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Research Article

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Correlation and Path Coefficient Analysis of Agronomic, Quality Characters and Growth Parameters on Seed Yield in Canola (*Brassica napus* L.)

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Abstract The success of indirect selection for high yield mainly depends on the relationships among yield and yield components. The study aimed to determine the correlation coefficients and direct and indirect effects by path analysis in canola. Two canola cultivars were planted at two different sowing times using five different seeding rates in 2014 and 2015. The experiment was arranged in Randomized Complete Block Design with four replications. Number of pods per plant, number of branches per plant, number of seeds per plant, oil content of seed and leaf area duration significant and positive correlated with seed yield. Path analysis showed that the highest and positive direct effect was recorded in LAD, NP, LAR and LAI, respectively. It was concluded that these characters should be used as selection criteria in canola breeding.

Keywords Correlation, growth parameters, path analysis, seed yield, yield components

1. Introduction

Canola (*Brassica napus* L.) has high-quality oil with a low quantity of saturated fatty acids and a medium level of polysaturated fatty acids in major oilseed crops. Therefore, it was cited as one of the main sources of high-quality vegetable oil [13]. Canola yield is a dependent characteristic contributed by yield components and occurred as a result of the interaction between genotype and environment [2]. Assessment of the relationship between yield and other components is useful for canola breeders to determine the direct and indirect contributors for high yield in canola breeding [12].

In studies that evaluated the correlation coefficients with seed yield of canola, positive and significant correlations were found between seed yield and 1000-seed weight [4, 5, 8], pods per plant [5, 3, 9, 10, 11, 6, 8]. It was emphasized that seed yield exhibited a positive significant correlation with CGR, RGR, NAR, plant height, the number of primary branches per plant and CGR revealed the highest degree of correlation [2].

Direct effects of the number of pods per plant, 1000-seed weight, number of primary branches per plant and harvest index on seed yield of canola were found high and positive in many studies [3, 4, 5, 6, 1, 7]. As a result of studies, it was recommended that the number of pods per plant was the most important contributors to seed yield, which could be taken in consideration for future hybridization programs. In addition, the growth parameters, RGR and CGR, had high and positive direct effects on seed yield [2]. The numbers of pods per plant and days from emergence to physiological maturity had the highest positive indirect effects on grain yield. The highest positive and negative indirect effects on grain yield were also related to plant height and 1000-grain weight, respectively [1].

Keeping in view, the present study was conducted to determine the correlation coefficients, direct and indirect effects of growth parameters, yield components and quality characters utilizing the variation due to seeding rate, sowing time and variety in canola.

2. Materials and Methods

This study was carried out in Adnan Menderes University experimental field for 2 years in 2015 and 2016 (37° 45' north, 27° 45' east). The quality analyzes such as oil and protein contents of seed were performed in Adnan Menderes University Food Engineering Laboratory. Sowing time as the main plot, cultivars as subplot and seeding rate as sub-sub plot were used. The experiments were arranged in Randomized Complete Block Design with four replications. Two canola cultivars, NK Petrol and Caravel, were planted at the beginning of November and December 2014 and October and December 2015 due to autumn precipitation, removal of pre-crop stubble etc. Seeding rates were 3.0, 5.0, 7.0, 9.0 and 11.0 kg ha^{-1}. Each plot consisted of 7 meters long, 13 cm row to row and 21 rows for each entry. 11 rows of 21 rows were used for observations of growth parameters and 10 rows were used for yield and quality measurements. The fertilization was planned to be 160 kg ha^{-1} N, 80 kg ha^{-1} P_2O_5 and 80 kg ha^{-1} K_2O. Half of the nitrogen fertilizer and all phosphorus and potassium were used as basal fertilization by 15.15.15. The ammonium nitrate in early spring was applied as the other half of the nitrogen. Azotrax™ (Metazachlor, 333 g/l + Quinmerac, 83 g/l effective) was applied at a dose of 2000 ml ha^{-1} after planting for weed control.

