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# Effect of irrigation and *rhizobium* inoculation on yield, yield attributes and water-use efficiency of summer groundnut (*Arachis hypogaea* L.)

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## ABSTRACT

A field experiment was conducted during summer season of 2003 and 2004 to study the effect of irrigation and *rhizobium* inoculation on yield, yield attributes and water-use efficiency of summer groundnut (*Arachis hypogaea* L.) at the Instructional Farm (New alluvial Zone) of Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal. Irrigation at vegetative and flowering stages was found to perform better with respect to pod yield (2149 kg/ha), yield attributes and water-use efficiency (3.52 kg/ha/mm) than other levels of irrigation. *Rhizobium* inoculation with Jcg-1 strain showed the maximum pod yield which was 11.16 % higher than no inoculation treatment.

***Key words :*** Summer goundnut, Irrigation, *Rhizobium*, Yield, Water-use efficiency

The demand for vegetable oil in the country has been steadily increasing at the rate of more than 4 % per annum, where as the rate of increase in its production is found to be only 2 % per annum. To meet the demand, the production of oilseeds has to be increased by 7 % per annum. Traditionally groundnut is a rainy season crop, but it is grown during summer in high rainfall region of eastern India, but still its average yield is very low (1000 kg/ha). At present, cultivation of groundnut is becoming popular during summer season as a cash crop in Indo-gangetic alluvial zone and there is ample scope of increasing yield to a greater extent by adopting suitable management practices. Hence, the present experiment was conducted with a view to study the response of summer groundnut to irrigation and *rhizobium* inoculation.

## MATERIAL AND METHODS

The present investigation was carried out during summer season of 2003 and 2004 at the Instructional Farm, B.C.K.V., Mohanpur, Nadia, West Bengal. The soil of the experimental site was sandy-clay loam having medium fertility status (0.59 % organic carbon, 0.07 % total N, 26.66 kg available P and 179.29 kg available K /ha respectively) and pH 6.87. The experiment was laid out in split plot design replicated thrice with 4 levels of irrigation [$I_0$- no irrigation, $I_1$- one irrigation at flowering stage (45 days after sowing), $I_2$- two irrigations each at vegetative (28 DAS) and flowering stage (45 DAS) and $I_3$- three irrigations each at vegetative (28 DAS), flowering (45 DAS) and pod development stage (68 DAS)] in the main plot and 3 levels of *rhizobium* inoculation ($S_0$- no inoculation, $S_1$- inoculation with IGR-6 strain and $S_3$- inoculation with Jcg-1 strain) in the sub plot. The variety 'TAG 24' was sown in third week of March with a spacing of 30 cm x 10 cm and grown for 100 days. Plot size was 5 m x 3 m. The crop was fertilized with N, $P_2O_5$ and $K_2O$ @ 20, 60 and 40 kg /ha respectively as basal dressing through urea, single super phosphate and muriate of potash respectively. Enough soil moisture was ensured by a pre sowing irrigation for proper germination. The crop was irrigated at 5 cm depth as per treatment schedule. Seeds of groundnut were inoculated with different strain of *rhizobium* as per the treatment schedule and dried in shed for 30 minutes before sowing. Consumptive use was determined by the soil moisture depletion method and water-use efficiency was calculated on the basis of kernel yield/mm of water use by the groundnut crop.

## RESULTS AND DISCUSSION

### Yield attributes and yield

Yield attributes and yield of groundnut (Table 1) were significantly influenced by the levels of irrigation, except number of kernels/pod. Two irrigation scheduled at vegetative and flowering stages produced higher pod and kernel yield might be due to higher yield attributes. Pod yield and kernel yield under two irrigations were significantly increased by 918 kg/ha (74.60 %) and 646 kg/ha (76.70 %)

**Table 1 Effect of irrigation and *rhizobium* inoculation on yield attributes and yield of groundnut (mean data of 2 years)**

