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# Drip irrigation system for the vegetable crop sequence of green chilly and cauliflower

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**Abstract**
A study was conducted to evaluate the performance of drip irrigation system for vegetable crop sequence. Three level of drip irrigation *viz* IW/CPE ratio 0.5, 0.75 and 1.0 (low, medium and high) were selected to irrigate the paired row planted crop. Similar planting technique was used for furrow irrigation method. Two years study shows that yield of green chilly (variety Sanour Anal) and cauliflower (variety Pusa Snowball) was significantly higher at low level of drip irrigation as compared to medium, high level of drip irrigation and furrow irrigation method. Low level of drip irrigation resulted in 30 and 38 percent higher yield as compared to furrow irrigation for green chilly and cauliflower, respectively. At the low level of drip irrigation, drip saves 63.3 and 38.5 percent of water for chilly and cauliflower crop, respectively as compared to furrow irrigation. Irrigation Water Use Efficiency was maximum (1021.6 kg/ha-cm) at low level of drip irrigation and minimum (316.56 kg/ha-cm) with furrow irrigation for the whole crop sequence. If one considers the full crop sequence, low level of drip gave 222.7 percent increase in the irrigation water use efficiency, 58.6 percent saving of irrigation water and 33.6 percent increase in crop yield as compared to furrow irrigation.

**Keywords:** Drip irrigation, irrigation water use efficiency, paired row planting, water saving

## Introduction
Water is one of the primary inputs in agricultural production. Efficient and proper utilization of this scarce resource is crucial for increasing agricultural production. This can be achieved by adopting methods having higher water application and distribution efficiencies. The modern method of irrigation *viz*. sprinkler irrigation, drip irrigation and micro-sprinkler irrigation are becoming increasingly popular. There application efficiencies are as high as 90 to 95 percent as compared to conventional surface irrigation methods (Bhagat et.al. 2014) [3].
Studies reported in the literature reveal that with the use of drip, there are substantial saving of water as well as increase in yield. Grimes *et al*. (1972) [6] reported higher yield of tomatoes from drip irrigated plots over furrow irrigated plots. Foster *et al*. (1989) [5] used the low cost, low head drip system on chilly and onion in the dry zone of Sri Lanka and recommended that it will lead to greater water saving and higher yield. Gutal *et al*. (1990) [7] reported the effect of drip irrigated capsicum and wetted the 50% of the cropped area, which gave 28% increase in yield and 63.4% saving of water. Jadhav *et al*. (1990) [8] studied the economic feasibility of drip irrigation system for tomato crop. They reported that there was a saving of 31.5 percent of water by drip and benefit cost ratio was found to be 5.15 whereas it was 2.96 for flood method. Sivakumar *et al*. (2001) [9] have reported that for cauliflower drip irrigation at 0.6 times pan evaporation (Epan) or 0.5 Epan was more economical with a shortest payback period of 0.49 year under paired row planting method. Chawla and Narda (2001) [4] have reported water and fertilizer savings to the extent of 30% and 70% respectively with comparable yield levels under trickle fertigated crop as compared to furrow irrigated crop of potatoes.
The United States Department of Commerce (Annon., 1999) [1] in its comprehensive market assessment of drip irrigation systems in India has reported that under various studies conducted in the country, increase in yield under drip irrigation system ranged as high as 100% in bananas, 40 to 50% in sugarcane, pomegranate, tomato and chilly and around 25% in grapes, cotton and groundnut. In these crops, the irrigation water saving compared to conventional methods ranges from 40 to 70%.

Review of the literature shows that there was no study conducted on vegetable crop sequence using drip irrigation system. Therefore, the present study was conducted to identify the crops which can be grown one after the other with the same set of drip irrigation system to maximize the returns per unit cost of the system.

## Materials and Methods

A field study was conducted at the research farm of the department of Soil and Water Engineering, Dr. Rajendra Prasad Central Agricultural University, Pusa, for two consecutive years for vegetable crop sequence of chilly and cauliflower using drip irrigation method and conventional furrow irrigation method. A built in type of drip irrigation system was used to irrigate the crop. Drip irrigation and conventional furrow irrigation method was used to irrigate the crop. Three level of drip irrigation were selected on the basis of IW/CPE ratios (irrigation water applied/cumulative pan evaporation) 0.5, 0.75 and 1.0 to irrigate the crop. To meet the water requirement of the crop, 10mm depth of water was applied during irrigation and interval between two irrigations depends upon the IW/CPE ratio for different treatment of drip irrigation. Irrigation to conventional furrow plots was provided as per recommended practice of the university (RPCAU, Pusa). The experiment was laid out in Random block design with total 12 plots and each treatment replicated thrice. The size of the each plot was 5.10 m X 2.70 m. Recommended dose of fertilizer was applied as per the package of practices for cultivation of vegetables of the university (RPCAU, Pusa).

