

Genetic Diversity Variability among the Interspecific F₄₋₅ Populations of *Brassica* for Agronomic and Biochemical Traits

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ABSTRACT

The study was carried out to determine genetic diversity, heritability, and genetic progress among the F₄₋₅ population of *Brassica* for several biochemical and morphological traits at Department of Plant Breeding and Genetics, The University of Agriculture, Peshawar, Pakistan, during the Rabi season 2018-19. In Pakistan, *Brassica* are economically important and high yielding oil seeds and it is needed to produce improved *Brassica* varieties for successful expansion of cultivation of oilseed crops. The genetic diversity among 51 populations (genotypes) of four interspecific crosses Bn-531xBr-118, Bn-525xBr-118, Bn-514xBj-109 and Bn-510xBj-109 with six parents of *Brassica* genotypes in paired rows of 4 m length with a spacing of 30 cm x 10-15 cm (row x plant). Data were recorded on ten different agro-morphological characters and six biochemical traits. The interspecific crosses of *Brassica* highly performed all types of morphological traits in populations viz; 142, 129, 196, 186 and 142. Biochemical traits are highly performed in interspecific crosses of F₄₋₅ populations other than parental genotypes. Majority had high to moderate heritability, whereas greatest had less environmental and genetic influence in the expression of these characters and had high heritability with substantial genetic advance. Interspecific crosses showed superior diversity for various traits and thus give a unique opportunity in further evaluation of these materials for profitable exploitation in next generations.

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Key words: Variability, Heritability, Genetic advance, Morphological and Biochemical traits, Brassica

1. INTRODUCTION

Oilseed *Brassica* is one of the most important and profitable oil crops in the world [1, 2]. It is the most important source of edible oil [3], and consists of 380 genera and 3000 species [4] is one of the ten most economically important plant families with a wide range of agronomic traits [5, 6]. In Pakistani, *Brassica* are economically important and high yielding oil seeds grown from long time that is why it is needed to produce improved oilseed brassica varieties for successful expansion of cultivation of oilseed crops [7]. In Pakistan, it is cultivated over an area of 219 thousand hectare ~~and with production of produced~~ 158 thousand tons seeds which in turn produced 51 thousand tons of edible oil during 2012-13 [8].

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Seed yield of ~~brassica~~ *Brassica* is the outcome of morphological and physiological belongings, the final concert of plant depends on the phonological stage and yield contributing traits, seed yield direct selection is not possible, and therefor indirect selection is the chief method for ~~brassica~~ *Brassica* breeding program [9]. For a new varieties of plants to be released should always fulfill the criteria of distinctness, plant protection uniformity and stability as per the guidelines prepared by UPOV. DUS testing is one of the important criteria to test in-bred lines for distinctness, uniformity, and stability [10]. Increasing demand for edible oil in world markets and the pressure from the cost of buying and importing oil are among the factors that determine the importance of developing oilseed crops and expanding scientific research programs [11].

Future edible oil requirement can only be achieved through the improvement of seed quality by breeding brassica [12, 13]. Estimation of the relationship between two variables is known as correlation. Measurable association alludes to a quantifiable relationship between two variables. Moreover, it is a ~~quality's~~ measure of quality between two variables. For plant breeders it is necessary to concentrate on the relationship between sets of characters keeping in mind the end goal to settle on the proper determination criteria for a breeding program [14]. The goal of study was to evaluate

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potential interspecific crosses on the basis of morphological and biochemical traits and to quantify the heritability and association of brassica species.

3. MATERIALS AND METHODS

3.1. Plant material, experimental design and location

The experimental materials were consisted of 51 populations (genotypes) of four interspecific crosses Bn-531×Br-118, Bn-525×Br-118, Bn-514×Bj-109 and Bn-510×Bj-109 and six parents. All 51 genotypes were grown in paired rows of 4 m length with a spacing of 30 cm × 10-15 cm (row × plant) at Department of Plant Breeding and Genetics form the University of Agriculture, Peshawar, Pakistan during Rabi season 2017-18. The coordinates of the experimental location are 34.04°N and 71.35°E with an altitude of 350m above sea level. The climate of the experimental location is subtropical with precipitation ranges 500-700mm of the growing season.

