RESEARCH

53(259), July 1, 2017

ISSN 2278–5469 EISSN 2278–5450

Discovery

Quantitative and qualitative evaluation of rapeseed (*Brassica napus* L.) genotypes for the development of high yielding canola quality cultivars

Hafiz Saad Bin Mustafa[1☼], Ejaz-ul-Hasan[1], Tariq Mahmood[1], Muhammad Aftab[1], Faisal Saddique[2], Habib-ur-Rehman[2]

1.Directorate of Oilseeds, Ayub Agricultural Research Institute, Faisalabad, Pakistan
2.Department of Plant Breeding & Genetics, University of Agriculture Faisalabad, Pakistan

☼**Corresponding author:**
Directorate of Oilseeds, Ayub Agricultural Research Institute, Faisalabad, Pakistan; Email: saadpbg@gmail.com

Publication History
Received: 28 April 2017
Accepted: 09 June 2017
Published: 1 July 2017

Citation
Hafiz Saad Bin Mustafa, Ejaz-ul-Hasan, Tariq Mahmood, Muhammad Aftab, Faisal Saddique, Habib-ur-Rehman. Quantitative and qualitative evaluation of rapeseed (*Brassica napus* L.) genotypes for the development of high yielding canola quality cultivars. *Discovery*, 2017, 53(259), 380-387

ABSTRACT
The present study was aimed to evaluate rapeseed genotypes on the basis of seed yield and oil quality for the selection of best canola quality strains to overcome the current situation of edible oil in Pakistan. Correlation analysis was also computed to check the relationship between different yield related traits in rapeseed genotypes. Fourteen genotypes of *Brassica napus* were grown in Randomized Complete Block Design with three replications during winter 2015-16. All recommended cultural practices were used

throughout the experiment. The data for days to flowering, days to maturity, plant height, branches per plant, seeds per siliqua, 1000 seed weight and seed yield per plot, oil content, erucic acid and glucosinolates was collected and analyzed. The correlation analysis revealed that seed yield per plot was highly and significantly correlated with number of branches per plant, 1000 seed weight and seeds per siliqua.RBN-13018, RBN-13017 and RBN- 13016 were significantly produced higher seed yield (2.5kg/plot), (2.1kg/plot) & (2.0kg/plot) respectively than the check variety Faisal Canola. These lines also showed their worth in oil quality analysis. The present study has clearly indicated the need for giving due weightage for number seeds per siliqua, 1000 seed weight and number of branches per plant for improving seed yield in Rapeseed.

Keywords: Canola quality, Correlation, Erucic acid, Glucosinolates, Rapeseed, Seed yield.

1. INTRODUCTION

Rapeseed (*Brassica napus* L.) is an important oilseed crop grown in the world. To assure efficient rapeseed production breeders have sighted to produce high yielding and good quality cultivars. The information on the genetic diversity in *B. napus* may help breeders and geneticists to understand the structure of *B. napus* germplasm and to envisagebest combinations for desired traits in next generations (Shengwu*et al.,* 2003). The important species of Brassicas grown for oil purposes are *Brassica campestris* L., *Brassica napus* L., *Brassica juncea* L., *Brassica carinata* L. and *Brassica nigra* L. Different varieties of these species are grown in the semi -arid and arid zones in various regions (Kumar and Rajdeep, 2014).

Rapeseed & Mustard are the third major oilseed crop in the world after soybean and palm oil. The crop grows well under both irrigated and rain-fed conditions and gives good production. But, there exists a big gap between production potential of approved cultivars and average production of farmersin Pakistan (Shekhawat *et al.,* 2012). Pakistan has to face extreme paucity of edible oil due to increase in demand and little local production, thus edible oil production does not match with growing demand of population (Fazal, *et al.,* 2015). Consequently, a huge volume of foreign exchange is spent every year on its import to accommodate the requirement (Hasan*et al.,* 2015). During the year 2013-14, the local edible oil production was 0.573 million tonnes against the 3.20 million tonnes total need and 2.627 million tonnes of edible oil worth US$ 2.50 billion was imported (Govt. of Pakistan, 2014-15).

