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Genetic Variability, Correlations and Heritability Estimates for Various Biochemical Traits in Rapeseed (*Brassica napus* L.)

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Abstract: To estimate genetic variability, correlations and heritability among various *Brassica* napus germplasm, an experiment was conducted comprising fifteen rapeseed genotypes during 2014-2015 at New Developmental Farm, The University of Agriculture Peshawar Pakistan. Rapeseed genotypes were laid out in a randomized complete block design (RCBD) with three replications. Data were recorded on following quality traits *viz*., oil content (%), protein content (%), glucosinolates content (μmolg^{-1}) and erucic acid content (%). Analysis of variance revealed significant difference (P=0.01) for all the traits, except erucic acid content (%). Mean values for quality traits ranged between 48.51–53.17, 17.87–21.79, 59.82–95.93, 44.52–57.28 for oil content (%), protein content (%), glucosinolates content (μmolg^{-1}) and erucic acid content (%), respectively. Genotype CA4 displayed maximum mean value (53.17 %) for oil content and minimum value of 17.87 % and 59.82 (μmolg^{-1}) for protein content and glucosinolate content, respectively. Whereas, genotype PGR17 exhibited maximum mean value of 21.79 % and 95.93 (μmolg^{-1}) for protein content and glucosinolate content, respectively. On the other hand PGR17 revealed minimum mean value (48.51 %) for oil content. The maximum mean value (57.28%) for erucic acid was recorded for genotype CH6 and minimum (44.52 %) was recorded for genotype CH1. The maximum broad sense heritability was observed for glucosinolates content (0.45), protein content (0.34) followed by erucic acid content (0.25) and oil content (0.24). Highly significant positive phenotypic correlation for protein content was observed with glucosinolates content whereas, highly significant negative association for oil content was examined with protein content and glucosinolates content. Based on the results of this study, genotype "CH-4" performs superiorly with maximum oil content and low glucosinolates content. Hence, could be used as parentage in future breeding program.

Key words: *Brassica napus* · NIRS · Variability · Heritability · Correlations · Quality traits · Oil content

INTRODUCTION

Rapeseed (*Brassica napus* L.) is an amphidiploid (AACC genome, 2n=38) comes under the Brassicaceae family, counts for the world's essential edible oilseed crop and ranks third largest source of vegetable oil after soybean and palm. Napus kernel yields about 40-46% oil and 18-22% protein content. Leftovers after oil extraction are precious and used as a good source of protein for livestock. Production of edible oil in Pakistan is 34% (0.606 million tons) of its total consumption (2.325 million tons). Rapeseed contributes about 0.068 million tons (approximately 11.22%) of the total production to the local market [1]. Presence of higher erucic acid and glucosinolates contents give bitter taste in brassica oil and hence make it unappealing for consumers to be used as edible oil. Not only these chemical compounds result in series of nutritional disorders but also lower seed press cake palatability in farm livestock [2]. So, lowering the contents of these undesirable chemicals to enhance the palatability of brassica oil has been one of the key breeding objectives of brassica.

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Genetic variability, heritability, correlation as well as genetic gain plays a vital role in the accomplishment of any breeding program [3]. Variation in plants on the basis of different characters leads to the genetic diversity. Heritability helps us in forecasting the performance of genotypes in subsequent generations and is important for transmissibility of characters and similarly, it splits the total variation into genetic and environmental components [4, 5]. Correlations are important in determining the degree to which various yield contributing characters are associated. It is believed that plant characters having high heritability and genetic advance are under the control of additive type of genes, which highlights the effectiveness phenotypic selection [6]. Keeping in view the importance of Brassica napus as oilseed crop, this experiment was designed to study genetic variation and estimate broad sense heritability and correlations for quality traits among candidate's *Brassica napus* genotypes.

MATERIALS AND METHODS

The present study was conducted at New Developmental Farm, The University of Agriculture Peshawar, Pakistan. Fifteen *Brassica napus* L. germplasm *viz.,* PGR17, PGR18, CA1, CA2, CA3, CA4, CA5, CA6, CA7, CH1, CH2, CH3, CH6, CH8, K11, introduced from China and also were collected from Plant Genetic Resources Islamabad, Pakistan were laid out in a randomized complete block design (RCBD) with three replications of 5 m row length. Row to row and plant to plant distance was kept as 50 cm and 30 cm, respectively. Recommended cultural practices were applied throughout the growing season.

