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PHENOTYPIC CORRELATION ANALYSIS OF ELITE $F_{3:4}$ BRASSICA POPULATIONS FOR QUANTITATIVE AND QUALITATIVE TRAITS

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ABSTRACT

Six $F_{3:4}$ derived inter-specific Brassica populations along with three checks were evaluated for phenotypic correlations for qualitative and quantitative characters at NWFP Agricultural University, Peshawar during 2005-06. A randomized complete block design with four replications was used. Higher significant values of association were observed for day to flowering with pods raceme^{-1} (0.90) and significant association with glocusinolate (-0.67), primary braches plant^{-1} show high significant correlation with pod length (-0.93), seed pod^{-1}(-0.88) and yield ha^{-1}(-0.78) and significant correlation with linolenic acid (0.68). Pod length highly significantly related with seed pod^{-1}(0.93), yield ha^{-1}(0.83) and linolenic acid (-0.83). The association of seed pod^{-1} was observe high significant with yield ha^{-1} (0.88) and linolenic acid (-0.89). Generally, low correlation was observed among different traits; however some of the related characters like days to flowering, pods raceme^{-1}, pos length, plant height, seed pod^{-1}, yield hac^{-1}, oleic acid, and moisture were highly significantly and positively correlated with each other as compares to the remaining traits which are negatively and non-significantly correlated with each other. So selections for such traits are useful for yield and quality improvement.

Keywords: brassica, phenotypic correlation, characters, yield.

INTRODUCTION

For centuries, Brassica species have been exploited by man, domesticated and modified to meet changing needs. Brassica species has high productivity, good yield and good agronomic characteristics. Many of the species are used for food, oils and as animal feed. The Brassicaceae family comprises of about 3000 species. The most important crop species from this family are the oilseed Brassicas. Brassica napus, B. campestris, and B. juncea, which are generally referred to as rapeseed, oilseed rape, or canola. Worldwide, rapeseed is grown on more than 20 million hectares and it is the third most important oil plant after palm oil and soybean (FAOSTAT, 2004). Leading producers of rapeseed are China, India, Japan, Sweden, France and Russia. Some rape is grown for seed production in Canada, but in US the plant is used mainly as a forage and green manure crop.

The cultivated Brassica species are grown in many countries and include important oil, vegetable and condiment crops. They contribute to the world economy; contain vitamins and anti-carcinogenic compounds, excellent balance of polyunsaturated fatty acids and oil can serve as a bio-fuel or a renewable resource for industrial applications. However, considerable improvement in yield, quality, robustness, range and input efficiencies is required if the full potential benefits of Brassica crops are to be realized. Rapeseed and mustard seed is a rich source of oil and protein. The seed has oil as high as 46-48 %; whole seed meal has 43.6 % protein. Rapeseed meal is an excellent feed for animals.

B. campestris and B. napus species mature earlier than other species but the available varieties of these species do not have a plant type which can be exploited to achieve a substantial increase in yield and quality under intensive cultivation Secondly, they are susceptible to insects' pest and diseases. Both of the species have a limited genetic variation for resistance to these factors. All brassica crops require good soil drainage and a soil pH between 5.3 and 6.8 for optimum production. Brassica dry matter yield will depend on the production potential of the soil and environment, and the brassica species. At present, cultivars of B. napus and B. campestris have been developed with both low-erucic and low glucosinolate (double low or canola) quality, and these are now widely grown commercially.

Pakistan is facing huge shortage of edible oil since long. Rapid rise in population is the major reason for the shortage of edible oil in the country. The domestic oil production hardly meets 30 percent of the national demand whereas remaining 70 percent is met through the import. A rough estimate shows that in 2004-2005 country imported 1.3 million tones by spending more than 31 billion rupees to meet the national requirement of 1.9 million tones (Anonymous, 2003). The consumption of edible oil is continuously increasing with an alarming rate of 13% annually (Razi, 2004).

In Pakistan after cotton, rapeseed-mustard is the second most important source of edible oil. During the year 2003-04, mustard or rapeseed was cultivated on an area of 259 thousand hectares with a production of 221 thousand tons with 853.4 kg/ha yield (MinFAL, 2005). In domestic production, the share of cottonseed is 70 per cent, that of rape and mustard including canola, etc 15.8 per cent, and that of sunflower and others 12.5 per cent. Depending upon the varieties or hybrid seed, oil content in cottonseed varies from 10-12 per cent, rape and mustard 36-41, canola 42, sunflower 32-36, safflower 17-32, groundnut up to 50, sesame 46-48, linseed 35-45, and coconut up to 50 per cent.

