Effect of irrigation and antitranspirant on biometric components, seed yield and plant water-use of spring sunflower (Helianthus annuus)

R.K. THAKURIA, HARBIR SINGH and TEJ SINGH

Department of Agronomy, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana- 125004

Received : September 2003

ABSTRACT

A field experiment was conducted during the spring seasons of 1999 and 2000 to study the effect of 5 irrigation levels and 4 antitranspirant treatments on sunflower (Helianthus annuus L.) at Hisar, Haryana. Scheduling of 4 irrigations (I4), one each at seedling, button, flowering and seed-developing stage recorded significantly higher growth and yield attributes, and seed yield (pooled 19.71 qt/ha) of sunflower. Cumulative water use, water-use efficiency, leaf water potential and transpiration rate as plant water-use parameters and average net return (Rs 8,031/ha) were also maximum with I4 treatment. Effect of antitranspirants, as an irrigation saving technique in semi-arid situation, however, was not satisfactory. Interaction between irrigation levels and antitranspirants on any of the parameters was observed non-significant.

Key words : Antitranspirants, Irrigation level, Sunflower, Consumptive water-use, Water-use efficiency.

Advantage of growing sunflower as an oilseed crop is that it can be grown throughout the year because of its photo-thermo-insensitiveness character. However, higher seed yield can be obtained from spring season sunflower crop (Singh et al. 1997). Yield of sunflower is greatly influenced by irrigation and better results both in terms of biometric components and seed yield can be achieved by the application of optimum irrigation. The irrigation requirements of sunflower however, is much higher when the crop is grown in arid and semi-arid regions during spring because of higher evaporative demand of atmosphere and low rainfall. Non-availability of sufficient canal irrigation water at this season as per requirements of sunflower crop causes moisture stress at critical stages of growth and development. Under such circumstances, finding out some appropriate solution for minimizing the irrigation requirement of sunflower crop without sacrificing yield should receive top most priority. One such solution may be the use of antitranspirants for reducing the water losses through transpiration. The present investigation was undertaken to study the effect of irrigation and antitranspirants on biometric components, seed yield and its attributes, consumptive water-use (CU), water-use efficiency (WUE) and economic analyses of spring sunflower.

MATERIALS AND METHODS

A field experiment was conducted during spring seasons of 1999 and 2000 at the Chaudhary Charan Singh Haryana Agricultural University Farm, Hisar (75°46' E, 22°10' N, 215 m above mean sea-level). The experimental soil was sandy loam, Typic Ustochrepts, consisting of 64.50% sand, 16.79% silt and 18.75% clay in 0-120 cm soil profile. It contained soil moisture 17.72% at -0.03 MPa and 7.42% at -1.5 MPa and 7.42% at -1.5 MPa on gravimetric basis with bulk density of 1.39-1.44 g/cc. The soil contained 176.5 kg available N, 17 kg available P and 301 kg K/ha and had alkaline reaction (pH 8.2).