Traditionally, *B. napus* is not suitable as a source of food for both humans and animals due to the presence of two naturally occurring toxicants, erucic acid and glucosinolates. However, in the 1970s, very vigorous breeding programs in many countries produced high quality varieties that were significantly lower in these two toxicants. The term 'canola' refers to those varieties of *B. napus* that meet specific standards on the levels of erucic acid and glucosinolates. Those cultivars must yield oil, low in erucic acid (below 2 %) and meal low in glucosinolates (total glucosinolates of 30 µmoles/g toasted oil free meal) (CODEX, 1999), and are often referred to as "double low" varieties. Canola lines have become more important in the world, through breeding for better quality of oil and improved processing techniques (OECD Paris, 1997). Low or zero erucic acid contents are desirable in edible oil due to its role as an agent of cardiac problems. Canola is now grown primarily for its seeds which contain about 35 % to over 45 % oil content. Cooking oil is the main use of canola but it is also used in margarine. After oil extraction from seed, the remaining by-product, canola seed meal is used as a high protein animal feed. Seeds per plant is the trait which has a major contribution in seed yield improvement because of high broad sense heritability, highly significant positive correlation and maximum positive direct effects with yield (Hasan, *et al.,* 2014).

All over the world, rapeseed &mustard is used for its appetizing flavor and preservative significance. Its seeds are used mostly for moderating food. Consumption of the oil for edible and non-edible purposes depends upon the composition of different fatty acids like oleic acid, linolenic acid, erucic acid etc. Development of cultivars having oil with high mono-unsaturated, low poly-unsaturated and very low saturated fatty acid contents is required for the frying of food and longer shelf life (Rakow and Raney, 2003).

Seed yield is quantitatively inherited trait and depends upon many other traits. These traits are also inherited quantitatively. The contribution of these factors in yield is also influenced by environment (Yadava*et al.,* 2011). Simple correlation analysis is used to study the association between two traits.A plant breeder must have knowledge about the importance of correlation because it shows the relationship between the different variables which are helpful in the selection of breeding material (Engqvist and Becker, 1993). The present study was planned to study the correlation coefficient between different yield related traits in rapeseed genotypes and evaluate different advanced lines on basis of seed yield and oil quality.

2. MATERIAL AND METHODS

Thirteen promising *Brassica napus*genotypes namely (RBN-11048, RBN-12038, RBN-12049, RBN-13008,RBN-13012, RBN-13015, RBN-13016, RBN-13017, RBN-13018, RBN-13022, RBN-13029, RBN-13030, RBN-13033) and one check variety (Faisal Canola) have been evaluated for seed yield and Canola quality. These genotypes were grown at Oilseeds Research Area,Ayub Agricultural Research Institute, Faisalabad (Pakistan) in Advance Yield Trial (AYT) during Rabi season (winter season) 2015-16. Presently, grown canola cultivar "Faisal Canola" was used as check variety for the evaluationseed yield and other characteristics. The trial was sown by following randomized complete block design (RCBD) with three replications. The plot size for each genotype was 16.5 feet long and 4.5 feet wide in each replication. Seeds were planted with the help of a seed drill and the distance between three rows of each genotype was kept 45cm. Standard agronomic and cultural practices recommended for Rapeseed cultivation were applied to the experiment throughout the growing season. The data regarding seed yield and other agronomic traits along with quality characters was collected during different growth stages. Randomly selected plants were tagged to record data for days to 50% flowering, days to maturity, plant height (cm), branches per plant, seeds per siliqua, 1000 seed weight (g) and seed yield per plot (kg). Nuclear Magnetic Resonance apparatus (MQA 7005 Oxford) were used to estimate the oil percentage while quality of oil (fatty acid profile & 00) was determined by Gas Chromatograph apparatus (Varian CP-3900) in Hi-Tech Oil Technology laboratory of Oilseeds Research Institute, Faisalabad, Pakistan.Weather records on rainfall, temperature and relative humidity (Figure 1 and Figure 2,)were collected from Meteorological department, Govt. of the Punjab (Pakistan) and www.worldweatheronline.com.

