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

H. D. Rank
College of Agricultural Engineering & Technology, Junagadh Agricultural University, Junagadh-362001, Gujarat, India.

ABSTRACT
The field experiments were conducted for consecutive three years to assess the crop performance and economics of micro sprinkler 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 1471 kg/ha and highest pod yield of 2550 kg/ha could be obtained at the IW/CPE of 0.6 and 0.9 respectively requiring 523 and 789 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 3.406 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 micro sprinkler was not that profitable.

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 (Stegman et al., 1980). 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 which these measures are undertaken mainly depends upon the economics of water use. The main objective of deficit irrigation is to increase the water use efficiency of a crop by eliminating irrigations that have little impact on yield (Rank et al., 2003). 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 (English et al., 1990). Before implementing a deficit irrigation programme, it is necessary to know crop yield responses to water applications (Kirda et al., 1999).

MATERIAL AND METHODS
Field Experiment: The experiment was carried out at Junagadh Agricultural University campus farm, Junagadh, Gujarat, India to assess the groundnut crop performance under micro sprinkler system at various water application levels during summer season (Feb. to May) for consecutive 3 years (1998-2000). 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. The lateral of 16mm was connected to submain (63mm PVC pipe) at 4 m interval and the micro sprinklers were fitted on it at 4.05m distances by extension tube. Each replication of the all treatment was having the gross and net plot size of 16m x 8.1m and 4.0 m x 4.05 m respectively. At inlet of each sub main, the pressure gauge was fitted to measure the pressure of the inflow. The operating pressure was kept as 2 kg/cm². The discharge capacity of the micro sprinkler was 160 lph.
open pan evaporimeter was installed at experimental site and daily evaporation data at 8.00 IST were taken. The irrigation frequency and depth were based on the respective IW/CPE ratio.

**Economics** : The cost of cultivation excluding cost of irrigation (C_c) included cost of various inputs like cost towards land preparation, seeds, seed treatment, fertilizer, sowing, agro chemicals, weeding, inter culturing, 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_f) included the cost of pumping / delivery and irrigation system. It was assumed that the 7.5 HP pumping system can serve 6 ha area (3 ha/season, 2 season/year) for 15 years as per USDA(1959). Also, it was assumed that the irrigation system could be useful for 2 seasons per year. The life of the micro sprinkler irrigation system was taken as 10 years (HeWitt et al. 1980). The following expressions were used for assessing the economics.

\[ C_t = C_c + C_i \]
\[ C_i = C_v + C_f \]
\[ C_f = \frac{P_1 \times b \times (1+I)^M}{2 \times 3 \times ((1+I)^M-1)} + \frac{P_2 \times b 	imes (1+I)^M}{2 \times ((1+I)^N-1)} \]
\[ B/C = \frac{NB}{C_t} \text{ or } B/C = \frac{GB}{C_t} \]

**RESULTS AND DISCUSSION**

**Crop Performance**

**Pod Yield** : The data as presented in Table-1 indicated that, during the first year, the highest yield of 2175 kg/ha was under treatment of MST_5(1.0) using seasonal water of 868 mm. The treatments MST_4(0.9), MST_5(1.0) and MST_6(1.2) were statistically at par. However, during the second year, the highest pod yield of 2775 kg/ha was observed in the treatment having IW/CPE of 0.9. The lowest pod yield of 1786 kg/ha was found in the MST_1(0.6) treatment requiring seasonal water application of 510 ha.mm/ha. The first and second highest treatments MST_4(0.9) and MST_3(0.8) were at par. The significant difference were observed among the MST_1(0.6), MST_2(0.7) and MST_3(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.
The 3 years pooled data showed that 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 0.8 was taken as statistically better one. It was found that the pod yield was decreased for the IW/CPE higher than 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 in Figure-1. It could be seen that the slope of the curve just before it attained peak was decreased sharply. It showed that the water was utilized more efficiently in deficit water applications as compared to higher water applications (Stegman et al., 1980). The optimal water requirements were found as 860 mm giving maximized pod yield of 2549 kg/ha using the best fitted curve.

**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 production increased with increase in irrigation water inputs. However, the rate of increase was low at higher water application levels indicating the lower water use efficiency. The best fitted curve gave the maximum fodder yield of 5357 kg/ha having the optimal water inputs of 987 mm.

