

# Study of Varied Drip Irrigation and Fertigation Regimes on Curd Yield and Water Productivity of Cauliflower

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## Authors' contributions

This work was carried out in collaboration among all authors. Authors MLP, MUD and VR designed the work. Author GS executed the work and performed the statistical analysis under the chairmanship of author MLP. Author MLP drafted the manuscript. Authors MUD and VR monitored regularly the experiment and corrected the draft. All authors read and approved the final manuscript.

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## ABSTRACT

An experiment on cauliflower was carried out at Water Technology Centre, Rajendranagar, Hyderabad, Telangana during *rabi* 2019-2020. Experiment was laid out in split plot design with nine treatments consists of three drip irrigation levels (0.6, 0.8 and 1.0 Epan) as main plots and three NK fertigation levels (Control, 40:50 and 80:100 kg N and K<sub>2</sub>O ha<sup>-1</sup>) as subplots. The results revealed that drip irrigation at 1.0 Epan recorded significantly higher curd yield (18.7 t ha<sup>-1</sup>) followed by 0.8 Epan (17.1 t ha<sup>-1</sup>) and lower curd yield (15 t ha<sup>-1</sup>) was obtained at 0.6 Epan. Fertigation at 80:100 kg N - K<sub>2</sub>O ha<sup>-1</sup> recorded significantly higher curd yield (23.8 t ha<sup>-1</sup>) than 40:50 kg N - K<sub>2</sub>O ha<sup>-1</sup> (19.7 t ha<sup>-1</sup>) and lower curd yield (7.2 t ha<sup>-1</sup>) was obtained in control treatment. Higher water productivity (9 kg m<sup>-3</sup>) of cauliflower recorded at lower drip irrigation regime of 0.6 Epan than 0.8 (8 kg m<sup>-3</sup>) and lower water productivity (7.2 kg m<sup>-3</sup>) recorded at higher drip irrigation regime of 1.0 Epan. It was recommended that scheduling of drip irrigation at 1.0 Epan and fertigation scheduled at 80:100 kg N - K<sub>2</sub>O ha<sup>-1</sup> to obtain higher curd yield where as high water productivity was observed in drip irrigation regime of 0.6 Epan.

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## 1. INTRODUCTION

Cauliflower is an important vegetable crop belongs to the Brassicaceae family. It is rich source for proteins, carbohydrates, minerals and vitamins and classified as 'Super Food' as it improves the human health due to presence of high antioxidants, poly phenols, phyto chemicals, dietary fiber and low fat content.

India is the second largest producer of cauliflower (0.45 M ha) in the world after china (0.52 M ha). In India, it is cultivated largely in West Bengal, Bihar and Madhya Pradesh. In Telangana, it is widely cultivated in per urban areas [1]. The cauliflower is grown in diverse climatic conditions like temperate, subtropics and tropical regions. It grows in wide range of soils which are fertile and having good water regime. In light soil, the plants are most sensitive to drought and therefore, adequate moisture supply is important.

Irrigation and nutrients are key inputs for obtaining higher yield. Economic use of these inputs is necessary as they are limited in nature and becoming costlier day by day. Sensible application of water and fertiliser are the need of the hour to enhance their use efficiency on sustainable basis.

Drip irrigation is an efficient method and judicious utilization of irrigation water through frequent irrigation with the volume of applied water approximating the consumptive use of plants thereby minimizing conveyance, deep percolation and application losses. Irrigation scheduling is crucial for proper irrigation management. Irrigation scheduling is the process to determine the timing and quantity of water to be applied to the crops. This helps in obtaining more crop per drop [2].

Conventional method of blanket fertiliser application goes waste due to leaching, evaporation and fixation in the soil. Further fertilizers get transmitted to area beyond the active root zone and are no longer useful to the plants. The effective utilization by the plant is in many cases less than 50% of the fertilizers applied [3]. Fertigation is a technique of applying water soluble fertilizers through drip irrigation, where both water and fertilizers are applied at a low rate to the vicinity of plant root zone directly in available forms to match crop nutritional

requirement at different growth stages. It resulted into higher and better quality of crops at lower fertilizer dose. Fertigation reduced 25% of fertilizers unlike in the traditional methods, where nutrients are lost in different ways [4].

