# Response of cluster bean to irrigation and nitrogen levels under micro sprinkler

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**ABSTRACT :**

A field experiment framed in split plot design was conducted to check response of cluster bean to irrigation and nitrogen levels under micro sprinklerat research farm of All India Co-ordinate Research Project for Dryland Agriculture, Dr. PDKV, Akola during 29 January to 28 May 2015. The experiment comprised of three main treatments of irrigation ($I_1$,$I_2$, $I_3$) and three sub treatments of nitrogen ($T_1$, $T_2$, $T_3$) with four replication. Seasonal water requirement of cluster bean was found to be highest under irrigation level at 1.2 $ET_c$ ($I_3$) followed by $I_2$and $I_1$. It was found lowest under irrigation level at 0.8 $ET_c$ with micro sprinkler irrigation. Amongst the irrigation levels, treatment $I_3$ (1.2 $ET_c$) was found to be significantly superior over treatment $I_2$ (1.0 $ET_c$) and $I_1$ (0.8 $ET_c$) in respect growth and yield of cluster bean. Gross returns and benefit cost ratio were higher in $I_3$ followed by $I_2$ and $I_1$. Nitrogen treatments also significantly influenced the growth and yield parameters. Nitrogen level $T_3$ (30 Kg/ha) recorded significantly highest growth and yield parameters followed by $T_2$ (25 Kg/ha) and $T_1$ (20 Kg/ha). Gross returns and benefit cost ratio were highest in treatment $T_3$ followed by $T_2$ and $T_1$. The total irrigation water applied highest in treatment $I_3$ followed by $I_2$ and $I_1$. Irrigation level at $I_3$ recorded highest water use efficiency.

**Keywords**: Cluster bean, micro sprinkler, nitrogen, water use efficiency, benefit cost ratio.

**Introduction:**

Cluster bean commonly called as guar (*Cyamopsis tetragonoloba* (L.)Taub) is an important legume vegetable crop belongs to family Leguminosae. In India, cluster bean occupies an area of 5152 hectares with a production of 2461 tonnes. India is considered to be the centre of origin for cluster bean. Green cluster bean pod contains moisture 81.0g, carbohydrates 10.8 g, protein 3.2 g, fat 0.4 g, minerals 1.4 g, thiamine 0.09 mg, riboflavin 0.09 mg, vitamin C 47 mg and vitamin A 316 IU per 100 g of pod. It is a drought tolerant and hardy legume hence its cultivation is being concentrated in the arid and semiarid regions of India, Pakistan and South Africa. In India cultivation of cluster bean is concentrated in the north-west regions comprising Haryana, Punjab, Rajasthan, Uttarpradesh, Gujarat and Maharashtra. It is very common and popular vegetable grown by farmers either as rainfed during kharif and irrigated in summer season.

The traditional surface irrigation methods are required to be replaced by modern water saving more yielding irrigation method like sprinkler, micro sprinkler and trickle. Micro-irrigation systems have been proved to be most useful in saving water and increasing crop yields. It is well documented fact that drip/trickle irrigation saves about 35-50% water and increases yield from 15 to 45% over conventional method of irrigation. Similarly, sprinkler irrigation is also reported to save water and increase yield of various crops. Micro sprinkler irrigation system, which combines the advantages of both trickle and

sprinkler irrigation system. It eliminates certain disadvantages of trickle as well as the conventional sprinkler system of irrigation.

The use of micro sprinkler depending upon situation and availability of water. The cost of initial establishment is lower compared to drip system. Further in summer the sprinkling of water helps in reducing the microclimate temperature and increasing the humidity, thereby improving the growth and yield of the crop. The water saved is to the tune of 20 to 30 per cent.

**Material and methods**

The experiment was laid out on the experimental farm of All India Co-ordinate Research Project for Dryland Agriculture, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during summer season of 2015. The topography of the field was fairly uniform and levelled. Average annual precipitation is 760 mm, out of which approximately 86 per cent is received during June to September.

The climate of the area is semi arid, characterized by three distinct seasons; mainly summer being hot and dry from March to May, the warm and rainy monsoon from June to October and winter with mild cold from November to February. The mean annual maximum and minimum temperature are 48.23°C and 22.05°C in summer and 32.88°C and 14.35°C in winter respectively.

**Soil at experimental site**

Physical and chemical analysis was carried out of the composite soil sample to know mechanical and chemical composition of the soil at experimental plot. The Soil samples were randomly collected from different locations of the experiment field before the start of the experiment at the depth of 30 cm with the help of auger. Soil samples were tested in the laboratory of Department of Agricultural Chemistry and Soil Science, Dr. PDKV, Akola.Results of these analyses are presented in Table 1 and Table 2.