Statistical analysis

Correlation analysis was performed to estimate the relationship between different traits and seed yield as described by Kwon and Torrie (1964) using computer software Statistix 8.1.

3. RESULTS AND DISCUSSIONS

The data presented in Figure 1 showed the maximum, minimum and mean temperature during the growing season of rapeseed in Faisalabad, Pakistan. The temperature was high during germination and seedling stages and gradually decreased at vegetative growth stages. After flowering, the temperature was again rising till harvesting of the crop.

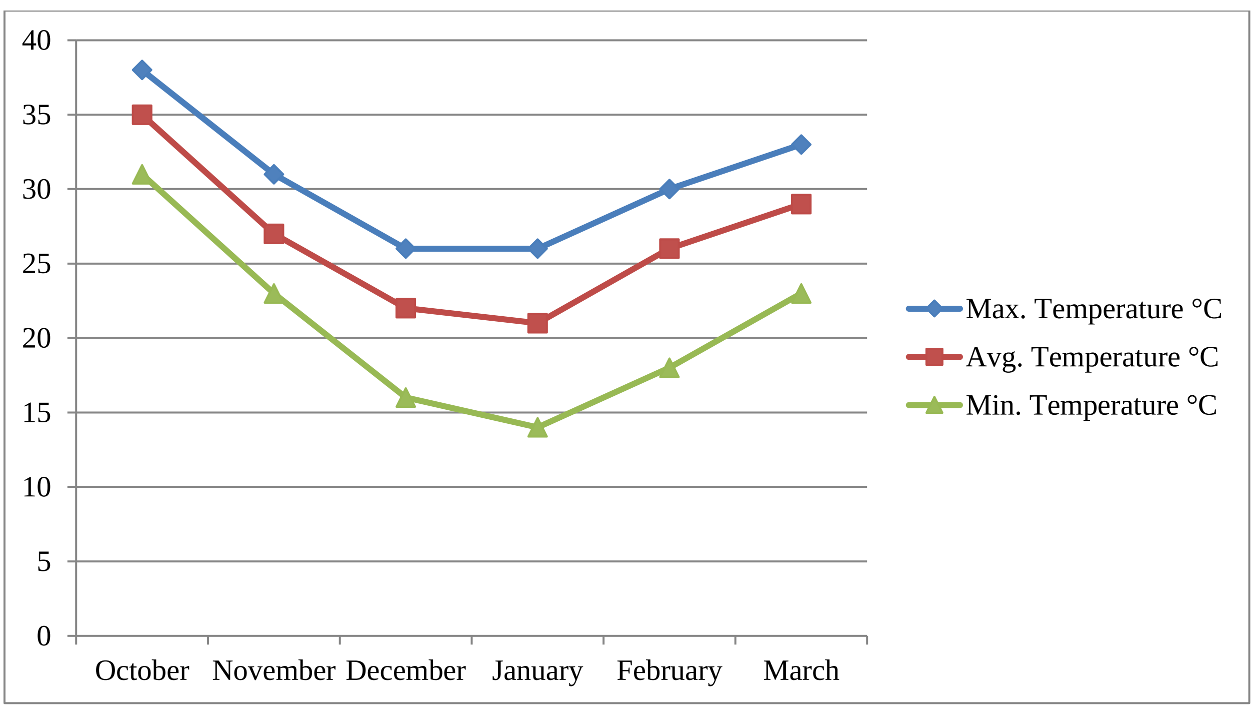

Figure 1 Data for temperature during crop growing period 2015-16

The data presented in Figure 2 showed rainfall, humidity and sunshine hour during the growing period of crop. The data shows there was no rainfall during vegetative growth stage of crop while during maturity stage 36.7 mm rainfall with hailstorm affected the crop, causing severe silique shattering.

