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Relationship among Yield and Component Characters in Different Planting Dates of Rapeseed Genotypes

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ABSTRACT
The present study was aimed to investigate the planting dates effects on yield associated traits and also determining stability of the result of factor analysis and stepwise regression analysis in different planting dates of rapeseed genotypes at Biekol Agriculture Research Station during 2011-12 cropping season. Result of split plot analysis exhibited significant genotypes effects for phenological traits, yield components and seed yield indicated significant differences of the genotypes for these traits. All the traits except 1000-seed weight were significant affected by planting dates. Significant positive correlation was detected between days to flowering and days to maturity in four planting dates. The correlation between seeds per pod with 1000-seed weight and seed yield were significant in all planting dates. Seed yield and biological yield had also significant and stable correlation. Based on stepwise regression analysis seeds per pod had important role in first and second planting dates, but in third and fourth planting dates, pods per plant was more important than other yield components for seed yield prediction model.

Keywords*:* Correlation, Phonological traits**,** Variation, Yield components**.**

INTRODUCTION

Rapeseed (*Brassica napus* L.) is now the second most important oilseed crop in the international oilseed market after soybean and is an important source of vegetative oil (Hasan *et al.,* 2006). For improving of seed yield of rapeseed and other brassica species, the important breeding strategies are understanding and utilization of genetical, physiological and morphological basis of yield associated traits in different environmental conditions (Sabaghnia, *et. al.*, 2010). Planting date has a considerable effect on seed yield by influencing the yield components so that late planting decreases the most important traits i.e, days to flowering, duration of flowering, plant height and pods per plant which cause a remarkable reduction in seed yield (Sharief and Keshta, 2002; Siadat and Hemayati, 2009). Development of ideotype genotype with minimum reduction of yield components and seed yield in different environmental conditions such as planting dates is an important goal of plant breeders. The ideotype concept provides opportunity to define the desired high-yield phenotype in terms of several relatively simple plant characters (Ma *et al*., 2014). Seed yield is a complex character that can be determined by several components reflecting positive or negative effects upon this trait, whereas it is important to examine the contribution of each of the various components in order to give more attention to those having the greatest influence on seed yield (Khaliq *et. al*., 2001; Sagir *et. al*.,2004; Mahasi et. al., 2006; Burhan, 2007). Therefore, knowing the relationship among the quantitative traits with the seed yield in different conditions make breeding programs and their success more optimistic and secure (Sharief and Keshta, 2002; Marjanovic-Jeromela, et. al., 2009). The response of seed yield to direct selection also may be unpredictable, therefore plant breeders needs to examine the relationships among various traits, especially between seed yield and other traits. As the number of independent variables influencing a particular dependent variable a certain amount of interdependence is expected among the independent variables (Aytac and Kinaci, 2008; Ogrodowczyk and Warzyniak, 2004; Sabaghnia, *et al*., 2010; Scheiner *et al.,* 2000;). Different statistical techniques have been used in modeling crops yield, including correlation, regression, path analysis, factor analysis, factor components and cluster analysis (Leilah and Al-Khateeb, 2005; Akbar *et al.,* 2007). In experiment with nine spring type rapeseed, Chango and McVetty (2001) observed that total dry matter and harvest index had a significant correlation with grain yield, but there was no correlation between chlorophyll or water use efficiency. Ali *et al.* (2003) also showed that pods per plant and 1000-seed weight had significant correlation with seed yield. Days to flowering and number of pods per plant were correlated significantly with seed yield (Khan *et al.,* 2006). Also a significant correlation was observed between pod number per plant and seed yield in species of *B. napus* and *B. juncea* (Akbar *et al.,* 2007; Marjanovic-Jeromela, *et al.*, 2009). This showed that among yield component number of pods had greatest and seed per pod and seed weight had weak influence on seed yield. Significant correlations between yield and yield associated traits were also reported in other important crops (Farshadfar and Farshadfar, 2008; Khalily, 2010; Azeez and Morakinyo, 2011; Belete, 2011;).

