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EVALUATION OF ETHIOPINA MUSTARD (*Brasica carinata* A. Braun) VARIETIES FOR YIELD AND YIELD COMPONENT TRAITS IN WESTERN SHEWA, OROMIYA, ETHIOPIA

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Abstract: **The experiment was carried out to evaluate the performance of mustard varieties for yield and yield components traits with specific adaptation. Therefore an experiment was initiated to assess yield and yield components trait of mustard varieties that are best suited to the western shewa zone of the Oromiya Regional state.The experiment was carried out in Randomized Complete Block Design in three replications at Holetta research center. The results of combined analysis of variance showed that, varieties were significantly different for seed yield, oil content, oil yield, date of flowering, date of maturity, primary branches indicating that the presence genetic variability for improving these traits, while none significant for number of seeds, number of pods, plant height and number of secondary branches. More important components of yield for the tested mustard varieties were number of seeds per plant, number of primary branches per plant, number secondary branches per plant and number of pods per plant. Based on these major traits of yield components three genotypes namely PGRC/E 208585, PGRC/E 208528/2, PGRC/E 208556 gave comparable seed yield, oil content, oil yield, number of seeds per plant and these varieties were also comparable for their reaction to major disease. These varieties with the highest yield component characters can be selected for the improvement and grown in western zone of Shewa.**

Keywords: **Ethiopian mustard, variety, traits, oil, yield.**

1. INTRODUCTION

The genus *Brassica* includes economically important species that provide oil for human consumption and raw materials for the industry, source as leaf and root vegetables and used for fodder and condiments (Getinet *et al.* 1991).

Ethiopian mustard locally known as gomenzer, is important as source of oil and as a leafy vegetable in mid altitude and highland areas, (1700 to 2800 meters a.s.l). Mainly small farmers grow the crop in more fertile and well- drained areas, often close to their houses. At its early stage of development the leaf is used as vegetable either by thinning or topping and seed can be also harvested from the same plant for oil extraction and other uses that include: greasing traditional bread baking clay pan (Mitad), curing certain ailments and preparing beverages (Alemayehu, 2001).

In Ethiopia research on mustard started in the late 1960s by Ethiopian Institute of Agricultural Research (EIAR). The objective of Mustard breeding in Ethiopia is to develop high-yielding genotype with increased of oil contents and meal quality. So far seven *Brasica carinata* varieties have been released. But the improved varieties developed had a wide adaptation and were nationally released and their performance for yield and yield components was not evaluated for

specific environmental condition. Recently a need has arisen to assess the performance of mustard varieties for yield and yield components traits with specific adaptation. With this background in mind an experiment was initiated to evaluate Ethiopian mustard varieties for yield and yield component traits that are best suited to the western shewa zone of the Oromiya regional state.

Objective: To evaluate Ethiopian mustard varieties for yield and yield component traits in western shewa zone.

2. MATERIALS AND METHODS

The experiment was conducted in experimental field at Holetta Agricultural Research Centre during 2007/08 cropping season. The test location, Holetta Agricultural Research Centre, is the main testing site for highland mustard varieties. It is believed to represent the major crop growing agro ecologies of Ethiopia in the highland areas. The centre is located 30 km south west of Addis Ababa at altitude of 2400 m.a.s.l.

It received an average annual rainfall of 956mm. Annual temperature ranges 24.60c to -0.20c minimum, is the typical of oil seed growing areas in the central high land. The soil type of the centre is luvisol /eutric nitosols with a good drainage system. Data on rainfall, relative humidity, maximum and minimum temperature were collected from a meteorological station belonging to Holetta agricultural research agro-meteorological information service situated in the center close to the experimental plot. Detail weather conditions of testing site of the year are shown in appendixI.

The experiment was carried out to evaluate ten Varieties of Ethiopian mustard against two standard checks (Yellow Dodolla and Holetta 1) and one cultivar as a local check. A seed rate of 10kg/ha was utilized to conduct the experiment. Planting was done on 19 June 2007. Two-hand weeding and fertilizer rate of 46/69 N/P_2O_5 Kg ha^{-1} was the inputs of improved packages used for evaluation purpose on each individual experimental plot. In addition manual cultivation after three weeks of planting was carried out equally to each treatment.