Previous workers reported higher water productivity and curd yield in cauliflower under different drip irrigation regimes. Different irrigation levels (40, 60 and 80 % of CPE) of surface drip irrigation were studied in cauliflower by Khodke and Patil, 2012 at Parbhani Maharashtra in a sandy loam soil and observed that 80 % CPE recorded significantly higher curd yield than 60 % and 40 % CPE. Popale et al. [5] tested different irrigation schedules (0.4, 0.6 and 0.8 CPE) in cauliflower at Parbhani Maharashtra and found that irrigation scheduled at 0.4 CPE registered higher water productivity ( $9.2 \text{ kg m}^{-3}$ ) than 0.6 CPE ( $7.4 \text{ kg m}^{-3}$ ) and 0.8 CPE ( $5.8 \text{ kg m}^{-3}$ ). In Telangana, meagre information is available on cauliflower under drip irrigation. Keeping in view of the above present experiment on cauliflower was conducted with an objective to study the effect of different drip irrigation regimes and fertigation levels on curd yield and water productivity.

## 2. MATERIALS AND METHODS

The experiment was carried out at Water Technology Centre, College Farm, College of Agriculture, Professor Jayashankar Telangana State Agricultural University (PJ TSAU), Rajendranagar, Hyderabad, Telangana during *rabi* 2019-2020. The experiment was laid out in split plot design with nine treatments consists of three drip irrigation levels ( $I_1$ -0.6 Epan,  $I_2$ -0.8 Epan and  $I_3$ - 1.0 Epan) as main plot treatments and three fertigation treatments ( $F_1$ -Control i.e.0:0 kg N and  $K_2O \text{ ha}^{-1}$ ,  $F_2$ - 40:50 kg N -  $K_2O \text{ ha}^{-1}$  and  $F_3$ -80:100 kg N -  $K_2O \text{ ha}^{-1}$ ) as sub plots. The experimental soil was sandy loam with a pH of 7.7 and EC of  $0.27 \text{ dS m}^{-1}$ . The soil fertility status was low in organic carbon (0.22 %), medium in available nitrogen ( $326.4 \text{ kg ha}^{-1}$ ), high in available phosphorus ( $77.83 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1}$ ) and potassium ( $429.9 \text{ kg K}_2\text{O ha}^{-1}$ ). A common dose of  $80 \text{ kg P}_2\text{O}_5 \text{ ha}^{-1}$  through SSP was applied as basal dose in all the treatments and N and  $K_2O$  applied as fertigation once in four days. 25 days old seedlings were transplanted at  $50/40 \text{ cm} \times 45 \text{ cm}$  in paired row method. Irrigation scheduling was done based on daily evaporation data recorded from observatory of Agro

Climatological Research Centre, ARI Farm, Rajendranagar, Hyderabad. The cumulative daily evaporation during crop growth period was 238 mm. The total water used by the crop was 165.8, 212.6 and 259.2 mm in 0.6, 0.8 and 1.0 Epan treatments. Weed, pest and disease management was done as per the recommendations of the university.

In the present experiment, data was recorded on yield attributes viz., curd diameter (cm), curd depth (cm), curd volume ( $\text{cm}^3$ ), and curd yield ( $\text{t ha}^{-1}$ ), irrigation water applied and water productivity. The collected data was statistically analyzed by analysis of variance (ANOVA) for split plot design [6]. Op stat software used for analysis. Whenever the treatment differences were found significant, critical differences were worked out at five per cent probability level in LSD. Treatment differences that were non-significant were denoted by NS and the results were critically interpreted with proper justification with relevant literature.