The weather during 2000 was dry (4.0 mm precipitation in May) but cloudy at later phase (reproductive stage). During 1999, showers of 1.0, 14.0 and 24.0 mm were received in February, May and June respectively. In 1999, mean pan evaporation was 3.1, 4.8, 9.6, 10.4 and 9.9 mm/day during February, March, April, May and June. Mean pan evaporation for corresponding months in 2000 was 3.0, 4.6, 9.3, 10.4 and 11.7 mm/day. The mean maximum and minimum air temperature for the same period of 1999 was 34.6°C and 16.1°C, respectively, while for 2000 corresponding air temperature recorded were 35.7°C and 15.3°C. The experiment was laid out in strip plot design having 3 replications with 5 irrigation levels [I0, non-post sowing irrigation; I1, 1 irrigation at seedling stage, 30 DAS]; I2, 2 irrigations one each at seedling (30 DAS) and button (50 DAS); I3, 3 irrigations one each at seedling (30 DAS), button (50 DAS) and flowering (70 DAS) stage; and I4, 4 irrigations one each at seed-
ling (30 DAS), button (50 DAS), flowering (70 DAS) and seed developing (90 DAS) stage in main plot; and 4 antitranspirants, viz. A<sub>n</sub>, no antitranspirant (control); A<sub>a</sub>, kaolin (aluminum silicate: H<sub>4</sub>Al<sub>2</sub>Si<sub>2</sub>O<sub>10</sub>(OH)<sub>2</sub>) @ 7%; A<sub>a</sub>, alar (B<sub>2</sub>C<sub>H</sub>_<sub>6</sub>N<sub>4</sub>O<sub>2</sub>) @ 0.001%; and A<sub>a</sub>, potassium sulphate (K<sub>2</sub>SO<sub>4</sub>) @ 4% in subplots. The sunflower hybrid (‘MSFH 8’) crop (seed presoaked in water for 8 hr) was sown on 18 February 1999 and 24 February 2000 by dibbling at 30 cm interval in rows 60 cm apart. The crop was harvested on 13 and 19 June 1999 and 2000, respectively, during 2 crop seasons. The crop was fertilized with uniform dose of 50 kg P<sub>2</sub>O<sub>5</sub>/ha through single superphosphate. Half of the N (50 kg/ha as urea) was applied at the time of sowing and remaining half (50 kg/ha) was top-dressed after first irrigation (30 DAS). A buffer channel of 0.5 m width was provided on all sides of the main plot. Measured volume of water was applied using Parshall flume of 8.0 cm throat. Post-sowing irrigations (each of 6.0 cm depth) to sunflower were scheduled on critical stages as per treatment.

**RESULTS AND DISCUSSION**

**Biometric character**

The growth of sunflower measured in terms of plant height, stem girth, leaf-area index (LAI) and biomass accumulation at maturity stage varied significantly under varying irrigational treatments (Table 1). Irrigated sunflower crop recorded significantly taller and stout plant with more LAI in comparison to no-post sowing—control (I<sub>o</sub>). With the increase in irrigation from 1 in I<sub>o</sub> to 4 in I<sub>4</sub> resulted increase in values(s) of various growth parameters; maximum being recorded with I<sub>4</sub>. Better growth under frequent irrigated conditions might be attributed to adequate soil moisture supply, the sunflower crop had, in comparison to crop with less frequent irrigation. Adequate water supply causes hydration of the protoplasm associated with gain in turgidity. The expansion of cells and cell division are enhanced, resulting in an increase in stem elongation, leaf area and weight of leaves, stems and reproductive parts. Prabhudeva et al. (1998) also observed improvement in overall growth of sunflower with adequate moisture supply.

In general, application of antitranspirants marginally improved the growth parameters. Kaolin (A<sub>a</sub>) spray recorded better results, while no-antitranspirant treatment (A<sub>n</sub>) recorded the lowest values for all the growth parameters. Favourable effect of kaolin spray on plant growth might be attributed to reduction in transpirational loss of water due to reflection of part of solar radiation incident on leaf surface, thus, making the soil moisture available for better over a longer period. The beneficial effect of kaolin spray is in conformity with the finding of Malik (1994).

