The effects of organic fertilizer and planting date on some traits of sesame varieties

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Abstract

The aim of this study was to examine the effect of planting date (May 31, June 15 and June 30) and organic fertilizers [compost (100%), manure (100%) and compost 50% + manure 50%] on the agronomic traits of sesame varieties (Tak Shakhe Naz, Kerman (MD) and Gorgan cultivars) in Kordkouy in the crop year 2012-2013. Split plot factorial experiments were performed with three replications in a randomized complete block design. The planting date was considered as the main plot. The sesame varieties and fertilizers were considered as subplots. The results indicated that the delay in planting reduced plant height (4%), dry matter yield (8.9%) and harvest index (3.1%). However, it increased seed oil content (5%) by reducing the plant density. Although the use of compost improves the agronomic traits, it will reduce the seed oil content (3.1%) due to increased plant density. The differences observed between varieties for different traits were significant at the significance level of 1%. The Kerman, Tak Shakhe Naz and Gorgan cultivars showed the best performance in terms of plant height (125 cm), dry matter yield (4579 kg/ha) and harvest index (25.2%) and seed oil (55.6%), respectively. According to the results of this experiment, the use of manure and planting in late June are recommended to achieve the highest seed oil content.

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**Introduction**

Sesame with the scientific name of *Sesamum indicum* L. is one of the most important and oldest oilseeds (Badijan, 2004). Sesame grows in tropical and subtropical regions in dry and rainy weather (Alhabashi *et al.*, 2007). Organic fertilizers used for growing crops, this is because manure and compost are easy to use, quickly absorbed and utilized by crops. Sesame is a survivor crop. For 5,000 years it has been planted by subsistence farmers in areas that will not support the growth of other crops or under very difficult conditions with drought and/or high heat (D. Ray Langham, 2007). Sesame yield is highly variable depending upon the growing environment, cultural practices and cultivars. Since the yielding ability of sesame crop is determined by many yield components, all of which are substantially influenced by environmental and agronomic conditions (EL MAHDI *et al.*, 2007). India, China and Sudan are the main producers of sesame and produce more than 60 percent of global production of this strategic product (Khazaei & Daneshmandi, 2007). Due to the high oil content (47-52%) and good quality (low cholesterol level and the presence of some antioxidants), the sesame seed oil plays an important role in human health (Kasab *et al.*, 2005; Bagheri *et al.*, 2013). The purpose of determining the best planting dates is to find an appropriate time in which the climatic factors are suitable for all vegetative and reproductive stages of plant growth. In other words, the purpose is to find a time in which each stage of plant growth is less exposed to unfavorable environmental conditions (Kazerani & Ahmadi, 2004). Day length affects flowering stage and the next developmental stages (Badijan, 2004). Since the suitable day length is not same for various sesame varieties, the effect of planting date on the number of days from planting to flowering and ripening will vary (Dehghan & Moazzam, 2010). Rezvani Moghaddam and Sadeghi Samarjan (2012) found that the number of pods per plant was greatly influenced by planting date. A delay in planting will reduce the number of pods (Lazemi, 2007). Delay in planting can lead to loss of biological yield through shortened vegetative and reproductive growth durations, decreased volume of available water and reduced plant height and number of branches (Abbasz Suraki *et al.*, 2004). On the other hand, the successful production of agricultural products requires proper soil and sufficient amount of nutrients available to the plant. Both organic and chemical fertilizers are needed to create favorable conditions for plant growth (Iqbal, 2002). Sesame does not show much reaction to chemical fertilizers, which is probably due to low fertilizer consumption of local varieties that are adapted to local conditions. However, nitrogenized fertilizers often increased the grain yield in modified varieties (Moghaddam Fard & Bahrani, 2005). To achieve the yield of one to two tons per hectare, approximately 35 to 75 kg/ha nitrogen is needed (Khajehpour, 2004). According to Kumar *et al.* (2009), the increased levels of nitrogenized fertilizer increased sesame seed oil content. Ahamdi and Bahrani (2009) found that the increase in sesame seed oil content was not affected by fertilizer treatments. Organic fertilizers, especially manure, contain large amounts of organic material compared to chemical fertilizers. Therefore, such fertilizers are resources rich in nutrients, especially nitrogen, phosphorus and potassium (Rezvani Moghaddam *et al.*, 2013). Although organic fertilizers gradually provide the plant with these elements, they cannot supply all the nutritional requirements of plants. However, the improvement of soil physical structure will balance the chemical constituents of the soil (Iqbal, 2002). Research on the effect of manures, especially organic fertilizers such as composting and vermicomposting, has been increasing in recent years. Singh *et al.* (2004) studied the effect of compost on increased production of some medicinal plants, including *Plantago psyllium* and *Arugula*. Their results showed that the biomass components of plants and the fruit yield increased significantly with increasing compost proportion. Compost stimulates biological activities in the soil and increases the organic matter. It also improves the biological, chemical and physical characteristics of the soil (Kouchaki *et al.*, 2005; Iqbal, 2002). According to Iqbal (2002), the use of compost for four years significantly increased the carbon content of the soil for several years compared to chemical fertilizers.
Manure increases organic matter of soil, phosphorus, nitrogen and other nutrients and improves soil structure and water retention in the soil. This subsequently leads to enhanced quality and quantity of the product (Sharply et al., 2004). Given the high thermal demand of sesame and low fertilizer consumption of local varieties, the aim of the present study is to investigate the effect of different planting dates and organic fertilizers on agronomic traits of sesame varieties in Kordkouy.