### 3. RESULTS AND DISCUSSION

#### 3.1 Curd Diameter (cm)

Curd diameter was significantly influenced by both drip irrigation and different drip NK fertigation levels. Interaction was found non significant (Table 1). Drip irrigation given at 1.0 Epan recorded significantly higher curd diameter (12.4 cm) than 0.6 Epan (10.3 cm) and on par with 0.8 Epan (11.7 cm). Drip irrigation at 0.8 Epan recorded significantly higher curd diameter than 0.6 Epan. This could be due to the optimum moisture in the surroundings of root zone all over the crop growth period enhances the vegetative growth of the crop thereby increase the photosynthesis and efficient translocation of photosynthates towards the reproductive organ development. Such an effect was responsible for significant improvement in curd diameter. These results were in conformity with the observations of Sohail et al. [7] and Shams and Farag [8].

Curd diameter was significantly increased with every increment in NK fertigation level from control to 40:50 and 80:100 kg N -  $\text{K}_2\text{O ha}^{-1}$ . Drip fertigation at 80:100 kg N -  $\text{K}_2\text{O ha}^{-1}$  recorded significantly higher curd diameter (14.1 cm) than 40:50 kg N -  $\text{K}_2\text{O ha}^{-1}$  (11.8 cm) and control (8.6 cm). It might be due to complete solubility, mobilization and availability of nutrients at regular

short interval in required quantity due to drip fertigation resulted into higher nutrient uptake by curds may lead to higher curd diameter. These results were similar with the observations of Ghadhavi et al. [9].

#### 3.1.1 Curd depth (cm)

Curd depth was significantly influenced by both drip irrigation and different drip NK fertigation levels. Interaction was found non significant (Table 1). Drip irrigation given at 1.0 Epan recorded significantly higher curd depth (5.7 cm) than 0.6 Epan (5.0 cm) and on par with 0.8 Epan (5.5 cm). Drip irrigation given at 0.8 Epan registered significantly higher curd depth than 0.6 Epan. This could be attributed to availability of ample soil moisture with higher uptake of nutrients led to enhanced photosynthetic area, cell metabolism and cell enlargement resulted into better partitioning of dry matter produced and finally induced the increased curd depth. These results were in conformity with the observations of Shams and Farag, [8].

Curd depth was significantly increased with every increment in NK fertigation level from control to 40:50 and 80:100 kg N -  $\text{K}_2\text{O ha}^{-1}$ . Drip fertigation at 80:100 kg N -  $\text{K}_2\text{O ha}^{-1}$  recorded significantly higher curd depth (6.7 cm) than 40:50 kg N -  $\text{K}_2\text{O ha}^{-1}$  (5.7 cm) and control (3.5 cm). It might be due to complete solubility, mobilization and availability of nutrients in the root zone at regular short interval in required quantity due to drip fertigation which contributed to the improvement of yield and yield related attributes. Optimum levels of potassium will maintain a favourable osmotic balance and thus can result in cell expansion and increase in curd depth. These results were in line with the observations of Kishor [10].

#### 3.1.2 Curd volume ( $\text{cm}^3$ )

Curd volume was significantly influenced by both drip irrigation and different drip NK fertigation levels. Interaction was found non significant (Table 1). Drip irrigation level at 1.0 Epan recorded significantly higher curd volume ( $548.7 \text{ cm}^3$ ) than 0.6 Epan ( $410.6 \text{ cm}^3$ ) and on par with 0.8 Epan ( $492.8 \text{ cm}^3$ ). Curd volume was significantly higher in drip irrigation regime at 0.8 Epan than 0.6 Epan. Mitigating the water deficit to the level of pan evaporation demand through drip irrigation improved the availability of applied water through the establishment of relatively

moist condition in the root zone and also increased the availability of nutrients throughout the crop growth period, which enhance the vegetative growth of the crop thereby increase in the photosynthesis and efficient translocation of photosynthates towards the reproductive organ i.e., curd. Such an effect was responsible for significant improvement in curd volume. These results were in conformity with the observations of Yanglem and Tumbare [11].

