Effect of sowing date on yield and yield components of three oilseed rape varieties

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Abstract

In order to elucidate the effect of sowing date on oilseed rape (\textit{Brassica napus} L.) yield and yield components, three varieties including Tower, Rafal and Global were sown from November 7 to December 22, 1998-99 in four dates with 15-day intervals in Dezful region. A split-plot design based on randomized complete blocks with four replications was used in which levels of sowing dates and cultivars formed the main and sub-plots, respectively. Variables including plant height, axillary branches/plant, pods/plant, seeds/pod, single seed weight, biomass, seed oil content and seed yield were measured. Results showed that the sowing date had a highly significant effect on morphological characteristics, yield components, oilseed rape yield and seed oil content. Delay in sowing date caused a reduction in all yield components, especially pods/plant and oilseed yield by 285.23 g/m\textsuperscript{2} to 135.57 g/m\textsuperscript{2} on November 7 and December 22, respectively. Variations in sowing dates had different effects on yield components and reduction rates of pods/plant, seeds/pod and single seed weight. The significant effect of variety on all characters, except single seed weight indicated that there were genetic differences among the studied cultivars. Oilseed yield had the significant positive correlations with pods/plant ($r = 0.93$), single seed weight ($r = 0.83$) and seeds/pod ($r = 0.66$). The results of path analysis showed that pods/plant and seeds/pod had the highest positive and negative effects on oilseed yield, respectively. Finally, considering the susceptibility of pods/plant to variations of sowing date and the important role of this character in oilseed yield production, the delay in sowing date in Dezful region reduced the oilseed yield by decreasing pods/plant.

Keywords: oilseed rape; sowing date; yield components; correlation and path analysis

Introduction

Determining suitable planting date plays an important role in conformation of plant growth stages with desirable environmental conditions which results in maximum yield. Planting date has a considerable effect on seed yield by influencing the yield components so that late planting decreases secondary branches/plant and pods/plant and finally causes a remarkable reduction in seed yield (Thurling, 1974). The late sowing of rapeseed decreased seed yield through synchronization of pod filling period with high temperatures, the decrease in assimilates production, drought stress occurrence, shortened pod filling period and acceleration of plant maturity (Mendham \textit{et al.}, 1981). In fact, early sowing of winter rapeseed is the most important method to increase seed and oil yield (Loof, 1960). Taylor and Smith (1992) reported that late sowing decreased biomass, harvest index and seed oil content and on the other hand, it led to a decrease in seed and pod no/m\textsuperscript{2} and 1000-seed weight; although seeds/pod exhibited a different response to the changes in sowing date. Whitefield (1992) reported that reduction of seed yield due to late planting would result in increasing respiration rate of pods but losing assimilates and rising unkernel seed percentage. The economical yield of the late-sown plants was decreased by the reduction of harvest index, emerged plants/unit area and axillary branches/plant (Scarisbrick \textit{et al.}, 1982). Thurling (1974) showed that the unsuitable planting date reduced pod-bearing axillary branches, seed yield and 1000-seed weight, but had negligible effects on seeds/pod. He suggests
that the response of seed yield late sowing dates depends on the interrelationship between seeds/pod and pods/unit area.

In regions with early cold weather, the limiting effects of late planting were more considerable (Mendham and Scott, 1975). In these regions, late planting of winter rapeseed produced short stems, reduced branching and green area of plants and finally, caused reduction in assimilates production in pod stage and pods/plant by 60% (Mendham et al., 1981). Hodgson (1979) showed that oil content of seeds was reduced by delaying planting date from April to September in Australia. In total, seed oil content is mainly determined by climatic conditions, variety and planting date so that late planting will decrease the oil content and oil yield (Jasinska, 1987).

Considering the interactions between environment and variety (Mahler and Auld, 1991), and in order to obtain maximum seed and oil yield in Dezful region, it is needed to identify adopted variety (or varieties) to the environmental conditions. The study was carried out in the region to evaluate the planting date and determine the appropriate rapeseed variety.

