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Response of cauliflower to irrigation schedules and fertilizer levels under drip irrigation

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Abstract : The present investigation was conducted during *Rabi* season of December 2008 to March 2009 at the farm of Irrigation and Drainage Engineering, Marathwada Agricultural University, Parbhani. The experimental design was split plot with drip irrigation schedules as main treatments and fertigation levels as sub treatments. The treatments were also compared with control. (Conventional application of water and fertilizer).The gross as well as net plot size was 4.8m x 3.6m and 4.2m x 3.0m, respectively. The plant to plant and row to row spacing was 60cm x 60cm. Drip Irrigation schedules comprised of I_1 (0.4 CPE), I_2 (0.6 CPE), I_3 (0.8 CPE) and fertigation levels included F_1 (50 per cent RDF), F_2 (75% RDF) and F_3 (100 %RDF). The control I_4 was furrow irrigation scheduled at 1.2 IW/CPW with 60 mm depth of irrigation. Thus ten treatment combinations were studied with three replications.The drip irrigation (I_1, I_2 and I_3) was scheduled at an alternate day as desired by the treatments and depending on pan evaporation. For control (I_4) furrow irrigation was 60 mm depth of water was applied when CPE reached to 60 mm (IW/CPW ratio of 1.2). The fertilizer dose of N: P: K (120:60:60 kg/ha) was considered for the irrigated cauliflower. The fertilizers were applied in splits through irrigation water in drip irrigated plots through venturi while in surface irrigated plots whereas they were conventionally applied in soil by ring placement. Combination fertilizer of grade of 19:19:19, MOP, SSP and urea were used as source. The study revealed that percentage of average water saving under drip irrigation system over surface irrigation was 43.45 per cent and it was 75.54 per cent, 63.87 per cent and 50.95 per cent under I_1, I_2 and I_3 irrigation schedules, respectively. The mean water use efficiencies under surface irrigation and irrigation schedules were 22.03 kg/ha-mm and 73.48 kg/ha-mm, respectively. Under drip irrigation system, higher water use efficiency was recorded at I_1 (92.67 kg/ha-mm), I_2 (73.88kg/ha-mm) and I_1 (58.57kg/ha-mm).

Key words : Cauliflower, Fertilizer, Drip irrigation

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Water and nutrient are the basic need of any crop. Cauliflower one of the most important vegetable crops, requires the ample quantity of water and fertilizer than other crops. Nevertheless water scarcity and high input cost of fertilizer are the major constraints in increasing the area, production and productivity of cauliflower crop. In order to get rid of these constraints irrigation with fertigation through drip is the most suitable option, which can save water and fertilizer in addition to increase in the area along with increasing productivity. Besides that, this method provides many other associated benefits like saving in pesticides and labour. Lot of work has been done on drip irrigation, including yield response and irrigation scheduling. However, the research on scheduling of fertilizer through fertigation and evaluation of drip system performance under fertigation is scanty.

The field experiment entitled response of cauliflower to irrigation schedule and fertilizer levels under drip irrigation was conducted during *Rabi* season of December 2008 to March 2009 at the farm of Irrigation and Drainage Engineering, Marathwada Agricultural University, Parbhani with objectives to assess the growth and yield response of cauliflower to fertilizer level under drip irrigation and compare the impact of irrigation scheduling and fertilizer level on water use efficiency for cauliflower.

METHODOLOGY

Cauliflower is one of the most important vegetable crops

belonging to the genus *Brassica* of the family *Cruciferae*.

Study area:

To meet the objectives of present research project a field experiment was carried out for cauliflower crop in respect of yield, water saving, water use efficiency. The experimental details and methodology used for this study had been described below. The experiment was conducted during the year 2008-2009 in *Rabi* season of AICRP on Water Management, Marathwada Agricultural University, Parbhani. Geographically, Parbhani is situated at 19^0 16' North latitude and 76^0 47' East Longitude with an altitude of 409 m above mean sea level.