**Table 1 Mechanical properties of soil**

| Sr. No. | Particulars | Observations | Analytical method used |
|---|---|---|---|
| 1 | Sand (%) | 14.30 | Buoyococus Hydrometer Method |
| 2 | Silt (%) | 47.55 | |
| 3 | Clay (%) | 38.15 | |
| 4 | Soil texture class | Silty clay loam | |

**Table 2 Chemical properties of soil**

| Sr. No. | Particulars | Observations | Analytical method used |
|---|---|---|---|
| 1 | pH | 8.20 | pH meter using 1:2.5 soil water ratio |
| 2 | EC (dS/m) | 0.60 | Conductivity bridge from 1:2.5 soil water ratio |
| 3 | Available nitrogen (Kg/ha) | 285 | Alkaline potassium permagnate method |

**Water source and its quality**

The existing source of water was water distribution system of university. The water was conveyed to the field through pipe line. Before start of experiment, water was analyzed for its quality to evaluate different parameter. The result are presented in Table 3

**Table 3 Chemical analysis of irrigation water**

| Sr. No. | Particulars | Observations |
|---|---|---|
| 1 | pH | 8.32 |
| 2 | Ec (dS/m) | 1.48 |

**Fertigation**

Fertigation is the application of water soluble solid fertilizers or liquid fertilizers. The factors that govern the fertigation are soil type, crop, method of irrigation used. Water quality, type of fertilizers, economic feasibility etc. The right combination of water and nutrient is the key for higher yield and quality of produce. With the fertigation, nutrient use efficiency can be increased also loss of nutrients to the ground water is reduced. Thus, along with saving of water fertilizer, time, labour and energy can also be saved substantially.

In this experiment we used soluble fertilizer. The treatments of different nitrogen levels were given through fertigation in five equal splits at 15 days interval after sowing.

**Venturi injector**

The operation principle of venturi is to create pressure difference in the pipeline which accelerates the water flow and creates suction effect, which is used by pump to suck the fertilizer solution into the main line.

**Water requirement of cluster bean**

**Irrigation water requirements to bring the soil to field capacity**

$$d = \left(\frac{Mfc - Mbi}{100}\right) \times As \times Ds$$

Where,

d = Net amount of water to be applied during an irrigation, cm

Mfc = Moisture content at field capacity, per cent

Mbi = Moisture content before irrigation, per cent

As = Apperent specific gravity, g/cc

Ds =Depth of effective rootzone, cm

Quantity of water required per plot in litres was calculated by using equation

**Q = d x A**

In which,

Q = Quantity of water required per plot, liters

d = Net amount of water to be applied during an irrigation, mm

A = Area of plot, $m^2$

**Irrigation water requirements for treatments based on irrigation scheduling at 1.2 $ET_c$, 1.0 $ET_c$ and 0.8 $ET_c$**

$$Q = A \times B \times C \times D$$

Where,

Q = Water requirement per plant (lit/plant)

A = $ET_o = E_{pan} \times K_p$

B = Crop coefficient ($K_C$)

C = Canopy factor

D = Area allotted per plant ($m^2$)

$E_{pan}$ = Cumulative evaporation for two days

$K_p$ = Pan coefficient (0.8)

**Estimation of Water Use Efficiency**

Water use efficiency is the ratio of crop yield to the amount of irrigation water applied in the field. It was calculated by using equation

$$Eui = \frac{Y}{WR}$$

Where,

Eui - Water use efficiency, $qha^{-1}cm^{-1}$

Y - Crop yield, q

WR - Water requirement, ha-cm

**Result and discussion:**

**Effect of irrigation levels**

1. Seasonal water requirement of cluster bean was found to be highest (57.45 lit/plant) under irrigation level at 1.2 $ET_c$ ($I_3$) followed by $I_2$ (50.19 lit/plant) and $I_1$ (42.93 lit /plant).It was found lowest under irrigation level at 0.8 ET ($I_1$).
2. Irrigation treatments significantly increase growth parameters like plant height, branches per plant, leaf area index. Treatment $I_3$ (1.2 $ET_c$) recorded maximum value of all the growth parameters followed by treatment $I_2$ (1.0 $ET_c$) and $I_1$ (0.8 $ET_c$).
3. Yield contributing parameters like days to first and days to 50 per cent flowering pod length, cluster per plant, green pod per plant, weight of green pod per plant, green pod yield per plot, green pod yield per hectare were significantly higher with irrigation level at $I_3$ (1.2 $ET_c$) followed by irrigation treatments $I_2$ (1.0 $ET_c$) and $I_1$ (0.8 $ET_c$).
4. Treatment $I_3$ (1.2 $ET_c$) recorded highest water use efficiency (1.98) followed by treatment $I_2$ (1.79) and $I_1$ (1.61).

