

Characterization of Rapeseed (*Brassica napus*) Genotypes on the basis of Phenotypic Traits**Sajjad Ali khan¹, Azhar Hussain Shah^{2*}, Fayaz Ahmad³, Arshad Ali⁴ and Hafsa Umer⁵**

1. Department of Botany, Hazara University, Mansehra
2. Department of Genetics, Hazara University, Mansehra
3. Senior Research Officer, Agriculture Research Center, Swat
4. Department of Zoology, Hazara University, Mansehra
5. Department of Chemistry, Hazara University, Mansehra
6. Department of Zoology, University of Malakand, Lower Dir.

***Corresponding author e-mail:** ahshahhu@gmail.com, azharshah25@yahoo.com**SUMMARY**

The present research study was conducted from October 2011 to May 2012 at the Agricultural Research Institute (ARI) Takhtaband, Mingora Swat, Pakistan. We used Randomized Complete Block Design (RCBD) with three (3) replications for ten quantitative characters i.e. Days to 50% Germination, Flowering, Pod Formation, Maturity, Plant Height (cm), Number of pods /Plant, Number of Seed /Pod, Plant Population, 1000 seed weight (gm) and Seed yield Kg /hectare. A total of 30 genotypes (401 B, 1200, 1301, 1505, 1600, 1701, 2715, 2717, 2723, 2723 B, 2801, 2812, Kabal, Swabi, 1300, 1700, 1801, 1802, 1803, 1804, 1806, 2000L, 2000M, Zarshad, 2768, 2769, 2780, 2785, 2788, Zafar) were evaluated to select high yielding genotypes of rapeseed based on morphogenic traits. The genotypes showed great variation for almost all the Morpho-agronomic traits. The highest 1000-seed weight (4.8g) was recorded for genotype 1301. The minimum weight (2.8g) of 1000-seeds was demonstrated by genotype Kabal. Among the entire evaluated genotypes maximum seeds yield was obtained by genotype 2785 (3522.2 kg per hectare), followed by genotypes 2000L (3112.2 kg per hectare), 1505 (3050.2 kg per hectare), 2788 (3044.4 kg per hectare) and 723B (2933.3 kg per hectare), While the minimum yield was obtained by genotype Zarshad (1077.1 kg per hectare). Our results show that genotypes 1505, 1600, 2715, 2723, 2723B, 2812, Kabal, 2000L, 2000M, and 2785 performed well for almost all the agronomic traits contributing towards yields, hence these genotypes are recommended for general cultivation both in spring and kharif seasons in the district Swat.

Keywords: Randomized Complete Block Design, Swabi, Pod Formation**INTRODUCTION**

The Cruciferae (Brassicaceae) is one of the biggest angiosperm's family, consisting about 340 genera and more than 3350 species (Al-Shehbaz, 1984). Brassica is a highly diverse genus of plants belonging to this family which provide edible roots, leaves, stems, buds, flowers and seed (AVRDC, 2000). containing 37 different species Brassica may either be diploid or amphiploid in nature. The diploid or elementary species includes Brassica oleracea ($2n=18$), Brassica campestris ($2n=20$) and Brassica nigra ($2n=16$). Amphidiploid species includes Brassica napus ($2n=38$), Brassica carinata ($2n=34$) and Brassica juncea ($2n=36$) (Habib et al., 2004). Of greatest importance in the world are the species Brassica napus, Brassica rapa, and

Brassica juncea as sources of edible oil, *Brassica oleracea* as a source of vegetable crops; and the species *Raphanus sativa* and *Sinapis alba*, along with *Brassica nigra* are sources of condiment mustard (Gomez-Campo 1980; Rahman, 2001).

Brassica napus has glaucous, dark bluish green foliage, partially clasping, and smooth, or with a few scattered hairs near the margins. The plant is grown on marginal lands. The stems are well branched, branches initiate in the axils of the maximum leaves on the stem, and each terminates in an inflorescence. The inflorescence is an elongated raceme, the flowers are yellow, clusters at the apex but not superior than the terminal buds and open upwards from the bottom of the raceme (Musil, 1950). *Brassica napus* is cultivated chiefly for the production of oil. *Brassica* species, supply more than 13 % of the world's edible oils and rank third after soybean and oil palm (Stewart et al., 1996).