In NWFP Rapeseed and Mustard is grown on about 20 thousand hectares with an average yield of 421 kg/ha (Anonymous, 2003). Most of the barani growers in NWFP cultivate desi type varieties (B. campestris) because of its drought tolerance, low fertilizer use, early maturity and low pest attack (mainly aphids). However, these varieties are low yielding as compared to B. napus types and also exhibit some undesirable characteristics like low oil percentage and high erucic acid and glucosinolate contents.

Due to ever increasing demand of edible oil for consumption and heavy expenditure on oil import it has become mandatory to develop local varieties that are high in oil and protein, low in erucic acid and glucosinolates content, which can with stand the biotic and abiotic stresses of our environment. Foreign varieties fail to cope with the extreme local environment, despite having good qualitative and quantitative characteristics. Similarly, non-availability of locally breed varieties that suit to our different ecological zones is also a limiting factor towards higher yields in Brassica oilseeds.

Keeping in view the importance of Brassica, the present study was thus an attempt to identify superior populations, among the six $F_{3:4}$ interspecific segregating Brassica populations along with three checks, for important agronomic and quality traits and developing new genotype to the already evolved cultivars.

MATERIALS AND METHODS

The study pertaining phenotypic correlation for yield and quality characteristics in $F_{3:4}$ populations of Brassica. The experiment was contacted at New Developmental Farm, NWFP Agricultural University, Peshawar during 2004-06. Six elite populations were selected on the basis of their best yield and quality performance from F_3 interspecific populations in 2004-5. These populations along with three checks were evaluated in four replication using a Randomized Complete Block Design (RCBD) in 2005-06. The checks used in the trial were two B. napus lines (A-20-28 and Rainbow) and one B, campestris line (1230). The experiment-I for this purpose F_3 seeds was sown in October 2005. The sowing plot comprised of 6 rows, each 5m long with row-to-row and plant to plant distance of 30cm. The crop was irrigated three times during the entire period of growth and development. First irrigation was given 29 days after sowing, second was given at the time of flowering and third irrigation was applied during grain filling period (PARC, 2006). The thinning was done once to maintain the space between the plants. All the experimental lines were grown under natural condition i.e. neither fertilizer and nor pesticide was applied in order to measure the full potential of the population under the natural conditions. At maturity, data were recorded on 5-10 randomly selected plants (depending on availability of plants) from each plot of each replication and were analyzed statistically for variability, heritability and selection response of different traits.

Genetic material

Selected lines

$F_{3:4}$ lines were selected/developed through interspecific hybridization of the following crosses:

Selected $F_{3:4}$ lines

	$F_{3:4}$ lines	Parents	Interspecific crosses
1.	19-83-5	A-20-28 x 1203	(*B.napus* x *B.campestris*)
2.	15-20-1	Maluko x 2163	(*B.napus* x *B.campestris*)
3.	19-2-2	A-20-28 x 1203	(*B.napus* x *B.campestris*)
4.	96-1-3	Maluko x 2065	(*B.napus* x *B.campestris*)
5.	12-16-1	Dunk led x 1203	(*B.napus* x *B.campestris*)
6.	2-22-1	ucd-40/1 x 8948-2	(*B.juncea* x *B.campestris*)

Selected checks

Selected checks, in which rainbow is grown commercially by the farmers used as checks were:

7. A-20-28 (Napus)
8. 1203 (Campestris)
9. Rainbow (Napus)

STATISTICAL ANALYSIS

The mean data from the nine replicated populations were subjected to Pearson correlation by using SAS program to determine the extent to which values of relationship between yield and various morphological and quality characters subsist in these populations.

RESULTS AND DISCUSSIONS

Plant scientists often assess correlation coefficients to develop a selection strategy for better plant type. Correlations are important for the breeder in order to associate all the possible valuable features in the newly created genotypes. Pearson correlation determines the extent to which values of the two traits are proportional to each other. The value of studies on relationship between yield and various morphological and quality characters of the plant population which influence yield and quality are very great indeed, as it furnishes to the plant breeder with an easy and fairly reliable means of isolating high yielding and better quality genotypes from the breeding material. The importance of yield and quality as the characters of first and foremost significance in plant breeding needs no comment. Even a slight superiority of newly evolved variety in respect of yield and quality over the commercial varieties is enough to ensure replacement of the former by the latter without any efforts on persuading the cultivators to take-up the new variety. They are always readily willing to take up the high yielding variety. Correlation analysis of important plant characters leads to a directional model for yield and quality response. In the present study an effort has been made to analyze the relationship between various traits. The results of correlation coefficient among the traits studied are shown in Tables-1 and 2.

