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Research Article

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Morphological characterization and selection of early maturing *Brassica napus* accessions

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ABSTRACT
Brassica napus is an important oilseed crop with an indeterminate growth habit. Farmers prefer major crops and avoid cultivation of *Brassica napus* due to its delay in maturity. Its sowing competes with the sowing of wheat. So the main objective of the research was the characterization of locally adapted germplasm and the selection of early maturating genotypes to avoid its competition with wheat. Twenty-seven accessions of *Brassica napus* were collected to estimate the genetic diversity of morphological characters under field conditions by using RCBD with 3 replications. Collected data for different quantitative No. of main branches, plant height, No. of secondary branches, silique length, leaf area, days to 50% blooming, days to 50% ripeness and qualitative traits (leaf shape, leaf colour, pod shape, petiole shape, seed colour, seed shape). Significant variations were estimated among quantitative characters. Minimum days to 50% blooming were observed for G16 and G18. Minimum days to 50% maturity were observed for G16 and G19. Accessions that were observed with minimum days to 50% flowering and minimum days to 50% maturity could be utilized in future breeding programs for early maturity of *Brassica napus.* A maximum No. of plants had lanceolate green leaves, cylindrical silique, round petioles and black seeds with round shape. Plant height and No. of secondary twigs/plants had substantial genotypic correlation with thousand seed weight and seed yield/plant. Except for plant height, secondary twigs, silique size, and days to 50% flowering, all the characteristics had a positive direct impact on seed weight per 1000.
Keywords: *Brassica napus*, maturity, accessions, correlation, seed weight

INTRODUCTION

The major oilseed crops of Pakistan are cotton seed, rapeseed, mustard, canola and sunflower. The overall market share for vegetable oil in 2020–21 was 3.291 M tonnes of which 0.374 M tons were supplied nearby and 2.917 million tons were imported (contributing $3.419 billion). 33000 tons of oil are produced from sunflowers. Oilseed crops are important to Pakistan's economy and provide more than 17% of the country's domestic edible oil needs. About 11% of domestic edible oil production comes from sunflowers (GOP, 2021). However, there is a significant deficit in this area that can be filled to boost domestic production. As a result, the country urgently needs to increase oilseed output to meet its needs.

Domestic consumption has been increasing steadily because of awareness and desire for better quality. Early *Brassica napus* consisted of high erucic acid contents that created a bitter taste in food and were the cause of injury to the heart and led to relevant health complications (Snowdon *et al.,* 2007). The oil contained high crude acid and was used for cooking and lighting lamps at the periods of wars in Europe during 20th century. Also, this oil had the capability to adhere to metal surfaces as lubricant which led to its acceptance as industrial oil. Rapeseed and mustard are one of conventional oilseed crops (Yousaf *et al.,* 2011). Rapeseed oils contains about 40-45% oil contents and 23% proteins. After crushing of seeds residual meal is used for animal feedstock which is rich in protein. Over the entire series of oils and fats 80% are used as a source of human food, livestock feed (6%) and in the fatty acid sector (14%) (Snowdon *et al*., 2007).

In ancient times seeds were mixed with salts and eaten as a source for treatment of cancer. Oil is used in massage creams for glowing skin, jojoba oil substitutes in waxes and as a bath essential oil for skin nourishment. It is mixed with camphor oil to get release from joint pain. Roots are crushed to obtain syrups to treat cough and bronchial catarrh (James A. Duke, 1983). Morphological characteristics of yield and associated traits are the most important elements for crop growers. Morphogenetic characterization is compulsory to identify the germplasm of interest having good potential for insect pest resistance, more resistant to biotic and abiotic stress or may be high yielding. Morphological and yield-relevant traits are the best criteria for selection of cultivars with diverse phenotypic traits. Crop improvement is possible through the evaluation and characterization of the available germplasm in a particular area (Ali *et al.*, 2018).