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3.2. Observations and evaluation

All the recommended package and practices were followed to raise the healthy crop. Observations were recorded on five random and competitive plants for ten agronomic and six biochemical traits viz; days to 50% flowering, plant height (cm), primary branches per plant (no.), main raceme length (cm), pod length (cm), seeds per pod (no.), number of pod on main raceme, days to maturity, hundred seeds weight (g), seed yield per plant (g) and Oil content (%), Protein content (%), Glucosinolates (%), Oleic acid (%), Linolenic acid (%), Erucic acid (%). To determine the chemical constituents of seed samples were scanned on Near Infrared (NIR) Spectroscopy System (FOSS 6500 equipped with ISI version 1.02 a software of Infra Soft International) according to the manufacturer's protocol. Near infrared reflectance (NIR) spectroscopy, has been successfully applied as an alternative technique to gas chromatography for the analysis of biochemical analysis of oilseed crops [15, 16, 17]. Heritability estimates were calculated by the formula [18].

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4. RESULT AND DISCUSSION

Genetic distance provides a measure of the degree of relatedness between individuals in a population [19] and it also plays a key role in genetic improvement through breeding methods [20]. Interspecific crosses gradually varied from parental genotypes of yield and yield contributing parameters ten agronomic traits is presented in Table 1 and Figure 1 & 2. Akabari *et al.* [21] and Kumar *et al.* [22] reported almost similar results found in these traits of our present investigation. Days to 50% flowering (155) calculated in the cross Bn-510×Bj-109 and variance (20.70) was estimated for the cross Bn-531×Br-118, all the interspecific crosses had high heritability with genetic advance (7.43) was found in the cross Bj-109×Bn-514. The tallest plant (161.8 cm) were noted in the crosses Bn-525×Br-118, high heritability (0.92) coupled with low genetic advance (2.23) was analyzed for the cross Bn-514×Bj-109. Longest main raceme length was (77 cm) measured in the cross Bn-510×Bj-109 and variances (312.16) was calculated for the crosses Bn-531×Br-118. Heritability and genetic advance estimation was 0.81, 15.76 for the cross Bn-514×Bj-109. Pod length was (7.8cm) recorded for the cross Bn-510×Bj-109 and variance (3.54) was estimated for the crosses Bn-531×Br-118. All the crosses had high heritability with low genetic advance except Bn-510×Bj-109. Seed per pod was calculated in the cross Bn-514×Bj-109, variances was high (52.33) and showed heritability with high genetic advance (7.71). The important parameter number of pods on main raceme (64) was counted for the cross Bn-525×Br-118 and variance (354.04) was calculated and showed high heritability (0.82) coupled with high genetic advance (21.83). Our Similar results of heritability and genetic advance was also reported by Muhammad *et al.* [23]; Singh *et al.* [24]. Days to maturity (199) in the cross Bn-510×Bj-109 and variance (22.26) was estimated in this cross. The heritability estimations was with low genetic advance in all the interspecific crosses. The hundred seed weight was (0.654) observed in the cross Bn-510×Bj-109 and variance (0.008) analyzed for Bn-510×Bj-109 and Bn-531×Br-118. High heritability (0.81) coupled with low genetic advance (0.1) was estimated in the cross Bn-510×Bj-109, rest of the crosses also had high heritability estimations (0.56, 0.54 and 0.35) with genetic advance estimations (0.038, 0.075 and 0.039). Seed yield per plant (18.3g) found in the cross Bn-525×Br-118 and variance (68.57) was found in Bn-525×Br-118 and Bn514×Bj-109. Maximum heritability and genetic advance (0.89 and 4.45) found in the cross Bn514×Bj-109. Our findings of present experiments for high heritability and high genetic advance for seed yield and morphological traits was strongly supported by Sandhu *et al.* [25]; Gupta *et al.* [26]; Kumar *et al.* [22].