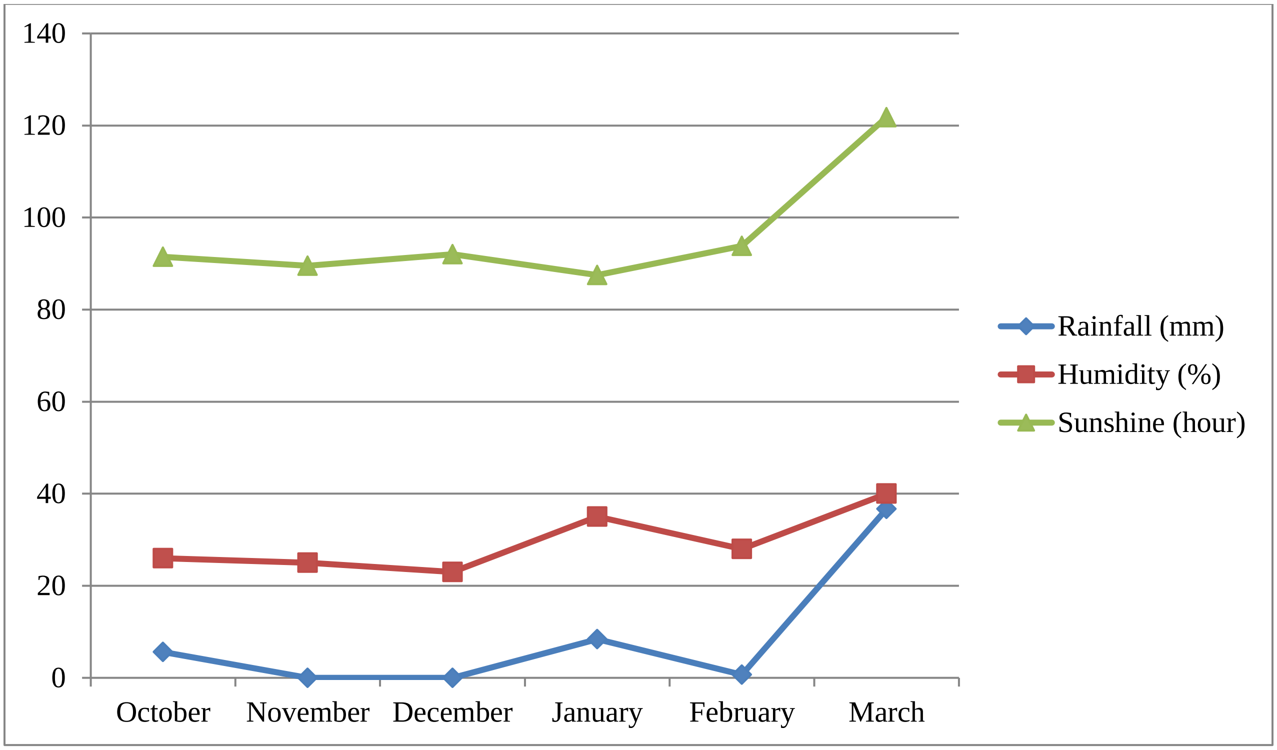

Figure 2 Data for Rainfall, Humidity & Sunshine during crop growing period 2015-16

