Effects of Sowing Date and Planting Density on Growth and Yield of Safflower Cultivars as Second Crop

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ABSTRACT

In order to study the effects of sowing date and planting density on productivity and yield of safflower (Carthamus tinctorius L.) cultivars as second crop (double cropping) in Sanandaj an experiment was carried out in a split-split plot layout with randomized complete block design in three replications. Main plots were three sowing dates of 25 June, 5 July and 15 July. Subplots were two planting densities of 20 and 40 plants per m² and sub-subplots were three cultivars including: Sina, Zarghan and 411. Number of days to flowering and maturity stages were significantly increased with delay in sowing date. The time from sowing to maturity decreased due to increasing the plant density from 20 to 40 plants/m². The lowest rates of yield components were obtained from the third sowing date. Number of heads/plant decreased by increasing the plant population density. Cultivars were significantly different regarding yield components. The highest and the lowest rates of seed yield were produced by the first and the third sowing dates respectively. Increasing the plant population from 20 to 40 plants/m² resulted in an increase of 30% in seed yield. Sina cultivar produced the highest rates of seed yield and harvest index. Results showed that the first sowing date (25 June) was the best time for sowing safflower as second crop in the region and Sina cultivar with the plant density of 40 plan/m² is recommended.

Key words: Carthamus tinctorius, Planting density, Second crop, Sowing date

Introduction

Considering the ascending trend of oil consumption and high expense of imported oil and oilseeds to Iran, it is essential to expand the cultivation of oilseed crops. Among the oilseed crops, safflower (Carthamus tinctorius L.) from Asteraceae family is one of the most valuable crops with multipurpose usage which is grown for oil, medicinal and industrial uses [13]. It is a xeric crop tolerant to drought, because it has roots that can take up water deep down in the soil profile [19]. Safflower oil is one of the highest quality vegetable oils, containing oleic acid and linoleic acid [13]. Seed quality and growth traits of safflower are affected by factors like genotype, environment and agronomic practices [14]. Among the agronomic factors affecting the crop growth and yield, sowing date has an expressing influence and determining the appropriate sowing date is one of the most critical factors for optimizing safflower productivity [14,19,21, 22, 23]. Samanci and Ozkaynak [17] studied the effects of three planting dates on seed yield, oil content and fatty acid composition of three safflower cultivars in a Mediterranean region and 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. They declared
that the decrease in seed yield could be attributed to higher air temperatures at the flowering stage when planting were delayed, and thus pollination and fertilization events were generally obstructed.

During the time period between the crop harvesting stage (late spring or early summer) and sowing stage of the following crop (early or mid autumn) in western regions of Iran, the field is usually vacant and unutilized by the farmers, however they can utilize the bare field in the summer through the cultivation of short season crops such as some safflower genotypes. There are little information about the summer sowing of crops especially safflower as second crop (double cropping) under climatic conditions of Sanandaj region. The objective of this experiment was to study the effects of summer sowing dates and two planting densities on growth and productivity of safflower cultivars as second crop.

Materials and Methods

This trial was carried out at the agricultural research station of Gerizeh, Sanandaj, west of Iran in the growing season of 2008-2009. This research station is located at latitude of 35° 16’ N and longitude of 47° 1’ E with an altitude of 1405 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 1.1 ds/m and 7.7 respectively.

The field of experiment was fertilized with 30 kg N ha⁻¹ in urea form according to soil tests before sowing. The experiment was laid out in a split-split plot arrangement with randomized complete block design in three replications. Main plots were three sowing dates (25 June, 5 July and 15 July). Subplots were two planting densities of 20 and 40 plants per m² and sub-subplots were three cultivars including: Sina, Zarghan and 411. Each sub-subplot was 7 m long and consisted of 5 rows, 50 cm apart with intrarow spacings of 10 and 5 cm to achieve the plant densities of 20 and 40 plant/m² respectively. Before sowing, the safflower seeds were treated with benomyl fungicide to prevent fungal diseases, then the seeds were hand-sown on related dates and irrigation was immediately performed.