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In *Brassica*, interspecific crosses genotypes are evaluated for biochemical traits wide range of variability with respect to different traits (Table 2). Maximum oil content (54.5%) found in the cross Bn-510xBj-109 from population (142) and variance (18.72) was calculated in Bn-531xBr-118 with high heritability and genetic advance (0.70) and (4.3) for the cross Bn-531xBr-118. Highest protein content and variance was (24.7% and 22.67) found in population (129) in the crosses Bn-510xBj-109 with high heritability (0.79) and high genetic advance (5.26). The high glucosinolates content was (107.7 μ mol/g) showed by the cross Bn-525xBr-118 in population (11 and 488) with high heritability (0.80) and high genetic advance (18.14). The desirable component oleic acid maximum (52.3%) found in Bn514xBj-109, and high heritability (0.80) coupled with high genetic advance (4.66) was calculated for the cross Bn-525xBr-118. Linolenic acid was (12.6%) observed in population (74) for the cross Bn-510xBj-109 and high heritability (0.48) with low genetic advance (0.74) was estimated in the cross Bn-525xBr-118. Erucic acid (EA) content was minimum (49.1%) found in population (129) for the cross Bn-510xBj-109. Heritability estimation was maximum (0.84) coupled with high genetic advance (6.64) for the cross Bn-525xBr-118. The results of our present investigations of biochemical traits are mostly similar to the findings reported by Fayyaz *et al.* [27]; Khan *et al.* [28]; Amsalu *et al.* [29].

5. CONCLUSION

The 51 genotypes of four interspecific crosses studied exhibited wide genetic variations from morphological and biochemical level. Majority traits with high genetic progress had high heritability, indicating that the investigated qualities were less affected by environmental factors. Highest oil, protein, low glucosinolates and low erucic acid were observed in Bn-510xBj-109 in population (142 and 129), population (11) of crosses Bn-525xBr-118 and crosses Bn-531xBr-118 in population (163). Maximum yield in population (47) along with low glucosinolates (53.8 μ mol g⁻¹) found in population (11) were observed in crosses Bn-525xBr-118. Population (142 and 129) in Bn-510xBj-109, population (111 and 193) in Bn-525xBr-118 and 531xBr-118 should be forwarded to next generations for developing varieties with high oil and protein, low glucosinolates and low erucic acid content, respectively. To generate sergeants with a combination of desirable qualities, genotypes from distinct clusters with specific desirable traits should be hybridized. The F₄₋₅ crosses analyzed demonstrated more variation for a variety of desired traits, and this knowledge can be utilized to improve the evaluation of available germplasm for future breeding operations.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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Table 1. Variance (σ^2), heritability (h_{BS}^2) and genetic advance (GA) of morphological traits for parental lines and four interspecific crosses.