Curd volume was significantly increased with every increment in NK fertigation level from control to 40:50 and 80:100 kg N - K<sub>2</sub>O ha<sup>-1</sup>. Drip fertigation at 80:100 kg N - K<sub>2</sub>O ha<sup>-1</sup> recorded significantly higher curd volume (875 cm<sup>3</sup>) than 40:50 kg N - K<sub>2</sub>O ha<sup>-1</sup> (403.2 cm<sup>3</sup>) and control (173.9 cm<sup>3</sup>). It might be due to complete solubility, mobilization and availability of nutrients at regular short interval in required quantity due to drip fertigation. Drip fertigation at higher doses enhances photosynthesis and higher photosynthates translocated to reproductive organs which ultimately increased curd volume. These results were similar with the observations of Kishor [10] and Yanglem and Tumbare [11].

### 3.1.3 Curd yield (t ha<sup>-1</sup>)

Curd yield was significantly influenced by both drip irrigation and different drip NK fertigation levels. Interaction was found non significant (Table 1). Curd yield was significantly higher in drip irrigation regime at 1.0 Epan (18.7 t ha<sup>-1</sup>) than 0.8 Epan (17.1 t ha<sup>-1</sup>) and 0.6 Epan (15.0 t ha<sup>-1</sup>). Curd yield at 0.8 Epan was significantly higher than 0.6 Epan. This might be due to the optimum moisture in the vicinity of root zone throughout the crop growth period enhanced the vegetative growth of the crop thereby increase in the photosynthesis and efficient translocation of photosynthates towards the reproductive organ i.e., curd, which increased the curd diameter, depth, volume and curd weight plant<sup>-1</sup> finally resulted into increased curd yield of cauliflower. Similar findings are reported by Khodke and Patil [12], Popale et al. [5], Biswal [13].

Every increment level in NK fertigation from control to 40:50 and 80:100 kg N - K<sub>2</sub>O ha<sup>-1</sup> significantly increased the curd yield. Drip

fertigation at 80:100 kg N - K<sub>2</sub>O ha<sup>-1</sup> recorded significantly higher curd yield (23.8 t ha<sup>-1</sup>) than 40:50 kg N - K<sub>2</sub>O ha<sup>-1</sup> (19.7 t ha<sup>-1</sup>) and control (7.2 t ha<sup>-1</sup>). Curd yield is a cumulative effect of yield attributes like curd diameter, depth, volume and curd weight plant<sup>-1</sup>. Curd yield increased gradually with increase in 80:100 kg N - K<sub>2</sub>O ha<sup>-1</sup>. This might be due to the continuous supply of nutrients in the root zone of the crop through drip fertigation, which created favourable conditions for growth and development by way of increasing metabolic activities in the plant system. These results are in harmony with the findings of Popale et al. [5], Kapoor and Sandal [14], Ghadhavi et al. [9] and Kumar and Sahu [15].

### 3.2 Irrigation Water Applied (mm)

Irrigation water was applied separately for each treatment based on Epan indicated that the quantity of water increased as Epan ratio increased from 0.6 to 1.0 Epan. The quantity of irrigation water applied including special operations (water applied at nursery and transplanting) at different drip irrigation levels of 0.6, 0.8 and 1.0 Epan was 160.8, 207.6 and 254.2 mm respectively (Table 2).

### 3.3 Water Productivity (kg m<sup>-3</sup>)

Different drip irrigation levels and drip NK fertigation levels significantly influenced the water productivity. Interaction was found non significant (Table 2). Water productivity was significantly higher in drip irrigation scheduled at 0.6 Epan (9.0 kg m<sup>-3</sup>) than 0.8 Epan (8.0 kg m<sup>-3</sup>) and 1.0 Epan (7.2 kg m<sup>-3</sup>). Drip irrigation at 0.8 Epan recorded significantly higher water productivity than 1.0 Epan. Though the curd yield was higher in drip irrigation scheduled at 1.0 Epan recorded significantly lower water productivity. The water productivity decreased gradually with the increase in irrigation level. Similar findings reported by Sohail et al. [7], Popale et al. [5] and Kapoor and Sandal [14].

Water productivity increased significantly with every increment in drip NK fertigation level from control to 80:100 kg N - K<sub>2</sub>O ha<sup>-1</sup>. Water productivity was significantly higher at 80:100 kg N - K<sub>2</sub>O ha<sup>-1</sup> (11.4 kg m<sup>-3</sup>) than 40:50 kg N - K<sub>2</sub>O ha<sup>-1</sup> (9.3 kg m<sup>-3</sup>) and control (3.5 kg m<sup>-3</sup>).