The correlation values presented in Tables-1 and 2 show highly significant positive correlation of days to flowering with pods raceme^{-1} (0.90), while non-significant positive relationship with plant height (0.43), primary braches plant^{-1} (0.23), seeds pod^{-1}(0.16), yield hac^{-1}(0.17), oil content (0.15), oleic acid (0.57). However, days to flowering had significant negative association with glucosinolate content (-0.67), while negative but non-significant correlation with pod length (-0.05), 100-grain weight (-0.34), protein content (-0.02), linolenic acid (-0.38) and erucic acid (-0.12) respectively.

Plant height showed positive but non-significant association with pod raceme^{-1} (0.6), pod length (0.59), seed pod^{-1} (0.54), 100-grain weight (0.22), yield ha^{-1} (0.67) and oil content (0.17), however, non-significant negative relationship with primary breaches plant^{-1} (-0.33), protein content (-0.35), glucosinolate content (-0.38), erucic acid (-0.53) respectively (Table-1). Plant height shows highly significant positive correlation with oleic acid (0.82) but significant negative relation with linolenic acid (-0.70) (Table-2).

The relationship of primary braches plant^{-1} with pod length (0.93), seed pod^{-1} (0.88) and yield ha^{-1} (0.78) is highly significant but negative, while positive significant correlation was observed with linolenic acid 90.68). The results also shows primary branches plant^{-1} has non-significant positive association with pods raceme^{-1}(0.16), and negative but non-significant with 100-grain weight (0.20), oil content (-0.51), glucosinolate content (-0.44), oleic acid (-0.22) and erucic acid (-0.26), respectively (Tables-1 and 2).

Pods raceme^{-1} showed highly significant correlation with oleic acid (0.73) and non-significant positive relationship with pod length (0.04), seed pod^{-1} (0.20), yield ha^{-1} (0.30) and oil content (0.14), while negative non-significant relation with100-grain weight (0.07), protein content (-0.06), glucosinolate content (-0.52), linolenic acid (-0.39) and negative but significant with erucic acid (-0.70).

The correlation results showed pod length has highly significant positive relation with seed pod^{-1} (0.93) and yield hac^{-1} but negative with linolenic acid (-0.83), while positive non-significant relation with 100-grain weight (0.28), oil content (0.43), glucosinolate (0.23), oleic acid (0.47) and erucic acid (004) but negative with protein content (-0.62), respectively.

The relation of seed pod^{-1} is highly significant positive with yield ha^{-1} and linolenic acid (-0.89), while positive non-significant with 100-grain weight (0.46), oil content (0.53), glucosinolate (0.23), oleic acid (0.41) and erucic acid 0.09) but negative association with protein content (-0.62), respectively. Non-significant positive relation of 100-grain weight with yield ha^{-1}(0.15), protein content (0.01), glucosinolate (0.23), oleic acid (0.40) and linolenic acid (0.15), while negative non-significant correlation with oil content (0.39) and erucic acid content (0.50).

The analysis of correlation showed highly significant positive correlation of yield ha^{-1} pod length (0.83) and seed pod^{-1} (0.88) bur negative relation with primary braches plant^{-1} (0.78) and linolenic acid (0.80), while non-significant association with days to flowering (0.17), plant height (0.67), pods raceme^{-1} (0.30), 100-grain weight (0.15), oil content (0.54), glucosinolate (0.29), oleic acid (0.49), protein content (-0.54) and erucic acid content (-0.06), respectively.

DISCUSSIONS

Analysis of correlation for majority of the traits presents highly significant positive correlation between the traits for days to flowering with pods raceme^{-1}, for primary braches plant^{-1} with pod length, seed pod^{-1}, yield ha^{-1} and oleic acid, for pod length with seed pod^{-1}, yield ha^{-1} and linolenic acid, for seed pod^{-1} with yield hac^{-1} and linolenic acid, for percentage of oil with protein content, for moisture content with oleic acid and erucic acid and for oleic acid with erucic acid.

Our results are supported by the studies of Malik *et al.*, (2000). They observed positive correlation of seed yield with primary branches, siliqua plant^{-1} number of secondary branches and siliqua length, while found negative and highly significant relation of days to flower and plant height. They also found negative and non-significantly correlation for seed yield with seed siliqua^{-1} and 1000-seed weight.