Rapeseed contains an average of 40-50% oil, 25% protein and 20% Polysaccharides (Murat and Cifci, 2007), 40-45% oil in seeds and at least 46.5% protein, 3.5% fat and 0.35% phosphorus in the meal, is a valuable oil crop in oil industry and animal feed (Downy et al., 1989). Canola oil is extensively use for salad oil, making margarine and cooking oil (Sovero, 1993). Mainly two types of oilseed crops are grown within Pakistan i.e., non-traditional and traditional. Non-traditional oilseed crops are (sunflower, safflower and soyabean) while Traditional are (rapeseed-mustard and groundnut). Rapeseed-mustard is the major contributor among traditional oilseed crops (Ali and Mirza, 2005). It is sown from mid-September to mid-November throughout the country. In Pakistan, *Brassica* is represented by 8 species (Nasir and Ali, 1973). In Pakistan the entire cropped area is 23.68 million hectares in which 0.807 million hectares are oilseed crops which become approximately 3% of the entire cropped area. The cultured area is 21.17 million hectares in which about 4.92 million hectare is recent fallow. On the basis of province division of the total cultivated parts are 4.88 million hectares (Sindh), 12.41 million hectares (Punjab), 1.96 million hectares (Balochistan) and 1.91 million hectares in Khyber Pakhtunkhwa (Government of Pakistan, 2008).

Information of genetic variation has become most dangerous and deciding factor in every future breeding program of these composite crop species. Keeping this in view present piece of research work was an attempt to find out the genetic diversity of canola germplasms with the following objectives:

1. To assess high yielding and short duration varieties among the various genotypes.
2. To identify the most appropriate cultivar for the environment in Swat.
3. To measure amount of yield potential of rapeseed genotypes for future utilization.
4. To provide basic information of rapeseed genotypes for future breeding programme.
5. To evaluate genetic variation present in the genotypes of rapeseed.

MATERIALS AND METHODS

Sources of Genetic Materials; To assess the quantity of differences that may be present in the agronomic and morphological character of rapeseed, thirty genotypes including 401 B, 1200, 1301, 1505, 1600, 1701, 2715, 2717, 2723, 2723 B, 2801,

2812, Kabal, Swabi, 1300, 1700, 1801, 1802, 1803, 1804, 1806, 2000L, 2000M, Zarshad, 2768, 2769, 2780, 2785, 2788, Zafar were collected from different research station of the Khyber Pakhtunkhwa.

The research was laid out at the Agricultural Research Institute (ARI) Takhtaband, Mingora Swat, Pakistan during 2012. Randomized Complete Block Design (RCBD) was used with 3 replications. All replications consist of 30 plots and every plot has 4 rows. Every row was 5m long and the distance among row to row was 45 cm. The plot size was 5 m \times 1.8 m = 9 m². Initially, the land was ploughed and brought into a well tilt by crushing the clods and harrowing it two times. Seeding was done by the direct method watering, fertilizers, thinning the plants and weeds control. The entire recommended local practices were used for raising a healthy Rapeseed crops. A basal dose of fertilizer, NP k g/ha (75: 60) were used in split doses, one at the time of sowing and the other at the time of flower initiation. For each parameter data was collected from 5 randomly selected plants within each plot and then averaged.

Parameters Studied; During the present research work the following ten quantitative characters were studied. Days to 50% Germination, Days to 50 % Flowering, Days to 50% Pod Formation, Days to Maturity, Plant Height (cm), Number of pods per Plant, Number of Seed per Pod, Plant Population, 1000 seed weight (gm).

Seed Yield Kg per hectare; The grain shelled from the ear and weighted in kilogram (kg) through electric balance. After that grain yield kilogram (kg) was changed into kg per hectare using the formula

STATISTICAL ANALYSIS

The data was subjected to statistical analysis using the statistical software SPSS 16.0 and Statistix 9 for the above-mentioned traits. Analysis of Variance (ANOVA) and the Least Significant Difference (LSD) test were done with the help of Statistix 9 at 0.05 probability level. While Correlation analysis was done with the help of SPSS 16.0.