**Table 1. Influence of different drip irrigation and NK fertigation regimes on yield attributes and curd yield of cauliflower during rabi 2019-20**

Treatments	Curd diameter (cm)	Curd depth (cm)	Curd volume (cm <sup>3</sup> )	Curd yield (t ha <sup>-1</sup> )
<b>Drip irrigation regimes</b>				
I <sub>1</sub> : Irrigation at 0.6 Epan	10.3	5.0	410.6	15.0
I <sub>2</sub> : Irrigation at 0.8 Epan	11.7	5.5	492.8	17.1
I <sub>3</sub> : Irrigation at 1.0 Epan	12.4	5.7	548.7	18.7
SEm ±	0.2	0.1	18.1	0.2
C.D (P=0.05)	0.8	0.4	72.9	0.8
<b>Fertigation doses</b>				
F <sub>1</sub> :Control (0:0 kg N - K <sub>2</sub> O ha <sup>-1</sup> )	8.6	3.5	173.9	7.2
F <sub>2</sub> : 40:50 kg N - K <sub>2</sub> O ha <sup>-1</sup>	11.8	5.7	403.2	19.7
F <sub>3</sub> : 80:100 kg N - K <sub>2</sub> O ha <sup>-1</sup>	14.1	6.7	875.0	23.8
SEm ±	0.3	0.1	12.9	0.6
C.D (P=0.05)	1.1	0.4	40.7	2.0
<b>Fertigation at same level of irrigation</b>				
SEm ±	0.3	0.2	31.3	0.4
C.D (P=0.05)	NS	NS	NS	NS
<b>Irrigation at same or different fertigation levels</b>				
SEm ±	0.5	0.2	25.7	1.0
C.D (P=0.05)	NS	NS	NS	NS

**Table 2. Total water consumed and water productivity (kg m<sup>-3</sup>) of cauliflower as influenced by varied drip irrigation and fertigation regimes**

Treatments	Total water consumption (mm)	Total water consumption (m <sup>3</sup> )	Curd yield (t ha <sup>-1</sup> )	Water productivity (kg m <sup>-3</sup> )
<b>Irrigation Regimes</b>				
I <sub>1</sub> : Drip irrigation at 0.6 Epan	165.8	1658	15.0	9.0
I <sub>2</sub> : Drip irrigation at 0.8 Epan	212.6	2126	17.1	8.0
I <sub>3</sub> : Drip irrigation at 1.0 Epan	259.2	2592	18.7	7.2
SEm ±	-	-	0.2	0.1
C.D (P=0.05)	-	-	0.8	0.4
<b>Fertigation doses</b>				
F <sub>1</sub> :Control (0:0 kg N - K <sub>2</sub> O ha <sup>-1</sup> )	212.5	2125	7.2	3.5
F <sub>2</sub> : 40:50 kg N - K <sub>2</sub> O ha <sup>-1</sup>	212.5	2125	19.7	9.3
F <sub>3</sub> : 80:100 kg N - K <sub>2</sub> O ha <sup>-1</sup>	212.5	2125	23.8	11.4
SEm ±	-	-	0.6	0.3
C.D (P=0.05)	-	-	2.0	0.9
<b>Fertigation at same level of irrigation</b>				
SEm ±	-	-	0.4	0.2
C.D (P=0.05)	-	-	NS	NS
<b>Irrigation at same or different fertigation levels</b>				
SEm ±	-	-	1.0	0.4
C.D (P=0.05)	-	-	NS	NS

#### 4. CONCLUSION

Cauliflower crop grown during rabi season under drip irrigation in sandy loam soils of Southern Telangana Zone, application of 1.0 Epan irrigation and 80 kg N, 100 kg K<sub>2</sub>O ha<sup>-1</sup> by fertigation is recommended for maximization of yield. Water productivity was higher in irrigation scheduled at 0.6 Epan. In semi arid climatic

conditions drip irrigation with fertigation is the need of the hour for sustainable yields and quality.

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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