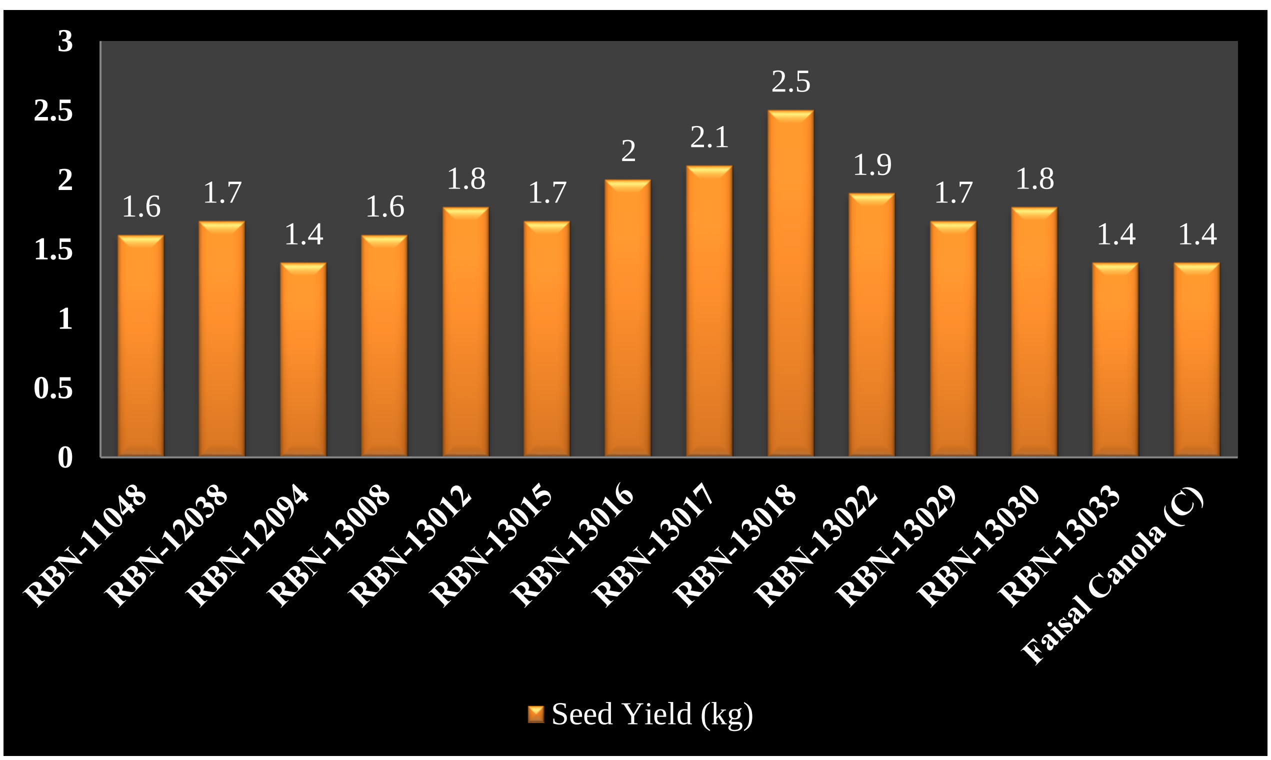

Figure 3 Mean seed yield (kg) comparison between different genotypes

Table 1 shows the mean data for all the measuring and calculating traits. Table 2 shows the correlation analysis between the different seed yield related traits. Figure 3 shows the mean seed yield comparison between the rapeseed genotypes while Figure 4 shows the qualitative characters including oil contents, amount of erucic acid and glucosinolates in each genotype.

Seed yield Evaluation

Genetic variation in breeding material is essential for running a successful breeding program. Differences in theseed yield showed in Figure 3 proved that all the genotypes had different genetic makeup because all the agronomic and cultural practices were same throughout the growing season. The check variety Faisal Canola produced 1.4 kg/plot mean seed yield. RBN-13018 produced highest mean seed yield (2.5kg/plot). Three genotypes RBN-13018, RBN-13017 and RBN- 13016 were significantly produced higher seed yield (2.5kg/plot), (2.1kg/plot) & (2.0kg/plot) respectively than the check variety Faisal Canola. These three lines are the sister lines and also performed well in preliminary yield trials. No genotype gave lower seed yield than the check variety. Hasan *et al.,* 2016 used same check variety in their experiment and found similar results.

Quality parameters

The data presented in Figure 4 showed the quality parameters including oil contents, erucic acid and glucosinolates in each genotype. The results showed that all the genotypes have canola quality characteristics. The maximum oil content (43%) was observed in the check variety Faisal canola with 2% erucic acid and 22.3 μmol/g glucosinolates. The minimum amount of oil (35%) was observed in RBN-13017 with 1.7% erucic acid and 18.3 μmol/g glucosinolates. T0he RBN-13018 showed the best performance regarding seed yield (2.5kg/plot) among all the genotypes having good oil content (40%) with 1.3% erucic acid and 18.33 μmol/g glucosinolates. Mahmood *et al.,* 2107 adapted same procedure for determining oil content and canola quality of their variety AARI Canola.