**Effect of nitrogen levels**

1. Nitrogen treatment $T_3$ (30 Kg/ha) recorded significantly highest value for all the growth parameters like plant height, branches per plant, leaf area index, days to first and days to 50 per cent flowering followed by $T_2$ (25 Kg/ha) and $T_1$ (20 Kg/ha) treatments.
2. Yield parameters like pod length, cluster per plant, green pod per plant, weight of green pod per plant, green pod yield per plot and green pod yield per hectare significantly influenced by various nitrogen treatments. Highest values were recorded by treatment $T_3$ followed by $T_2$ and $T_1$ respectively.
3. Highest water use efficiency was recorded by treatment $T_3$ (1.83) followed by treatment $T_2$ (1.81) and $T_1$ (1.79).

**Table 4 : Crop growth stage wise water requirement of cluster bean**

| Sr. No. | Crop stage | Water applied per plant (lit) | | |
|---|---|---|---|---|
| | | $I_1$ | $I_2$ | $I_3$ |
| 1 | Common irrigation pre sowing | 13.84 | 13.84 | 13.84 |
| 2 | Initial stage | 2.5 | 3.13 | 3.75 |
| 3 | Crop development | 5.17 | 6.46 | 7.75 |
| 4 | Mid stage | 11.56 | 14.45 | 17.34 |
| 5 | Late stage | 9.86 | 12.31 | 14.77 |
| Total (lit/ plant) | | 42.93 | 50.19 | 57.45 |

**Table 5 : Effect of irrigation and nitrogen levels on plant height (cm), branches per plant and leaf area index**

| Treatments | Plant height (cm) | | | Branches per plant | | | Leaf area index | |
|---|---|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS | 60 DAS | 90 DAS |
| **A. Irrigation levels** | | | | | | | | |
| $I_1$ | 10.51 | 39.56 | 78.62 | 4.28 | 12.32 | 15.60 | 0.67 | 0.78 |
| $I_2$ | 12.59 | 41.20 | 80.79 | 5.36 | 14.45 | 17.44 | 0.77 | 0.88 |
| $I_3$ | 14.11 | 43.11 | 82.56 | 6.18 | 16.77 | 18.82 | 0.87 | 0.96 |
| SE(m)± | 0.19 | 0.22 | 0.31 | 0.18 | 0.36 | 0.50 | 0.03 | 0.02 |
| CD at 5% | 0.64 | 0.75 | 1.08 | 0.62 | 1.23 | 1.73 | 0.09 | 0.07 |
| **B. Nitrogen levels** | | | | | | | | |
| $T_1$ | 11.20 | 40.03 | 79.48 | 4.86 | 13.33 | 16.16 | 0.68 | 0.80 |
| $T_2$ | 12.25 | 41.16 | 80.54 | 5.32 | 14.65 | 17.45 | 0.77 | 0.89 |
| $T_3$ | 13.77 | 42.67 | 81.25 | 5.63 | 15.36 | 18.25 | 0.86 | 0.93 |
| SE(m)± | 0.23 | 0.24 | 0.25 | 0.15 | 0.40 | 0.36 | 0.02 | 0.03 |
| CD at 5% | 0.68 | 0.73 | 0.76 | 0.45 | 1.19 | 1.08 | 0.06 | 0.08 |
| **Interaction Effect** | | | | | | | | |
| SE(m)± | 0.40 | 0.42 | 0.44 | 0.26 | 0.69 | 0.63 | 0.04 | 0.05 |
| CD at 5% | 1.18 | 1.26 | 1.31 | NS | NS | NS | NS | NS |
| General Mean | 12.40 | 41.29 | 80.65 | 5.28 | 14.44 | 17.29 | 0.77 | 0.87 |