Although in planting date studies *et al.,* of rapeseed and other brassica species, correlation among the yield associated traits were noticed but in a few studies stability of correlations, regression and factor analysis were stressed. The objectives of the present study were to detect the planting date effects on yield associated traits and also to estimate correlation, regression and factor analysis in different planting dates to identify suitable selection criteria for rapeseed breeding.

MATERIALS AND METHODS

In order to evaluate the effects of planting dates on yield associated traits a split-plot experiment based on randomize complete block design with three replications was conducted at Biekol Agriculture Research Station, located in Neka, Iran (53˚, 13′ E longitude and 36˚ 43′ N latitude, 15 m altitude) during 2011-12 cropping season. Four planting dates including October 18 and 31 and November 5 and 15 were considered as main plots and the cultivars including L10 (19HSAR), Sarigol, L7(SLMR308), L4(SLM308) and Hyola401 were considered as sub- plots.

The soil was classified as a deep loam soil (Typic Xerofluents, USDA classification) with a pH of 7.3. Each sub plot was consisted of four rows 5 m long and 30 cm apart. The distance between plants on each row was 5 cm resulting in approximately 400 plants per plot, which were sufficient for statistical analysis.

Crop management factors like land crop rotation, fertilizer application, and weed control were followed as recommended for local area. All the plant protection measures were adopted to make the crop free from insects. The data were recorded on ten randomly selected plants of each entry of each replication for days to flowering, days to maturity, plant height, pods per plant, seeds per pod and 1000-seed weight. Twenty plant samples selected from middle part of each row were used to measure the traits including biological yield and harvest index. Seed yield of two middle rows of each plot, excluding the border area, was measured at physiological maturity and yield was adjusted to 12.5% seed moisture content. Analysis of variance of split-plot experiment was done for all the traits (Steel *et al*., 1997). Also correlation and stepwise regression analyes were done to study the relationship between traits All statistical analyses were carried out using SAS software version 9.

RESULTS AND DISCUSSION

Planting dates had significant effect on days to flowering, duration of flowering days to maturity, plant height yield components except 1000-seed weight and seed and biological yields. Genotypes had also significant differences for all the traits. Significant interaction effects of planting dates and genotypes were detected for phenological traits, pods per plant and seeds per pod (Table 1). Significant planting dates effects have been previously reported for days to flowering, duration of flowering, plant height and yield components and seed yield in rapeseed (Sharief and Keshta, 2002; Siadat and Hemayati, 2009).

Table 1-Analysis of variance for phenological traits, yield components and seed yield.

S.O.V	df	F-test									
		Days to flowering	Duration of flowering	Days to maturity	Plant height	Pods per plant	Seeds per pod	1000-seed weight	Seed yield	Harvest index	Biological yield
Replication	2	ns	ns	*	**	**	*	*	ns	ns	ns
Planting Date (D)	3	**	**	**	**	**	*	-	**	**	**
Error-1	6	-	-	-	-	-	-	-	-	-	-
Genotype(G)	4	**	**	**	**	**	**	**	**	**	**
D × G	12	**	**	**	ns	**	**	-	*	ns	ns
Error-2	32	-	-	-	-	-	-	-	-	-	-
CV%		1.60	8.78	1.50	8.35	10.35	7.82	5.95	9.27	13.26	10.83

*, ** Significant at p=0.05 and 0.01, respectively.