Sowing and harvesting of *Brassica napus* collapse with the sowing of wheat. Wheat is a major cereal crop in Pakistan. Sugarcane, cereals, wheat, rice, seed cotton, maize and vegetables are the most produced commodities (FAOSTAT, 2018). Farmers are mostly concerned with the crops that are the source of earning for a whole year. Due to the intensive cultivation of kharif crops especially i.e., especially rice, potato and cotton, the yield of *Brassica napus* is undesirably affected by delayed planting. Delayed sowing problem results in aphid attack and blight diseases ultimately resulting in increased cost of production. There is a need for early maturing genotypes for maximum yield (Yousaf *et al.*, 2002).

MATERIALS AND METHODS

Experimental conditions

The experiment was conducted at the research area of the Department of PBG, University of Agriculture, Faisalabad. City Faisalabad is located at a latitude of 31°-44° North, longitude of 73°-07° East and altitude of 184.4m. It has an arid climate.

Collection of *Brassica napus* accessions

Twenty-seven *Brassica napus* accessions were collected from the oilseed research group, Department of PBG, University of Agriculture Faisalabad.

Layout and design of the experiment

The experiment was conducted at the field of Department of PBG, University of Agriculture, Faisalabad. The research was sown on 25 October. Twenty plants of each accession per replication were grown in the field by using RCBD with 3 replications.

Plant to plant distance was 4cm and Row to Row distance was 30cm. Two seeds were planted at a depth of about 2cm per hole. Four irrigations were applied according to the following schedule:

1st irrigation: 30-45 days after sprouting

2nd irrigation: at bud emergence

3rd irrigation: When the blossoms appear

4th irrigation: at Seed ripening

Data Recording

Data were recorded on qualitative and quantitative traits i.e., plant height, No. of main twigs, No. of sub-branches, Leaf area (cm^2), Silique length (cm), 50% Day to blooming, 50% Days to maturity, thousand seed weight, Seed yield/plant.

At maturity, the data for the following traits were measured,

Plant Height (cm)

With the help of a measuring tape, the height of each accession was determined from the soil surface to the tip of the plant in centimetres.

No. of primary branches

No. of primary branches were estimated were counted manually at the time of maturity. average of 10 plants of each accession per replication was calculated.

No. of secondary branches

Secondary branches were estimated were counted manually at the time of maturity. average of 10 plants of each accession per replication was calculated.

Leaf Area (cm^2)

Three leaves per plant of each genotype per replication were selected and leaf length and leaf width were measured from three points of each leaf and calculated the averages for determining leaf areas. The following formula was used to determine the leaf area:

Leaf area= (length × width) 0.75

Silique length (cm)

Silique length was measured in cm using a ruler. The silique length of 10 plants of each accession per replication was recorded.

Days to 50% flowering

The number of days from germination to 50% flowering was recorded.

Days to 59% maturity

Days from 1st plant germination to 50% plant maturity and 50% silique production were recorded. An average of 10 plants per accession per replication was calculated.

Statistical analysis

Collected facts were analysed through ANOVA (Steel et al., 1997) by using a Randomized Complete Block Design. (1971). Correlation (Kwon *et al.,*1964) and path Analysis (Dewey *et al*,.1959) were estimated.

RESULTS AND DISCUSSION

Analysis of variance for yield-related traits in *Brassica napus*

Analysis of variance for plant height, No. of primary branches/plant, No. of secondary branches/plant, thousand seed weight, Seed yield/plant, Leaf area, Silique length, Days to 50% flowering, and Days to 50% maturity were recorded which is presented in (Table 1).

Significant variations were estimated among quantitative characters. Minimum days to 50% flowering were observed for G16 and G18. Minimum days to 50% maturity were observed for G16 and G19. Accession that was observed with minimum days to 505 flowering and minimum days to 50% maturity could be used in future breeding programs for early maturity of *brassica napus.*

Correlation coefficient analysis for yield-related traits in *Brassica napus*

The height of the plant had a strong and positive correlation with the number of secondary branches per plant, the weight of one thousand seeds, and the yield of seeds per plant. The number of primary branches per plant had a significant and positive correlation with the time it took for the plant to reach 50% maturity. The number of secondary branches per plant had a significant and positive correlation with the weight of one thousand seeds and the yield of seeds per plant. The weight of one thousand seeds had a significant and positive correlation with the number of seeds per plant. The yield of seeds per plant had a significant and negative correlation with the area of the plant's leaves. The area of the plant's leaves had a significant and positive correlation with the length of the silique, which was determined by the plant's genes. The length of the silique had a negative but not significant correlation with the time it took for the plant to reach 50% flowering. The time it took for the plant to reach 50% flowering had a significant and positive correlation with the time it took for the plant to reach 50% maturity. The time it took for the plant to reach 50% flowering had a significant and positive correlation with the time it took for the plant to reach 50% maturity, as determined by the plant's genes.