During the April 8th to June 1st, ten sampled from each plot were collected four times with an interval of one mount in order to determine the growth parameters, net assimilation rate (NAR), crop growth rate (CGR), leaf area index (LAI), leaf area duration (LAD), leaf area rate (LAR) and relative growth rate (RGR). The growth parameters were calculated according to the formula given below:

Dry matter (DM) = The samples were dried at 70 °C and 48 h in shoots (above ground)

Leaf Area Index (LAI) = leaf area (m^2) / land area (m^2)

Crop Growth Rate (CGR) = $(weight_2 – weight_1) / (time_2 – time_1)$ expressed as $g/m^2/day$

Relative Growth Rate (RGR) = $(\log_e weight_2 – \log_e weight_1) / (time_2 – time_1)$, expressed as mg/g/day

Net assimilation Rate (NAR) = $(weight_2 – weight_1)$ x $(\log_e leaf\ area_2 – \log_e leaf\ area_1 / (time_2 – time_1)$

Leaf Area Rate (LAR) = $[(leaf\ area_1 / weight_1) + (leaf\ area_2 / weight_2)] / 2$

Leaf Area Duration (LAD) = LAI x (days to first flowering – days to end of flowering)

Plant height (PH; cm), number of pods per plant (NP), number of seeds per pod (NSP), number of branches per plant (NB), 1000-seed weight (TSW; g), oil content of seed (OIL; %) and protein content of seed (PRO; %) were recorded from randomly selected 10 plants in each trial. Seed yield (kg ha^{-1}) was calculated using parcel yield.

The phenotypic correlation was calculated by using the formula suggested by [14]. Correlation coefficients were partitioned into path coefficients to determine direct and indirect effects [15]. The correlation and path analysis were carried out using TARPOPGEN statistical program [16]. Seed yield was considered as dependent variables and, yield components and growth parameters were considered as independent variables.

3. Results and Discussion

The correlation matrix of observed characters in the study showed a significant relationship among the variables (Table 1).

The correlation coefficients of seed yield (YI) with NB, NP, NSP, OIL and LAD were significant and positive. These results paralleled with the findings of many researchers [2, 3, 5, 6, 8, 9, 10, 11]. The significant and negative correlation coefficients were found between PH and NB, NP, NSP, OIL and RGR, whereas PH was significant and positive associated with DM, NAR, CGR, LAI and LAD. These relationships indicated that yield components positively related to seed yield have a negative relationship with plant height, whereas PH favorably correlated with all growth parameters except LAR. The number of branches per plant (NB) was significant and positive correlated with TSW, NSP and OIL, whereas the correlation coefficients between NB and PRO and DM were significantly negative direction. The number of pods per plant with NSP, OIL, NAR, LAD and RGR; 1000-seed weight (TSW) with NSP, NAR, LAD and LAR; protein content (PRO) with DM, NAR and RGR exhibited significant and positive correlations (Table 1).

Table 1: Correlation coefficients for studied characters

	PH	NB	NP	TSW	NSP	OIL	PRO	DM	NAR	CGR	LAI	LAD	LAR	RGR
YI	-0.27	0.35*	0.59**	-0.03	0.38*	0.42**	-0.22	-0.18	0.05	0.16	-0.21	0.48**	-0.09	0.19
PH		-0.47**	-0.46**	0.07	-0.34*	-0.44**	0.12	0.42**	0.42**	0.50**	0.48**	0.60**	0.16	-0.56**
NB			0.25	0.53**	0.76**	0.47**	-0.70**	-0.54**	-0.17	0.30	-0.31	0.31	0.07	-0.08
NP				-0.39*	0.38*	0.39*	-0.15	-0.10	0.41*	0.07	-0.15	0.69**	-0.61**	0.37*
TSW					0.57**	0.11	-0.74**	-0.42**	0.57**	0.15	-0.01	0.34*	0.52**	-0.55**
NSP						0.47	-0.87	-0.60**	-0.40	0.11	-0.29	-0.31	0.11	-0.26
OIL							-0.37*	-0.32**	0.02	0.07	0.01	-0.22	-0.17	0.08
PRO								0.61**	0.49**	-0.09	0.10	0.03	-0.20	0.43**
DM									0.20	-0.27	0.25	0.21	-0.08	-0.05
NAR										0.47**	-0.18	0.49**	-0.54**	0.79**
CGR											0.59**	0.38*	0.28	0.63**
LAI												0.72**	-0.21	-0.35*
LAD													0.42**	-0.50**
LAR														-0.13

*: %5 and **: %1 significant at probability level, respectively.