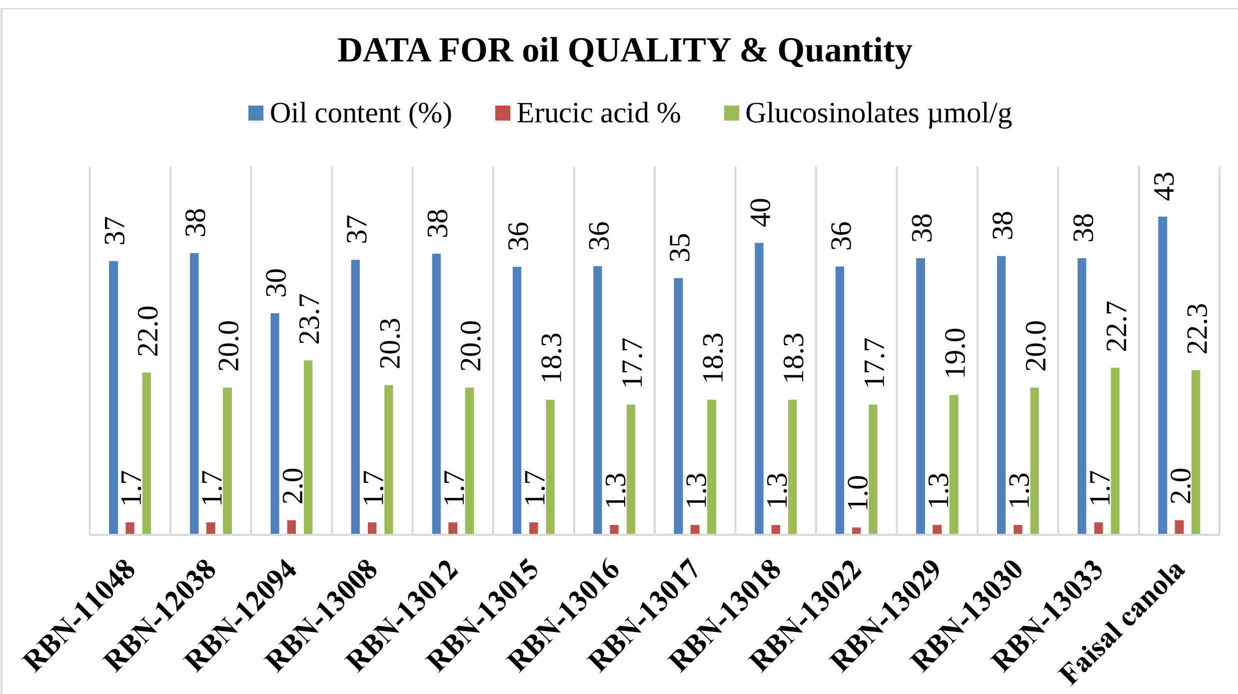

Figure 4 The data for Oil content, Erucic acid and Glucosinolates

Branches per plant

Branches per plant showed the significant and positive correlation with 1000 seed weight and highly significant and positive correlation with seed yield. As the number of branches increases the number of silique per plantalso increases which will ultimately increase the number of seeds and seed yield. Hasan*et al.,* 2014 conducted same study and found similar results in *Brassica napus*. The same results are reported in *Brassica juncea* by Yadava (1973), Singh & Singh (1974) and Paul *et al.,* (1976).

Seed per silique

Seed per silique showed positive and significant correlation with seed yield. As the number of seeds increases it will directly increase the seed yield. The same results are reported by Sirohi *et al*., (2004) and Doddabhimappa *et al.,* (2009). Hasan *et al.,* 2014 conducted same study and found similar results in *Brassica napus*.

1000 seed weight

1000 seed weight also shows the positive and highly significant correlation with the seed yield, more the 1000 seed weight more will be yield the same results are reported by Singh (1974); Seifert & Boelcke (1977); Özer*et al.,* (1999); Algan & Aygün, (2001). Hasan *et al.,* 2014 conducted same study and found similar results in *Brassica napus*.