Randomized Complete Block Design with three replications was employed. The gross plot size was nine-meter square (six rows of 5meter long and 30 cm spacing) and the net harvest plot size was six-meter square (four central rows). The four central rows in each plot were used for data recording. By considering the central four rows the pre harvested agronomic data such as 50% date of flowering, 50% date of maturity and disease score (for leaf spot and Downey mildew) was recoded. On the other side another pre harvested agronomic data such as plant height, number of primary branches, number of secondary branches and number of pods of these characters per five plants were respectively collected. On the other hand for post harvest agronomic data such as number of seeds per five plants was counted by seed counter machine, seed yield which was obtained from the central four rows, oil content that was measured by using Nuclear Magnetic Resonance spectroscope, oil yield that was also obtained by multiplying seed yield with corresponding oil percentage and thousand seed weight which was obtained by weighing counted thousand seeds using seed counter machine and were taken and statistically analysed using Agro base Demo 20 computer soft ware. Major criteria during the evaluation considered were seed yield, oil content, oil yield, primary and secondary branches, and number of seeds per plants.

In this experiment ten genotypes of Ethiopian mustard were randomly taken from different stages of mustard trial that were evaluated for the last season and stocked at Holetta Agricultural Research Centre to represent the available germplasm /breeding stock. These genotypes were originally acquired from the Institute of Biodiversity conservation of Ethiopia and were randomly collections from different regions of Ethiopia. Besides, two released varieties and one local check were included for comparison. List of 13 Ethiopian Mustard genotypes used in the evaluation purpose and their area of collection is described in table 1 as follows.

Table 1: List of 13 Ethiopian Mustard genotypes used in the evaluation purpose and their area of collection

No.	Genotype	Area of Collection	Altitude of collection area
1	PGRC/E 21369/1/1	Kefa	1772
2	PGRC/E 21369/1/2	Kefa	1772
3	PGRC/E 21369/1/4	Kefa	1772

4	PGRC/E 20112/1	Gojam/Tehnan	1980
5	PGRC/E 208585/1	Shewa/Yerer	1600
6	PGRC/E 208556	Shewa/Addis Alem	2620
7	PGRC/E 21176/1/1	Wellega	2180
8	PGRC/E 208528/2	Shewa/Becho	2200
9	PGRC/E 208524	Shewa/Wollisso	2280
10	PGRC/E 208585/	Shewa/Yerer	1600
11	Yellow Dodolla	Bale/Dodolla	2430
12	Holetta-1	Cross	2400
13	Local check	Holletea area	2400

3. RESULTS AND DISCUSSION

The results of combined analysis of variance are presented in Table 2. The result indicated that, varieties were highly significantly different for seed yield, oil content, oil yield, date of flowering, date of maturity and also least significant for primary branches while none significant for number of seeds, number of pods, plant height and number of secondary branches.

Table 2: Analysis of variance table

Source varation	df	SY	NS	OC	OY	DFL	DM	NP	PH	PB	SB
Replication	2	0.396**	1130956.9**	0.109ns	0.068*	5.2 ns	0.2 ns	21.5 ns	152.6ns	1.3 ns	52.6*
Varieties	12	0.222**	344817.4ns	4.982**	0.047**	66.4**	24.7**	1539.5 ns	107.4 ns	2.2*	13.1 ns
Error	24	0.065	654173.6	1.000	0.013	1.6	0.9	1072.2	96.5	0.5	13.0

df= degree of freedom, SY =seed yield , NS= number of seeds, OC =oil content, OY= oil yield, DFL =Date of flowering, DM= Date of maturity, NP= number of pods; PH=Plant height, PB=Primary branches, SB, Secondary branches , **=highly significant, *= least significant, ns= non significant