Recommended row-to-row spacing was 45 cm and plant to plant spacing was 30 cm for single row planting method for both the crops. Instead of single row, paired row planting technique was used to raise the crop. For paired row planting technique row-to-row spacing was changed, keeping plant to plant spacing same (30 cm) such that number of plants per unit area remains the same.

## Results and Discussion

### Effect of different Irrigation levels

Table 1 shows that different level of irrigation has no effect on average fruit length of chilly. However, dry matter of the chilly plant and its yield varies significantly due to different level of irrigation. Drip irrigated chilly crop at low level of irrigation gave 16.2 and 29.2 percent (Table 2) higher yield as compared to drip with high level of irrigation and furrow irrigation method, respectively. Table 3 shows that cauliflower with drip at low level of irrigation results in the increase in size of head diameter and head weight by 11.3 and 35.4 percent respectively as compared to furrow irrigation method. Table 4 indicates that drip at different level of irrigation gave almost same yield for cauliflower crop. But, drip at low level of irrigation gave 38 percent higher yield of cauliflower as compared to furrow irrigation.

Table 5 shows that total yield from the full crop sequence and total water applied at each level of irrigation. The total yield from the crop sequence at low level and medium level of irrigation was 33.6 and 28 percent higher, respectively as compared to conventional furrow irrigation method.

### Amount of water saved

Table 2 depicts the amount of water applied to the different irrigation treatments for chilly crop. Drip at low level of irrigation results in maximum yield of 219.1 qtls/ha and water used for this treatment was 31.9 cm. At low level of drip irrigation 63.3 percent of water was saved as compared to conventional furrow irrigation method. Table 4 shows that yield of cauliflower remains almost same for different level of drip irrigation.

Drip at low level of irrigation gave maximum yield of 235.5 qtls/ha, whereas furrow irrigation method yield 170.7 qtls/ha. Drip at low level of irrigation saves 38.5 percent of irrigation water as compared to furrow irrigation. The total water applied to the whole crop sequence and total yield has been presented in the Table 5. The maximum yield from the full crop sequence was 454.6 qtls/ha for low level of drip irrigation, which is 33.6 percent higher as compared to furrow irrigation method. Total water saved at low level of irrigation was 58.6 percent as compared to furrow irrigation method.

### Irrigation water use efficiency

Table 2 depicts the irrigation water use efficiency (IWUE) for chilly at different level of irrigation. The maximum IWUE was at low level of drip irrigation and minimum at conventional furrow irrigation method. IWUE at low level of drip irrigation was 95.1 and 252.3 percent higher as compared to high level of drip irrigation and conventional furrow irrigation method, respectively. Similarly, IWUE for Cauliflower at low level of drip irrigation was 39.7 and 124.4 percent higher (Table 4) as compared to high level of drip irrigation and conventional furrow irrigation method, respectively. The overall IWUE of the whole crop sequence has been presented in Table 5. IWUE at low level of drip irrigation was 222.7 and 73.2 percent higher as compared to conventional furrow irrigation and drip at high level of irrigation, respectively.

### Economic analysis

To calculate the net return from the whole crop sequence the cost of different inputs and outputs were taken from department of Agricultural Economics, RPCAU, Pusa. These values were used for calculating the net income from each crop and then from the whole crop sequence.

Table 6 depicts the cost of different components for the cauliflower and chilly, net return from each crop and from the whole crop sequence. Table 6 shows that net seasonal income from cauliflower was Rs.27,654 and Rs.14,723 per hectare for drip and conventional furrow irrigation method, respectively. Similarly, for chilly net seasonal income was Rs.250,31 and Rs.20,695 per hectare for drip and conventional furrow irrigation method, respectively. The whole crop sequence of cauliflower-chilly gave benefit ratio of 1.62:1 for drip irrigation as compared to 1.56:1 for conventional furrow irrigation. The net increase in income by drip irrigation method was 40 percent more as compared to conventional furrow irrigation method.

