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# Evaluation of normal and late planting effects on variation and relationship of the quantitative traits in rapeseed

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## Abstract

Effect of normal and late planting on yield associated traits in 10 spring rapeseed (*Brassica napus* L.), genotypes were evaluated in randomized complete block design with four replications. Significant planting dates effects were exhibited for days to flowering, plant height, yield components and seed yield, indicating that all the traits were significantly affected by planting dates. Significant mean squares of the genotypes for all the traits revealed the significant genetic differences for these traits. On the basis of late to normal dates mean ratio, pods on main raceme and seed yield were more affected from late planting date than the other traits. Yield associated traits were more correlated to seed yield in normal planting date than late planting date condition. Among yield components, pods per plant were correlated with seed yield in both planting dates' conditions. Seed yield was significantly affected by planting dates, and the mean values for normal and late planting dates were 2726 and 1599.3 kg ha$^{-1}$, respectively. Genotypes Zafar, Zabol0 and Zabol15 with seed yield of 3300, 3115 and 2997.5 kg ha$^{-1}$, respectively, produced higher yield in normal planting date condition.

***Key words** : Coefficient of variation, planting dates, rapeseed, yield components*

## Introduction

Spring rapeseed, with its broad leaves and high photosynthetic capacity, provides a convenient alternative as a break crop, in continuous cereal-based agricultural systems (Khachatourians *et al.*, 2001; Mahasi and Kamundia, 2007). It is becoming a popular oilseed crop in Iran also, especially in Northern provinces, due to its high oil and protein contents. For increasing yield, determining effect of yield parameters provides the good opportunity for successful breeding program (Aytac *et al.*, 2008; Marjanovic-Jeromela *et al.*, 2009). Determining appropriate planting date is very important in maximizing yield. Planting dates affect seed yield by influencing several yield parameters including days to flowering, duration of flowering, plant height, and pods per plant (Sharief and Keshta, 2002; Siadat and Hemayati, 2009). Optimizing yield is one of the most important goals for most rapeseed growers. Seed yield is a complex character affected positively or negatively by several yield parameters. Therefore, in order to single-out the component(s) having the greatest effect on yield, contribution of each of the several components have to be determined. Therefore, information on the association of plant characters with seed yield is of great importance to a breeder in selecting a desirable genotype (Thurling, 1991).

The ideotype concept helps define the desired high-yield phenotype in terms of several relatively simple plant characters ( (Khaliq *et al.*, 2001; Khan *et al.*, 2003; Sagir *et al.*,2004; Mahasi *et al.*, 2007; Agahi, *et al.*, 2007; Marjanovic-Jeromela, *et al.*, 2007). Therefore, knowing the variations of the quantitative traits under different environmental conditions make the breeding programs move successful (Sharief and Keshta, 2002; Marjanovic-Jeromela, *et al.*, 2009). To determine the effect of independent variables on a particular dependent variable a certain amount of interdependence among the independent variables is expected (Aytac and Kinaci, 2009; Ogrodowczyk and Warzyniak, 2004; Sabaghnia, *et al.*, 2010; Scheiner *et al.*, 2000). Different statistical techniques including coefficient of variation (CV), factor analysis, factor components, and cluster analysis, have been used to identify crop yield variations under different environments conditions (Leilah and Al-Khateeb, 2005; Akbar *et al.*, 2007). Significant genetic variations have been reported for pod number per plant and seed yield in *B. napus* and *B. juncea* (Akbar *et al.*, 2007; Marjanovic-Jeromela, *et al.*, 2009; Alishah, *et al.*, 2008; Farshadfar and Farshadfar, 2008; Khalily, *et al.*, 2010; Azeez and Morakinyo, 2011; Belete, 2011; Hefny, 2011). Since the number of pods per plant has the greatest effect on yield, seed per pod, and seed weight can be used as indirect criteria. The objectives of the present study were to determine not only the effect of planting dates on yield associated traits, but also to estimate the correlation among the traits to identify suitable selection criteria for rapeseed breeding.