Mean Performance of the Traits

As indicated in table 3 similarly, significant variations were observed among the varieties for days to flowering and days to maturity. Days to flowering ranged from 74 to 89, days to maturity from 175 to 184 and plant height from 186 to 208cm.The high yielding varieties, PGRC/E 208585, PGRC/E 208528/2, PGRC/E 208556 were 89, 85, 82 days in flowering and maturity dates 184, 184 and 181 respectively. The late flowering date and maturity date was for the highest yielding variety 89 and 184 days respectively. Plant height for ten varieties including the standard checks and local checks (PGRC/E 21369/1/2,Yellow Dodolla, PGRC/E21176/1/1,PGRC/E208585, PGRC/E208528/2, local check, PGRC/E208585/1, PGRC/E208524, PGRC/E208556, Holetta-1) was above two meters in heights and below two meters was recorded for the varieties of PGRC/E 20112/1, PGRC/E 21369/1/1 and PGRC/E 21369/1/4 respectively. The highest plant height was observed for the varieties Yellow Dodolla and PGRC/E 21369/1/2 (208m) and the least was for PGRC/E 21369/1/4 (186m). Major diseases (as shown in table 3) of Ethiopian mustard varieties like, Leaf spot and Downey mildew cased by *alternaria brassicae*, *peronospora parsitica* respectively was observed in all varieties with slight severity of leaf spot. The mean average number of primary branches of the tested genotypes ranges from 8 (for PGRC/E21369/1/2) to 11 (for PGRC/E 208585 and PGRC/E208524). On the other hand number of secondary branches also ranges from 8 (for PGRC/E21369/1/2, PGRC/E 21369/1/4 and PGRC/E 21176) to 15 (for PGRC/E 208585). Over all among the tested genotypes the highest number of primary branches, number of secondary branches and number of pods per plant, 11, 15 and 239 was observed respectively for the genotype PGRC/E 208585.On the other hand number of pods per plant was similar for genotypes PGRC/E 208585 and Yellow Dodolla (239 pods/per plant).

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Table 3: Pre harvest mean agronomic characteristics of 13 mustard varieties tested at Holetta agricultural research centre during 2007/08 cropping season

No	Genotype	Flowering	Maturity	Leaf spot (0-5)	Downey Mildew (0-5)	height cm	branches	branches	pods
1	PGRC/E 21369/1/1	77	178	1.7	0.8	197	9	9	166
2	PGRC/E 21369/1/2	75	177	1.7	0.8	208	8	8	184
3	PGRC/E 21369/1/4	77	178	1.7	0.9	186	9	8	208
4	PGRC/E 20112/1	85	183	1.0	0.9	198	10	9	195
5	PGRC/E 208585/1	79	179	1.8	0.9	202	9	10	191
6	PGRC/E 208556	82	181	1.5	0.8	202	9	9	211
7	PGRC/E 21176/1/1	82	180	1.3	0.9	207	9	8	187
8	PGRC/E 208528/2	85	184	1.0	0.9	206	9	7	198
9	PGRC/E 208524	80	177	1.3	0.9	202	11	13	221
10	PGRC/E 208585	89	184	1.2	0.9	207	11	15	239
11	Yellow Dodolla	80	181	1.7	0.8	208	10	9	239
12	Holetta-1	74	177	2.2	0.8	202	9	9	175
13	Local check	74	175	2.2	0.7	204	9	9	187
	Mean	80	179	1.6	0.9	202	9	9	200
	CV (%)	1.58	0.54	17.50	15.22	4.86	7.8	5.75	16.37
	LSD (5%)	1.76	1.34	0.38	0.2	13.72	1.02	5.04	45.74

