SUMMER GROUNDNUT CROP PERFORMANCE AND ECONOMICS UNDER DRIP IRRIGATION AT VARIOUS WATER APPLICATION LEVELS

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Abstract— The field experiments were conducted for consecutive three years to assess the crop performance and economics of drip system for groundnut (GG-2) during summer season (Feb. to May). Total Six treatments having different water application levels based on IW/CPE like 0.6, 0.7, 0.8, 0.9, 1.0 and 1.2 were selected. The lowest pod yield of 1917 kg/ha and highest pod yield of 2927 kg/ha could be obtained at the IW/CPE of 0.6 and 0.9 respectively requiring 502 and 757 ha.mm/ha of irrigation water respectively. The treatment of IW/CPE of 0.8 was found statistically better one having the highest water use efficiency of 4.148 kg/ha/mm. The IW/CPE of 0.8 was found most economical water application level. Also, in case of excess water supply (IW/CPE=1.2) and deficit water conditions (0.6), the drip was not that profitable.

I. INTRODUCTION

During the summer season, there is a higher yield potential of groundnut in Saurashtra and Kutch region of Gujarat State. However, the biggest constraint is the limited water resources. One of the critical challenges to water resources management is to shift from the extensive supply oriented approach to the one focusing upon deficit applications. There are several ways of increasing efficiency in irrigation. One way is changing from surface to pressurized methods of irrigation and second is to apply deficit water. The extent to second is to apply deficit irrigation is to increase the water use efficiency of a crop by eliminating irrigations that have little impact of yield. The resulting yield reduction may be small compared with the benefits gained through diverting the saved water to irrigate additional area or other crops for which water would normally be insufficient under traditional practices. Before implementing a deficit irrigation programme, it is necessary to know crop yield responses to water applications.

II. MATERIAL AND METHODOLOGY

Field Experiment : The experiment was carried out at Junagadh Agricultural University campus farm, Junagadh, Gujarat, India to assess the groundnut crop performance under drip irrigation system at various water application levels during summer season (Feb to May) for consecutive 3 years. The GG-2 variety of groundnut crop recommended for this area was selected. The row spacing, seed and fertilizer rate were kept as 0.45m, 100 kg/ha and 25:50:00 (N:P:K) kg/ha as per agronomic recommendations for this region. Total Six treatments having different water application levels (IW/CPE of 0.6, 0.7, 0.8, 0.9, 1.0 and 1.2) were replicated 4 times.

The water meters were used to measure the volume of water applications. For the drip irrigation system drip line of 16mm was fitted at 0.9m distances so that one drip line can serve two rows of the crops. The inlet of the drip line was fitted with sub main by the 16mm grommet take off. The other end of the drip line was closed by the end plug of 16mm. The operating pressure was 1 kg/cm². The length of the drip line was varied to match the plot size of the replication.

Economics : The cost of cultivation excluding cost of irrigation (Cᵢ) included cost of various inputs like cost towards land preparation, seeds, seed treatment, fertilizer, sowing, agro chemicals, weeding, inter cultivating, harvesting, threshing, cleaning and packing etc. The cost of seeds, fertilizer and agro chemicals were taken following the recommended package of agronomic practices. The
cost of irrigation (C_i) includes the cost of labor, electricity and maintenance required for the irrigation application. The fixed cost (C_t) included the cost of pumping/delivery and irrigation system. It was assumed that the 7.5 HP pumping system can serve 6 ha area (4 ha/season, 2 season/year) for 15 years. Also, it was assumed that the irrigation system could be useful for 2 seasons per year. The following expressions were used for assessing the economics.

\[ C_t = C_c + C_i \]

\[ B/C = NB/C_t \]

in which, \( C_c = C_t = C_i \)

\[ \frac{P_i}{2} \times \left[ \frac{1}{2} \times \left( 1 + \frac{1}{2} \right)^{M-1} + \frac{P_i}{2} \times \left( 1 + \frac{1}{2} \right)^{M-1} \right] \]

Where,

- \( C_t \) = Total Cost of cultivation (Rs./season/ha);
- \( C_c \) = Cost of cultivation excluding cost of irrigation (Rs./ha/season);
- \( C_i \) = Cost of irrigation (Rs./ha/season);
- \( P_i \) = Variable cost of irrigation water application (Rs./ha/season);
- \( P_t \) = Cost of pumping and delivery system, Rs/
- \( M \) = Life of the pumping system, years;
- \( N \) = Life of the irrigation system, years;
- \( I \) = prevailing rate of interest, fraction.