Treatment details:

Treatments constituted the combination of three irrigation levels and three fertilizer levels and one control with there three replication in split plot design having crop spacing 60 x 60 cm of recommended fertilizer dose 120:60:60Kg/ha. The details of treatment are

Irrigation treatments:

I_1 – Irrigation of 0.4 PE by drip
I_2 – Irrigation of 0.6 PE by drip
I_3 – Irrigation of 0.8 PE by drip

Fertilizer treatments:

F_1 – 50 per cent RDF (Recommended dose of fertilizer)
F_2 – 75 per cent RDF
F_3 – 100 per cent RDF

Control:

I_4 – Surface irrigation at IW/CPE = 1.2

Other details:

Table A : List of treatment combinations

Treatments	Treatment combinations	Specifications
T_1	I_1F_1	Irrigation at 0.4 PE and 50% RDF
T_2	I_1F_2	Irrigation at 0.4 PE and 75% RDF
T_3	I_1F_3	Irrigation at 0.4 PE and 100% RDF
T_4	I_2F_1	Irrigation at 0.6 PE and 50% RDF
T_5	I_2F_2	Irrigation at 0.6 PE and 75% RDF
T_6	I_2F_3	Irrigation at 0.6 PE and 100% RDF
T_7	I_3F_1	Irrigation at 0.8 PE and 50% RDF
T_8	I_3F_2	Irrigation at 0.8 PE and 75% RDF
T_9	I_3F_3	Irrigation at 0.8 PE and 100% RDF
T_{10}	Control	Conventional surface irrigation with 100% RDF

– Replication : Three
– Statistical design : Split plot design
– Crop : Cauliflower
– Botanical name : *Brassica oleracea* L.
– Variety : Hunsa (Seminis seed)
– Spacing : 60 cm x 60 cm
– Recommended dose fertilizer : 120: 60: 60

Drip irrigation was scheduled at an alternate day. Initially cumulative pan evaporation (CPE) of two days was computed. The depth of irrigation, volume of water to be applied and operating time was calculated by taking into account pan evaporation of two days. The depth of irrigation was calculated as per irrigation schedules.

Fertilizer application:

Liquid fertilizer of grade 19:19:19 was used for the treatments T_1 to T_9 and urea (46.6% N), single super phosphate (16% P_2O_5) and murate of potash (60% K_2O) were used for the control or surface treatments. The recommended dose of fertilizer (RDF) for the cauliflower crop is 120:60:60.

Mahadhan liquid fertilizer of grade 19:19:19 was used for treatments T_1 and T_9. The fertilizer application was started 10 days after transplanting. RDF was divided into 8 splits and was applied at10 days interval. For treatment T_{10} the first dose of fertilizer (60:30:30) was applied at 20 days after transplanting and remaining dose was applied one month after application of 1st dose. The schedule of RDF application during crop growth period is presented in Table B.

Table B : The schedule of RDF application during crop growth

Date	Days after transplanting	N (kg/ha)	P (kg/ha)	K (kg/ha)
25/12/08	10	15	20	10
04/01/09	20	15	--	--
14/01/09	30	15	20	10
24/01/09	40	15	--	--
03/02/09	50	15	10	10
13/02/09	60	15	10	10
23/02/09	70	15	--	10
05/03/09	90	15	--	10
	Total application	120	60	60

Water use efficiency:

The water use efficiency for all treatment was determined from the data on corresponding yield and volume of water applied using the following equation:

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

where,
WUE = Water use efficiency (t/ha-mm)
Y = Yield of crop product (t/ha)
WR = Irrigation water applied (mm)

RESULTS AND DISCUSSION

The field investigation was carried out to compare the growth and yield attributing characteristics, water saving, water use efficiency and effect of fertilizer level on cauliflower under different irrigation schedules. The details of investigation have been discussed below:

Effect of irrigation methods on yield of cauliflower (q/ha):

Table 1 revealed that application of water by drip method recorded numerically higher yield than surface method of irrigation. The yield difference between surface and drip methods was non significant. In drip irrigation for I_1 treatment 75.54 per cent, I_2 63.87 per cent and I_3 50.87 per cent water was saved than surface irrigation (Table 2). Therefore, drip irrigation proved more effective than surface irrigation method. Table 1 also shows that treatment I_3F_3 obtained higher yield than surface irrigation. This treatment also saved 50.87 per cent of irrigation water. Therefore I_3F_3 treatment of drip irrigation was superior over the surface method of irrigation.