**Seed yield and its attributes**

The pooled seed yield with 4 irrigations, one each at

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Biometric parameter</th>
<th>Yield attribute</th>
<th>Seed yield (q/ha)</th>
<th>CU (mm)</th>
<th>WUE (kg/ha-mm)</th>
<th>Leaf water potential (MPa)</th>
<th>Transpiration rate (m mol H&lt;sub&gt;2&lt;/sub&gt;O/m&lt;sup&gt;2&lt;/sup&gt;/sec)</th>
<th>Average net return (Rs/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I&lt;sub&gt;o&lt;/sub&gt;</td>
<td>105.74</td>
<td>9.70</td>
<td>0.612</td>
<td>69.47</td>
<td>416</td>
<td>15.49</td>
<td>43.59</td>
<td>5.45</td>
</tr>
<tr>
<td>I&lt;sub&gt;1&lt;/sub&gt;</td>
<td>146.86</td>
<td>15.90</td>
<td>1.286</td>
<td>122.77</td>
<td>611</td>
<td>25.48</td>
<td>44.51</td>
<td>10.62</td>
</tr>
<tr>
<td>I&lt;sub&gt;2&lt;/sub&gt;</td>
<td>149.34</td>
<td>16.27</td>
<td>1.375</td>
<td>131.61</td>
<td>717</td>
<td>30.52</td>
<td>45.36</td>
<td>14.32</td>
</tr>
<tr>
<td>I&lt;sub&gt;3&lt;/sub&gt;</td>
<td>151.55</td>
<td>16.46</td>
<td>1.425</td>
<td>140.91</td>
<td>801</td>
<td>36.51</td>
<td>45.92</td>
<td>17.24</td>
</tr>
<tr>
<td>I&lt;sub&gt;4&lt;/sub&gt;</td>
<td>153.10</td>
<td>16.61</td>
<td>1.454</td>
<td>148.45</td>
<td>881</td>
<td>41.06</td>
<td>46.55</td>
<td>19.71</td>
</tr>
</tbody>
</table>

LAI, Leaf-area index; CU, cumulative water use; WUE, water-use efficiency
seedling, buttoning, flowering and seed-developing stage was recorded significantly highest (19.71 q/ha) and each successive decrease in number of irrigation resulted in significantly reduction in it. No-post-sown irrigation resulted in significantly lowest pooled seed yield (5.45 q/ha). The seed yields were 12.53, 27.35, 46.12 and 72.35% less under I_1, I_2, I_3 and I_4, respectively, than I_0 treatment. Seed yield attributes (seeds/capitulum, seed yield/plant and 100-seed weight) also showed the similar trend in results with seed yield. The better results in respect of yield and yield attributes under frequently irrigated conditions might be due to the positive impact of biometric components. These results confirm the findings of Raj et al. (1999).

The spray of antitranspirants could not exert any significant effect on seed yield and its attributes. Non-significant variations in seed yield and yield attributes might be due to insufficient improvement of internal plant water status after antitranspirant spray.

Water-use

The cumulative water use (CU), water-use efficiency (WUE), leaf water potential and transpiration rate (Table 1) increased markedly with the increase in number of irrigations from non-irrigations in I_0 to 4 irrigations at seedling, buttoning, flowering and seed developing stage in I_4. The values of CU, WUE, leaf water potential and transpiration rate at I_4, respectively, were 193.7 mm, 2.77 kg/ha-mm, -1.268 MPa and 3.07 m mol H_2O/m^2/second while the respective values increased to 370.0 mm, 5.32 kg/ha-mm, -0.957 MPa and 4.71 m mol H_2O/m^2/second. In general, the better growth and higher yield of sunflower due to increase in number of irrigation might be attributed to the higher CU resulting in better soil-plant water relationship.

Various antitranspirant treatments, however, did not cause marked variation in respect of different water-use parameters for sunflower crop.

Economics

Economics of different irrigational treatments showed the maximum net profit (Rs 8,031/ha) with the 4 irrigations (I_4) treatment applied at seedling, buttoning, flowering and seed-developing stage (Table 1). The minimum net profit was, however, recorded with no irrigation control (I_0). The higher net return with higher irrigational treatment is owing to more seed yield harvested in comparison to expenditure incurred on irrigation treatment.

For antitranspirational treatment, maximum net return (Rs 5,718/ha) was recorded with no antitranspirant control (A_0) followed by potassium sulphate (A_1) spray (Rs 3,715/ha). The maximum net return obtained without any antitranspirant spray is might be due to the lesser beneficial effect of antitranspirant in comparison to the cost of spray.

REFERENCES