**Table 6 : Effect of irrigation and nitrogen levels on days to first,days to 50% flowering, cluster per plant, green pod per plant, pod length and weight of green pod per plant**

| Treatments | Days to first Flowering | Days to 50% flowering | Cluster per plant | Green pod per plant | Pod length (cm) | Weight ofgreen pod per plant (gm) |
|---|---|---|---|---|---|---|
| **A. Irrigation levels** | | | | | | |
| $I_1$ | 31.12 | 41.87 | 8.62 | 83.25 | 8.69 | 80.58 |
| $I_2$ | 32.45 | 43.48 | 9.43 | 95.16 | 9.25 | 104.92 |
| $I_3$ | 33.78 | 44.72 | 10.49 | 106.51 | 9.62 | 133.08 |
| SE(m)± | 0.24 | 0.23 | 0.17 | 1.29 | 0.10 | 0.55 |
| CD at 5% | 0.83 | 0.80 | 0.60 | 4.47 | 0.36 | 1.90 |
| **B. Nitrogen levels** | | | | | | |
| $T_1$ | 31.97 | 42.46 | 9.12 | 89.97 | 9.12 | 89.97 |
| $T_2$ | 32.36 | 43.50 | 9.56 | 95.65 | 9.56 | 95.65 |
| $T_3$ | 33.01 | 44.11 | 9.86 | 99.30 | 9.86 | 99.30 |
| SE(m)± | 0.11 | 0.24 | 0.13 | 1.67 | 0.13 | 1.67 |
| CD at 5% | 0.33 | 0.71 | 0.39 | 4.98 | 0.39 | 4.98 |
| **Interaction Effect** | | | | | | |
| SE(m)± | 0.19 | 0.41 | 0.23 | 2.90 | 0.23 | 2.90 |
| CD at 5% | NS | NS | NS | NS | NS | NS |
| General Mean | 32.45 | 43.36 | 9.51 | 94.97 | 9.51 | 94.97 |

**Table 7: Effect of irrigation and nitrogen levels on green pod yield per plot**

| Treatments | Green pod yield per plot (Kg) |
|---|---|
| **A. Irrigation levels** | |
| $I_1$ | 1.93 |
| $I_2$ | 2.52 |
| $I_3$ | 3.19 |
| **B. Nitrogen levels** | |
| $T_1$ | 2.26 |
| $T_2$ | 2.57 |
| $T_3$ | 2.80 |
| General Mean | 2.55 |

**Table 8 : Effect of irrigation and nitrogen levels on green pod yield per hectare**

| Treatments | Green pod yield per hectare (q/ha) |
|---|---|
| **A. Irrigation levels** | |
| $I_1$ | 38.29 |
| $I_2$ | 50.00 |
| $I_3$ | 63.29 |
| SE(m)± | 0.50 |
| CD at 5% | 1.72 |
| **B. Nitrogen levels** | |
| $T_1$ | 48.31 |
| $T_2$ | 50.61 |
| $T_3$ | 52.66 |
| SE(m)± | 0.46 |
| CD at 5% | 1.37 |
| **Interaction Effect** | |
| SE(m)± | 0.80 |

| | |
|---|---|
| CD at 5% | 2.38 |
| General Mean | 50.23 |

**Table 9 : Yield, irrigation water applied and water use efficiency as influenced by different treatments**

| Treatment | Yield of cluster bean (q/ha) | Irrigation water applied (ha-cm) | Water use efficiency (q/ha-cm) |
|---|---|---|---|
| **A. Irrigation levels** | | | |
| $I_1$ | 38.29 | 23.85 | 1.61 |
| $I_2$ | 50.00 | 27.88 | 1.79 |
| $I_3$ | 63.29 | 31.92 | 1.98 |
| **B. Nitrogen levels** | | | |
| $T_1$ | 48.31 | 26.95 | 1.79 |
| $T_2$ | 50.61 | 27.95 | 1.81 |
| $T_3$ | 52.66 | 28.76 | 1.83 |
| GM | 50.53 | 27.89 | 1.80 |

## Conclusions

1. Irrigation level at 1.2 $ET_c$ ($I_3$) recorded significantly higher growth and yield parameters of summer cluster bean over $I_2$ (1.0 $ET_c$) and $I_1$ (0.8 $ET_c$).
2. Nitrogen level of 30 Kg/ha ($T_3$) recorded significantly superior growth and yield parameter of summer cluster bean over $T_2$ (25 Kg/ha) and $T_1$ (20 Kg/ha).
3. The best combination $I_3$ x $T_3$ (1.2 $ET_c$ x 30 Kg N/ha) was observed maximum yield per hectare in summer condition.
4. The observations are based on the results of experiment conducted for only one season and therefore these results are suggestive.

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