)								0.982**	0.227	0.024	0.322*	-0.053
Leaf area (LA)									0.193	0.053	0.347**	-0.079
Leaf biomass at 40 date of topping (LB40)										0.084	0.087	0.086
Leaf biomass at 50 date of topping (LB50)											0.275	0.110
Leaf biomass at 60 date of topping (LB60)												-0.186
Number of leaf intact at flowering(NOL)												

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

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 per plant and leaves agro morphological related characters and to estimate the extent of genetic correlation.

The analysis of variance showed the presence of significant differences among the tested genotypes for seed yield per plant, thousand seed weight, petiole length, leaf length, leaf width and leaf area traits but seed yield per plant, leaf weight per plant topped at 40, 50 and 60 days of topping and number of intact leaves at flowering showed non-significant differences. The significant difference indicates the existence of genetic variability among the accessions which is important for leave agro morphological traits improvement. High phenotypic coefficient of variation (PCV) was recorded for number of leaves intact at vegetative stage, petiole length and seed yield per plant. But low PCV was detected for thousand seed weight, leaf area and seed yield of 50 dates of leaves topped plants. Generally, the magnitudes of phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) were high for leaves biomass topped at 50 dates of topped plants.

Heritability in broad sense estimates was high for thousand seed weight, petiole length, leaf area and leaf width. Similarly, the heritability values of seed yields of 40 days leaf topped plants, yields of 60days leaf topped plants and leaf biomass at 60 days topping were also medium. Genetic advance as percent of the mean (GAM) was high for petiole length, seed yield per plants and leaf biomass of plants topped/defoliated at 40,50 days of growth stage where as the rest shows low GAM below 50%.

In genotypic correlation coefficients of the leaf topped plants of vegetative related traits seed yield per plants showed word positive correlation for all leaf agro morphological traits, seed yield per topped plants of 40 days growth stage of plants showed positive correlation with 50 and 60 days of growth stage of leaves topped plants respectively. Similarly, positive correlation was shown in leaf biomass among plants topped at 40 days and 60 days and 50 days. These results indicate that there is good opportunity to improve leave agro morphological traits using the tested genotypes

REFERENCES

[1] Abebe Delesa. 2006. Genetic Variability and Association Among Seed Yield and Yield Related Traits in Ethiopian mustard *(Brassica carinata* A. Braun) at Kulumsa, Arsi. An M.Sc. Thesis Presented to the School of Graduate Studies of Alemaya University. 75p.

[2] Adefris Teklewold. 2005. Diversity Study Based on Quality Traits and RAPD Markers and Investigation of Heterosis in Ethiopian Mustard. Ph.D. diss. Georg-August Univ. of Göttingen, Germany. 161p..

[3] Allard, R.W. 1999. Principles of plant breeding. 2th ed. New York, John Wiley & Sons, 254 p. ISBN 978-0-471-02309-8.

[4] Copper, H.D., C. Spillane and H. Hogkin. 2001. Broadening the Genetic bases of crop production. FAO, IPGRI.

[5] CSA (Central Statistical Authority). 2013/14. Report on land utilization: Private peasant holdings, 'Meher' season. Statistical bulletin. Addis Ababa, Ethiopia.

[6] Dabholkar, A.R. 1992. Elements of biometrical genetics. Concept Publishing Company, New Delhi, India.431p.

[7] Dewey, D.R. and K.H. Lu. 1959. A correlation and path coefficient analysis of components of crested wheat grass seed production. *J. Agron.* 51:515-518

[8] Doweny R.K. and G. RÖbbelen. 1989. Brassica Species. In RÖbbelen G, Doweny RK and Ahri A (eds) Oil crops of the world. McGraw-Hill New York. pp. 339-359

[9] Gomez-Campo, C. and S. Prakash. 1999. Origin and domestication of the Brassica. pp. 33-58. In: Gomez-Campo C (ed.). Biology of Brassica Coenospecies. Elsevier, Amsterdam.

[10] Hemingway, J.S. 1976. Mustards Brassica species and Sinapsis alba (Cruciferae). *In*: Evolution of Crop Plants. N.W. Simmounds (ed.) Longan. London. 339p.

[11] Jane Muthoni.2010.Characterization of Ethiopian Mustard(*Brassica carinata* A. Braun)lines for vegetative agromorphological traits at Arusha,Tanzania.Jornal of Horti and forestry Vol.2(1)pp.002006

[12] Kumar, P.R., R.K. Arora, R.C. Yadav, N.P. Singh and K. Parkash. 1987. Association and path analysis of economic traits in yellow sarson. *J. Oil Seeds Res.* 4: 257-260

[13] Muhamad Zat ,Nahida Zakir,Ashia Rabbani and Zabat Shinwari ,2013. Assesement of genetic variation in Ethiopian Mustard (*Brassica carinata* A. Braun) gerplasm using multivariate techniques .pak.J.Bot 45(51)583-593.

[14] Nigussie Alemayehu and Mesfin Abebe. 1994. Relative importance of some managmnet factors in seed and oil yields of Ethiopian mustasrd *(Brasica carinata* Braun.) and Rapeseed *(Brasica napus L.). Ethiop. J. Agric. Sci.* 14: 27-36

[15] SAS Institute INC., 2002- 2008. SAS*STAT, users guide, version 9.2, Cary N.C., SAS INC

[16] Revilla,P. and W.W. Tracy.1995.Morphological characterization and classification of open – pollinated sweet corn cultivar. J.Amer. Soc.Hort. Sci., 120:112-118.

[17] Sigmmonds, N.W. 1962. Variability in crop plants, its use and conservation. *Biological reviews*, 37: 422-465

[18] Singh, B. D. 1993. Plant breeding principles and methods. Kalyani Publishers, Ludhiana, New Delhi.

[19] Singh, R.K. and B.D. Chaydhary. 1985. Biometrical methods in quantitative genetic analysis

[20] Thruling, N. 1974a. Morphophysiological determinants of yield in rapeseed (*Brassica campestris* and *Brassica napus*). Growth and morphological characters. Aust. J. Agric. Res. 25: 697-710.

[21] U.N. 1935. Genome analysis in Brassica with special reference to the experimental formation of*B. napus* and peculiar mode of fertilization. *Jpn. J. Bot.* 9: 389-452

[22] Yared Semahegn. 2010. Genetic diversity and Relationship among Association amongEthiopian mustard *(Brassica carinata* A. Braun) genotypes based on their agronomic and quality Traits in at Holetta Agricultural research,. An M.Sc. Thesis Presented to the School of Graduate Studies of Jima University. 75p.

[23] Yodice, R. 1990. Nutritional and stability characteristics of high oleic sunflower seed oil. *Fat Sci. and Tech.*92:121-12

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