EFFECT OF WATER STRESS AND DIFFERENT TYPES OF ORGANIC FERTILIZERS ON ESSENTIAL OIL CONTENT AND YIELD COMPONENTS OF CUMINUM CYMINUM

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ABSTRACT
Cumin (Cuminum cyminum L.) is one of the most economical medicinal plants and distribution considerably in different parts of the Iran. In order to study the effects of drought stress and different types of organic fertilizers on yield components of cumin, this experiment was conducted in 2014 at the Agricultural Research Institute, University of Zabol, Iran in a complete randomized block in factorial design with three replications. Treatments including irrigation intervals (I1: two times irrigation, I2: three times irrigation and I3: four times irrigation that are irrigation in germination, seedling, flowering and seed filling stages) and fertilizers treatment (T1: without fertilizer application (Control), T2: 10 t/ha vermicompost, T3: 15 t/ha compost and T4: 30 t/ha animal manure. The characteristics such as Biological yield (kg/ha), Total yield (kg/ha), Harvest Index, Essential oil yield (kg/ha) and Essential oil percentage were evaluated. The results showed that there were significantly affected by Irrigation times at 1% probability level in all variables Except Essential oil percentage. Also the highest (458.29 kg/ha) and lowest (146.08 kg/ha) Seed yield was produced under the traits 4 and 2 irrigations times. The application of 15 t/ha compost obtain highest Biological yield, Total yield, Harvest Index, Essential oil yield and Essential oil percentage. Highest (1.61) and lowest (1.41) levels of Essential oil percentage were obtained in 4 irrigations (I3) and 2 irrigations (I1) treatments, respectively.

Keywords: Cumin, Drought Stress, Organic Fertilizers, Essential Oil

INTRODUCTION
Cumin is the world's oldest discovered in Burnt City, zabol, Iran. Cumin was discovered in this area shows that five thousand years ago, the herbs used in the diets of many city residents have been burned. The black cumin and caraway today as it was with particular discovered vessels bearing the graves of the dead were placed. Since typical older cumin Burnt City in Sistan and Baluchistan in any region of the world has never seen (Ghafari-Moghaddam and Mirshekary, 2013). Peaks in the local dialect it is called Krabyeh. Water stress is the most influential factor affecting crop yield particularly in irrigated agriculture in arid and semi-arid regions, it is necessary to get maximum yield in agriculture by using available water in order to get maximum profit from per unit area because existing agricultural land and irrigation water are rapidly diminishing due to rapid industrialization and urban development. Optimizing irrigation management due to water scarcity together with appropriate crops for cultivation is highly in demand; the cost of irrigation pumping and inadequate irrigation scheme capacity as well as limited water sources is among the reasons that force many countries to reduce irrigation applications. Potential of water stress tolerance and the economic value of medicinal and aromatic plants, make them suitable alternative crops in dry lands (Ghanbari et al., 2007). Usage of manure is more important and beneficial than chemical fertilizers (Loecke, 2004). Ahmadian (2011a) reported that Irrigation times imposed a positive effect on the number of seed and number of umbrella per plant, and it had negative effect on seed weight in Cumin, but no effects on number of seed per umbrella and plant height per plant. The effect of fertilizer treatment and its interaction with irrigation on seed yield in Cumin was significant. In water stress conditions, higher seed yield was related to 5 t/ha manure+ kg/ha nitrogen treatment (Seghatoleslami, 2013). According to results Shafagh and Heris (2013), Animal manure produced the highest, seed number per plant, 1000-seed weight and seed yield of dragon, s head (Lallemantia iberica), 5.673 and 5.646 (gr), respectively. Saboor (2004) also reported that manure application increases cumin
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yield. James et al., (2005) suggested that the change of finite nutrient availability would have the largest impact in altering community and ecosystem properties rather than changes in water availability or efficiency of water utilization. Fertilization increases the availability of limited nutrient, and then could alter system properties, which might be a potentially practical way to stimulate plant growth, enhance stress tolerance, and improve the efficiency in using finite resources in infertile and dry environment (Baligar et al., 2001, Singh et al., 200, Dang et al., 2006). The highest harvest index (40.66) was produced on Lallemantia iberica under at the treatment of 150 mm evaporation from class A pan and the application of Compost.