RESULTS AND DISCUSSION

QUANTITATIVE CHARACTERISTICS OF BRASSICA GENOTYPES

Days to 50% Germination: In present research work rapeseed genotypes observed variation in the studied quantitative traits. Days to 50% germination showed significant variation in the current study. For germination of genotypes 1806 and 2000M Maximum days (7) were recorded. while minimum days (4) for germination were recorded for genotypes 1200, 1301, 1505, 1600, 1701, 2717, 2723, 2723B, 2769 and 2788 respectively as shown in Table 1. Torabi and Rabii, (2013) found significant variation in days to germination.

Days to 50 % Flowering

The rapeseed genotypes showed significant Variability in days to 50% flowering. Maximum number of days (142.67) was recorded for genotype 1802 while genotype 1301 recorded the minimum number of days (106) as illustrated in Table 1. Our results are in line with the earlier results of Choudhary and Joshi, (2001); Jeena and

Sheikh, (2003) and Perveen et al., (2005) who also found significant variation in days to 50% flowering.

Days to 50% Pod Formation

A great variation was found in days to 50% pod formation. The maximum number (149) of days to 50% pod formation was observed in genotypes 1802, 2000L and 2769 whereas the minimum number (123) of days was observed in genotypes 1701 and 2715 as illustrated in Table 1. Our findings are similar to the results of Perveen et al., (2005) and Mir, (2007) who also recorded significant amount of variability days to 50% pod formation.

Days to Maturity

Significant variations were observed in days to maturity as demonstrated in Table 1. Maximum number (200.33) of days to maturity was by genotype 1806 whereas the minimum number (182.33) days to maturity was showed by genotype 1301. Marjanovic-Jeromela et al., (2011) and Mekonnen et al., (2013) recorded great differences in days to maturity in their study.

Plant Height (cm)

Plant height showed significant variation as displayed in Table 1. The genotype swabi showed a height of 144 cm while the genotype Zafar the minimum height of 38.67 cm. These results agree with the results of Choudhary and Joshi, (2001); Khan and Khan, (2003); Jeena and Sheikh, (2003); Tuncur et al., (2005) and Perveen et al., (2005) also found different amount of variability for plant height.

Number of pods per Plant

The findings of the present work recorded significant differences in the number of pods plant-1 as shown in Table 2. The genotype 2801 recorded the highest number (227.67) whereas the genotype 2717 recorded the lower number (50.33) of pods plant-1. Khan and Khan, (2003); Jeena and Sheikh, (2003); Anjum et al., (2005); Tuncur et al., (2005) also found significant variability in number of pods per plant in their study.

Number of Seed per Pod

Variation in the number of seed per pod was significant. The highest number (19) was showed by genotypes 2780 and 2785 whereas the lowest number (7) was showed by genotype Zafar as shown in Table 2. Our findings are similar with the results of Anjum et al., (2005) and Tuncur et al., (2005) who found significant differences in number of seed pod-1.

Plant Population

Plant population showed significant variation as illustrated in Table 2. The genotype Zarshad showed the maximum (45.667) while genotypes 2812 and 2785 showed the minimum (19) population of plant. Rad and Zandi, (2012) also recorded significant differences in plant population.

1000 seed weight (gm)

Thousand seed weight recorded great variation as demonstrated in Table 2. The maximum weight (4.8 gm) was recorded by genotype 1301 whereas the minimum weight (2.8 gm) was recorded by genotype kabal. Similarly, Choudhary and Joshi, (2001); Jeena and Sheikh, (2003) and Tuncur et al., (2005) also noticed significant variation in thousand seed weight in their research work.

Seed Yield Kg per hectare

In the present study seed yield recorded significant differences as shown in Table 2. Maximum seeds yield (3522.2 kg ha⁻¹) was recorded in genotype 2785 whereas the minimum seeds yield (1077.1 kg ha⁻¹) was recorded by genotype Zarshad. Our findings agree with the results of Anjum et al., (2005); Tuncur et al., (2005); Perveen et al., (2005) and Aytac and Kınac, (2009) who also reported significant differences seed yield amongst Rapeseed genotypes.