Number of days from sowing date to flowering and maturity stages, yield components, yield and harvest index were recorded. Date of flowering was determined when 50% of the plants had opened flowers. Date of physiological maturity was recorded when 75% of the heads in a plot had changed to yellow color. Number of heads per plant and number of seeds per head were determined based on seven randomly selected plants from the central three rows of each sub-subplot at maturity stage. Four randomly 100 seeds subsamples from harvest area were used for recording the 1000-seed weight trait. Seed yield was determined by harvesting the three central rows of each sub-subplot. Harvest index was calculated as the percentage of seed yield over biological yield. All data were subjected to 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

Crop phenology:

Safflower growth stages were affected by sowing date. The number of days to flowering and maturity stages were significantly increased as the result of delaying in sowing date (Table 1). Date of flowering was not affected by planting density however was significantly influenced by cultivar factor. Maturity date was affected by planting density and cultivar. By increasing the planting density from 20 to 40 plants/m², number of days from sowing date to maturity was significantly decreased (Table 1). Sina cultivar had the longest growth stages as compared with other two cultivars. The earliest maturity genotype was 411 cultivar with 105 days from sowing to physiological maturity.

Yield components:

The effects of sowing date on number of seeds/head and 1000-seed weight were significant. The highest rates of seeds number per head and 1000-seed weight were recorded by the plants sown at the first sowing date (25 June) (Table 1). The lowest rates of yield components were obtained by safflower plants sown on 15 July (the third sowing date). Planting density affected only the number of heads/plant, so that more heads per plant were produced in 20 plants/m² density (Table 1). Safflower cultivars were statistically different with respect to yield components. Sina cultivar produced the maximum number of heads/plant and 411 cultivar was superior than Sina and Zarghan from the view point of seeds number/head and 1000-seed weight.

Seed Yield and Harvest Index:

Seed yield and harvest index (HI) were significantly affected by sowing date, planting density and cultivar. The highest and the lowest rates of seed yield were produced by the first and the third sowing dates respectively. Increasing the plant population from 20 to 40 plants/m² resulted in an increase of 30% in seed yield. Sina cultivar produced the highest seed yield as compared with Zarghan and 411. Harvest index ranged from 0.21 at the third sowing
from 20 to 40 plants/m² resulted in decreasing the number to maturity stage (Table 2) i.e. the changing trend of mean temperature in this stage and shrinkage of photoperiod. Grain yield obtained from the third planting date indicatively decreased at the rate of 49% as compared with the first sowing date mainly due to low temperature occurred during seed formation stage. The consequent increase in seed yield/ha by increasing the plant density from 20 to 40 plants/m² may be attributed to increases in head number per unit area as the result of elevated plant population. This is in agreement with those reported by Alessi et al. [1], Ozel et al. [16] and Fazeli Khakaki et al. [10]. On the other hand harvest index despite of yield, was lower in the plant density of 40 plants/m² than the density of 20 plant/m². It seems that the ratio of growth enhancement in vegetative parts of plant was more evident than reproductive organs, due to increasing of plant density. Superiority of Sina cultivar over 411 and Zarghan with respect to grain yield and harvest index in this study suggested that Sina was the most compatible genotype for cultivation in the region. Variations among different genotypes regarding productivity and yield have been shown by other authors [4,5,11,14].

