**Grain Yield and Yield Components of Safflower Genotypes as Influenced by Different Spring Sowing Dates**

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Golaleh Pakrou, Asad Rokhzadi, Shahram Shahrokhi: Grain Yield and Yield Components of Safflower Genotypes as Influenced by Different Spring Sowing Dates

**ABSTRACT**

In order to evaluate the effects of different spring sowing dates on yield and yield components of safflower (*Carthamus tinctorius* L.) genotypes in Sanandaj region an experiment was conducted using a split-plot layout with randomized complete block design in three replications. Main plots were three sowing dates of 7 April, 4 May and 31 May. Subplots were three genotypes including: IL111, Sina and 411. The results showed that head number per plant and 1000-seed weight were affected by sowing date. The lowest rate of head number was recorded in the third sowing date. The highest rates of 1000-seed weight were obtained from the first and the third sowing dates. The genotype factor statistically affected heads number/plant and 1000-seed weight so that the maximum rates of these traits were recorded by the genotype of 411. Sowing date × genotype interaction did not affected the yield components. Grain yield was affected by sowing date and genotype. The highest rates of grain yield i.e 1096.2 & 983.9 kg ha⁻¹ were produced in the first and the third sowing dates respectively which were statistically differed from the grain yield in the second sowing date (728.2 kg ha⁻¹). The genotype of 411 was superior to other two genotypes with respect to grain yield. Sowing date × genotype interaction did not affect any of the studied traits. Considering the results, for spring cultivation of safflower in the region it is recommended that safflower should be sown as soon as possible early spring to achieve suitable yield. In the case of sowing delay as the result of any reason, for avoiding coincidence of seed-filling stage with high temperatures, it is advised that the sowing operation be delayed until late spring in order to cultivate safflower as second crop (double cropping) in the cropping system, resulting in a reasonable yield.

**Key words:** *Carthamus tinctorius* L., Planting date, Seed yield, Spring sowing.

**Introduction**

Safflower (*Carthamus tinctorius* L.) is an annual oilseed crop from the *Asteraceae* family which is grown in semiarid areas; it is cultivated for oil, medicinal and many industrial purposes [15,10]. Safflower is resistant to abiotic stresses such as saline and water deficit conditions [8]. Growth traits and productivity of safflower are influenced by various factors including genotype, environment and agronomic practices [11]. One of the most critical management techniques as a prerequisite for attaining full potential of crop productivity is determining a proper sowing date in a given climatic condition. The effects of spring sowing dates on production traits of safflower cultivars in a Mediterranean region were studied by Samanci and Ozkaynak [13]. They reported that seed yield, oil content, palmitic acid, stearic acid and oleic acid contents decreased while linoleic acid content increased with delay in planting date. Seed yield reduction in delayed sowing dates was ascribed to higher air temperatures at the flowering stage that consequently led to obstruction in pollination and fertilization events.

In spite of multiple values of safflower and its advantages for cropping systems, safflower cultivation has not been completely familiar to the farmers in Sanandaj region. Therefore the aim of this study was to determine the effects of spring sowing dates on grain yield and yield components of safflower genotypes in the region of Sanandaj.

**Materials and Methods**

This investigation was conducted at the research farm of agriculture faculty, Islamic Azad University, Sanandaj Branch in the growing season of 2009-2010. The site of experiment is located at latitude of 35° 10’ N and longitude of 46° 39’ E with an altitude.
of 1393 m above sea level. The long-term values of mean temperature and annual rainfall in this location are 13.35 °C and 471 mm respectively. Soil texture of experimental site was clay loam and the electrical conductivity and pH were 0.57 dS/m and 7.8 respectively. The experiment was arranged in a split-plot layout with randomized complete block design in three replications. Main plots were three sowing dates of 7 April, 4 May and 31 May. Subplots were three genotypes of IL111, Sina and 411. Each subplot was 6 m long and consisted of 4 rows, 50 cm apart with intrarow spacings of 5 cm. In order to prevent fungal pathogens prevalence, the safflower seeds were treated with benomyl fungicide. Then hand-sowing operation on relevant dates and immediate irrigation were performed.