Materials and methods
The experiment was conducted in the 2012-2013 crop year in Kordkouy in the Golestan, Iran. Kordkouy is located in West Golestan at 54°, 6’ E and 36°, 47’ N and is 28 km from Gorgan. Its height from sea level is 50 m with a maximum height of 3500 and the annual rainfall of 450 mm in the 2012-2013 crop year.

A split plot factorial experiment with a randomized complete block design (RCBD) was performed with three replications. Three planting dates (May 31, June 15 and June 30), as the main plot, were implanted in the main plots. Three sesame varieties (Tak Shakhe Naz, Kerman native variety (MD) and Gorgan native variety) and three types of organic fertilizers [compost (100%), manure (100%) and compost 50% + manure 50%], as the subplots, were implemented in the subplots. To apply fertilizer treatments, 30 tons of manure, 10 tons of compost and a combination of these two fertilizers with a same ratio of 50% were distributed in the land. In total, 81 plots were prepared as stacks. The surface area of sub-plots area was 16 m² (4 × 4). Before planting, the land was irrigated on each of the planting dates and then furrowed after two to three days.

To evaluate the traits (height, dry matter yield, harvest index (Derikvand & Hossainpour, 2008) and oil content), samples were taken from each plot at the end of growth season. The seed oil content was measured by soxhlet method (Ukocha et al., 2008). Analysis of variance was performed by SAS 9.1. Duncan test was used to compare means (at significance level of 5%) and the graphs were plotted in Excel 2010.

Results and discussion
ANOVA table was performed by a split plot factorial with a randomized complete block design. Table 1 summarizes the results. The block effect was insignificant for all traits. The effect of planting date, fertilizer and variety for all traits was significant at the significant level of 1%. Only the effect of fertilizer on oil content and the effect of cultivar on the harvest index were significant at the significance level of 5%. Except for the significant interaction of planting date × fertilization for harvesting index at the significance level of 1%, the other interactions were insignificant. Table 2 shows comparison of means for various traits.

Table 1. Analysis of variance for agronomic traits of sesame varieties.