Biochemical Analysis: Biochemical analysis was carried out at Nuclear Institute for Food and Agriculture (NIFA) Peshawar using Nuclear Infra-Red Spectroscopy (NIRS) technique for the following traits.

- Oil content (%)
- Protein content (%)
- Glucosinolates content (µmolg^{-1})
- Erucic acid content (%)

Statistical Analysis

Analysis of Variance: Data recorded on each trait was subjected to analysis of variance (ANOVA) appropriate for RCBD were worked out using computer software SPSS v.16. Mean separation for quality traits were carried out following LSD test at 5% level of probability.

Heritability (B.S): Heritability estimates for all traits were worked out from genotypic variances, phenotypic variances and environmental variances using following formula:

$$\text{Genotypic variance}(\delta^2 g) = \frac{GMS - EMS}{r}$$

$$\text{Phenottypic variance } (\delta^2 p) = \delta^2 g + \delta^2 e$$

$$\text{Environmental variance } (\delta^2 e) = EMS$$

$$h^2_{(B.S)} = \frac{\delta^2 g}{\delta^2 p}$$

whereas,

$\delta^2 g$ = Genotypic variance for a trait
$\delta^2 p$ = Phenotypic variance for a trait
$\delta^2 e$ = Environmental variance for a trait
$h^2_{(B.S)}$ = Broad sense heritability for a trait

Correlations Analysis: Pearson correlation coefficient was computed using computer software SPSS v.16.

RESULTS AND DISCUSSION

Oil Content (%): Analysis of variance exhibited significant difference among all the fifteen genotypes of rapeseed for oil content (Table 1), indicating the presence of sufficient amount of variation among genotypes for oil content. Rameeh, (2012), Khan *et al.*, (2008), Tuncturk and Ciftci, (2007) [7, 8, 9] also reported significant variation for oil content in Brassica napus. Mean value for oil content varied from 48.51 to 53.17% with a mean value of 50.66%. The minimum oil content 48.51% was recorded for PGRI7, whereas the maximum 55.17% was recorded for CA4 (Table 2). Genotypic and environmental variances for oil content were 0.65 and 1.94, respectively. Oil content exhibited low broad sense heritability (0.25). Low heritability for oil content was also reported earlier by Khulbe *et al.* (2000) [10]. Oil content displayed highly significant negative correlation with protein content and glucosinolates content, while non-significant correlation was observed with the remaining traits (Table 3). Similar results have been reported by Ali *et al.* [11], who observed significantly negative correlation of oil content with protein content and other oil contributing traits.

Protein Content (%): Mean square values for protein content displayed highly significant difference among genotypes for protein content (Table 1). Mean value for protein content ranged between17.87% to 21.79% with a mean value of 20.30 %. Genotype CA4 displayed minimum

Table 1: Mean squares table for quality traits of rapeseed evaluated during 2014-15

Parameters	Replication (df=2)	Genotype (df=14)	Error (df=28)	CV (%)
Oil content	0.527	3.896*	1.942	2.75
Protein content	4.457	4.362**	1.69357	6.41
Glucosinolates content	161.643	188.655**	55.165	9.78
Erucic acid content	0.314	44.016^{NS}	22.430	9.34

CV= coefficient of variation, df = degree of freedom

Table 2: Means values table for quality traits of rapeseed evaluated during 2014-15

Genotypes	Oil (%)	Protein (%)	Glucosinolates ($\mu molg^{-1}$)	Erucic acid (%)
PGRI8	50.87	19.68	69.66	46.72
CH3	51.48	20.12	81.19	54.20
CA4	53.17	17.87	59.82	52.23
CA5	52.03	18.66	71.79	48.09
CA2	48.94	19.81	76.14	46.28
CH1	51.52	21.24	68.09	44.52
K11	50.81	20.16	74.26	54.21
CH2	50.40	19.84	77.82	50.30
CA7	50.53	20.41	73.14	55.83
CA3	49.82	20.18	79.09	50.24
CA1	50.39	21.00	73.88	48.18
CA6	50.43	20.69	79.59	49.60
CH8	50.51	21.68	76.74	54.70
PGRI7	48.51	21.79	95.93	48.56
CH6	50.47	21.42	81.66	57.28
Mean	50.66	20.30	75.92	50.73
$LSD_{0.05}$	2.33	2.17	12.42	NS