### III. RESULTS AND DISCUSSION

#### A. Crop Performance:

**Pod Yield**: The data as presented in Table-1 indicated that, during the first year, the highest yield of 2855 kg/ha was under treatment of MST_4(0.9) using seasonal water of 791 mm. The treatments MST_4(0.9), MST_4(1.0) and MST_4(1.2) were statistically at par. However, during the second year, the highest pod yield of 3082 kg/ha was observed in the treatment having IW/CPE of 0.9. The lowest pod yield of 2327 kg/ha was found in the MST_4(0.6) treatment requiring seasonal water application of 472 ha.mm/ha. The first and second highest treatments MST_4(0.9) and MST_4(0.7) and MST_4(0.8) treatments. During the third year of experimentation, significant differences in the pod yields were found among the treatments having IW/CPE of 0.6, 0.7 and 0.8. However, the treatments having IW/CPE of 0.8 and 0.9 were found statistically at par.

#### Fodder Yield: The pooled data of three years (Table-1) showed that fodder yield was increased with increase in the water application level from IW/CPE of 0.6 to 1.2. The yield under the IW/CPE of 0.6, 0.7, 0.8 and 0.9 differed significantly. However, the difference between the fodder yield under IW/CPE of 0.9 and 1.0 as well as 1.0 and 1.2 were insignificant. It could be seen in Figure-2 that the fodder productions increased with increases in irrigation water inputs. However, the rate of increase was low at higher water application levels indicating the lower water use efficiency. The maximum fodder yield of 6640 kg/ha having the optimal water inputs of 1011 mm.

### TABLE I

<table>
<thead>
<tr>
<th>IWCPE</th>
<th>First year</th>
<th>Second year</th>
<th>Third year</th>
<th>Pooled</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total water Applied (mm)</td>
<td>Pod Yield (Kg/ha)</td>
<td>Fodder Yield (Kg/ha)</td>
<td>Total water Applied (mm)</td>
</tr>
<tr>
<td>0.6</td>
<td>527</td>
<td>1459</td>
<td>3580</td>
<td>472</td>
</tr>
<tr>
<td>0.7</td>
<td>625</td>
<td>1908</td>
<td>4252</td>
<td>556</td>
</tr>
<tr>
<td>0.8</td>
<td>703</td>
<td>2551</td>
<td>5300</td>
<td>639</td>
</tr>
<tr>
<td>0.9</td>
<td>791</td>
<td>2855</td>
<td>5646</td>
<td>722</td>
</tr>
<tr>
<td>1.0</td>
<td>878</td>
<td>2774</td>
<td>6444</td>
<td>806</td>
</tr>
<tr>
<td>1.2</td>
<td>1054</td>
<td>2547</td>
<td>6999</td>
<td>972</td>
</tr>
<tr>
<td>SEM</td>
<td>-</td>
<td>79.4</td>
<td>110.5</td>
<td>-</td>
</tr>
<tr>
<td>CD</td>
<td>-</td>
<td>226.4</td>
<td>315.0</td>
<td>-</td>
</tr>
</tbody>
</table>

The 3 years pooled data showed that the significant differences were observed among the pod yields data of treatments having IW/CPE of 0.6, 0.7 and 0.8. The treatments having IW/CPE of 0.8 and 0.9 were found statistically at par. The IW/CPE of 0.9 was taken as statistically better one. It was found that the pod yield was decreased for the IW/CPE higher that 0.9. The pod yield increased with decreasing rate from the IW/CPE of 0.6 to 0.9. The observed pod yields at various seasonal irrigation depths are presented. It could be seen that the slope of the curve just before it attained peak was utilized more efficiently in deficit water applications as compared to higher water applications. The optimal water requirements were founds as 757 mm giving maximized pod yield of 2927 kg/ha.
B. Crop Response Models:

The knowledge of crop yield response to water inputs is highly desirable to make sound irrigation management decisions. The following crop response models could be developed using the observed data for this region.