Genotypes	DTFF			PH			PBPP			MRL			PL		
	σ^2	$h_{(BS)}^2$	GA	σ^2	$h_{(BS)}^2$	GA	σ^2	$h_{(BS)}^2$	GA	σ^2	$h_{(BS)}^2$	GA	σ^2	$h_{(BS)}^2$	GA
Parents															
Bn-531	9.3			167.5			0.3			132.5					0.912
Bn-525	15.7			42.5			0.7			71.8					0.425
Bn-514	15.5			167.5			0.2			25					0.517
Bn-510	14.5			189.2			0.8			450					3.872
Br-118	14.2			95			0.2			49.3					0.157
Bj-109	30.2			211.2			0.3			50.7					0.185
Crosses															
Bn-531 x Br-118	20.70	0.73	1.92	487.4	0.67	2.92	3.24	0.92	2.32	312.16	0.38	7.55	3.54	0.73	1.92
Bn-525 x Br-118	31.85	0.75	1.08	351.89	0.87	7.71	2.25	0.83	1.75	202.3	0.70	14.05	1.05	0.75	1.08
Bn-514 x Bj-109	58.91	0.77	1.25	263.83	0.66	5.05	1.67	0.85	1.54	191.46	0.81	15.76	1.35	0.77	1.25
Bn-510 x Bj-109	56.99	0.25	0.37	487.4	0.27	2.82	3.2	0.84	2.12	197.04	0.38	7.55	1.1	0.25	0.37
Genotypes															
Parents															
Bn-531	8.243			82.5			7.7			0.0074					2.4233
Bn-525	4.597			75.3			2.2			0.0062					6.0945
Bn-514	9.603			45.7			5.5			0.0023					5.5428
Bn-510	53.23			73.2			10.8			0.0050					2.2300
Br-118	5.403			49.3			3.3			0.0026					42.334
Bj-109	26.87			139.7			16.3			0.0004					1.8013
Crosses															
Bn-531 x Br-118	9.61	0.67	2.92	354.04	0.82	21.83	7.71	0.34	1.34	0.001	0.54	0.075	17.87	0.43	2.56
Bn-525 x Br-118	39.73	0.87	7.71	243.3	0.74	16.36	6.78	0.60	2.2	0.006	0.35	0.039	68.57	0.76	8.87
Bn-514 x Bj-109	29.52	0.66	5.05	95.52	0.52	7.13	15.35	0.38	2.1	0.002	0.56	0.038	12.65	0.89	4.45
Bn-510 x Bj-109	52.33	0.27	2.82	169.8	0.6	11.08	22.26	0.40	2.66	0.008	0.81	0.1	18.14	0.80	4.78

DTFF, Days to 50% flowering; PH, Plant height (cm); PBPP, Primary branches per plant (no.); MRL, Main raceme length (cm); PL, Pod length (cm); SPP, Seeds per pod (no.); MR, Number of pod on main raceme; DTM, Days to maturity; HSW, Hundred seeds weight (g); SYPP, Seed yield per plant (g).

Table 2. Variance, heritability (h_{BS}) and genetic advance of biochemical traits for parental lines and four interspecific crosses.

Genotypes	Oil content (%)			Protein content (%)			Glucosinolates (%)			Oleic acid (%)			Linolenic acid (%)			Erosic acid (%)		
	σ^2	$h^2_{(BS)}$	GA	σ^2	$h^2_{(BS)}$	GA	σ^2	$h^2_{(BS)}$	GA	σ^2	$h^2_{(BS)}$	GA	σ^2	$h^2_{(BS)}$	GA	σ^2	$h^2_{(BS)}$	GA
Parents																		
Bn-531	4.277			3.476			14.56			7.993			0.770			1.208		
Bn-525	4.570			3.444			10.13			1.493			1.076			4.875		
Bn-514	0.833			6.435			36.14			7.255			0.227			13.72		
Bn-510	2.433			4.878			10.18			5.065			0.435			3.827		
Br-118	6.958			6.503			188.70			7.083			0.947			4.702		
Bj-109	4.438			4.882			68.23			7.748			0.508			19.11		
Crosses																		
Bn-531×Br-118	18.72	0.70	4.30	22.67	0.79	5.26	262.40	0.80	18.14	19.06	0.60	3.7	1.44	0.41	0.69	14.64	0.83	4.48
Bn-525×Br-118	8.07	0.29	1.17	7.44	0.42	1.63	197.60	0.77	15.32	16.96	0.80	4.66	1.21	0.48	0.74	31.37	0.84	6.64
Bn-514×Bj-109	4.4	0.56	1.65	8.51	0.34	1.39	109.70	0.54	8.02	28.6	0.73	5.52	0.56	0.40	0.42	35.96	0.54	4.61
Bn-510×Bj-109	7.62	0.56	2.20	10.96	0.55	2.57	99.83	0.79	11.18	11.02	0.43	2.57	0.83	0.46	0.59	12.48	0.57	2.83