Table 1: Analysis of Variance and LSD Test for Rapeseed Genotypes

S.No	Genotypes	Means of 50% Germination	means of 50% Flowering	Means of 50% Pod formation	Means of Maturity	Means of Plant height
1	401B	5.0000 BCD	110.67 IJK	126.00 GH	193.00 GH	109.33 H
2	1200	4.0000 CD	110.00 IJKL	146.00 ABCD	183.67 IJK	85.33 NO
3	1301	4.0000 D	106.33 L	124.33 H	182.33 K	84.67 O
4	1505	4.0000 CD	129.00 BCD	145.00 BCD	183.00 IJK	87.33 N
5	1600	4.0000 CD	115.33 GH	129.67 FG	184.00 IJK	93.00 L
6	1701	4.0000 CD	108.67 KL	123.33 H	182.67 JK	98.67 K
7	2715	4.0000 CD	109.00 JKL	123.00 H	184.00 IJK	85.33 NO
8	2717	4.0000 CD	130.33 BC	143.67 CDE	184.33 IJ	114.00 G
9	2723	4.0000 CD	115.67 GH	129.33 FG	184.67 I	90.00 M
10	2723B	4.0000 CD	109.67 IJKL	126.33 GH	183.00 IJK	97.00 K
11	2801	5.0000 BCD	111.00 IJK	146.33 ABC	193.00 GH	116.67 F
12	2812	5.0000 BCD	115.33 GH	145.33 ABCD	192.33 H	132.33 C
13	Kabal	5.0000 BC	125.00 EF	145.00 BCD	192.33 H	135.33 B
14	Swabi	6.0000 AB	130.00 BCD	142.00 DE	191.67 H	144.00 A
15	1300	6.0000 AB	110.67 IJK	146.00 ABCD	199.67 ABC	92.00 LM
16	1700	6.0000 AB	116.00 GH	129.33 FG	199.67 ABC	118.67 EF
17	1801	6.0000 AB	131.00 B	146.33 ABC	198.33 BCD	104.00 I
18	1802	6.0000 AB	142.67 A	149.33 A	197.00 DE	104.33 I
19	1803	6.0000 AB	128.33 BCDE	145.33 ABCD	199.67 ABC	119.00 EF
20	1804	6.0000 AB	128.33 BCDE	145.00 BCD	199.00 ABC	116.67 F
21	1806	7.0000 A	128.00 BCDE	146.00 ABCD	200.33 A	111.00 H
22	2000L	6.0000 AB	127.00 CDEF	149.00 AB	199.00 ABC	101.33 J
23	2000M	7.0000 A	118.67 G	132.00 F	200.00 AB	106.00 I
24	Zarshad	6.0000 AB	116.00 GH	131.00 F	198.00 CD	96.33 K
25	2768	5.0000 BC	113.00 HI	130.00 FG	194.33 FG	118.67 EF
26	2769	4.0000 CD	113.00 HI	149.00 AB	194.33 FG	108.67 H
27	2780	5.0000 BC	123.33 F	140.00 E	194.33 FG	119.67 E
28	2785	5.0000 BCD	126.33 DEF	143.00 CDE	194.33 FG	129.00 D
29	2788	4.0000 CD	108.33 KL	125.00 H	183.33 IJK	75.00 P
30	Zafar	5.0000 BCD	116.00 GH	146.67 ABC	195.67 EF	38.67 Q
LSD Value at α level 0.05		1.6212	3.9055	4.0301	1.9267	2.5350

Table 2: Analysis of Variance and LSD Test for Rapeseed Genotypes.