## Materials and Methods

Ten spring rapeseed genotypes including RGS003, Zabol0, Zabol15, Safi7, Safi6, Safi5, Safi31, S841, L7 and Zafar were sown in a randomized complete block design with four replications on normal (18 October) and late (16 November) planting dates at Baykola Agriculture Research Station, located in Neka, Iran (53º, 13´ E longitude and 36° 43´ N latitude, 15 m above sea level) during 2012-13. The soil was classified as a deep loam soil (Typic Xerofluents, USDA classification) and contained an average of 280 g clay $kg^{-1}$, 560 g silt $kg^{-1}$, 160 g sand $kg^{-1}$, and 22.4 g organic matter $kg^{-1}$ with a pH of 7.3. Each sub plot consisted of four rows 5 m long and 30 cm apart. The distance between plants was 5 cm resulting in approximately 400 plants per plot, sufficient for statistical analysis. Crop cultivation practices including land preparation, crop rotation, fertilizer, and weed control were followed as recommended for the local area. All plant protection measures were adopted to make the crop free from insects and diseases. The data were recorded on ten randomly selected plants from each replication for days to flowering, plant height, number of branches per plant, number of pods on main raceme, number of pods per plant, pods length, and seeds per pod. Seed yield (adjusted to kg/ha) was recorded from plants in two middle rows of each plot. Combined analysis of variance for normal and late planting dates was done for all the traits (Steel *et. al.*, 1997). The Pearson correlation of coefficient was estimated for relationship of the traits in normal, and late planting dates conditions. All statistical analyses were carried out using SAS soft ware.

## Results and Discussion

### Analysis of variance

Except for seeds per pod, significant mean squares of planting dates detected for days to flowering, plant height, yield, and yield associated traits indicated that most traits were affected from normal and late planting dates. Significant mean squares of the genotypes for all traits revealed the significant genetic differences for these traits. Significant mean squares of interaction between of planting dates and genotypes recorded for days to flowering, number

Table 1: Combined analysis of variance for days to flowering, plant height, yield components and seed yield

| S.O.V | df | M.S | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Days to flowering | Plant height | Number of branches | Pods on main raceme | Pods per Plant | Pods length | Seeds per Pod | Seed yield |
| Planting dates (D) | 1 | 6125.0** | 5060.9* | 7.81* | 7738.2** | 14399* | 10.51* | 22.7 | 25388494** |
| Rep/D | 6 | 3.3 | 628.1 | 1.19 | 51.4 | 1652 | 0.82 | 38.2 | 1384045 |
| Genotypes (G) | 9 | 123.6** | 876.4** | 1.52** | 1339.2** | 21755** | 0.95** | 34.6** | 684227** |
| D x G | 9 | 16.8** | 50.6 | 0.94** | 88.7** | 567** | 0.19 | 1.1 | 165694** |
| Error | 54 | 2.4 | 120.6 | 0.21 | 22.0 | 83 | 0.19 | 3.8 | 55427 |

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

of branches, pods on main raceme, pods per plant, and seed yield, suggested different trend variations of the traits of the genotypes in different planting dates (Table 1). Planting date has a considerable effect on seed yield by influencing the yield components; late planting decreases the most important traits (Sharief and Keshta, 2002; Siadat and Hemayati, 2009).

**Performanceof the genotypes over two planting dates**

The means of the genotypes over normal and late planting dates are presented in Table 2. Genotypes 5841 had the earliest flowering (90.8 days) followed very closely by Safi5, Safi7 and L7 with days to flowering of 92.6, 92.8 and 92.3, respectively.

Table 2. Means of spring rapeseed genotypes over tow planting dates for several yield parameters and seed yield.

| Traits Genotypes | Days to flowering | Plant height (cm) | Number of branches | Pods on main shoot | Pods per Plant | Pods length (cm) | Seeds per Pod | Seed yield (kg ha$^{-1}$) |
|---|---|---|---|---|---|---|---|---|
| 1-RGS003 | 95.8 | 139.4 | 4.0 | 33.8 | 124.0 | 5.8 | 17.8 | 2313.8 |
| 2-Zabol0 | 96.4 | 144.9 | 4.0 | 32.1 | 145.0 | 5.8 | 24.0 | 2531.2 |
| 3-Zabol15 | 96.3 | 138.0 | 4.2 | 40.0 | 134.0 | 5.9 | 22.7 | 2231.2 |
| 4-Safi7 | 92.8 | 131.2 | 4.3 | 34.2 | 107.8 | 6.4 | 22.9 | 1743.1 |
| 5-Safi6 | 94.0 | 136.1 | 4.2 | 30.9 | 124.3 | 5.6 | 20.3 | 2339.6 |
| 6-Safi5 | 92.6 | 128.3 | 3.6 | 32.2 | 100.4 | 5.9 | 23.2 | 1777.2 |
| 7-Safi31 | 95.6 | 119.4 | 3.7 | 33.7 | 98.7 | 6.0 | 22.9 | 1879.4 |
| 8-S841 | 90.8 | 136.8 | 3.8 | 32.7 | 109.8 | 5.3 | 19.6 | 2130.0 |
| 9-L7 | 92.3 | 132.7 | 3.1 | 32.6 | 113.5 | 5.9 | 21.7 | 2110.2 |
| 10-Zafar | 104.9 | 159.0 | 4.6 | 44.8 | 147.0 | 6.6 | 24.3 | 2570.6 |
| LSD(p=0.05) | 2.19 | 15.5 | 0.65 | 6.63 | 12.88 | 0.62 | 2.76 | 332.95 |
| LSD(p=0.01) | 2.91 | 20.6 | 0.86 | 8.82 | 17.14 | 0.82 | 3.67 | 442.82 |

Genotype Zafar with 104.9 days to flowering was the most late flowering genotypes and also had significantly higher values for all yield parameters including highest seed yield per hectare.