MATERIALS AND METHODS

The field experiment was conducted in 2013, 2014 growing seasons at the Agricultural Research Institute of University of zabol, Iran. The experiment was arranged complete randomized block in factorial design with three replications. The soil texture was sandy-loam, having 1.1% organic matter. Soil chemical analysis was as follows: pH = 7.7; ECdS/m) = 2.4; cations (meq/L): Ca$^{2+}$ = 2.43, Mg$^{2+}$ = 2.5, Na$^+$ = 6.46, K$^+$ = 2.74; anions (meq/L): CO3$^{2-}$ = zero, HCO3$^{-}$ = 3.6, Cl$^-$ = 2.4, SO4 $^{2-}$ = 5.6 (Jackson, 1973). The experimental plot size was 2 meters long and 2 meters width, occupying an area of 4 m2 and Seeds were planted on 14 December, 2014 in 40 cm row distance, 1.5 cm sowing depth. (I1: two times irrigation, I2: three times irrigation and I3: four times irrigation that are irrigation in germination, seedling, flowering and seed filling stages) and fertilizers treatment (T1: without fertilizer application (Control), T2: 10 t/ha vermicompost, T3: 15 t/ha compost and T4: 30 t/ha animal manure. The characteristics such as Biological yield (kg/ha), Total yield (kg/ha), Harvest Index, Essential oil yield (kg/ha) and Essential oil percentage by Clevenger were evaluated. The studied traits were measured on the 10 randomly selected. Weeds were controlled by hand weeding during crop growth and development. At maturity, plants of 2 m$^2$ in the middle part of each plot were harvested and calculated. All data were averaged and statistically analyzed using analysis of variance (ANOVA) by MSTATC and SAS analytical software. The Duncan’s multiple range test level was used to compare means.

RESULTS AND DISCUSSION

Biological Yield

Drought stress had significant effect on Biological yield. Also the effect of fertilizer treatment and its interaction with irrigation on Biological yield was not significant (Table 1). The lowest Biological yield (309.08 kg/ha) was obtained from I1: two times irrigation (Table 2). The highest Biological yield resulted from 15 t/ha compost application treatment and animal manure. The reduction of cumin Biological yield in water stress condition also has reported by Ahmadian et al., (2011a). In that experiment, the highest Biological yield resulted from 3 applications of irrigation with an application of 30 t/ha animal manure. Tatari (2004) reported that increasing irrigation times enhanced biological yield significantly.

Total Yield

According to results of analysis of variance, total yield was significantly affected by Irrigation times at 1% probability level and Fertilizers at 5% probability level. Also interaction between irrigation times and fertilizers types were not significant differences (Table 1). The highest (458.29 kg/ha) and lowest (146.08 kg/ha) total yield was produced under the treatments 4 and 2 irrigations times respectively. Also the application 30 t/ha animal manure treatment was obtained 316.39 kg /ha total yield (Table 2). Manure application improves the soil structure and soil moisture content, provides plant with essential elements, increases growth, number of umbrella per plant and biological yield and finally led to increase seed yield (Ahmadian et al., 2011b). Bilandi (2004) on cumin and Seghatoleslami (2013) on cumin also reported that manure application increases cumin yield.

Harvest Index

Table 1 shows the effects of irrigation times and fertilizers organic on cumin growth. fertilizers organic and Interaction FxI had no significant effects on the harvest index but Irrigation times was significant on harvest index at 5% probability level (Table 1). Also Results showed that the highest harvest index

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(121.17 %) was obtained from four times irrigation (I3). In Fertilizers application had no significant effects on the harvest index (Table 2).

Essential Oil Yield

According to results of analysis of variance, essential oil yield was significantly affected by Irrigation times and Fertilizers at 1% probability level. According to results of analysis of variance, all traits in different levels of drought stress were significant so the Essential oil yield decreased under drought stress (Table 2). Highest (7.08) and lowest (1.09) levels yield were obtained in 4 irrigations (I3) and 2 irrigations (I1) treatments, respectively. In Fertilizers application, higher yield was related to compost treatment (4.84) and vermicompost (4.77) and Control treatments (2.36) had lower Essential oil yield respectively. In conclusion, results showed that manure could be used effectively to modify the impact of water shortage and to stimulate an increase in cumin seed and essential oil yields probably through improving the water holding capacity of the soil (Seghatoleslami, 2013).