Table 3: Pearson correlation coefficient among quality traits of rapeseed during 2014-2015

	Protein content	Glucosinolates content	Erucic acid
Oil content	-0.825**	-0.548**	0.160
Protein content	--	0.691**	0.132
Glucosinolates content		--	0.148

Table 4: Variance components and heritability $_{(BS)}$ for various quality traits of rapeseed genotypes evaluated at The University of Agriculture Peshawar during 2014-15

Traits	V_g	V_e	V_p	$h^2_{(BS)}$
Oil content	0.65	1.94	2.59	0.25
Protein content	0.89	1.69	2.58	0.34
Glucosinolates content	44.50	55.15	99.65	0.45
Erucic acid content	7.19	22.43	29.62	0.24

Vg =Genetic variance, Ve =Environ mental variance, Vp =Phenotypic variances, $h^2_{(BS)}$ =Heritability (broad sense)

protein content, whereas, maximum protein percentage was recorded for PGR17 (Table 2). Genotypic and environmental variance for protein contents were 0.89 and 1.69, respectively. Protein content exhibited moderate broad sense heritability (0.34). Protein content showed highly significant positive correlation with glucosinolates content, whereas significantly negative association was observed between oil content and protein content (Table 3). Contrasting results have been reported earlier by Sadat *et al.*, (2010), Khan *et al.*, (2008) [12, 8] as they reported high heritability for protein content in brassica populations which could be the result of different germplasm used in their study.

Glucosinolates Content ($\mu molg^{-1}$): Analysis of variance displayed highly significant difference among genotypes for glucosinolate content of rapeseed (Table 1). Overall, genotypes, glucosinolates content varied from 59.82 to 95.93 $\mu molg^{-1}$ with a mean value of 75.92 $\mu molg^{-1}$ (Table 2). These results are in conformity with the work of Shaukat *et al.*, (2014), Aytac and Kinaci, (2009) [13, 6] as they observed significant differences among *Brassica napus* genotypes. Among the rapeseed genotypes, the minimum glucosinolates content (59.82 $\mu molg^{-1}$) was recorded for CA4, whereas the maximum (95.93 $\mu molg^{-1}$) was recorded for PGRI7 (Table 2). Genotypic and environmental variances for glucosinolates content were

44.50 and 55.15 (Table 4). Glucosinolates displayed highly significant negative correlation with oil content and protein content. While non-significant association was observed with erucic acid content (Table 3). Results of correlations are in confirmation with the findings of [11] who reported that oil content was negatively and significantly correlated with protein contents.

Erucic Acid Content (%): Mean square values for erucic acid showed non-significant ($p \leq 0.05$) differences among rapeseed genotypes (Table 1). Mean values for erucic acid ranged between 44.52 to 57.28% with a mean value of 50.73% (Table 2). Minimum erucic acid value (44.52%) was recorded for CH1, whereas maximum (57.28%) was recorded for CH6 (Table 4). Contradictory results have been reported by of Shaukat *et al*. (2014), Ahmad *et al.* (2013) and Khan *et al.*, (2008) [13, 14, 8] as they reported significant differences for erucic acid in *Brassica napus* genotypes. In light of the fact that breeders are striving hard to minimize the content of erucic acid in brassica genotypes it's quite understandable that diversity for erucic acid content is on the decline. Genotypic and environmental variances for erucic acid contents were 7.19 and 22.43, respectively (Table). Erucic acid exhibited non-significant association with oil content, protein content and glucosinolates content (Table 3). The non-significant association of erucic acid with other chemicals such as protein and oil content will make the job easy for the breeders to eliminate the undesirable alleles responsible for the production of erucic acid from brassica napus.

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