The result of Pearson correlation coefficient among the traits is presented in Table 2. Significant negative average correlation (-0.67**) was observed between days to flowering and duration of flowering and it was significant for all of the planting dates except third planting date. High significant negative correlation between days to flowering and duration of flowering, indicates that high temperature and short day length in late planting dates had considerable decreasing effects on duration of flowering, therefore days to flowering had significant negative correlation with yield components and seed yield. Significant negative average correlation was detected between days to flowering and harvest index, and it was also significant in all three planting dates except second planting date. Days to maturity was significantly correlated with plant height, but it had significant negative correlation with harvest index. Plant height had significant positive correlation with biological yield in first planting date and due to less variation of plant height in late planting dates, this correlation was not significant in the late planting dates, Significant positive correlation was determined between plant height and seed yield in most of the planting dates. This findings is in agreement with Sabaghnia, *et. al.*, (2010) who reported significant correlation of seed yield with plant height and pods per plant. Pods per plant had significant positive correlation with seeds per pod and 1000-seed weight in all of the planting dates and most of the planting dates,. Seeds per pod was significantly correlated with 1000-seed weight and seed yield in all of the planting dates, therefore this trait can be used as suitable selection criterion for improving1000-seed weight and seed yield. Significant positive correlation was exhibited between seed yield and biological yield and it was consistance in all of the planting dates.

Table 2. Correlation between traits of rapeseed genotypes in different planting dates.

Traits		Days to flowering	Duration of flowering	Days to maturity	Plant height	Pods per plant	Seeds per pod	1000-seed weight	Seed yield	Harvest index	Biological yield
Days to flowering	D1	1	-0.81**	0.96**	0.67**	0.06	-0.34	0.09	-0.16	-0.80**	0.27
	D2	1	-0.56*	0.81**	0.34	-0.01	-0.26	-0.16	-0.39	-0.47	0.07
	D3	1	-0.41	0.78**	0.38	-0.15	-0.16	-0.31	-0.21	-0.68**	0.15
	D4	1	-0.88**	0.82**	0.60*	-0.72**	-0.64*	-0.48	-0.69**	-0.87**	-0.02
average			-0.67**	0.84**	0.46	-0.21	-0.35	-0.22	-0.36	-0.71**	0.12
variance			0.05	0.01	0.08	0.13	0.04	0.06	0.06	0.03	0.02
Duration of flowering	D1		1	-0.73**	-0.68**	0.15	0.21	-0.01	-0.11	0.80**	-0.49
	D2		1	-0.22	-0.41	0.20	0.28	0.03	0.31	-0.16	0.42
	D3		1	0.02	0.30	-0.19	0.16	0.07	-0.27	-0.33	-0.09
	D4		1	-0.73**	-0.35	0.69**	0.61*	0.57*	0.66**	0.81**	0.07
average				**-0.42**	**-0.29**	**0.21**	**0.32**	**0.17**	**0.15**	**0.28**	**-0.02**
variance				**0.14**	**0.17**	**0.13**	**0.04**	**0.07**	**0.18**	**0.37**	**0.14**
Days to maturity	D1			1	0.68**	0.01	-0.36	0.03	-0.27	-0.82**	0.20
	D2			1	0.39	-0.24	-0.40	-0.06	-0.49	-0.80**	0.15
	D3			1	0.77**	-0.39	-0.18	-0.37	-0.53*	-0.78**	-0.13
	D4			1	0.43	-0.63*	-0.58*	-0.40	-0.43	-0.84**	0.32
average					**0.57***	**-0.31**	**-0.38**	**-0.20**	**-0.43**	**-0.81****	**0.14**
variance					**0.03**	**0.07**	**0.03**	**0.05**	**0.01**	**0.00**	**0.04**
Plant height	D1				1	0.06	-0.01	0.32	0.17	-0.79**	0.60*
	D2				1	0.08	-0.01	0.62*	0.02	-0.03	0.04
	D3				1	-0.31	-0.04	-0.18	-0.58*	-0.65**	-0.26
	D4				1	-0.28	0.03	0.06	-0.33	-0.41	-0.05
average						**-0.11**	**-0.01**	**0.21**	**-0.18**	**-0.47**	**0.08**
variance						**0.04**	**0.00**	**0.12**	**0.12**	**0.11**	**0.13**
Pods per plant	D1					1	0.57*	0.55*	0.47	0.08	0.33
	D2					1	0.64**	0.25	0.69**	0.24	0.51
	D3					1	0.71**	0.62*	0.65**	0.25	0.58*
	D4					1	0.78**	0.63*	0.82**	0.83**	0.22
average							**0.68***	**0.51***	**0.66***	**0.35**	**0.41**
variance							**0.01**	**0.03**	**0.02**	**0.11**	**0.03**

*, ** Significant at p = 0.05 and 0.01, respectively.