Table 1 Mean data for seed yield and yield contributing traits

Genotypes	*DF 50%	**DM	Height (cm)	Branches	Seeds/ siliqua	1000 seed weight (g)	Seed yield/plot (kg)	Oil %	Erucic acid %	Glucosinolates (µmoles/g)
RBN-11048	74	150	187	7	22	2.8	1.6	37	1.7	22.0
RBN-12038	86	152	192	7	24	2.7	1.7	38	1.7	20.0
RBN-12049	85	151	183	6	18	2.8	1.4	30	2.0	23.7
RBN-13008	105	152	202	7	22	3	1.6	37	1.7	20.3
RBN-13012	108	153	181	8	24	3	1.8	38	1.7	20.0
RBN-13015	107	154	187	6	24	2.8	1.7	36	1.7	18.3
RBN-13016	103	151	180	6	26	3.2	2.0	36	1.3	17.7
RBN-13017	103	152	190	10	26	3.2	2.1	35	1.3	18.3
RBN-13018	104	150	175	12	24	3.5	2.5	40	1.3	18.3
RBN-13022	103	151	187	9	26	2.8	1.9	36	1.0	17.7
RBN-13029	104	152	185	7	20	2.9	1.7	38	1.3	19.0
RBN-13030	105	151	192	7	22	2.8	1.8	38	1.3	20.0
RBN-13033	106	150	186	5	18	2.7	1.4	38	1.7	22.7
Faisal Canola (C)***	81	151	173	6	18	2.8	1.4	43	2.0	22.3

*Days to 50% flowering
**Days to maturity
***Check variety

Table 2 Correlation between different seed yield related traits.

	DF	DM	HEIGHT	BRANCHES	SEEDS/SILIQUA	1000 SEEDSwt.
DM			0.3645			
P-VALUE			0.2001			

HEIGHT 0.1847 0.2677
0.5272 0.3548

BRANCHES 0.2341 -0.1120 -0.1319
0.4205 0.7032 0.6532

SEEDS/SILIQUA 0.3705 0.3020 0.1614 0.5566
0.1922 0.2940 0.5814 0.0387

1000SEEDSwt.0.3642 -0.1072 -0.2940 0.7271 0.4785
0.2004 0.7152 0.3076 0.0032 0.0835

SEED YIELD 0.4299 -0.0532 -0.1849 0.8593 0.7438 0.8460
0.1250 0.8566 0.5269 0.0001 0.0023 0.0001

4. CONCLUSION

It is concluded from results of experiment that the number of seeds per siliqua, 1000 seed weight and number of branches per plant are the yield contributing traits in Rapeseed (*Brassica napus* L.). Brassica breeders should select plants with more number of seeds/siliqua, high 1000 seed weight and more number of branches/plot to develop high yielding Rapeseed cultivars. Furthermore, a great yield potential had been found in RBN-13018, RBN-13017 & RBN-13016 so, these lines should be evaluated in Micro Yield Trials to check the yield stability in different agro-ecological zones.