Table 1 : Effect of various irrigation levels and fertilizer level on yield of cauliflower (q/ha)

Treatments	Yield of cauliflower (q/ha)
Effect of irrigation method on yield of cauliflower (q/ha)	
Drip	187.07
Surface	157.65
S.E.±	1.28
C.D. (P=0.05)	NS
Effect of drip irrigation against surface irrigation method on yield of cauliflower (q/ha)	
I_1F_1	161.23
I_1F_2	162.00
I_1F_3	166.34
I_2F_1	181.99
I_2F_2	189.34
I_2F_3	202.20
I_3F_1	191.18
I_3F_2	208.90
I_3F_3	220.50
Surface	157.65
S.E.±	1.29
C.D. (P=0.05)	NS
Effect of irrigation levels on yield of cauliflower (q/ha)	
I_1	163.39
I_2	192.17
I_3	206.86
S.E.±	0.79
C.D. (P=0.05)	2.49
Effect of fertilizer levels on mean yield of cauliflower (q/ha)	
F_1	162.28
F_2	192.84
F_3	206.36
S.E.±	3.58
C.D. (P=0.05)	NS

NS=Non-significant

Effect of irrigation levels on yield of cauliflower (q/ha):

Data on effects of different irrigation levels *i.e.* I_1 (0.4 PE), I_2 (0.6 PE) and I_3 (0.8 PE) on yield of cauliflower head were statistically significant. In I_3 (0.8 PE) level more yield was obtained as compared to I_1 (0.4 PE) and I_2 (0.6 PE) levels. That means I_3 was significantly superior over I_1 and I_2 treatments, but I_1 and I_2 treatments were at par to each other.

Effect of fertilizer levels on yield of cauliflower (q/ha):

Effect of different fertilizer levels studied under drip method shows that, the yield obtained in fertilizer level was statistically significant. In F_3 (100% RDF) level more yield was obtained as compared F_1 (50% RDF) and F_2 (75% RDF) levels and that means F_3 was significantly superior over F_1 and F_2 treatments. But F_1 and F_2 treatments were at par to each other.

Water saving:

Date on water application in different treatments during crop period along with water saving and its percentage are presented in Table 2.

Table 2 : Water expense under different irrigation levels

Treatments	Water (ha-mm)		Water saving (%)
	Applied	Saved	
Control I_4 (Surface)	720	--	--
Drip irrigations schedule			
I_1	176.09	543.91	75.54
I_2	260.10	459.90	63.87
I_3	353.13	366.87	50.95

These results show that water applied under surface irrigation methods (I_4) was for higher than drip irrigation system. Among drip irrigation systems water was applied as per irrigation schedules. It was lowest in irrigation schedule I_1 *i.e.* 0.4 PE of water requirement, while it was the highest under irrigation schedule I_3 *i.e.*0.8 PE of water requirement. This data further shows that the percentage of water saving under drip irrigation system over surface irrigation method was 75.54, 63.87 and 50.95 per cent under I_1, I_2 and I_3, respectively.

Water use efficiency:

Data on water use efficiency (kg/ha-mm) of cauliflower crop as influenced by different treatments are presented in Table 3. The mean water use efficiencies under surface irrigation and irrigation schedule were 22.03 kg/ha-mm and

Table 3 : Water use efficiency (kg/ha-mm) of cauliflower crop as influenced by different irrigation levels

Treatments	Yield(q)	Water applied (mm)	Water use efficiency (kg/ha-mm)
Irrigations schedule			
I_1	163.19	176.09	92.67
I_2	192.17	260.10	73.88
I_3	206.86	353.13	58.57
Mean	187.40	263.10	73.48
Control I_4	157.65	720	22.03

73.48 kg/ha mm, respectively. The application of irrigation water through drip irrigation method appreciably improved water use efficiency approximately three times higher than surface irrigation.

It is revealed from the Table 3 that the water use efficiency was found higher in I_1 (92.67kg/ha mm) followed by treatment I_2 (73.88 kg/ha-mm) I_3 (58.57 kg/ha-mm) and minimum in control I_4 (22.03kg/ha-mm).

Conclusion:

Results concluded that irrigation applied at I_3 (0.8 PE) level recorded significantly higher yield than other irrigation levels. Fertilizer applied at F_3 (100% RDF) level recorded significantly higher yield than other fertilizer levels among the treatments, I_3F_3 (0.8PE with 100% RDF) was significantly superior over the all other treatments followed by I_2F_2 in respect of growth parameters throughout the growth period. The I_3F_3 treatment was significantly higher fruit yield than other treatment. Yield of cauliflower crop (variety- Hunsa) under drip was 187.07 q/ha and in surface irrigation it was 157.65q/ha Drip irrigation system recorded higher water use efficiency than surface irrigation method. Studies on reponse of cauliflower to irrigation schedules and fertilizer levels under drip irrigation were also conducted by Popale (2009).

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