S. No	Genotypes	Means of Pods Plant-1	Means of Seed Pod-1	Means of Plant Popn	Means of 1000 Seed Weight	Means of Seed Yield Kg Hectare-1
1	401B	134.00 HI	15.000DEFGH	30.333 GHI	4.7A	1610.2 R
2	1200	130.33 HIJ	9.000 LM	21.667 OPQ	3.8 GH	2155.2 J
3	1301	136.67 HI	16.667 BCD	30.333 GHI	4.8 A	1944.4 O
4	1505	104.67 LMN	13.667 FGHIJ	41.000 B	4.1 DE	3050.2 C
5	1600	149.33 FG	12.667 IJ	34.333 CD	4.0 EF	2855.2 E
6	1701	171.00 CD	12.667 IJ	31.667 EFG	4.0 EF	2210.2 H
7	2715	164.67 CDE	16.000 CDE	34.000 DE	4.2 CD	2655.1 F
8	2717	50.33 S	13.333 GHIJ	29.000 HIJ	4.4 B	1985.3 N
9	2723	92.67 OPQ	17.000 ABCD	40.333 B	3.8 GH	2844.4 E
10	2723B	98.67 MNO	15.333CDEFG	30.000 GHI	4.1 DE	2933.3 D
11	2801	227.67 A	13.000 HIJ	30.333 GHI	4.2 CD	2122.2 K
12	2812	160.00 DEF	10.000 KL	19.000 R	3.9 FG	2644.4 F
13	Kabal	95.67 NOP	8.333 LM	24.333 MN	2.8 L	2522.2 G
14	Swabi	158.00 EF	12.000 JK	24.000 MNO	3.2 K	2185.3 I
15	1300	172.67 C	10.000 KL	45.333 A	4.4 B	1522.2 T
16	1700	140.67 GH	14.333 EFGHI	29.000 HIJ	3.2 K	1844.4 P
17	1801	196.00 B	15.333CDEFG	28.333 IJK	4.1 DE	1144.4 W
18	1802	140.33 GH	15.667 CDEF	33.333 DEF	4.4 B	1933.3 O
19	1803	111.67 KL	10.333 KL	21.333 PQR	3.1 K	1322.2 V
20	1804	120.67 JK	13.000 HIJ	23.333 NOP	3.6 IJ	2044.4 L
21	1806	156.00 EF	10.333 KL	25.333 LMN	4.1 DE	1455.5 U
22	2000L	128.67 IJ	12.667 IJ	29.667 GHI	3.7 HI	3112.2 B
23	2000M	54.33 S	9.333 L	26.000 KLM	3.5 J	1721.2 Q
24	Zarshad	78.33 R	14.000EFGHIJ	45.667 A	4.3 BC	1077.1 X
25	2768	115.00 KL	13.333 GHIJ	31.000 FGH	4.4 B	1583.7 S
26	2769	139.67 GHI	17.333 ABC	27.000 JKL	4.1 DE	1985.3 N
27	2780	111.67 KL	19.000 A	30.000 GHI	3.9 FG	2021.2 M
28	2785	109.33 KLM	19.000 A	19.000 R	4.2 CD	3522.2 A
29	2788	86.00 PQR	18.333 AB	36.667 C	3.6 IJ	3044.4 C
30	Zafar	83.00 QR	7.000 M	19.667 QR	3.8 GH	2155.2 J
LSD Value at α level 0.05		11.495	2.2804	2.4128	0.1651	16.221

CORRELATION ANALYSIS

Correlation analysis is a practice that explain the quantity of interaction among significant quantitative traits. The interactions among seed yield and other yield traits have been computed and demonstrated in Table 3. In the present study seed yield kg per hectare significantly correlated with plant height (.095* $P \leq 0.05$), plant population (.057*, $P \leq 0.05$), number of pod plant-1 (.139**, $P \leq 0.01$) and number of seed pod-1 (.258**, $P \leq 0.01$). These findings are similar with the results of Marjanovic-Jeromela et al., (2008); Khan and Khan, (2003); Tuncturkt and Ciftci, (2007); Aytac et al., (2008). Days to 50% germination recorded positive significant correlation with days to 50% flowering (.550**, $P \leq 0.01$) and days to maturity (.901**, $P \leq 0.01$). Days to

50% flowering positively associated with days to pod formation (.650**, $P \leq 0.01$). Similarly, Ali et al., (2003) and Ejaz-Ul-Hasan et al., (2014) recorded significant correlation between Days to 50% flowering, days to pod formation, days to maturity and plant height. Days to pod formation displayed positive significant association with days to maturity (.489**, $P \leq 0.01$). Ejaz-Ul-Hasan et al., (2014) also found significant relationship among days to pod formation and days to maturity. The number of pods plant-1 recorded positive significant associations with number of seed pod-1 (.014**, $P \leq 0.01$). Our finding is agreed with the findings of tuncurkt and Ciftci, (2007).