YI: Yield, PH: Plant height, NB: Number of branches per plant, NP: Number of pods per plant, TSW: 1000-seed weight, NSP: Number of seeds per pod, OIL: Oil content, PRO: Protein content, DM: Dry matter, NAR: Net assimilation rate, CGR: Crop growth rate, LAI: Leaf area index, LAD: Leaf area duration, LAR: Leaf area rate, RGR: Relative growth rate.

As a result of path analysis, the percentage of direct and indirect effects of yield attributing traits on seed yield were given in Table 2. The highest and positive direct effect was recorded in LAD (31.4%) followed by NP (29.4%), LAR (26.7%) and LAI (26.2%). NSP had the highest and negative direct effect on seed yield. The number of pods per plant (NP) among the yield components was detected as the most important contributors to yield in parallel with many studies [3, 4, 5, 6, 1, 7]. Although RGR and CGR were found to be the most effective on seed yield in another study [2], we estimated that growth parameters such as LAD, LAI and LAR, show leaf activity at the flowering-ripening stage in the plant, were more effective. Parallel to this finding, indirect effects of LAD and LAR through NP, TSW and indirect effects of LAD through LAI, CGR and LAR were high and positive. The positive direct effect of NP, LAD, LAI and LAR associated with significant and positive correlation with seed yield suggested that these parameters may be a good selection criterion to improve seed yield of canola.

Table 2: The percentage direct and indirect effects of independent variables on seed yield.

	PH	NB	NP	TSW	NSP	OIL	PRO	DM	NAR	CGR	LAI	LAD	LAR	RGR
PH	**9.2**	-3.0	-16.4	1.8	8.3	-4.7	1.9	-2.8	5.8	-3.0	11.2	24.9	4.3	3.6
NB	-4.6	**6.7**	9.5	10.3	-20.0	5.3	-11.4	3.8	2.5	1.8	-7.9	13.8	1.9	0.6
NP	-3.5	1.3	**29.4**	-5.6	-7.6	3.4	-3.9	0.5	-4.7	0.3	-2.9	23.4	13.3	-2.0
TSW	0.6	3.3	-13.1	**17.2**	-13.3	1.1	-10.8	2.6	7.4	0.8	-0.1	13.3	13.2	3.3
NSP	-2.8	4.5	12.3	9.5	**-22.7**	4.6	-12.3	3.6	5.1	0.6	-6.1	11.6	2.8	1.6
OIL	-5.9	4.5	20.5	2.98	-17.0	**15.9**	-8.4	3.1	-0.3	0.6	0.1	13.4	-6.8	-0.7
PRO	1.3	-5.1	-6.0	-15.3	24.4	-4.5	**17.4**	-4.6	-7.6	-0.6	2.6	1.2	-6.2	-3.1
DM	5.3	-4.8	-4.7	-10.3	20.0	-4.6	12.8	**-8.9**	-3.8	-2.1	7.8	11.6	-3.0	-0.5
NAR	-3.5	-1.0	13.6	-9.4	9.1	0.2	6.9	-1.2	**-12.7**	2.6	-3.7	18.5	-13.1	-4.6
CGR	-6.4	2.6	3.5	3.8	-3.5	1.0	-1.8	2.4	-9.2	**8.4**	19.2	22.1	10.4	-5.7
LAI	5.0	-2.3	-6.1	-0.1	7.9	0.3	1.7	-1.8	2.7	-3.9	**26.2**	33.5	-6.3	2.5
LAD	4.2	-1.5	-18.8	4.7	5.7	-1.8	0.3	-1.0	5.1	-1.7	12.8	**31.4**	8.4	2.4
LAR	1.5	0.4	-21.7	9.5	-2.8	-1.8	-3.1	0.6	7.4	1.7	-4.9	17.1	**26.7**	0.8
RGR	-5.4	-0.6	13.8	-10.3	6.8	0.8	6.8	-0.4	-11.3	3.9	-8.0	21.3	-3.6	**-6.7**

*: %5 and **: %1 significant at probability level, respectively. Bold figures represent direct effects.

YI: Yield, PH: Plant height, NB: Number of branches per plant, NP: Number of pods per plant, TSW: 1000-seed weight, NSP: Number of seeds per pod, OIL: Oil content, PRO: Protein content, DM: Dry matter, NAR: Net assimilation rate, CGR: Crop growth rate, LAI: Leaf area index, LAD: Leaf area duration, LAR: Leaf area rate, RGR: Relative growth rate.