| Treatment | Plant population/ $m^2$ | Yield attributes | | | Pod yield (kg/ha) | % increase over control | Kernel yield (kg/ha) | % increase over control | Oil content (%) | Oil yield (q/ha) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Pods/ plant | No. of kernels/pod | 100-kernel weight (g) | | | | | | |
| Levels of irrigation (I) | | | | | | | | | | |
| $I_0$ | 18.22 | 11.67 | 1.68 | 25.15 | 1231 | - | 842 | - | 44.17 | 3.72 |
| $I_1$ | 18.55 | 14.07 | 1.69 | 27.01 | 1492 | 21.22 | 1005 | 19.31 | 45.18 | 4.54 |
| $I_2$ | 18.89 | 21.08 | 1.79 | 30.33 | 2149 | 74.60 | 1488 | 76.70 | 48.35 | 7.20 |
| $I_3$ | 18.78 | 18.18 | 1.72 | 28.50 | 1959 | 59.14 | 1359 | 61.39 | 47.31 | 6.44 |
| SEm (±) | 0.745 | 0.190 | 0.068 | 0.352 | 47.50 | | 35.90 | | 0.101 | 0.177 |
| CD (P= 0.05) | *NS | 0.658 | NS | 1.220 | 164.4 | | 124.3 | | 0.350 | 0.612 |
| *Rhizobium* inoculation (S) | | | | | | | | | | |
| $S_0$ | 18.33 | 15.22 | 1.62 | 27.09 | 1605 | - | 11.06 | - | 45.82 | 5.11 |
| $S_1$ | 18.76 | 16.50 | 1.70 | 27.80 | 1731 | 7.74 | 11.86 | 7.19 | 46.16 | 5.52 |
| $S_2$ | 18.74 | 17.23 | 1.84 | 28.35 | 1786 | 11.16 | 12.29 | 11.09 | 46.77 | 5.79 |
| SEm (±) | 0.539 | 0.210 | 0.050 | 0.390 | 27.4 | | 17.8 | | 0.133 | 0.088 |
| CD (P=0.05) | NS | 0.630 | 0.151 | NS | 82.3 | | 53.3 | | 0.400 | 0.265 |

*NS, non-significant

**Table 2 Effect of irrigation on consumptive use and water-use efficiency of groundnut (mean data of 2 years)**

| Treatment | Kernel yield (kg/ha) | Consumptive use (mm) | Water-use efficiency (kg/ha/mm) |
|---|---|---|---|
| Levels of irrigation (I) | | | |
| $I_0$ | 842 | 254.45 | 3.31 |
| $I_1$ | 1005 | 302.70 | 3.32 |
| $I_2$ | 1488 | 422.61 | 3.52 |
| $I_3$ | 1359 | 399.27 | 3.40 |

$I_0$- no irrigation; $I_1$- one irrigation at flowering stage (45 DAS); $I_2$- two irrigations each at vegetative (28 DAS) and flowering stage (45 DAS) and $I_3$- three irrigations each at vegetative (28 DAS), flowering (45 DAS) and pod development stage (68 DAS)

respectively over control. Similar positive effect of irrigation with yield attributes and yield was also reported by Tiwari *et al.*(1994). However, kernel yield was statistically at par among three levels of irrigation scheduled at vegetative, flowering and pod development stages of groundnut.

*Rhizobium* inoculation with Jcg-1 strain proved to be superior over IGR-6 strain and are statistically at par in respect of yield attributes and yield of groundnut, except 100-kernel weight (Table 1). Pod as well as kernel yield of groundnut was significantly increased due to *Rhizobium* inoculation with Jcg-1 strain by 181 kg/ha (11.16 %) and 123 kg/ha (11.09 %) respectively over control (no inoculation). Higher pod and kernel yield might be due to the effect of inoculation on nodulation which helped to produce greater yield attributes of groundnut crop as reported by Chen (1989) who observed that inoculation of groundnut seeds with *Rhizobium* strain 1046 increased number of root nodules/plant by 12.86 %, number of pods/plant by 9.1 %, shelling percentage by 2 %, 100-seed weight by 3.1 % and pod yield by 7.9 % over without inoculation.

**Oil content and oil yield**

Irrigation level significantly influenced the oil content and oil yield of groundnut (Table 1). The oil content and oil yield were maximum under two levels of irrigation scheduled at vegetative and flowering stages, followed by three levels of irrigation scheduled at vegetative, flowering and pod development stages. However, in both the cases these two treatments were at par to each other. Better utilization of plant nutrients under optimum soil moisture might be the reason for higher production of oil. Similar observation was also reported by Rao and Singh (1989).

Maximum oil content and oil yield were recorded when groundnut seeds were inoculated with Jcg-1 strain (Table 1). This treatment was significantly superior over IGR-6 strain and no inoculation. Saad and Mohandes (1998) also reported increase in oil content and oil yield due to *rhizobium* inoculation.

**Consumptive use and water-use efficiency**

Irrigation influenced seasonal consumptive use in groundnut. It is the lowest under rainfed condition and increased by the application of irrigation water. Two irrigations at vegetative and flowering stages recorded maximum value of consumptive use (422.61 mm) which was 66.09 % higher than control (Table 2). Irrigation increased the moisture status in the root zone depth of soil resulting in greater loss of moisture through evapotranspiration. Jana *et al.* (1989) also made similar observation.

The water-use efficiency of groundnut under different levels of irrigation were greater over the rainfed groundnut (Table 2). Two irrigations scheduled at vegetative and flowering stages showed the higher water-use efficiency (3.52 kg/ha/mm). Greater water-use efficiency with irrigation was due to higher kernel yield of irrigated groundnut as compared to it's corresponding increase in consumptive use. Similar finding was reported by Desai *et al.* (1985).

The present study indicates that the use of *rhizobium* (Jcg-1) strain for seed inoculation along with two irrigations each at vegetative and flowering stages is found beneficial to improve the productivity as well as water-use efficiency of summer groundnut and economize water utilization during dry period.

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