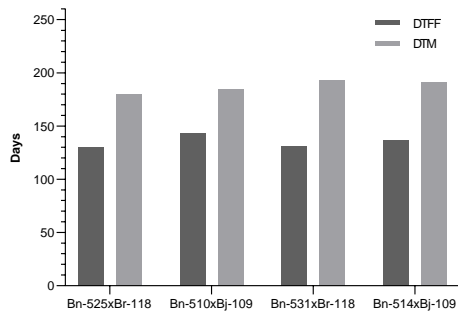


Fig: 1(a)

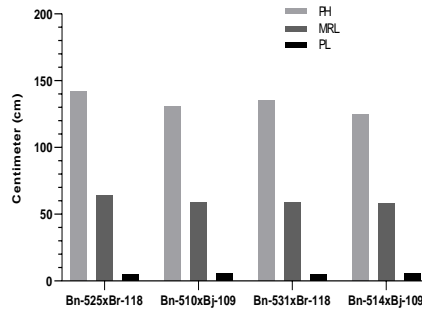


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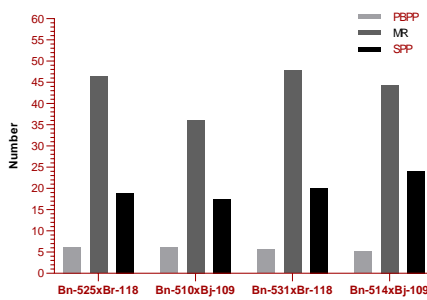


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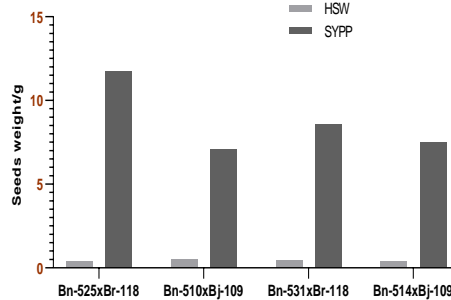


Fig: 1(d)

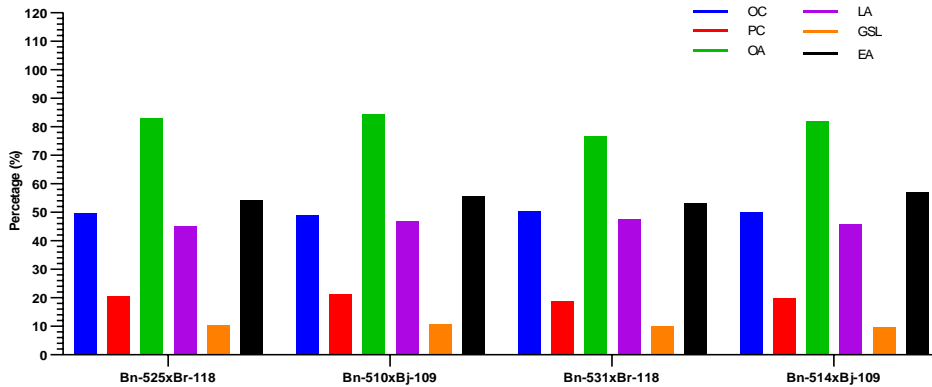


Fig: 1(e)

Fig: 1. Mean values of different morphological and biochemical traits for the populations of four interspecific crosses. 1(a) Days to 50% flowering (DTFF) and Days to maturity (DTM). 1(b) Plant height (PH), Main raceme length (MRL) and Pod length (PL). 1(c) Primary branches per plant (PBPP), Number of pod on main raceme (MR) and Seeds per pod (SPP). 1(d) Hundred seeds weight (HSW) and Seed yield per plant (SYPP). 1(e) Oil content (OC), Protein content (PC), Oleic acid (OA), Linoleic acid (LA), Glucosinolates (GSL) and Erucic acid (EA).