D1, D2, D3 and D4 are planting dates of October 18, October31, November 5 and November15, respectively.

Continued of Table 2.

Traits		Days to flowering	Duration of flowering	Days to maturity	Plant height	Pods per plant	Seeds per pod	1000-seed weight	Seed yield	Harvest index	Biological yield
Seeds per pod	D1						1	0.56*	0.65**	0.28	0.41
	D2						1	0.54*	0.85**	0.46	0.51*
	D3						1	0.67**	0.68**	0.06	0.72**
	D4						1	0.71**	0.66**	0.71**	0.09
average								0.62*	0.71**	0.38	0.43
variance								0.01	0.01	0.06	0.05
1000-seed weight	D1							1	0.51*	-0.21	0.53*
	D2							1	0.39	0.28	0.15
	D3							1	0.35	0.28	0.25
	D4							1	0.68**	0.66**	0.23
average									0.48	0.25	0.29
variance									0.02	0.10	0.02
Seed yield	D1								1	0.01	0.83**
	D2								1	0.46	0.67**
	D3								1	0.43	0.84**
	D4								1	0.71**	0.62*
average										0.40	0.74**
variance										0.06	0.01
Harvest index	D1									1	-0.53*
	D2									1	-0.32
	D3									1	-0.10
	D4									1	-0.10
average											-0.26
variance											0.03

*, ** Significant at p=0.05 and 0.01, respectively.
D1, D2, D3 and D4 are planting dates in October18, October31, November 5 and November15, respectively.

The results of stepwise regression analysis in different planting dates are shown in Table 3, in which seed yield was considered as dependent variable while other studied traits were considered as independent variables. In the first and second planting dates, seeds per pod had important role for seed yield prediction. In third planting date, days to flowering and pods per plant had more important role for seed yield estimation. In forth planting date, pods per plant, biological yield and harvest index were important for seed yield prediction. Final regression model in fourth planting date detected as $Y=-1315.07+3.42X_5+57.61X_8+20X_9$ in which Y, X_5, X_8 and X9 were seed yield, pods per plant, biological yield and harvest index, respectively. This model generally justified 100 percent of variation in seed yield (Table 3). In earlier studies (Khayat *et al.*, 2014; Mohammadjani Asrami *et al.*, 2014) based on stepwise regression analysis, reported that pods per plant and plant height had important role for seed yield prediction it was in rapeseed genotypes.

Table 3. The results of stepwise regression analysis

Step	Variable entered The model	Partial R-square	Model R-square	F-test
		D1		
1	X6:seeds per pod	0.88	0.88	23.3*
Final regression model: Y(seed yield)= 202.87+99.06 X6				
		D2		
Step	Variable entered The model	Partial R-square	Model R-square	F-test
1	X6:seeds per pod	0.91	0.91	30.11*
Final regression model: Y(seed yield)= -387.76+106.81 X6				
		D3		
Step	Variable entered The model	Partial R-square	Model R-square	F-test
1	X5: Pods per plant	0.91	0.91	29.86*
2	X1: Days to flowering	0.08	0.99	36.46*
Final regression model: Y(seed yield)= 1062.07-20.17X1+29.68X5				
		D4		
Step	Variable entered The model	Partial R-square	Model R-square	F-test
1	X5: Pods per plant	0.88	0.88	23.38*
2	X9: Biological yield	0.10	0.98	11.37*
3	X8: Harvest index	0.02	1.00	3658.67**
Final regression model: Y(seed yield= -1315.07+3.42X5+57.61X8+20X9				

*, ** Significant at p=0.05 and 0.01, respectively.
D1, D2, D3 and D4 are planting dates in October 18, October 31, November 5 and November 15, respectively.

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