As shown in table 4 among the tested varieties, PGRC/E 208585, PGRC/E 208528/2 and PGRC/E 208556 in seed yield and oil yield are first, second and third respectively. Among the tested genotypes seven genotypes (PGRC/E208585, PGRC/E208528/2, PGRC/E208556, PGRC/E21369/1/2, PGRC/E21176/1/1, PGRC/E 21369/1/1 and PGRC/E208524) gave the highest seed yield over the mean of the standard checks respectively. Ten genotypes (PGRC/E208585, PGRC/E208528/2, PGRC/E208556, Yellow Dodolla, PGRC/E21369/1/2, PGRC/E21176/1/1, PGRC/E 21369/1/1, PGRC/E208524, PGRC/E21369/1/4 and PGRC/E 208585/1) also gave the highest seed yield from Holetta-1 recently released standard check. Among the tested genotypes except PGRC/E 20112/1 all genotypes including the standard checks gave the highest seed yield above the local check genotype and the lowest yield was for PGRC/E 20112/1(1.90t/ha). The yield range was 1.90 t/ha (PGRC/E 20112/1) to 2.77 t/ha (PGRC/E 208585). Oil content ranges from 39.6 % (PGRC/E 208585/1) to 43.7 % (PGRC/E 208524). In oil content aspect only one genotype (PGRC/E 208524) gave the highest oil content percent, i.e., 43.7% from all tested genotypes and standard checks. The oil yield ranges from 0.77 t/ha (PGRC/E 20112/1) to 1.16 t/ha (PGRC/E 208585) and almost one variety (PGRC/E 20112/1) gave comparable seed yield with local check. The number of seeds per plants was highest for the genotype PGRC/E 208524 (3347) and it ranges in number from 2124 (PGRC/E 21176/1/1) to 3347 (PGRC/E 208524). In thousand seed weight Holetta –1 gave the highest thousand seed weight (5.0 gm) from all tested genotypes. It also ranges from 4.0gm (for PGRC/E 208585 and PGRC/E 20112/1) to 5.0 gm (Holetta-1).

Table 4: Post harvest mean agronomic characteristics of 13 mustard varieties tested at Holetta agricultural research centre during 2007/08 cropping season

No	Genotype	Number of seeds	Seed yield t/ha	Oil content %	Oil yield t/ha	1000seed weight (gm)
1	PGRC/E 21369/1/1	2418	2.32	39.7	0.92	4.3
2	PGRC/E 21369/1/2	3068	2.37	39.9	0.94	4.4
3	PGRC/E 21369/1/4	2684	2.15	40.2	0.86	4.3
4	PGRC/E 20112/1	2790	1.90	40.4	0.77	4.0
5	PGRC/E 208585/1	2688	2.12	39.6	0.84	4.5
6	PGRC/E 208556	2723	2.58	41.3	1.07	4.1
7	PGRC/E 21176/1/1	2124	2.36	41.5	0.98	4.3
8	PGRC/E 208528/2	3004	2.74	41.1	1.13	4.2
9	PGRC/E 208524	3347	2.24	43.7	0.98	4.4
10	PGRC/E 208585	3083	2.77	41.7	1.16	4.0
11	Yellow Dodolla	2538	2.41	43.5	1.05	4.9
12	Holetta-1	2380	2.05	40.9	0.84	5.0
13	Local check	2496	1.99	40.5	0.81	4.7
	Mean	2719	2.308	41.09	0.95	4.4
	CV (%)	3.73	11.03	2.43	11.98	6.05
	LSD (5%)	1129.9	0.3554	1.397	0.159	0.37

Again Among the tested varieties, PGRC/E 208585, PGRC/E 208528/2 and PGRC/E 208556 gave 24.22 %, 22.87 % and 15.69 % increment in seed yield respectively over the mean of standard checks and at the same time these varieties gave 39.76%, 36.14% and 28.91 % increment in oil yield respectively (Table 5). From the tested genotypes PGRC/E 208524, PGRC/E 208585 and Yellow dodolla gave 7.37 %, 6.88 % and 2.46 % increment in oil content percent respectively over the mean of standard checks. Among the tested genotypes 38.46% showed positive increment in oil content percent ranging 0.98% to 7.37 % while 46.15% of genotypes showed negative increment over the mean of standard checks. On the other side from the tested genotypes PGRC/E 208524, P% GRC/E 208585 and PGRC/E 21369/1/2 gave 36.11 %, 25.37 % and 24.77 % increment in number of seeds respectively over the standard checks.