Materials and Methods

The experiment was carried out in Sibli region of Dezful (Lat. 32°16’ N., Long. 45°25’ E., Alt. 82 m. from sea level) during 1998-99. The region with an annual precipitation of 250 mm is located in a semi-arid zone. The soil texture was loamy-clay. The experiment was in split-plot design based on RCBD with four replications, in which the main plots included planting dates (Nov. 7, Nov. 22, Dec. 7 and Dec. 22) and the sub-plots included varieties (Tower, Rafal and Global). The seeds were sown after preparing soil in fall. The agro-technological practices took place based on measurements of Dezful Agricultural Research Center.

During the growing season, plant height, axillary branches/plant, pods/plant, seeds/pod and single seed weight were measured on five randomly selected plants/plot. The plants were harvested in 4-m² plots on May 8-18, 1999. After harvesting, the seed yield (Y) and its moisture content (WC) were measured and standard yield (Y) with 12 percent moisture was estimated by the following formula:

\[ Y = Y_r \times \frac{100 - WC}{88} \]

In addition, seed oil content was determined by Soxcelle method. Analysis of variance and means comparison were done by using the Software MSTATC and graphs were drawn by the Software MS-EXCEL.

Results and Discussion

Yield components

Delayed planting caused significant (p < 0.01) decreases in pods/plant, seeds/pod and single seed weight (Tables 1 and 2). The decrease in pods/plant and single seed weight is the common effect of delayed planting (Allen at al., 1971; Mendham et al., 1981; Pechan and Morgan, 1985; Taylor and Smith, 1992). In spite of this result, the seeds/pod has a different response to variations of planting date (Taylor and Smith 1992).

In our study, the intensities of variations made in each yield component by delayed planting were differentiated and pods/plant, seeds/pod and single seed weight showed the highest responses, respectively (Fig. 1a). The importance of pods/plant and its susceptibility to environmental conditions have been emphasized by others (Norton and Bilsborrow, 1991; Thurling, 1974). The differences between varieties for the pods/plant and seeds/pod were highly significant (p < 0.01) but non-significant for single seed weight (Table 1). The cultivar Tower with 302.5 pods/plant, 24.75 seeds/pod and single seed weight of 3.6 mg
gained the highest rank (Table 2). Estimated coefficients of correlation between seed yield and yield components showed that pods/plant \( r = 0.93 \), single seed weight \( r = 0.83 \) and seeds/pod \( r = 0.66 \) had the highest correlation with seed yield, respectively (Table 3 and Fig. 2) (Taylor and Smith, 1992; Thurling, 1974).

**Biomass and harvest index (HI)**

The biomass and HI were significantly \( p < 0.01 \) reduced by delaying the planting dates (Tables 1 and 2). The results were consistent with other studies (Rao and Mendham, 1991; Taylor and Smith, 1992; Whitefield, 1992). Searisbrick et al. (1982) showed that HI reduction due to delayed sowing was one of the most important factors in decreasing seed yield. That is, delayed planting dates lead to a reduction in seed yield by decreasing assimilate transition efficiency to economical sinks (grains) (Searisbrick and Daniels, 1986). As delayed planting dates cause more reduction in biomass than seed yield, HI was higher than biomass (Fig. 1b). However, biomass and HI were the most important factors that affected the final seed yield/plant (Table 3). The studied varieties showed differences \( p < 0.01 \) in biomass and HI (Table 1) and the Cv. Tower produced the highest biomass (973.4 g/m\(^2\)) and HI (21.97%) (Table 2).

### Table 2. Effects of planting date and variety on rapeseed yield, yield components, biomass, harvest index and oil percentage.

<table>
<thead>
<tr>
<th>Planting dates</th>
<th>Means of squares</th>
<th>Seed yield (g/m(^2))</th>
<th>Biomass (g/m(^2))</th>
<th>HI (%)</th>
<th>Oil content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>07 November</td>
<td>331.00 a†</td>
<td>25.33</td>
<td>3.763a</td>
<td>285.23a</td>
<td>1050.83a</td>
</tr>
<tr>
<td>22 November</td>
<td>301.67b</td>
<td>24.58ab</td>
<td>3.647b</td>
<td>236.68b</td>
<td>1011.42b</td>
</tr>
<tr>
<td>07 December</td>
<td>276.67c</td>
<td>23.67bc</td>
<td>3.595c</td>
<td>160.04c</td>
<td>904.10c</td>
</tr>
<tr>
<td>22 December</td>
<td>268.33c</td>
<td>22.67c</td>
<td>3.360d</td>
<td>135.57d</td>
<td>818.06d</td>
</tr>
<tr>
<td>LSD (P=0.05)</td>
<td>15.06</td>
<td>1.180</td>
<td>0.051</td>
<td>14.76</td>
<td>30.23</td>
</tr>
</tbody>
</table>