REFERENCE

1. Algan, N. and H. Aygün. 2001. Correlation between yield and yield components in some winter rape genotypes (In Turkish). The journal of Ege University, Agricultural Faculty, 38(1): 9-15.
2. CODEX . Codex Standard for Named Vegetable Oils. CODEX-STAN 210-1999, 1- 16. 1999
3. Doddabhimappa R. Gangapur, B. G. Prakash, P. M. Salimath, R. L. Ravikumar AND M. S. L. Rao. 2009. Correlation and path analysis in Indian mustard (*Brassica juncea* L.Czern and Coss). Karnataka J. Agric. Sci., 22 (5):971-977.
4. Engqvist MG, Becker HC. 1993. Correlation studies for agronomic characters in segregating families of spring oilseed rape (*Brassica rapa* L.). Hereditas 118, 211-216.
5. Fazal, A., H.S.B. Mustafa, E. Hasan, M. Anwar, M.H.N. Tahir and H.A. Sadaqat. 2015. Interrelationship and Path Coefficient Analysis among Yield and Yield Related Traits in Sesame (*Sesamumindicum* L.). Nat. Sci. 13(5): 27-32.
6. Govt. of Pakistan. 2014-15. Pakistan Economic Survey. Ministry of Finance, Economic Advisor's Wing, Islamabad.
7. Hasan, E., H.S.B. Mustafa, M. Hassan, T. Mahmood and S. Din. 2016. Correlation and path coefficient studies in rapeseed (*Brassica napus* L.). J. Agric. Basic Sci., 1(2): 54-59.
8. Hasan, E., H.S.B. Mustafa, T. Bibi and T. Mahmood. 2014. Genetic variability, correlation and path Analysis in advanced lines of rapeseed (*Brassica napus* L.) For yield components. CercetăriAgronomiceîn Moldova. 157 (1): 71-79.
9. Hasan, E., T. Bibi, H.S.B. Mustafa, T. Mahmood, M.T.A. Kalyar and J. Salim. 2015. Genetic evaluation and characterization for yield and related traits in mustard (*Brassica juncea* L.). Res. J. Agri. Environ. Management. 4(2):82-87.
10. https://www.worldweatheronline.com/faisalabad-weather/punjab/pk.aspx
11. Kumar, S. and R. Kudesia. 2014. Study of yield contributing characters of oleiferousbrassicas in Bundelkhand region. Journal of Global Biosciences. 3(6):931-934.
12. Kwon S.H., J.H. Torrie, 1964 - Heritability and interrelationship among traits of two soybean population. Crop Sci., 4: 196-198.
13. Mahmood T, Hussain M., Mustafa H.S.B.,Hasan E. and Aftab M. 2017. AARI CANOLA: Pakistan's first ever canola quality and short duration Mustard (*Brassica juncea* L.) cultivar resilient to climate change. 2017. Int. J. Biol. Pharm. Al. Sci. 6(4): 777- 787.
14. OECD Paris. Consensus document on the biology of *Brassica napus*L. (Oilseed rape).7. 1997.
15. Özer, H., E. Oral and Ü. Doğru. 1999. Relationships between yield and yield components on currently improved spring rapeseed cultivars. Tr. J.of Agriculture and Forestry, 23: 603-609.
16. Paul, NEK,. 001, Joarder and A.M. Eunus,, 1976, Genotypic and phenotypic variability and correlation studies in *Brassica juncea* L Zeitschriftfùrpflanzenzuchzung, 77: 145454.

17. Rakow, G. and J.P. Raney. 2003. Present status and future perspectives of breeding for seed quality in brassica oilseed crop. Proc. Int. Rape Seed Congress, Copenhagen, Denmark: 181-185.
18. Seifert, M. and B. Boelcke. 1977. Untersuchungenzumertragsaufbaubeiwinterraps. Akademiader Landwirtschaftswissenschaften der DeutschenDemokratischenRepublik, Berlin. *Tagungsbericht Nr.* 149: 183-193.
19. Shekhawat, K., S. S. Rathore, O. P. Premi, B. K. Kandpal, and J. S. Chauhan. 2012. Advances in Agronomic Management of Indian Mustard (*Brassica juncea* L.) Czernj. Cosson): An Overview. Int. J. of Agron. Volume 2012, Article ID 408284, 14 pages.
20. Shengwu, H., J. Ovesná, L. Kučera, V. Kučera, M. Vyvadilová. 2003. Evaluation of genetic diversity of Brassica napus germplasm from China and Europe assessed by RAPD markers. Plant Soil Environ. 49(3): 106–113.
21. Singh D.P& and D. Singh. 1974. Correlations in Indian Colza (*Brassicacampestris* L, var. SarsonPrain). Ind. Agri, Sci„ 44: 1424 440
22. Singh, D.P., 1974. Correlation in India Colza. Indian Journal of Agricultural Science, 44(3): 142-144.
23. Yadava, T,P, 1973, Variability and correlation studies in *Brassica juncea* L Madras Agri. Je, 60: 9-12.