Table 5: Percent increase in number of seeds; seed yield and oil yield of the tested mustard varieties over the mean of standard checks

No	Variety	SY	Inc %	NS	Inc %	OC	Inc %	OY	Inc%
1	PGRC/E 21369/1/1	2.32	4.03	2418	-1.67	39.7	-2.46	0.92	10.84
2	PGRC/E 21369/1/2	2.37	6.27	3068	24.77	39.9	-1.97	0.94	13.25
3	PGRC/E 21369/1/4	2.15	-3.59	2684	9.15	40.2	-1.23	0.86	3.61
4	PGRC/E 20112/1	1.90	-14.78	2790	13.46	40.4	-0.74	0.77	-7.22
5	PGRC/E 208585/1	2.12	-4.93	2688	9.31	39.6	-2.7	0.84	1.20
6	PGRC/E 208556	2.58	15.69	2723	10.74	41.3	1.47	1.07	28.91
7	PGRC/E 21176/1/1	2.36	5.83	2124	-13.62	41.5	1.97	0.98	18.07
8	PGRC/E 208528/2	2.74	22.87	3004	22.16	41.1	0.98	1.13	36.14
9	PGRC/E 208524	2.24	0.45	3347	36.11	43.7	7.37	0.98	18.07
10	PGRC/E 208585	2.77	24.22	3083	25.37	41.7	2.46	1.16	39.76
11	Yellow Dodolla	2.41	8.07	2538	3.21	43.5	6.88	1.05	26.50
12	Holetta-1	2.05	-8.07	2380	-3.21	40.9	0.49	0.84	1.20
13	Local check	1.99	-10.76	2496	1.50	40.5	-0.49	0.81	-2.41
Mean		2.308	3.49	2719	10.57	41.09	0.96	0.95	14.46

NS: number of seeds, SY: seed yields, OC: oil content, OY: oil yield, Inc%: increment percent

Correlation among Traits

A correlation of yield and yields components of the tested mustard varieties during 2007/08 cropping season are presented in table 6. Oil content percent was non-significantly correlated with seed yield (r: 0. 239) while oil yield highly significantly correlated with seed yield (r: 0. 976) and oil content percent(r: 0. 443). Date of 50% flowering was highly significant and significantly correlated with oil yield (r: 0. 432) and least significantly correlated with seed yields(r: 0.405) and non-significantly with oil contents(r: 0. 266). On the other side date of 50% maturity was also highly and significantly correlated with seed yield (r: 0. 435), oil yield(r: 0. 436), date of 50% flowering (r: 0. 888) and non-significantly correlated with oil content(r: 0. 153). As already explained days to 50% flowering as well as days to 50% maturity had significant positive correlation with seed yield and oil yield indicating that the seed grain produced during growth as well as maturity period was altered to the seed embryo and utilized in the physiological maturity of grains that result good yield and oil yield. Number of primary branches was highly significantly correlated with oil content percent(r: 0. 458), date of 50 % flowering(r: 0. 421) and least significantly correlated with oil yield (r: 0. 341), Date of 50% maturity and none significantly for seed yield (r: 0. 261).

Number of secondary branches was highly significantly correlated with primary branches (r: 0. 601) and least significantly correlated with oil yield (r: 0. 342) and none significantly for seed yield (r: 0. 319), oil content(r: 0. 219) and date of 50% flowering(r: 0. 176) and Date of 50% maturity(r: 0. 143). Number of primary branches as well as Number of secondary branches showed non-significant positive correlation with seed yield indicating that the presence of branches was more important at the lower plant population density. On the other hand number of pods was highly and positively correlated with oil content(r: 0. 425), date of 50% flowering (r: 0. 422), number of primary branches(r: 0. 0.544) and number of secondary branches(r: 0. 0.451) and significantly correlated with oil yield (r: 0. 382) and non-significantly correlated with seed yield(r:0. 306) and date of 50%t maturity (r:0. 309). Number of pods per plant also shown the non-significant positive correlation with seed yield indicating that number of pods or pod bearing nods also decrease as