Table 3: Correlation Analysis of Rapeseed genotypes among various quantitative parameters

	DTG	DTF	DTPF	DTM	PH	NPP	NSP	PP	TSW
DTG	.550**								
DTF	.399*	.650**							
DTPF	.901**	.456*	.489**						
DTM	.357	.413*	.227	.321					
PH	.067	.071	.143	.088	.183				
NPP	.369	.061	-.357	-.264	.050	.014**			
NSP	.157	.131	.367	-.211	.329	.006	.312		
PP	-.319	-.206	-.189	.221	-.282	.187	.380*	.377*	
TSW	.491	.112	.094	.537	.095*	.139**	.258**	.057*	.137

**=Correlation is significant at the 0.01 level, *=Correlation is significant at the 0.05 level, DTG=days to 50% germination, DTF=days to 50% flowering, DTPF= days to pod formation, DTM= days to maturity, PH=plant height, NPP= number of pod per plant, NSP= number of seed per pod, PP= plant population, TSW= 1000 seeds weight, SY=seed yield

CONCLUSION

During the present work the 30 genotypes of Rapeseed were evaluated for different morphological and agronomical traits which displayed great variations. Based on these traits the genotypes 1505, 1600, 2715, 2723, 2723 B, 2812, Kabal, 2000L, 2000M, 2785, 2788 have been chosen for the ecological situations of Swat to get maximum production.

RECOMMENDATIONS

For more research work the following recommendations were suggested to be considered. For more study it is essential to assess rapeseed genotypes for DNA variations using biochemical molecular marker to prove variety based on morphological and agronomical traits. Morphological variations of these rapeseed genotypes require confirmation by sowing them in other areas of Pakistan. The chosen rapeseed genotypes are superlative for Swat environment and it require initiating in the open market.

AUTHOR'S CONTRIBUTION

The first and second author design the study and analysed the data. The third author contributed in data arrangement and analysis. The fourth author design the manuscript

and complete the manuscript submission process. The remaining author help in reviewing the manuscript.