Number of heads per plant and number of seeds per head were determined based on five randomly selected plants from the central two rows of each sub-plot at maturity stage. Four randomly 100 seeds sub-samples from harvest area were used for recording the 1000-seed weight trait. Seed yield was determined by harvesting the two central rows of each sub-plot.

The collected data were statistically analyzed by analysis of variance (ANOVA) and differences among treatments were tested by Duncan's multiple range test (at \( P \leq 0.05 \)) using MSTAT-C software.

**Results and Discussion**

**Yield components:**

Number of heads per plant and 1000-seed weight were significantly affected by sowing date \( (P \leq 0.05) \). The highest rates of heads number per plant were recorded by the first and the second sowing dates (i.e. 7 April & 4 May), and the lowest number of heads/plant was obtained by the third sowing date (31 May) (Table 1). Decrease of heads number/plant at the third sowing date may be referred to the coincide of head appearance stage with high mean temperature (about 30°C) (Table 2). Heads number variations due to sowing date alteration have been reported by Cholaky et al. [6], Tomar [14] and Cazzato et al. [5].

Seeds number per head was not significantly influenced by sowing date factor, however the lowest number of seeds/head was recorded at the second date of sowing. The maximum rate of 1000-seed weight was recorded by the plants sown at the first sowing date and was declined to its minimum rate at the second date of sowing, even though it was risen at the third sowing date again (Table 1). The reduction of seeds number/head and 1000-seed weight at the second sowing date may be attributed to the trends of mean temperature alterations from head appearance (heading) stage to maturity time. The alteration of mean temperature from heading to flowering stage at the second sowing date, indicated an ascending trend whereas a descending trend was found for other two sowing dates (Table 2). Besides mean temperature at the flowering time of plants sown at the second sowing date was pretty high as compared to other two sowing dates. Anthesis confusion and consequent reduction in seeds number may be arised from ascending change of temperature during the time period between heading and flowering stages. Moreover assimilates translocation to grains may be retarded due to rising trend of mean temperature changing from flowering to maturity stage that consequently caused a significant decrease in seed weight of the plants sown at the second sowing date. On the other hand changing trend of mean temperature for the third sowing date during reproductive phase (from heading to maturity) followed a descending tendency (Table 2) leading to improved translocation of assimilates to grains that resulted in elevated 1000-seed weight as compared with the second sowing date. Dadashi and Khajehpour [7] declared that high temperature during the flowering and seed development phases had undesirable effects on translocation of photosynthetic assimilates to grains leading to decrease in 1000-seed weight. Significance of sowing date effect on seed weight has been also reported by Able [1], Tomar [14], Bagherti et al. [4] and Ahadi et al. [2].

The highest values of heads number/plant and 1000-seed weight were recorded by 411 genotype (Table 1). Variations among genotypes with regard to heads number/plant and 1000-seed weight suggest different reactions of genotypes to alterations in climatic conditions arising from sowing date changing. Similar results regarding the significance of genotype influence on yield components have been reported by Cholaky et al. [6], Gonzales et al. [9], Arslan et al. [3] and Cazzato et al. [5]. Yield components were not affected by sowing date × genotype interaction in this study.