Conclusion:

According to the results of present study, in order to cultivate safflower as second crop in conditions similar to the region of this experiment, it is recommended that safflower should be sown as soon as possible after cereal harvesting. Delaying of safflower planting from late June afterwards will result in late flowering due to day length shortage and consequently the reproductive phase of crop development and seed filling stage may coincide with autumn low temperatures leading to expressing drop in crop yield and productivity. The relatively high yielding cultivar of Sina with more compatibility than other two genotypes is suggested for cultivation as second crop in the region with a plant population of about 40 plants/m².
Table 1: The effects of sowing date, planting density and cultivar on agronomic traits of safflower

<table>
<thead>
<tr>
<th>Sowing date</th>
<th>Number of days to flowering</th>
<th>Number of days to maturity</th>
<th>Number of heads/plant</th>
<th>Number of seeds/head</th>
<th>1000-seed weight (g)</th>
<th>Seed yield (kg/ha)</th>
<th>Harvest index</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-Jun</td>
<td>62.3 c</td>
<td>103 c</td>
<td>8.2 ab</td>
<td>16.7 a</td>
<td>28.6 a</td>
<td>762.5 a</td>
<td>0.25 a</td>
</tr>
<tr>
<td>5-Jul</td>
<td>67.3 b</td>
<td>109.3 b</td>
<td>8.7 a</td>
<td>13 b</td>
<td>27.2 b</td>
<td>560 b</td>
<td>0.23 b</td>
</tr>
<tr>
<td>15-Jul</td>
<td>73.5 a</td>
<td>115.1 a</td>
<td>7.7 b</td>
<td>11.5 c</td>
<td>22.9 c</td>
<td>392.2 c</td>
<td>0.21 c</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Planting density</th>
<th>Number of days to flowering</th>
<th>Number of days to maturity</th>
<th>Number of heads/plant</th>
<th>Number of seeds/head</th>
<th>1000-seed weight (g)</th>
<th>Seed yield (kg/ha)</th>
<th>Harvest index</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 plants/m²</td>
<td>68.6 a</td>
<td>111.4 a</td>
<td>8.7 a</td>
<td>13.8 a</td>
<td>26.3 a</td>
<td>496 b</td>
<td>0.26 a</td>
</tr>
<tr>
<td>40 plants/m²</td>
<td>66.8 a</td>
<td>106.9 b</td>
<td>7.7 b</td>
<td>13.7 a</td>
<td>26.2 a</td>
<td>647.2 a</td>
<td>0.20 b</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Number of days to flowering</th>
<th>Number of days to maturity</th>
<th>Number of heads/plant</th>
<th>Number of seeds/head</th>
<th>1000-seed weight (g)</th>
<th>Seed yield (kg/ha)</th>
<th>Harvest index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sina</td>
<td>70.5 a</td>
<td>122 a</td>
<td>10.7 a</td>
<td>13.4 b</td>
<td>24.7 b</td>
<td>708.7 a</td>
<td>0.24 a</td>
</tr>
<tr>
<td>Zarghan</td>
<td>67.4 b</td>
<td>109.9 b</td>
<td>6.7 b</td>
<td>13.7 ab</td>
<td>25.4 b</td>
<td>394.9 c</td>
<td>0.21 c</td>
</tr>
<tr>
<td>411</td>
<td>65.2 b</td>
<td>105.4 c</td>
<td>7.1 c</td>
<td>14.2 a</td>
<td>28.5 a</td>
<td>611 b</td>
<td>0.23 b</td>
</tr>
</tbody>
</table>

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

Table 2: Days number and mean temperatures during growth stages of safflower cultivars in three sowing dates

<table>
<thead>
<tr>
<th>Sowing date</th>
<th>Days number</th>
<th>Mean temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>From sowing to flowering</td>
<td>25 June</td>
<td>62.3</td>
</tr>
<tr>
<td>5 July</td>
<td>67.3</td>
<td>26.4</td>
</tr>
<tr>
<td>15 July</td>
<td>73.5</td>
<td>24.8</td>
</tr>
<tr>
<td>From sowing to maturity</td>
<td>25 June</td>
<td>103</td>
</tr>
<tr>
<td>5 July</td>
<td>109.3</td>
<td>23</td>
</tr>
<tr>
<td>15 July</td>
<td>115.1</td>
<td>21.2</td>
</tr>
</tbody>
</table>

References