REFERENCES

- Ali, N., F. Javidfar, J. Y. Elmira and M. Y. Mirza. 2003. Relationship among yield components and selection criteria for yield improvement in winter rapeseed (*Brassica napus* L.). *Pak. J. Bot.*, 35(2): 167-174.
- Ali, N and M. Y. Mirza. 2005. Present status of research for increased oilseeds production. Proceedings of National Conference on "Achieving Self Sufficiency in Edible Oils". Agricultural Foundation of Pakistan, Islamabad, Pakistan.
- Al-Shehbaz, I.A. 1984. The tribes of Cruciferae (Brassicaceae) in the southeastern United States. *J. Arnold Arbor.* 65: 343–373.
- Anjum, R., M. Yousaf, M. Jahangir, M. Hussain, N. Nawaz and A. Ahmed. 2005. Adaptation and Yield Potential of Different Genotypes of Rapeseed and Mustard under Agro-Climatic Conditions of Bahawalpur (Pakistan). / *Int. J. Agri. Biol.*, Vol. 7, No. 4; 609–611.
- AVRDC (Asian Vegetable Research Development Center). 2000. Evaluation and Selection of Leafy Vegetable Cultivars. Shanhua, Taiwan: Asian Vegetable Research Development Center p. 50 – 55.
- Aytaç, Z and G. Kınac. 2009. Genetic variability and association studies of some quantitative characters in winter rapeseed (*Brassica napus* L.). *African Journal of Biotechnology* Vol. 8 (15), pp. 3547-3554, 4 August, 2009.
- Aytac, Z., G. Kınac, E. Kınac. 2008. Genetic variation, heritability and path analysis of summer rapeseed cultivars. *Journal of Applied Biological Sciences*: 3, 35-39.
- Choudhry, B.R and P. Joshi. 2001. Genetic diversity in advanced derivatives of *Brassica* interspecific hybrids. *Euphytica*, 121:1-7.
- Downy, R. K, G. Robbelen. 1989. *Brassica* species. In: G. Robbelen, et al. (Eds). *Oil crop of the world*. Mc Graw-Hill Publishing Company, (1989).
- Gomez-Campo, C. 1980. Morphology and morpho-taxonomy in the tribe Brassiceae. In *Brassica crops and wild allies*. Edited by S. Tsunoda, K. Hinata, and C. Gomez-Campo. Japan Scientific Societies Press, Tokyo, Japan.
- Habib, A., S. Hasnain and A. Khan. 2004. Genome Biology of the Cultivated *Brassica*. *Quarterly science vision* Vol.9 No.1-2 (Jul - Dec, 2003) & 3-4 (Jan - Jun, 2004).
- Jeena, A. S and F. A. Sheikh. 2003. Genetic divergence analysis in gobbisarson, *Brassica napus* L. *J. Oilseeds Res.*, 20(2): 210-212.
- Khan, R. S. A and F. A. Khan. 2003. Evaluation of Genetic Potential of Some *Brassica* Germplasm Collections. *Int. J. Agri. Biol.*, Vol. 5, No. 4: 630–631.
- Marjanović-Jeromela, A., R. Marinković, A. Mijić, Z. Zdunić, S. Ivanovska, M. Jankulovska. 2008. Correlation and Path Analysis of Quantitative Traits in Winter Rapeseed (*Brassica napus* L.). *Agriculturae Conspectus Scientificus*. Vol. 73 (2008) No. 1 (13-18).
- Marjanovic-Jeromela, A., R. Marinkovic, S. Ivanovska, M. Jankulovska, A. Mijić, and N. Hristov. 2011. Variability of yield determining components in winter rapeseed (*Brassica napus* L.) and their correlation with seed yield.- *Genetika*, Vol 43, No. 1, 51 -66.
- Mekonnen, T. W., A. Wakjira, T. Genet. 2013. Correlation and Path Coefficient Analysis among Yield Component Traits (*Brassica Carinata* A. Brun) in Ethiopian Mustard at Adet, Northwestern, Ethiopia. *International Journal of Cereals and Oilseeds* Vol. 1, No. 1, December 2013, PP: 01 – 16.
- Murat, T and V. Ciftci. 2007. Relationships between yield and some yield Components in rapeseed (*brassica napus* ssp. *Oleifera* L.) Cultivars by using correlation and path analysis. *Pak. J. Bot.*, 39(1): 81-84.
- Musil, A.F. (1950) Identification of Brassicas by seedling growth or later vegetative stages. *USDA Circular* pp. 857. 26.
- MIR, H. R. 2007. Morphophysiological Basis of Variation in Rapeseed (*Brassica napus* L.) Yield. *Int. J. Agri. Biol.*, Vol. 9, No. 5: 701–706.
- Nasir, E and S.I. Ali. 1973. *Brassicaceae*. *Flora of Pakistan*, 55: 17-28.
- Perveen, L., M. Jamal, K. Nawab, M. S. S. Khan. 2005. Comparative performance of local and exotic Canola hybrids for grain yield and oil contents. *Indus J. Biol. Sci.*, 2(4): 503-507.
- Rahman, M.H. 2001. Production of yellow seeded *Brassica napus* through interspecific crosses. *Plant Breeding* 120:463-472.

- Sovero, M. (1993). Rapeseed a new oilseed crop for the United States. In: Janick J, Simon JE (eds.), New Crops. Wiley, New York, USA, pp. 302-307.
- Stewart, C.N., Adang, M.J. All, J.N. Raymer, P.L. S. Ramachandran, and W. A.Parrot.1996. Insect control and dosage effects in transgenic canola containing a synthetic *Bacillus thuringiensis* cryIAc gene. *Plant Physiol.* 112, 115-120.
- Torabi, B and A. Rabii. 2013. Germination Response of Canola (*Brassica napus* L.) to Pre-Soaking Duration. *ntl J Agri Crop Sci.* Vol., 5 (4), 421-425.
- Tunçtürk, M and V. Çiftçi. 2007. Relationships between yield and some yield components in rapeseed (*Brassica napus* ssp. *Oleifera* L.) Cultivars by using correlation and path Analysis. *Pak. J. Bot.*, 39(1): 81-84.
- Tuncturk, M., I. Yılmaz, M. Erman and R. Tuncturk. 2005. Comparison of summer rapeseed (*Brassica napus* subsp. *oleifera* L.) cultivars for yield and yield components under Van ecological conditions. *Tarim-Bilimleri-Dergisi*, 11(1): 78-85.
- Ul-Hasan, E., H.S.B. Mustafa, T. Bibi, T. Mahmood. 2014. Genetic variability, correlation and path analysis in advanced lines of rapeseed (*brassica napus* l.) For yield components. *CercetăriAgronomiceîn Moldova* Vol. XLVII, No. 1(157); 71-79.