4. Conclusions

The growth parameters, LAD, LAI and LAR, are very important for solar radiation interception, assimilatory capacity and totally biomass. It was clearly seen that plant breeders could use LAD, LAI and LAR as selection criteria for phenotypic improvement in the yield of canola. Also, the number of pods per plant among yield components, which is easily determined, were the most important contributors to seed yield, which could be taken in consideration for future hybridization programs.

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References

[1]. Zare, M. (2011). Correlation and path analysis of some agronomic traits of rapeseed (*Brassica napus* L.) genotypes. *World Academy of Science, Engineering and Technology,* 60:1452- 1456.

[2]. Ray, K., Pal, A.K., Banerjee, H. & Phonglosa, A. (2014). Correlation and path analysis studies for growth and yield contributing traits in Indian mustard (*Brassica juncea* L.). *International Journal of Bio-reseurce and Stress Management,* 5(2):200-206.

[3]. Ali, N., Javaidfar, F. & Attary, A.A. (2002). Genetic variability, correlation and path analysis of yield and its components in winter rapeseed (*Brassica napus* L.*). Pak. J. Bot.,* 34(2):145-150.

[4]. Ali, N., Farzad, J. Jaferieh, Y.E. & Mırza, M.Y. (2003). Relationship among yield components and selection criteria for yield improvement in winter rapeseed (*Brassica napus* L.). *Pak. J.Bot.,* 35(2): 167-174.

[5]. Tuncturk, M., & Ciftci, V. (2007). Relationships between yield and some yield components in rapeseed (*Brassica napus* ssp. oleifera L.) cultivars by using correlation and path analysis. *Pakistan Journal of Botany*, 39(1): 81.

[6]. Parwin, E. Mahmud, F. & Haque, M.M. (2020). Heritability, genetic advance, correlation and path coefficient analysis in advanced generation of *Brassica napus* L. *American-Eurasian J. Agric. & Environ. Sci*., 20(2): 116-123.

[7]. Asfour, M.M. (2013). Correlation and path coefficient analysis of some quantitative characters in canola oil (*Brassica napus* L.). *Egypt. J. Agronomy,* 35(1): 65-75.

[8]. Seyedmohammadi, S.A. (2013). Evaluate correlation and path coefficient analysis for agronomic traits on grain yield of canola (*Brassica napus* L.) genotypes. *Scientific Journal of Agronomy and Plant Breeding*, 1(1): 52-59.

[9]. Rameeh, V. (2014a). Multivariate analysis of some important quantitative traits in rapeseed (*Brassica napus*) advanced lines. *Journal of Oilseed Brassica*, 5(2):162-169.

[10]. Rameeh, V. (2014b). Multivariate regression analyses of yield associated traits in rapeseed (*Brassica napus* L.) genotypes. *Advances in Agriculture*, Volume 14: 5 pages.

[11]. Sharafi, Y., Maidi, M.M., Jafaradeh, M. & Mirlohi, A. (2015).Multivariate analysis of genetic variation in winter rapeseed (*Brassica napus* L.) cultivars. *J. Agr. Sci. Tech*., 17: 1319-1331.

[12]. Khayat, M., Rahnama, A., Lorzadeh, S. & Lack, S. (2018). Physiological indices, phenological characteristics and trait evaluation of canola genotypes response to different planting dates. *Proc. Natl. Acad. Sci., India, Sect. B Biol. Sci*., 88(1):153–163

[13]. Biabani, A., Foroughi, A., Karizaki, A.R., Rassam, G.A., Hashemi, M., & Afshar, R.K. (2020). Physiological traits, yield, and yield components relationship in winter and spring canola. *J. Sci. Food Agric*., 101(8): 3518–3528.

[14]. Singh, R.K., & Chaudhary, B.D. (1985). Biometrical Methods in Quantitative Genetic Analysis. Kalayani Publisher, New Delhi (India).
[15]. Dewey, D. R., & Lu, K.H. (1959). A correlation and path coefficient analysis of components of crested wheat grass seed production. *Agronomy Journal*, 51: 515-518.
[16]. Ozcan, K., Acikgoz, N. (1999). Statistical packet program for population genetics. 3th Computer Applications Symposium in Agriculture. University of Cukurova 3-6 October, Adana, Turkey.