The contrasting relationship between protein and oil content was also supported by the consistent to the outputs of Alemayehu and Becker (2002) who observed highly significant negative correlation coefficient, and this was also the case for positive association of oil content with 1000-seed weight. Further more Hodgson (1978) found that oil content was inversely related to protein. Aggarwal *et al.*, (2003) reported contents of linolenic, linoleic and oleic acids had significant positive correlation among them. The content of erucic acid was negatively correlated with that of all other fatty acids. The negative phenotypic correlation between erucic acid and other fatty acid contents was reflected by opposite additive effects of parental alleles at the common/linked loci.

Our results is opposite to that of Pablo *et al.*, (2004), Butruille *et al.*, (1999) and Udall *et al.*, (2004), who found that oil content, was positively and significantly correlated with seed yield in both testcross populations. Ali *et al.*, (2003) reported positive and significant correlation was found between seed yield, seed weight and flower duration. Significant and positive correlation of seed weight with seed yield indicated that improvement in seed weight would give high seed yield. Positive direct effect of seed weight with seed yield suggested that these yield components may be good for selection criteria to improve seed yield of winter type rapeseed. They also observe branches plant^{-1} has negative but highly significant correlations with seeds pod^{-1} (-0.326). Since the simple correlation coefficients did not give clear information about the interrelationship between the causal and resultant variables, the correlation coefficient estimates were partitioned into direct and

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indirect effects to establish the intensity of effects of independent variables on dependent one.

Zhang and Zhou (2006) observed that number of seed pod^{-1} and 1000- grain weight were positively correlated with seed yield plant^{-1}. Number of pods raceme^{-1} and primary branches was negatively but insignificant correlated with seed yield. ÖZER and ORAL (1999) found that relationship between oil content and protein content was negative. A negative correlation between oil content and crude protein percentage in oilseeds had seems reasonably proven. Regarding oil content, correlation study revealed that in general, the association between oil content and the other characters showed consistent trend. It was found positively correlated with days to flowering, plant height, number of seeds pod^{-1}, pod length and 1000-seed weight.

Significant correlation was found between days to flowering and glucosinolate, plant height and linolenic acid, primary branches plant^{-1}and linolenic acid, pod raceme^{-1} with oleic acid and erucic acid, respectively. Similarly the results show all the remaining characters non-significant correlation with each other.

In support of our study, Khan *et al.*, (2003) found 100-grain weight is significantly and positively correlated with days to flowering and grain yield while non-significantly correlated with plant height. Correlation data indicate that selection for days to flowering, plant height and 100-grain weight will be effective for higher grain yield. Akbar *et al.*, (2003), Malik *et al*., (2000) and Khan *et al.*, 1992 found that 1000 seed weight had non significant positive correlation with plant height while significant association with seed yield which was minimized with adversely effected environment.

Further Lionneton *et al.*, (2004) reported plant height is non-significantly correlated with days to flowering and1000-grain weight. He further observed that oil content is significantly but negatively correlated with days to flowering and non-significantly correlated with plant height and 100-grain weight. He found the relationship of GSL is non-significant with days to flowering, plant height, 1000-seed weight and oil content. ÖZER and ORAL (1999) found that seed yield was significantly and positive correlated with 1000-seed weight and pod length is positively correlated with seed yield.

Generally, low correlation was observed among different traits; however some of the related characters like days to flowering, pods raceme^{-1}, pos length, plant height, seed pod^{-1}, yield hac^{-1}, oleic acid, and moisture were highly significantly and positively correlated with each other as compares to the remaining traits which are negatively and non-significantly correlated with each other. So selections for such traits are useful for yield and quality improvement. The results indicated that oilseed mustard in Pakistan has narrow genetic base and experiencing high level of genetic erosion perhaps due to selection for similar traits, replacement by new uniform varieties and socio-economic changes in agriculture.

Table-1. Pearson correlation between yield and yield contributing characters calculated from six advanced $F_{3:4}$ lines and three checks of Brassica evaluated at NWFP Agricultural University, Peshawar during 2005-2006.