Essential Oil Percentage

Analysis of variance showed that the Essential oil yield was significantly affected by Irrigation times at 5% probability level and Fertilizers and interaction between irrigation × fertilizers at 1% probability level (Table 1). The highest (1.61) and lowest (1.41) Essential oil Percentage was produced under the treatments 4 and 2 irrigations times respectively. Also in the application to compost and vermicompost treatments was obtained highest Essential oil Percentage (Table 2). These results are in agreement with those obtained by Forouzandeh et al., (2012).

Table 1: Square means of yield components affected by fertilizers organic and drought stress

<table>
<thead>
<tr>
<th>Sources of variation</th>
<th>df</th>
<th>Biological yield (kg/ha)</th>
<th>Total yield (kg/ha)</th>
<th>Harvest Index (%)</th>
<th>Essential oil percentage (%)</th>
<th>Essential oil yield (kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replication</td>
<td>2</td>
<td>106502.63*</td>
<td>29770.34*</td>
<td>382.21ns</td>
<td>0.020ns</td>
<td>0.060ns</td>
</tr>
<tr>
<td>Irrigation</td>
<td>2</td>
<td>993524.42**</td>
<td>316927.42**</td>
<td>1885.62**</td>
<td>0.116*</td>
<td>90.40**</td>
</tr>
<tr>
<td>Fertilizers Interaction</td>
<td>3</td>
<td>87177.91ns</td>
<td>26838.34*</td>
<td>150.24ns</td>
<td>1.52**</td>
<td>12.03**</td>
</tr>
<tr>
<td>Replication × Fertilizers Interaction</td>
<td>6</td>
<td>39822.63ns</td>
<td>11212.20ns</td>
<td>10.44ns</td>
<td>2.40**</td>
<td>5.40**</td>
</tr>
<tr>
<td>Error</td>
<td>22</td>
<td>22504.19</td>
<td>5933.43</td>
<td>103.81</td>
<td>0.022</td>
<td>0.018</td>
</tr>
<tr>
<td>CV %</td>
<td>-</td>
<td>27.6</td>
<td>27.8</td>
<td>9.4</td>
<td>9.7</td>
<td>3.4</td>
</tr>
</tbody>
</table>

**, * statistical significant on 0.01 and 0.05 ns: not significant.

Table 2: Mean of yield components affected by fertilizers organic and drought stress

<table>
<thead>
<tr>
<th>Sources of variation</th>
<th>Biological yield (kg/ha)</th>
<th>Total yield (kg/ha)</th>
<th>Harvest Index (%)</th>
<th>Essential oil yield (kg/ha)</th>
<th>Essential oil percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I1</td>
<td>309.08 C</td>
<td>146.08 C</td>
<td>96.55 B</td>
<td>1.90 C</td>
<td>1.41 B</td>
</tr>
<tr>
<td>I2</td>
<td>454.21 B</td>
<td>223.92 B</td>
<td>104.78 B</td>
<td>2.91 B</td>
<td>1.54 AB</td>
</tr>
<tr>
<td>I3</td>
<td>863.92 A</td>
<td>458.29 A</td>
<td>121.17 B</td>
<td>7.08 A</td>
<td>1.61 A</td>
</tr>
<tr>
<td>Control</td>
<td>407.67 B</td>
<td>200.33 B</td>
<td>102.06 A</td>
<td>2.36 C</td>
<td>1.08 C</td>
</tr>
<tr>
<td>vermicompost</td>
<td>530.44 AB</td>
<td>272.00 AB</td>
<td>109.89 A</td>
<td>4.77 A</td>
<td>1.82 A</td>
</tr>
<tr>
<td>compost</td>
<td>614.56 A</td>
<td>315.67 A</td>
<td>111.27 A</td>
<td>4.84 A</td>
<td>1.92 A</td>
</tr>
<tr>
<td>animal manure</td>
<td>616.94 A</td>
<td>316.39 A</td>
<td>106.78 A</td>
<td>3.88 B</td>
<td>1.26 B</td>
</tr>
</tbody>
</table>

There were no statistical differences among the means shown by the same letters at 5 % probability level.

REFERENCES


Tatari M (2004). The effect of different levels of salt and irrigation times on growth and yield of cumin. MSc thesis, Faculty Agriculture, Ferdowsi University of Mashhad, Iran.