**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>
<thead>
<tr>
<th>IW/CPE</th>
<th>Year-1998</th>
<th>Year-1999</th>
<th>Year-2000</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>529</td>
<td>846</td>
<td>2147</td>
<td>510</td>
</tr>
<tr>
<td>0.7</td>
<td>620</td>
<td>1183</td>
<td>3063</td>
<td>600</td>
</tr>
<tr>
<td>0.8</td>
<td>708</td>
<td>1748</td>
<td>3824</td>
<td>680</td>
</tr>
<tr>
<td>0.9</td>
<td>803</td>
<td>2168</td>
<td>4479</td>
<td>760</td>
</tr>
<tr>
<td>1.0</td>
<td>868</td>
<td>2175</td>
<td>4811</td>
<td>840</td>
</tr>
<tr>
<td>1.2</td>
<td>1082</td>
<td>2362</td>
<td>4964</td>
<td>1010</td>
</tr>
<tr>
<td>SEM</td>
<td>- 79.44</td>
<td>- 110.5</td>
<td>- 57.34</td>
<td>- 53.01</td>
</tr>
</tbody>
</table>

The 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.
$Y_p = -4690.6 + 14743.0 (I) - 7511.9 (I)^2, (R^2=0.97)$ 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 and Heady (1978), Wanjura et al. (2002), Fabeiro et al. (2003) and many others had also found the quadratic form for 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.

**Economics:** The Table-2 showed that the total cost of cultivation of summer groundnut crop under micro sprinkler irrigation increased with increase in water application levels. The gross income increased from 23545 Rs./ha in IW/CPE of 0.6 to 36644 Rs./ha in IW/CPE of 0.9 and it decreased up to 36644 Rs./ha in IW/CPE of 1.2. The highest benefit cost ratio (gross income to total cost) was found to be 1.69 at IW/CPE of 0.9. It increased from 1.13 in IW/CPE of 0.6 to 1.69 in IW/CPE of 0.9. After that, it decreased for the IW/CPE higher than 0.9. The highest return of 16574 Rs./ha was found at IW/CPE of 0.9. The net return from water saving over base IW/CPE (0.9) were accounted as Rs. 4110, 9725, 16656 and 16574 respectively in the IW/CPE of 0.6, 0.7, 0.8 and 0.9 respectively. The internal rate of return (IRR) of the investment made in the cultivation of summer groundnut crop irrigating by micro sprinkler irrigation increased from 13 per cent at IW/CPE= 0.6 to 69% at IW/CPE= 0.9 and again decreased to 35% at IW/CPE =1.2.

**CONCLUSIONS**

(a) The optimal irrigation scheduling for the summer groundnut under micro sprinkler should be based on IW/CPE of 0.8. (b) The highest possible water use efficiency under micro sprinkler irrigation for summer groundnut crop can be 3.406 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 micro sprinkler was found to be 1.69 at IW/CPE of 0.9. (e) The micro sprinkler irrigation is not economically viable for deficit and high water application.

<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 Cost of Water Saving Control) (Rs./ha)</th>
<th>Additional Benefits of System (Rs./ha)</th>
<th>B/C Ratio of System</th>
<th>Internal rate of return adoption (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6</td>
<td>20823</td>
<td>23545</td>
<td>2722</td>
<td>4110</td>
<td>2575</td>
<td>2835</td>
<td>3.10</td>
</tr>
<tr>
<td>0.7</td>
<td>21951</td>
<td>29549</td>
<td>7598</td>
<td>9725</td>
<td>2919</td>
<td>5317</td>
<td>3.04</td>
</tr>
<tr>
<td>0.8</td>
<td>22947</td>
<td>37687</td>
<td>14740</td>
<td>16656</td>
<td>3219</td>
<td>9799</td>
<td>3.04</td>
</tr>
<tr>
<td>0.9</td>
<td>24015</td>
<td>40589</td>
<td>16574</td>
<td>16574</td>
<td>3727</td>
<td>8479</td>
<td>2.28</td>
</tr>
<tr>
<td>1.0</td>
<td>24963</td>
<td>39631</td>
<td>14668</td>
<td>N.A.</td>
<td>3891</td>
<td>5250</td>
<td>1.35</td>
</tr>
<tr>
<td>1.2</td>
<td>27111</td>
<td>36644</td>
<td>9533</td>
<td>N.A.</td>
<td>4543</td>
<td>3266</td>
<td>0.72</td>
</tr>
</tbody>
</table>

**TABLE 2.** Cost benefits (per season) of the cultivation of summer groundnut crop under micro sprinkler irrigation
REFERENCES