density of plant population increased. A fundamental objective of agricultural plant breeding is to increase yield. This requires not only an identification of the more important components of yield but also the possibility of exerting selection pressure in favor of these components. The correlation coefficients shows that the number of seeds per plants were highly and positively correlated with number of primary branches(r:0. 451), secondary branches, (r:0. 473) and number of pods (r:0. 524) and least significantly correlated with seed yield(r:0. 337) and none significantly correlated with oil content percent(r:0. 125), oil yield (r :0. 337), date of 50% flowering (r:0. 229) and 50 % date of maturity (r:0. 09). On the other side it was negatively non-significantly correlated with Plant height(r:-0. 061). Thousand seed weight was highly significantly negatively correlated with date of flowering (r:-0. 573) and date of maturity (r:-0. 477). The correlation coefficients show that number of seeds per plant is the components of yield most significantly correlated with yield, primary branches, secondary branches, and number of pods therefore, perhaps the most important determinant of yield. However there was little difference in the size of the correlation coefficients between of number of seeds, primary branches, secondary branches, number of pods and seed yield, which confirms other suggestions that number of pods may be crucial determinants of yield in mustard varieties. The result supports the suggestion of Hardwick (1988) that the determination of yield by assimilate production and utilization is too simplistic and, that, since yield component compensation reduces the effective ness of the increased selection pressure in favor of particular components, a greater understanding the physiological interactions between one component and another is required if rapid improvements in yield are to be achieved by plant breeding.

Table 6: Correlation coefficients between yield and yield components in13 Ethiopian mustard Varieties tested at Holetta in 2007/08 cropping season

	YT	OC	OY	DF	DM	PBR	SBR	NPS	PH	NS
OC	0.239ns									
OY	0.976**	0.443**								
DF	0.405*	0.266ns	0.432**							
DM	0.435**	0.153ns	0.436**	0.888**						
PBR	0.261ns	0.458**	0.341*	0.421**	0.408*					
SBR	0.319 ns	0.219ns	0.342*	0.176ns	0.143ns	0.601**				
NPS	0.306 ns	0.425**	0.382*	0.422**	0.309ns	0.544**	0.451**			
PH	0.134 ns	0.277ns	0.184ns	0.084ns	0.139ns	-0.006ns	-0.031ns	-0.256ns		
NS	0.337*	0.125ns	0.337ns	0.229ns	0.090ns	0.451**	0.473**	0.524**	-0.061ns	
TSW	-0.127ns	0.086ns	0.098ns	-0.573**	-0.477**	-0.104ns	-0.008ns	-0.101ns	0.566ns	-0.208ns

YT: yield in tones, OC: oil content, OY: oil yield, DF: date of flowering, DM: date of maturity, PBR: primary branches, SBR: secondary branches, NPS: number of pods per plant, PH: plant height, Ns: number of seeds: TSW: thousand seed weight, **: highly significant at 1 %, * significant at 5%, ns: non significant at 5% level.

4. CONCLUSION

More important components of yield for the tested mustard varieties were number of seeds per plant, number of primary branches per plant, number secondary branches per plant and number of pods per plant. Based on these major traits of yield components three genotypes namely PGRC/E 208585, PGRC/E 208528/2, PGRC/E 208556 gave comparable seed yield, oil content, oil yield, number of seeds per plant and these varieties were also comparable for their reaction to major disease. These varieties with the highest yield component characters can be selected and grown in western zone of Shewa. Indeed in general, PGRC/E 208585 gave highest mean seed yield, oil yield, primary branches, secondary branches, number of pods per plant and had desirable yield component traits. This variety is recommended for further improvement and production in western Shewa, Oromia.

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APPENDIX - A

Appendix I: Weather data of experimental site (Holetta agricultural research Center) in 2007/08 cropping season

	Jan.	Feb.	March.	April.	May.	Jun.	Jul.	August.	Sep.	Oct.	Nov.	Dec.
Rainfall (mm)	0.0	14.0	61.2	36.4	75.5	253.3	159.3	249.5	90.0	18.8	0.0	0.0
Maximum temperature	23.5	23.5	24.0	23.0	24.0	21.2	19.0	19.1	19.6	21.0	22.0	24.6
Minimum temperature	4.6	6.4	6.2	8.8	8.5	8.3	10.0	9.4	8.3	4.3	4.2	-0.2
Relative humidity	56	37	49	54	63	77	83	82	59	54	33	44