Path coefficient analysis for yield-related traits in Brassica napus

Table 4 presents the results of a path analysis that estimated the direct and indirect effects of different traits on the thousand seed weight. The analysis showed that all traits had a positive effect on the thousand seed weight, except for plant height, number of secondary branches per plant, silique length, and days to 50% flowering, which had a negative direct effect on it. The greatest positive indirect effect was observed through plant height, while the highest positive indirect effect of silique length was seen through the number of secondary branches per plant. These findings were reported by (Sandhu et al. in 2017).

Brassica napus, commonly known as rapeseed or canola, is a species of flowering plant in the Brassicaceae family. It is a versatile crop, used for oil production, animal feed, and biofuel. Rapeseed oil is considered a healthy alternative to other vegetable oils due to its low saturated fat content and high levels of unsaturated fats. Brassica napus accessions were identified and their genetic diversity was assessed in the present study.

Genetic parameters of Brassica napus accessions for different traits

The article discusses three measures of inheritance and variation in characteristics. These measures are the phenotypic coefficient of variance, genotypic coefficient of variance, and broad sense heritability. The phenotypic coefficient of variance is slightly higher than the genotypic coefficient of variance, which suggests that the environment has some influence on the traits being measured. The heritability values for all traits were found to range from 0.99 to 0.30. The strongest genetic influence was observed for plant height, followed by days to 50% flowering, leaf area, and seed weight per 1000.

Rapeseed seed yield and yield-related traits were evaluated by Ali et al., 2003. Significant variation was observed in the accession of rapeseed. Silique/plant and plant height were determined with maximum variation. Based on the direct and positive effect of seed weight and harvest index it was concluded that yield-related traits could be ideal criteria for selection of rapeseed with improved yield.

Aytac and Glycan, (2009) evaluated the significant differences of No. of primary branches of Brassica napus accessions. Maximum primary branches were recorded for G17 followed by G8 and G2. Minimum primary branches were recorded for G20 followed by G21. Based on thousand seed weight and seed yield per plant, Jeromela et al., (2016) found that secondary branches/plants were significantly different from primary branches/plant. It was found that the number of secondary branches per plant was highly significant and positively correlated with the thousand seed weight and seed yield per plant. Tuncturk et al., (2007) found significant differences in thousand seed weight with seed yield per plant describing similar results. Results showed that increased seed yield per plant would increase thousand seed weight. Ali et al., (2003) found significant differences in seed yield per plant with leaf area. Seed yield per plant presented a highly significant but negative genotypic correlation with leaf area. Silique length had a negative but no significant correlation with days to 50% flowering (Halder et al., 2016). Ghosh and Gulati, (2001) showed a significant and positive phenotypic correlation of days to 50% flowering with the days to 50% maturity. Days to 50% flowering were observed with positive indirect effects through plant height, and silique length (Sandhu et al., 2017)

Sandhu et al., (2017) found a significant and positive genotypic correlation of days to 50% flowering with days to 50% maturity. Results determined if days to 50% flowering decreased then days to 50% maturity would decrease accordingly.

Table 1. Analysis of Variance of different traits of *Brassica napus*

SOV	Df	PH	PBPP	SBPP	TSW	SYPP	LA	SL	Days to 50% flowering	Days to 50% maturity
Block	2	0.6	0.34	0.97	0.03	0.06	8.75	1.46	1.46**	12.049
Treatment	26	668.47 ***	1.49 ***	2.47 ***	1.88 ***	7.90 ***	303.48 ***	3.84 ***.	3.84 ***	148.31 ***
Residual	52	1.96	0.30	0.38	0.05	0.26	5.43	1.66	1.66	1.85