<table>
<thead>
<tr>
<th>S.O.V</th>
<th>DF</th>
<th>Plant height</th>
<th>Dry matter yield</th>
<th>Harvest index</th>
<th>Seed oil content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block</td>
<td>2</td>
<td>34.70 **</td>
<td>8103 **</td>
<td>0.12 **</td>
<td>6.26 **</td>
</tr>
<tr>
<td>Planting date</td>
<td>2</td>
<td>239.22 **</td>
<td>1180994 **</td>
<td>64.37 **</td>
<td>166.78 **</td>
</tr>
<tr>
<td>Cultivar</td>
<td>2</td>
<td>47.96</td>
<td>63586</td>
<td>4.84</td>
<td>25.59</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>2</td>
<td>573.64 **</td>
<td>2606659 **</td>
<td>17.97 **</td>
<td>95.36 **</td>
</tr>
<tr>
<td>Planting date × cultivar</td>
<td>4</td>
<td>12.88 **</td>
<td>81991 **</td>
<td>3.65 **</td>
<td>48.88 **</td>
</tr>
<tr>
<td>Planting date × fertilizer</td>
<td>4</td>
<td>69.48 **</td>
<td>86543 **</td>
<td>24.35 **</td>
<td>53.46 **</td>
</tr>
<tr>
<td>Fertilizer × Cultivar</td>
<td>4</td>
<td>19.78 **</td>
<td>107116 **</td>
<td>1.46 **</td>
<td>13.40 **</td>
</tr>
<tr>
<td>Fertilizer × Cultivar × planting date</td>
<td>8</td>
<td>5.13 **</td>
<td>34722 **</td>
<td>0.82 **</td>
<td>8.33 **</td>
</tr>
<tr>
<td>Error II</td>
<td>48</td>
<td>38.80</td>
<td>49445</td>
<td>3.11</td>
<td>25.09</td>
</tr>
</tbody>
</table>

**, * and ** indicate non-significant, significant at significant levels of 5 and 1%, respectively.
Plant height
The comparison of means (Table 2) showed a significant difference between various varieties in terms of plant height. Kerman (125 cm) and Gorgan (118 cm) cultivar had the highest and lowest heights, respectively. There was a significant difference between the first and third planting dates. The plant height in the first planting date was higher than in the second and third planting dates. However, the difference between the first and second planting dates as well as the second and third planting dates was insignificant. According to Abbasi Suraki et al. (2004), a delay in planting reduces the plant height by reducing the volume of available water.

Table 2. Comparison of means for agronomic traits.

<table>
<thead>
<tr>
<th>Traits</th>
<th>May 31</th>
<th>June 15</th>
<th>June 30</th>
<th>Fertilizer</th>
<th>Compost</th>
<th>Compost×Manure</th>
<th>Manure</th>
<th>Cultivar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oil seed content (%)</td>
<td>Harvest index (%)</td>
<td>Dry matter yield (kg/ha)</td>
<td>Plant height (cm)</td>
<td>Oil seed content (%)</td>
<td>Harvest index (%)</td>
<td>Dry matter yield (kg/ha)</td>
<td>Plant height (cm)</td>
</tr>
<tr>
<td>Planting date</td>
<td>50.3 b</td>
<td>53.0 a b</td>
<td>55.3 a</td>
<td>Compost</td>
<td>50.7 b</td>
<td>54.2 a</td>
<td>53.6 a</td>
<td>Tak Shakhe Naz</td>
</tr>
<tr>
<td></td>
<td>26.1 a</td>
<td>24.2 b</td>
<td>23.0 b</td>
<td>Compost×Manure</td>
<td>25.4 a</td>
<td>24.2 b</td>
<td>23.8 b</td>
<td>Kerman</td>
</tr>
<tr>
<td></td>
<td>4631 a</td>
<td>4483 a</td>
<td>4218 b</td>
<td>Manure</td>
<td>4701 a</td>
<td>4532 b</td>
<td>4099 c</td>
<td>Gorgan</td>
</tr>
<tr>
<td></td>
<td>123 a</td>
<td>122 ab</td>
<td>118 b</td>
<td>Cultivar</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In each column, there is no significant difference between treatments with common letters according to Duncan test.

The plant height increased using compost and showed a significant difference with other fertilizers. No significant difference was found between the plant height of various varieties using manure and compost × manure fertilizers. According to Rezvani Moghaddam et al. (2013), the use of fertilizers increased plant height compared to the control (no fertilizer applied), but no significant difference was found between treatments.