### Table 2: Cost Benefits (Per Season) of the Cultivation of Summer Groundnut Crop Under Micro Sprinkler Irrigation

<table>
<thead>
<tr>
<th>Treatment (IW/CPE)</th>
<th>Total Cost (Rs./ha)</th>
<th>Gross Income (Rs./ha)</th>
<th>Net Return (Rs./ha)</th>
<th>Total Net Return (With Return of Water Saving)</th>
<th>Additional Cost of System Over Control</th>
<th>Addi. Benefits of System over border</th>
<th>B/C ratio of System Adoption</th>
<th>Internal rate of return (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6</td>
<td>25436</td>
<td>30486</td>
<td>5050</td>
<td>7626</td>
<td>7188</td>
<td>9776</td>
<td>1.36</td>
<td>20%</td>
</tr>
<tr>
<td>0.7</td>
<td>26306</td>
<td>3767</td>
<td>10461</td>
<td>13495</td>
<td>7274</td>
<td>12535</td>
<td>1.72</td>
<td>40%</td>
</tr>
<tr>
<td>0.8</td>
<td>27156</td>
<td>44513</td>
<td>17357</td>
<td>19940</td>
<td>7428</td>
<td>16625</td>
<td>2.24</td>
<td>64%</td>
</tr>
<tr>
<td>0.9</td>
<td>27986</td>
<td>46903</td>
<td>18917</td>
<td>18917</td>
<td>7698</td>
<td>14793</td>
<td>1.92</td>
<td>68%</td>
</tr>
<tr>
<td>1.0</td>
<td>28846</td>
<td>46220</td>
<td>17374</td>
<td>17357</td>
<td>7774</td>
<td>11839</td>
<td>1.52</td>
<td>60%</td>
</tr>
<tr>
<td>1.2</td>
<td>30526</td>
<td>43578</td>
<td>13052</td>
<td>13052</td>
<td>7958</td>
<td>10201</td>
<td>1.28</td>
<td>43%</td>
</tr>
</tbody>
</table>

\[ Y_P = -4690.6 + 14743.0 (I) - 7511.9 (I)^2, (R^2 = 0.97) \] for pod yield

\[ Y_P = -4625.5 + 16.684 (W) - 0.0097 (W)^2, (R^2 = 0.96) \] for pod yield

\[ Y_f = -6049.2 + 20275.0 (I) - 8995.2 (I)^2, (R^2 = 0.99) \] for fodder yield

\[ Y_f = -5953.0 + 22.908 (W) - 0.0116 (W)^2, (R^2 = 0.98) \] for fodder yield

Where, \( Y_P \) and \( Y_f \) = pod and fodder yield respectively, kg/ha, 
\( I = \) IW/CPE level, \( W = \) Seasonal irrigation depth (mm). The high goodness of fit indicated that the observed data were well described by quadratic form. Hexem Heady (1978), Wanjura et al. (2002), Fabiro et al. (2003) and many other had also found the quadratic from the different crops of different regions. The maximized pod yield and respective input were higher than the values found through statistical analysis. The reason was that the individual model gave simply the highest possible yield without considering the possibilities of more reduction in inputs by slightly lowering the yield just near to highest yield. As we increased the irrigation water inputs, the rate of increase of pod yield was very less just before it reached to peak.

### IV. Conclusions

(a) The optimal irrigation scheduling for the summer groundnut under drip should be based on IW/CPE of 0.8.

(b) The highest possible water use efficiency under Drip irrigation for summer groundnut crop can be 4.148 kg/ha.mm in this zone.

(c) The yield response to irrigation water for summer groundnut crop can be described well by quadratic from (d) The highest internal rate of return (IRR) for investments made in growing the summer groundnut using drip was found to be 2.24 at IW/CPE of 0.8 (e) The drip irrigation is not economically viable for deficit and high water application.

### References