**Table 1:** Effect of different irrigation treatments on chilly plant height, dry matter accumulation and average fruit length

| Method of irrigation | When to irrigate (IW/CPE ratio) | Final plant height (cm) | Dry matter accumulation gm/plant | Average fruit length (cm) |
|---|---|---|---|---|
| Drip | 0.50 | 82.9 | 92.2 | 4.47 |
| | 0.75 | 79.8 | 70.8 | 4.38 |
| | 1.00 | 80.2 | 84.5 | 4.36 |
| Furrow | as rec. by RPCAU | 79.3 | 81.7 | 4.26 |

**Table 2:** Yield and irrigation water use efficiency (IWUE) of chilly influenced by different levels of irrigation

| Method of irrigation | When to irrigate (IW/CPE ratio) | Yield (qtls/ha) | Irrigation water applied (cm) | IWUE (kg/ha-cm) |
|---|---|---|---|---|
| Drip | 0.50 | 219.10 | 31.90 | 686.83 |
| | 0.75 | 201.10 | 42.80 | 469.85 |
| | 1.00 | 188.50 | 53.80 | 350.37 |
| Furrow | as rec. by RPCAU | 169.60 | 87.00 | 194.94 |

**Table 3:** Head diameter and head weight of cauliflower for different level of irrigations

| Method of irrigation | When to irrigate (IW/CPE ratio) | Head diameter (cm) | Head weight (gm) |
|---|---|---|---|
| Drip | 0.50 | 22.70 | 272.50 |
| | 0.75 | 21.30 | 265.20 |
| | 1.00 | 21.30 | 250.80 |
| Furrow | as rec. by RPCAU | 20.40 | 201.2 |

**Table 4:** Depth of irrigation water applied and yield of cauliflower for different irrigation treatments

| Method of irrigation | When to irrigate (IW/CPE ratio) | Yield (qtls/ha) | Irrigation water applied (cm) | IWUE (kg/ha-cm) |
|---|---|---|---|---|
| Drip | 0.50 | 235.50 | 12.60 | 1869.00 |
| | 0.75 | 235.00 | 14.90 | 1577.18 |
| | 1.00 | 230.00 | 17.20 | 1337.20 |
| Furrow | as rec. by RPCAU | 170.70 | 20.50 | 832.70 |

**Table 5:** Total yield from the crop sequence (chilly and cauliflower) and depth of water applied to different irrigation treatments

| Method of irrigation | When to irrigate (IW/CPE ratio) | Yield (qtls/ha) | Irrigation water applied (cm) | IWUE (kg/ha-cm) |
|---|---|---|---|---|
| Drip | 0.50 | 454.60 | 44.50 | 1021.57 |
| | 0.75 | 436.10 | 57.70 | 755.80 |
| | 1.00 | 418.80 | 71.00 | 589.85 |
| Furrow | as rec. by RPCAU | 340.30 | 107.50 | 316.56 |

**Table 6:** Net return from Cauliflower–Green chilly crop sequence under drip and conventional furrow irrigation method

| Sr. No. | Different Components taken | Cost (Rs) | |
|---|---|---|---|
| | | Drip | Conventional |
| | **Cauliflower** | | |
| 1 | Seasonal total cost | 66546 | 53557 |
| 2 | Yield of produce (qtls) | 235.5 | 170.7 |
| 3 | Selling price (Rs/qtl) | 400 | 400 |
| 4 | Income from produce (2 x 3) | 94200 | 68280 |
| 5 | Net seasonal income (5 - 1) | 27654 | 14723 |
| | **Green Chilly** | | |
| 1 | Seasonal total cost | 51654 | 38665 |
| 2 | Yield of produce (qtls) | 219.1 | 169.6 |
| 3 | Selling price (Rs/qtl) | 350 | 350 |
| 4 | Income from produce (2 x 3) | 76685 | 59360 |
| 5 | Net seasonal income (5 - 1) | 25031 | 20695 |

## Conclusions

1. Drip at low level of irrigation gave 30 to 40 percent more yield of cauliflower and chilly as compared to furrow irrigation method.
2. At low level of drip irrigation 33.6 percent higher yield was achieved as compared to furrow irrigation method for the whole crop sequence.
3. Drip at low level of irrigation saves 58.6 percent of irrigation water as compared to conventional furrow irrigation method.
4. In spite of higher cost of drip irrigation system the whole crop sequence of cauliflower and chilly gave higher benefit-cost ratio for drip as compared to furrow irrigation method.

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