The interactions of different treatments were insignificant (Table 1). However, the highest plant height (139 cm) was observed for Kerman cultivar in the first planting date with the use of compost as fertilizer (Fig. 1).

Table 3. Simple correlation coefficients.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Plant height (cm)</th>
<th>Dry matter yield (kg/ha)</th>
<th>Harvest index (%)</th>
<th>Seed oil content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant height (cm)</td>
<td>1</td>
<td>0.523 **</td>
<td>0.426 **</td>
<td>-0.295 *</td>
</tr>
<tr>
<td>Dry matter yield (kg/ha)</td>
<td>1</td>
<td>0.362 **</td>
<td>0.436 **</td>
<td></td>
</tr>
<tr>
<td>Harvest index (%)</td>
<td>1</td>
<td>0.420 **</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seed oil content (%)</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* and ** indicate a significant correlation at significant level of 5 and 1%, respectively.

Dry matter yield
There was a significant difference between different cultivars in terms of dry matter at the significance level of 1% (Table 1). Tak Shakhe Naz (4579 kg/ha) and Kerman (4539 kg/ha) cultivars showed higher yields than Gorgan cultivar (4215 kg/ha). The difference observed between various cultivars was significant. The results of other researchers (Rezvani Moghaddam et al, 2013; Kumar et al, 2009) also confirmed this result. The effect of planting date on
Dry matter yield was significant at the significant level of 1% (Table 1). There was no significant difference between the first and second planting dates. But the difference of first and second planting dates with the third planting date was significant. In general, delay in planting date reduced the amount of dry matter and thus, the dry matter yield. This is consistent with the results of previous studies (Rezvani Moghaddam et al., 2013; Lazemi, 2007).

**Table 4.** Physical and chemical properties of the soil.

<table>
<thead>
<tr>
<th>Soil texture</th>
<th>Sand (%)</th>
<th>Silty clay (%)</th>
<th>Clay (%)</th>
<th>pH</th>
<th>Ec (%)</th>
<th>Depth (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Si-Lo</td>
<td>24</td>
<td>54</td>
<td>22</td>
<td>7.6</td>
<td>69</td>
<td>0-30</td>
</tr>
</tbody>
</table>

The effect of fertilizer treatments on dry matter yield was significant at the significance level of 1%. Comparison of means (Table 2) showed that the use of compost increased the dry matter yield and showed a significant difference with other treatments. The highest and lowest dry matter yields obtained using compost (4701 kg/ha) and manure (4099 kg/ha), respectively. The interactions for dry matter yield were insignificant. The highest dry matter yield obtained for Tak Shakhe Naz cultivar in the second planting date (June 15) using compost. The lowest dry matter yield observed for Gorgan cultivar in the third planting date (June 30) using manure (Figure 2).

Organic fertilizers have positive effects on soil fertility, increased organic matter, soil enrichment and ultimately increased biomass content of plants (Jahan, 2004).

**Harvest Index**

The effect of cultivar on harvest index was significant at the significance level of 5% (Table 1). Rezvani Moghaddam et al. (2013) found a significant difference between various varieties in terms of harvest index. Comparison of means (Table 2) indicated that Tak Shakhe Naz, with the highest harvest index (25.5%), showed a significant difference with other two varieties. There was no significant difference between Kerman and Gorgan cultivars in terms of harvest index. Similar results were obtained for the effect of planting date and fertilizer treatments on harvest index. The highest harvest index was obtained in the first planting date using compost (Fig. 3). The difference between the second and third planting dates as well as the first and second fertilizer treatments were insignificant. The interaction of planting date x fertilization for harvest index was significant. As seen in Figure 3,
planting date has a positive effect on harvest index. A higher harvest index was obtained in the first planting date using compost × manure compared to the second planting date using compost as fertilizer treatment. The harvest index for various varieties was different.

Although the biological yield of a single specific cultivar varied in different situations, the harvest index of a cultivar was nearly constant in different conditions. This indicated that the harvest index was mainly influenced by genetic factors rather than environmental and agronomic factors (Rezvani Moghaddam et al., 1992).