***=Highly significant at 0.001 probability level, **=highly significant at 0.01 probability level, *=Significant at 0.05 probability level

Table 2. Phenotypic correlation coefficient

	NPB/P	NSB/P	TSW	SY/P	LA	SL	DT50%F	DT50%M
PH	-0.195	0.640*	0.809*	0.903*	-0.387*	-0.128	-0.045	-0.109
NPB/P		-0.208	-0.381*	-0.268*	0.024	-0.353*	0.167	0.241*
NSB/P			0.693*	0.676*	-0.215	-0.108	-0.078	0.115
TSW				0.836*	-0.302*	-0.048	-0.031	-0.107
SY/P					-0.346*	-0.024	-0.030	-0.135
LA						0.202	0.112	0.138
SL							0.020	-0.019
DT50%F								0.868*

PH=Plant Height, NPB/P=No. of Primary Branches/Plant, NSB/P=No. of Secondary Branches/Plant, TSW=Thousand Seed Weight, SY/P=Seed Yield/Plant, LA=Leaf Area, SL=Silique Length, DT50%F=Days to 50%Flowering, DT50%M=Days to 50%Maturity

Table 3. Genotypic Correlation Coefficient

	NPB/P	NSB/P	TSW	SY/P	LA	SL	DT50%F	DT50%M
PH	-0.267*	0.768**	0.830**	0.940**	-0.400**	-0.220*	-0.041	0.107
NPB/P		-0.384**	-0.505**	-0.337**	0.047	-0.670**	0.237*	0.316*
NSB/P			0.835	0.804**	-0.273*	-0.023	-0.074	-0.100
TSW				0.866	-0.337**	-0.061	-0.026	-0.102
SY/P					-0.382**	-0.073	-0.039	-0.136
LA						0.231*	0.114	0.136
SL							-0.082	-0.092*
DT50%F								0.891*

PH=Plant Height, NPB/P=No. of Primary Branches/Plant, NSB/P=No. of Secondary Branches/Plant, TSW=Thousand Seed Weight, SY/P=Seed Yield/Plant, LA=Leaf Area, SL=Silique Length, DT50%F=Days to 50%Flowering, DT50%M=Days to 50%Maturity

Table 4. Direct and Indirect Effects of various traits on thousand seed weight

	PH	NSB/P	NPB/P	SY/P	LA	SL	DT50%F	DT50%M
PH	-0.875	-0.428	0.075	0.719	-0.010	0.051	0.003	-0.034
NSB/P	-0.726	-0.515	0.069	0.779	-0.012	0.169	0.005	-0.036
NPB/P	-0.730	-0.396	0.089	0.667	-0.008	0.018	0.010	-0.034
SY/P	-0.758	-0.484	0.072	0.830	-0.012	0.056	0.005	-0.045
LA	0.297	0.206	-0.024	-0.316	0.031	-0.177	-0.015	0.046
SL	0.058	0.113	-0.002	-0.060	0.007	-0.767	0.011	-0.031
DT50%F	0.020	0.021	-0.007	-0.032	0.004	0.062	-0.130	0.299
DT50%M	0.088	0.055	-0.009	-0.112	0.004	0.070	-0.116	0.335

PH=Plant Height, NPB/P=No. of Primary Branches/Plant, NSB/P=No. of Secondary Branches/Plant, TSW=Thousand Seed Weight, SY/P=Seed Yield/Plant, LA=Leaf Area, SL=Silique Length, DT50%F=Days to 50%Flowering, DT50%M=Days to 50%Maturity

CONCLUSIONS

It concluded that accession i.e., Chakwal Sarson, Punjab Sarson, ZN-12-8, ZMR-10, ZMR-4, Duckled, Sarson, Sarson Long, ZM-R, Cyclone, Faisal Canola, ZM-21 and ZMM-6 were observed with early maturing and average values of yield traits. These genotypes could be used for early maturing with good yield. Common accessions presented by PCA and cluster analysis were Rainbow, ZM-R-2, ZMR-19 and DGL which were observed with diversity and early maturity. So, these accessions could be used for early maturity and diversified traits.

CONFLICT OF INTEREST

The author here declares that there is no conflict of interest in the publication of this article.

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