**Interaction effect of planting dates and genotypes**

Interaction effect of planting dates and genotypes are presented in Table 3. Days to flowering varied from 101 to 116.3 days in L7 and Zafar, respectively for the normal planting date, and from 81 to 93.5 in S841 and Zafar, respectively for the late planting date. The average values for days to flowering for all the genotypes in normal and late planting dates were 103.9 and 86.4, respectively. Planting dates significantly affected all yield parameters; the values were significantly lower for late than the normal planting date. The average plant height for normal and late planting dates respectively were 144.5 cm and 128.0 cm. This trait ranged from 130 to 163.8 cm in Safi31 and Zafar, respectively in the normal planting date, and from 117.8 to 154.2 cm, respectively for the late planting date condition. Number of branches was significantly affected by planting dates and its mean in normal and late planting dates were 4.3 and 3.6, respectively. Zafar and Safi6 produced higher mean values in normal planting date, whereas Safi7 and Zabol15 has the higher values in late planting date. Pods on main raceme were affected more than the other traits by late planting date and their average in normal and late planting dates ranged from 44.5 and 24.9, respectively. Planting dates also affected pods per plant their average ranged from 133.8 to 107 in

Table 3. Means of days to flowering, plant height, yield components and seed yield in normal and late planting dates and interaction effect of planting dates and rapeseed genotypes for the traits.

| Traits Genotypes | Days to flowering | Plant height (cm) | Number of branches | Pods on main raceme | Pods per Plant | Pods length (cm) | Seeds per Pod | Seed yield (kg ha$^{-1}$) |
|---|---|---|---|---|---|---|---|---|
| Normal planting date (D1) | 103.9 | 144.5 | 4.3 | 44.5 | 133.8 | 6.3 | 22.5 | 2726.0 |
| Late planting date (D2) | 86.4 | 128.6 | 3.6 | 24.9 | 107.0 | 5.6 | 21.4 | 1599.3 |
| (D2/D1)*100 | 83.2 | 89.0 | 83.7 | 56.0 | 80.0 | 88.9 | 95.1 | 58.7 |
| 1-D1× RGS003 | 104.5 | 149.8 | 4.4 | 44.9 | 136.3 | 5.9 | 18.1 | 2962.5 |
| 2- D1× Zabol0 | 103.0 | 155.2 | 4.8 | 42.5 | 163.6 | 6.4 | 25.0 | 3115.0 |
| 3- D1× Zabol15 | 106.0 | 146.7 | 4.3 | 51.2 | 154.0 | 6.5 | 23.3 | 2997.5 |
| 4- D1× Safi7 | 101.5 | 138.4 | 4.4 | 48.2 | 129.1 | 6.7 | 23.0 | 2173.3 |
| 5- D1× Safi6 | 101.5 | 142.1 | 4.7 | 38.8 | 138.9 | 6.1 | 21.0 | 2911.3 |
| 6- D1× Safi5 | 102.0 | 138.9 | 4.1 | 42.8 | 107.7 | 6.2 | 23.3 | 2343.8 |
| 7- D1× Safi31 | 102.5 | 130.0 | 3.7 | 44.8 | 119.5 | 6.4 | 23.2 | 2212.5 |
| 8- D1× S841 | 100.5 | 143.8 | 3.5 | 35.3 | 104.1 | 5.6 | 20.9 | 2506.3 |
| 9- D1× L7 | 101.0 | 136.7 | 3.5 | 39.4 | 121.3 | 6.3 | 22.4 | 2737.5 |
| 10- D1× Zafar | 116.3 | 163.8 | 5.4 | 57.7 | 164.2 | 6.8 | 24.7 | 3300.0 |
| 11-D2× RGS003 | 87.0 | 129.0 | 3.6 | 22.7 | 111.6 | 5.7 | 17.5 | 1665.0 |
| 12- D2× Zabol0 | 89.8 | 134.6 | 3.3 | 21.6 | 126.5 | 5.3 | 23.0 | 1947.4 |
| 13- D2× Zabol15 | 86.5 | 129.3 | 4.2 | 28.8 | 114.0 | 5.3 | 22.2 | 1464.8 |
| 14- D2× Safi7 | 84.0 | 124.1 | 4.3 | 20.2 | 86.5 | 6.0 | 22.8 | 1312.9 |
| 15- D2× Safi6 | 86.5 | 130.1 | 3.7 | 23.1 | 109.7 | 5.2 | 19.7 | 1768.0 |
| 16- D2× Safi5 | 83.3 | 117.8 | 3.1 | 21.6 | 93.1 | 5.6 | 23.1 | 1210.6 |
| 17- D2× Safi31 | 88.8 | 108.8 | 3.6 | 22.6 | 77.9 | 5.5 | 22.7 | 1546.2 |
| 18- D2× S841 | 81.0 | 129.8 | 4.1 | 30.2 | 115.5 | 5.1 | 18.4 | 1753.7 |
| 19- D2× L7 | 83.5 | 128.8 | 2.7 | 25.9 | 105.6 | 5.5 | 21.1 | 1482.8 |
| 20- D2× Zafar | 93.5 | 154.2 | 3.9 | 31.9 | 129.8 | 6.3 | 23.9 | 1841.1 |
| LSD(p=0.05) | 2.19 | 15.5 | 0.65 | 6.63 | 12.88 | 0.62 | 2.76 | 332.95 |
| LSD(p=0.01) | 2.91 | 20.6 | 0.86 | 8.82 | 17.14 | 0.82 | 3.67 | 442.82 |