Seed oil content
As seen in Table 1, the effect of cultivar on the seed oil was significant at the significant level of 1%. Comparison of means (Table 2) for seed oil content showed that Gorgan (55.6 %) and Tak Shakhe Naz cultivars had the highest and lowest seed oil content, respectively. There was a significant difference between these two cultivars. The difference between Kerman and Gorgan cultivars was insignificant in terms of seed oil content. The result of Rezvani Moghaddam et al. (2013) showed the significant impact of cultivar on oil yield. The effect of planting date on oil content was significant at the significance level of 1%. According to the results, the seed oil yield increased with prolonged planting date, as the highest oil yield (55.3 %) was observed in the third planting date. However, the differences between the first and second planting dates as well as the second and third planting dates were insignificant.

According to some studies (Rezvani Moghaddam & Samarjan, 2002; Lazemi, 2008), the sesame oil content decreased with delay in planting date. Dehghan & Moazzam (2010) examined the sesame seed oil in three planting dates including June 22, July 6 and July 21. Their results showed that a delay in planting reduced the seed oil content. It seems that the selected planting dates and the climatic conditions were effective in increasing oil content despite delay in planting. It can be concluded that the increase in the number of seeds caused a distribution of photosynthesized material between seeds. Thus, the level of oil in each seed decreased compared to late planted sesame, in which lower number of seeds were formed per plant. This conclusion correlates to other studies as well, including studies by Rezvani Moghaddam & Samarjan, 2002; Lazemi, 2007; Dehghan & Moazzam, 2010.

The effect of fertilizer treatments on oil content was significant at the significance level of 5% (Table 1). Comparison of means showed the highest oil content for the fertilizer treatment of compost × manure

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Fig. 2. The effect of planting date and various fertilizers on the dry matter yield of various sesame varieties.
However, it was not significant in comparison to the application of manure. The use of compost resulted in lowest oil content (50.7%). According to Weiss (2000), excessive vegetative growth due to the high density of plant or too much nitrogenized fertilizer was usually associated with reduced oil content in most oilseeds due to increased plant metabolism.

![Fig. 3. The effect of planting date and various fertilizers on the harvest index of various sesame varieties.](image)

![Fig. 4. The effect of planting date and various fertilizers on the seed oil content of various sesame varieties.](image)

As seen in Figure 4, the highest oil content was obtained for Gorgan cultivar in the second planting date using a mixture of compost and manure.

**Correlations between traits**

Table 3 shows correlation coefficients between various traits. The positive correlation of plant height with dry matter yield and harvest index was significant. The most significant correlation was found between the plant height and dry matter yield. The negative correlation between plant height and oil content was significant at the significance level of 5%.

There was a significant positive correlation between the harvest index and dry matter index. The harvest index was also negatively correlated with seed oil content, and both were significant at the significance level of 1%. The positive and significant correlation of oil seed content with harvest index was also interesting.

**Conclusions**

In general, the delay in sesame planting reduced the plant height (4%), dry matter yield (8.9%) and harvest index (3.1%). However, it resulted in
increased oil content (5%) by reducing the plant density. Fertilizer treatments had significant effects on traits. The use of compost increased functional traits. However, it reduced the oil content (3.1%) due to increased plant density. The different varieties showed different reactions to planting dates and different fertilizer treatments. The difference between various cultivars was significant at the significance level of 1%. Kerman, Tak Shakhe Naz and Gorgan cultivars showed best performance in terms of plant height (125 cm), dry matter yield (4579 kg/ha) and harvest index (25.2%) and seed oil (55.6%), respectively. According to the results of this experiment, the use of manure and planting in late June are recommended to achieve the highest oil yield.

References


Rezvani Moghaddam P, Samarjan S. 2002. The effect of different planting dates and different irrigation regimes on morphological characteristics and yield of chickpea (Cicer arietinum) cultivar ILC-3279 in Nishapur. Ferdowsi University of Mashhad, Faculty of Agriculture. (in Persian).