**Grain Yield:**

Grain yield was affected by sowing date and genotype factors. The greatest amount of grain yield (1096.2 kg/ha) was produced at the first sowing date (7 April). Delaying of sowing from 7 April to 4 May (the second sowing date) resulted in a significant decrease at the rate of 33.6% in grain yield and reached to 728.2 kg/ha, whereas more delaying of planting from 4 May to 31 May (the third sowing date) led to a significant improvement in grain yield to 983.9 kg/ha (Table 1). Among the studied genotypes in this experiment, the genotype 411 produced the maximum seed yield of 1070.8 kg/ha. The reduction of seed yield to its minimum rate in the second sowing date may have been due to shortened vegetative growth stage (from sowing to head appearance) in this sowing date. The plants at the first sowing date had comparatively a longer vegetative growth phase (Table 3), in other words the
crop after a sufficient vegetative development arrived at its reproductive development stage. Leaf area index and net assimilation rate can generally increase as the result of vegetative growth stage elongation. In addition to, heads capability for photoassimilates absorbing may be improved [12]. On the other hand the renewed increase of grain yield as the result of delaying in sowing time from 4 to 31 May can be ascribed to changing trends of mean temperature during reproductive development stage (from head appearance to maturity) of the crop. Because of declining trend in temperature and lower mean temperature during reproductive phase especially from flowering to maturity stage at the third sowing date the crop growth and development took place in a more favorable temperature conditions which caused amelioration of photoassimilates transfer to grains and consequently elevation of grain yield, as compared with the second sowing date. Similar results have been reported by Arslan et al. [3], Samanci and Ozkaynak [13] and Dadashi and Khajehpour [7].

Conclusion:

Considering the results, for spring cultivation of safflower in the region of this experiment it is recommended that safflower should be sown as soon as possible early spring to achieve suitable yield. Whenever the sowing date is delayed as the result of any reason, in order to avoid coincidence of seed-filling stage with high temperatures, it is advised that the sowing operation be delayed until late spring after cereal harvesting in order to cultivate safflower as second crop (double cropping) in the cropping system of the region resulting in a reasonable yield.

Table 1: The effects of sowing date and genotype on yield components and yield of safflower

<table>
<thead>
<tr>
<th>Sowing date</th>
<th>Number of heads/plant</th>
<th>Number of seeds/head</th>
<th>1000-seed weight (g)</th>
<th>Grain yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 April</td>
<td>9.3 a</td>
<td>16.4 a</td>
<td>30.4 a</td>
<td>1096.2 a</td>
</tr>
<tr>
<td>4 May</td>
<td>9.3 a</td>
<td>12.4 b</td>
<td>24.6 b</td>
<td>728.2 b</td>
</tr>
<tr>
<td>31 May</td>
<td>6.4 b</td>
<td>14.5 ab</td>
<td>29.0 a</td>
<td>983.9 a</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Genotype</th>
<th>Number of heads/plant</th>
<th>Number of seeds/head</th>
<th>1000-seed weight (g)</th>
<th>Grain yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL111</td>
<td>7.0 b</td>
<td>13.5 a</td>
<td>26.6 b</td>
<td>986.5 ab</td>
</tr>
<tr>
<td>Sina</td>
<td>8.5 ab</td>
<td>15.7 a</td>
<td>23.3 b</td>
<td>751.0 b</td>
</tr>
<tr>
<td>411</td>
<td>9.5 a</td>
<td>14.1 a</td>
<td>34.2 a</td>
<td>1070.8 a</td>
</tr>
</tbody>
</table>

*Values followed by same letters in a group of a column are not significantly different at $P \leq 0.05$ according to Duncan's multiple range test.

Table 2: Mean temperature changes at different growth stages of safflower genotypes in three sowing dates

<table>
<thead>
<tr>
<th>Sowing date</th>
<th>Mean temperature (˚C)</th>
<th>Head appearance</th>
<th>Flowering</th>
<th>Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 April</td>
<td>24.4</td>
<td>22.8</td>
<td>29.7</td>
<td></td>
</tr>
<tr>
<td>4 May</td>
<td>24.2</td>
<td>28.2</td>
<td>29.0</td>
<td></td>
</tr>
<tr>
<td>31 May</td>
<td>30.0</td>
<td>27.3</td>
<td>26.8</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Mean number of days from sowing to head appearance in three sowing dates

<table>
<thead>
<tr>
<th>Sowing date</th>
<th>Days number (from sowing to head appearance)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 April</td>
<td>70.7</td>
</tr>
<tr>
<td>4 May</td>
<td>54.1</td>
</tr>
<tr>
<td>31 May</td>
<td>57.8</td>
</tr>
</tbody>
</table>

References

Components and Seed Yield of Safflower in Isfahan. Journal of Science and Technology of Agriculture and Natural Resources., 8(3): 95-112.