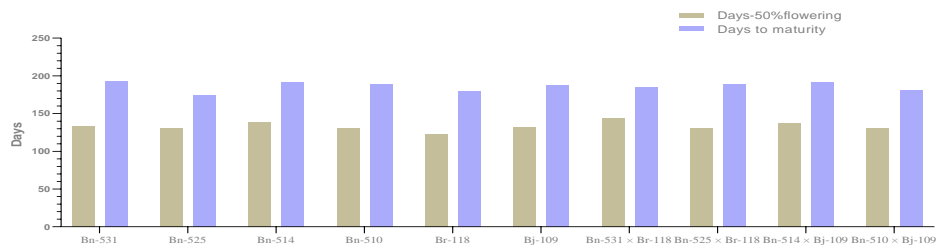


Fig: 2(a)

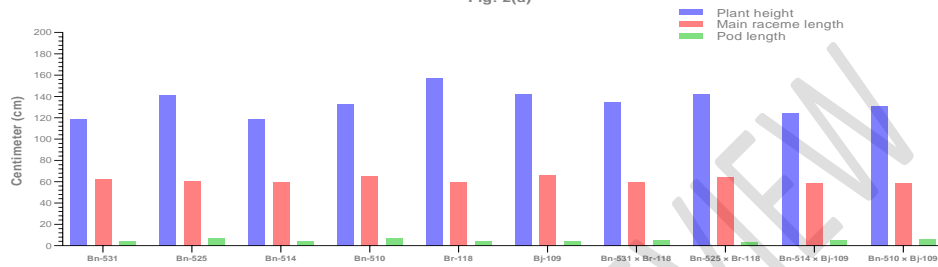


Fig: 2(b)

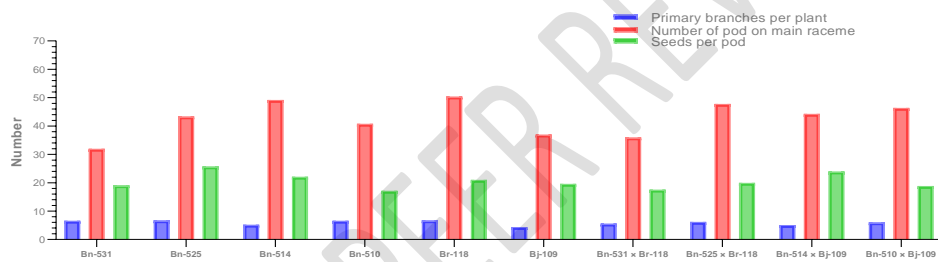


Fig: 2(c)

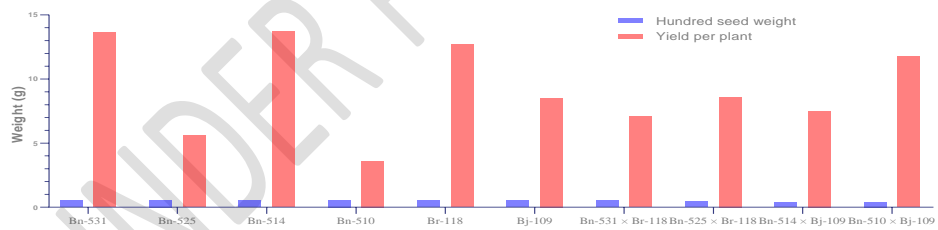


Fig: 2(d)

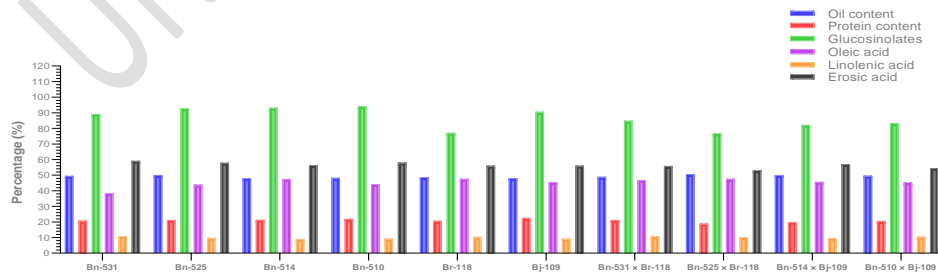


Fig: 2(e)

Fig: 2. Mean values of different morphological and biochemical traits of Parental and interspecific crosses.