normal and late planting dated, respectively. Pod length and seeds per pod were affected very slightly by planting dates. Seed yield was significantly affected by planting dates; mean values for seed yield in normal and late planting were 2726 and 1599.3 kg ha$^{-1}$, respectively. Zafar, Zabol0 and Zabol15 with seed yield of 3300, 3115 and 2997.5 kg ha$^{-1}$ respectively were the high yielding genotypes in normal planting date, whereas genotypes Zafar and Zabol0 were the higher seed yielder in late planting date condition.

## Correlation analysis

Correlation analyses for the traits in normal and late planting dates are presented in Table 4. Out of 28 coefficient of correlation estimates, 15 in normal and 4 in late planting dates were significant. Days to flowering had significant positive correlation with plant height, number of branches, pods on main raceme, pods per plant, and seed yield in normal planting date only. Plant height had significant positive correlation with number of branches, pods per plant and seed yield in normal, and late and on

Table 4. Coefficient correlation estimates among the quantitative traits of rapeseed genotypes in normal and late planting dates conditions.

| Normal planting date | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Traits | Days to flowering | Plant height | Number of branches | Pods on main raceme | Pods per Plant | Pods length | Seeds per Pod | Seed yield |
| Days to flowering | 1 | | | | | | | |
| Plant height | 0.76** | 1 | | | | | | |
| Number of branches | 0.72* | 0.79** | 1 | | | | | |
| Pods on main raceme | 0.85** | 0.51 | 0.65* | 1 | | | | |
| Pods per Plant | 0.66* | 0.76** | 0.83** | 0.64* | 1 | | | |
| Pods length | 0.54 | 0.21 | 0.54 | 0.80** | 0.58 | 1 | | |
| Seeds per Pod | 0.35 | 0.20 | 0.31 | 0.44 | 0.39 | 0.74* | 1 | |
| Seed yield | 0.63* | 0.84** | 0.65* | 0.35 | 0.81** | 0.03 | 0.07 | 1 |
| Late planting date | | | | | | | | |
| Traits | Days to flowering | Plant height | Number of branches | Pods on main raceme | Pods per Plant | Pods length | Seeds per Pod | Seed yield |
| Days to flowering | 1 | | | | | | | |
| Plant height | 0.51 | 1 | | | | | | |
| Number of branches | 0.05 | 0.26 | 1 | | | | | |
| Pods on main raceme | 0.16 | 0.61* | 0.29 | 1 | | | | |
| Pods per Plant | 0.38 | 0.88** | 0.05 | 0.59 | 1 | | | |
| Pods length | 0.47 | 0.38 | 0.13 | 0.06 | -0.04 | 1 | | |
| Seeds per Pod | 0.45 | 0.07 | -0.05 | -0.05 | -0.13 | 0.45 | 1 | |
| Seed yield | 0.54 | 0.62* | 0.07 | 0.34 | 0.74* | -0.16 | -0.22 | 1 |

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

pods on main raceme, pods per plant and seed yield in late planting date, therefore the genotypes with more reduction of plant height had also more reduction of seed yield. Number of branches had significant and non significant positive correlation in normal and late planting dates conditions, respectively, indicating pods on primary branches had more important effect on seed yield. Pod length was significantly and positively correlated with seeds per pod in normal planting date but in late planting it was not significantly correlated, concluded that the null seeds had important role in late planting date condition. Significant correlation of yield components with seed yield were reported in earlier studies (Farshadfar and Farshadfar, 2008; Khalily, *et. al.*, 2010; Azeez and Morakinyo, 2011; Belete, 2011), therefore these traits can be used as indirect selection criteria for improving of seed yield in *Brassica* species.

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