† Means followed by the same letter are not significantly different at the \( p = 0.05 \) level according to Duncan’s multiple range test.

### Table 3. Path analysis coefficients of seed yield-related traits

<table>
<thead>
<tr>
<th>Character</th>
<th>Direct effect</th>
<th>Indirect effect via:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Plant height</td>
<td>Branches/plant</td>
</tr>
<tr>
<td>Plant height</td>
<td>-0.008</td>
<td>-0.007</td>
</tr>
<tr>
<td>Branches/plant</td>
<td>-0.342</td>
<td>-0.309</td>
</tr>
<tr>
<td>Pods/plant</td>
<td>1.248</td>
<td>1.166</td>
</tr>
<tr>
<td>Seeds/pod</td>
<td>-0.107</td>
<td>-0.090</td>
</tr>
<tr>
<td>Seed weight</td>
<td>0.211</td>
<td>0.163</td>
</tr>
<tr>
<td>Biomass</td>
<td>-0.042</td>
<td>-0.038</td>
</tr>
</tbody>
</table>

Residual effect= 0.227

Fig 1. The effect of planting date on (a) yield components and (b) seed yield, biomass, harvest index and oil content of rape seed.
The results showed that seed yield was significantly (p < 0.01) decreased by delaying planting date (Table 1). Indeed, a 15-, 30- and 45-day delay from Nov. 7 reduced seed yield from 285.33 g/m$^2$ to 236.68, 160.04 and 135.57 g/m$^2$, respectively (Table 2). This result was consistent with some other studies (Mahler and Auld, 1991; Mendham and Scott, 1975; Scarisbrick et al., 1982; Taylor and Smith, 1992; Thurling, 1974).

The studied varieties showed significant (p < 0.01) differences by producing rapeseed yields of 217.79 (Tower), 204.93 (Rafal) and 190.43 g/m$^2$ (Global) (Tables 1 and 2). The significant (p < 0.01) planting date × variety interactions were confirmed by various responses of varieties via planting date variations. In other words, delaying planting date caused rapeseed yield reduction, but the Cv. Global showed a high susceptibility by considerable decreases in seed yield as well as its late-maturity nature.

Effects of the studied sowing dates and varieties on seed oil content were significant (Table 1). Decreased rapeseed oil content because of delayed planting date has been reported by some others (Jasinska, 1987; Pechan and Morgan, 1985; Thurling, 1974). Response of rapeseed oil content to changes in planting date was low and showed that this trait was controlled by genotypes rather than environmental effects; although, in the latest planting date and due to severe reduction in seed yield, the oil yield was reduced dramatically (Hodgson, 1979; Jasinska, 1987; Loof, 1960; Pechan and Morgan, 1985; Taylor and Smith, 1992; Thurling, 1974).

Path analysis

Pods/plant (1.248) and seeds/pod (-0.107) had the highest positive and negative direct effects on seed yield (Table 4). The pods/plant had the highest indirect effects on seed yield via branches/plant (1.217), biomass (1.167) and plant height (1.166). Thurling (1974) reported that the rapeseed yield potential had a positive correlation with the growth period and vegetative growth and therefore, timely planted rapeseed obtained the highest seed yield due to a prolonged growth period and hence increased the number of flower and pods per plant. Finally, considering the high susceptibility of pods/plant to planting date variations (Fig. 1a), and the most important role of this trait in determining rapeseed yield (Fig. 2a and Table 3), the results of the study showed that delaying planting date decreased rapeseed yield through the decrease in pods/plant in Dezful re-
gion. On the other hand, the pods/plant is the most important trait which can be used in the rapeseed selection programs.

References