Traits	Plant height	Primary braches plant^{-1}	Pods raceme^{-1}	Pod length	Seed pod^{-1}	HGW	Yield ha^{-1}
Days to flowering	0.43	0.23	0.90**	-0.05	0.16	-0.34	0.17
Plant height	-----	-0.33	0.6	0.59	0.54	0.22	0.67
Primary braches plant^{-1}	-----	-----	0.16	-0.93**	-0.88**	-0.20	-0.78**
Pods raceme^{-1}	-----	-----	------	0.04	0.20	-0.07	0.30
Pod length	-----	-----	----	----	0.93**	0.28	0.83**
Seed pod^{-1}	----	-----	-----	----	----	0.46	0.88**
HGW	----	----	----	----	----	----	0.15

* = Significant at 1 % level
** = Highly significant at 5 % level

Table-2. Pearson correlation between yield, yield contributing and quality characters calculated from six advanced $F_{3:4}$ lines and three check of Brassica evaluated at NWFP Agricultural University, Peshawar during 2005-2006.

Traits	Days to flowering	Plant height	Primary braches plant^{-1}	Pods raceme^{-1}	Pod length	Seed pod^{-1}	HGW	Yield ha^{-1}
Oil	0.15	0.17	-0.51	0.14	0.43	0.53	-0.39	0.54
Protein	-0.02	-0.35	0.62	-0.06	-0.62	-0.62	0.01	-0.54
GSL	-0.67*	-0.38	-0.44	-0.52	0.23	0.23	0.23	0.29
Oleic acid	0.57	0.82**	-0.22	0.73*	0.47	0.41	0.40	0.49
Linolenic acid	-0.38	-0.70*	0.68*	-0.39	-0.83**	-0.89**	0.15	-0.80**
Erucic acid	-0.12	-0.53	-0.26	-0.70*	0.04	0.09	-0.50	-0.06

HGW = 100-grain weight
GSL = Glucosinolates
* = Significant at 1 % level
** = Highly significant at 5 % level

REFERENCES

Aggarwal R.A., K.R. Sharma, R. Kumar, T. Mohapatra, and R.P. Sharma. 2003. Molecular mapping of loci affecting the contents of three major fatty acids in Indian Mustard (Brassica juncea L). J. Plant Biochem. and Biotech. 12:131-137.

Anonymous. 2002-03. Crops Area Production by (Districts). Govt. of Pakistan, Ministry of Food, Agric. and Livestock (Economic wing), Islamabad.

Akbar M., M. Tariq, M. Yaqub, M. Anwar, M. Ali and N. Iqbal. 2003. Variability, correlation and path coefficient studies in Summer Mustard (Brassica Juncea L.). Pak. Asian J. Plant Sci. 2(9): 696-698.

Alemayehu N. and H. Becker. 2002. Genotypic diversity and patterns of variation in a germplasm material of Ethiopian mustard (Brassica carinata A. Braun). Genetic Resources and Crop Evolution. 49: 573-582.

Ali N. 1985. Genetic variability and correlation studies in Brassica juncea. Pak. J. Bot. 17: 297-303.

Butruille D.V., R.P. Guries and T.C. Osborn. 1999. Increasing yield of spring oilseed rape hybrids (Brassica napus L.) through introgression of winter germplasm. Crop Sci. 39: 1491-1496.

FAOSTAT. 2004. Agriculture data. Food and Agricultural Organisation of the United Nations. February 2004 http://apps.fao.org/page/collections?subsetDagriculture

Hodgson A.S. 1978. Rapeseed adaptation in northern New South Wales. III. Yield, yield components and grain quality of Brassica campestris and Brassica napus in relation to planting date. Aust. J. Agri. Res. 30(1): 19-27.

Khan A., Ullah I., Murtaza S.B. and M.Y. Khan. 2003. Variability and correlations study in different newly developed sunflower hybrids. Asian J. Plant Sci. 2(12): 887-890.

Khan A.H., T. Mahmood and S.A. Shah. 1992. Path coefficient analysis of morphological parameters with seed yield in Raya. Pak. J. Agric. Res. 3: 334-337.

Lionneton E, Aubert G, Ochatt S and Merah O. 2004. Genetic analysis of agronomic and quality traits in mustard (Brassica juncea). TAG. E-mail: ochatt@epoisses.inra.fr

Malik M. A., A S. Khan, Shafiullah and M. K. Ayub. 2000. Study of correlation among morphological parameters in different varietites/accessions of Brassica species. Paki. J. Bio. Sci. 3(7): 1180-1182.

MINFAL. 2005. Daily NEWS, Islamabad-Pakistan. p.10.

ÖZER H. and E. ORAL. 1999. Relationships between yield and yield components on currently improved spring rapeseed cultivars. Tr. J. of Agri. and Forestry. 23: 603-607.