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RESEARCH ARTICLE

Yield response and economic feasibility of cauliflower under drip irrigation

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ABSTRACT : The experiment was conducted during the year 2008-09 in *Rabi* season at department of Irrigation and Drainage Engineering, Marathwada Krishi Vidyapeeth, Parbhani.The experimental plot was 3.6 m wide and 4.8 m long. The statistical split plot design was used. The treatments constituted the combination of three irrigation levels and three fertilizer levels with two replication. The climatological approach *i.e.* pan evaporation (PE) is one of the irrigation scheduling criteria. The treatments were a) Main treatmentsI_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, b) Sub treatments F_1 – 50 per cent RDF, F_2 – 75 per cent RDF,F_3 – 100 per cent RDF, c) Control: I_4 – Surface irrigation at IW/CPE = 1.2. Irrigation applied at I_3 (0.8 PE) level recorded significantly higher yield than other irrigation levels. I_3F_3 (0.8PE with 100% RDF) was significantly superior for yield of cauliflower crop (variety- Hunsa) which was 187.07 q/ha for drip irrigation and 157.61q/ha for surface irrigation. Drip irrigation system recorded higher water use efficiency than surface irrigation method. It was also observed that the benefit cost ratio of drip irrigation system (1.88) was higher than surface irrigation method (1.62).

Key words : Cauliflower, Yield, Fertilizer, Drip irrigation, Economics

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INTRODUCTION

The importance of vegetables in human nutrition is well known, vegetable are rich and comparatively cheaper source of vitamin and minerals. Their consumption in sufficient amount provides vitamin, minerals, proteins, carbohydrates and fibers in the diet besides having medicinal value and provides nutritional security. Among the vegetables, cauliflower (*Brassica oreracea* L.) has got more importance and popularity in various parts of the world. It is liked due to its white, tender head or curd formed by the shortened flower parts, which is useful in various ways due to its attractive appearance, good taste and rich nutritive content.Efforts have been made to increase the vegetable production by developing number of high yielding, quality, and disease resistant varieties with higher and better production technologies. There is a need to achieve over a target to meet the requirement of large population of the country. The Indian farmers need to be trained to adopt modern technology in which water management plays a key role.The yield of cauliflower can be increased by adopting improved irrigation, fertilizer and cultural practices. Among improved irrigation and fertigation practices, application of manures and fertilizer through drip irrigation system play an important role to increase the yield of crop. Cost estimation for cultivation of any crop under drip irrigation plays vital role in adoption of drip irrigation. With these considerations in view, the present experiment entitled yield response cauliflower crop under drip irrigation was planned during winter (*Rabi*) season at department of Irrigation and Drainage Engineering Marathwada Krishi Vidyapeeth, Parbhani with objectives to determine appropriate irrigation scheduling for cauliflower under drip irrigation and to study the economic feasibility of drip irrigation system for cauliflower crop.

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EXPERIMENTAL PROCEDURE

The experiment was conducted during the year 2008-2009

in *Rabi* season at Department of Irrigation and Drainage Engineering, Marathwada Krishi Vidyapeeth, Parbhani University. 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. The plot size of each treatment was 4.8 m x 3.6 m. The buffer strip with 1 m was left between three treatment plots and two replications.The climatological approach *i.e.* pan evaporation (PE) is one of the irrigation scheduling criteria. Therefore, the treatments constituted the combination of three irrigation levels and three fertilizer levels. The treatments were a) Main treatmentsI_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,b) Sub treatments F_1 – 50 per cent RDF, F_2 – 75 per cent RDF, F_3 – 100 per cent RDF, c) Control: I_4 – Surface irrigation at IW/CPE = 1.2

The list of treatment combinations is presented in Table A.

Table A : List of treatment details

No.	Treatments	Specification
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.

Other details:

- 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 Fertilizer dose : 120: 60: 60

Surface irrigation treatment:

The surface irrigation method was control treatment for comparison. The surface irrigation was scheduled on the basis of climatological approach. The IW/CPE ratio was 1.2 and depth of irrigation water applied for irrigation was 6 cm. The irrigation water was measured with the help of water meter and constant discharge was maintained throughout the time of application. Time of water application was calculated by considering the discharge through water meter, depth of water to be applied and area to be irrigated.

Drip irrigation:

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.

Volume of water to be applied per plot in drip was calculated by using the equation.

$V = D \times A$

where,

V = Volume of water applied (l)

D = Depth of water to be applied (mm)

A = Area of one plot (m^2)

Operating time for drip unit was calculated with the help of following equation.

$$T = \frac{V}{Q \times Eu \times N}$$

where, T = Operating time of system (hrs)

V = Volume of water to be applied (l)

Q = Emitter discharge (lph)

Eu= Field emission uniformity

N = Number of emitters

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 surface treatments. The recommended dose of fertilizer (RDF) for the cauliflower crop is 120:60:60.

Water use efficiency:

The water use efficiency for all treatments 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)

Cost economics:

Cost economics of the system was worked out by considering the general layout for one hectare. The amount of curd produced based on the average hectare per hectare yield derived from the method with, in the experimental plot. It was assumed that curd that was grown that all produce was sold at market price of 6 Rs/kg. Cost was self divided into fixed cost and variable costs. Fixed costs include cost of all components included in respective drip irrigation system. Variable cost

includes fertilizers, pesticides, seed and labour cost incurred in land preparation, weeding, irrigating etc.

Statistical analysis:

The statistical inferences of significant or non significant result were informed on variance ratio test (f test). The treatment mean were compared by computation of critical different at appropriate error, degrees of freedom and 5 per cent probability. The observations recorded on treatment were tested against variance ratio of split plot design. The comparisons of furrow verses drip irrigation were made on the basis of t test (fraction replication design).

EXPERIMENTAL FINDINGS AND ANALYSIS

The results of the present study as well as relevant discussion have been summarized under following heads:

Weight of head (g):

Data on weight of head of cauliflower as influenced by different irrigation level and fertilizer level are presented in Table 2 and depicted in Fig. 1.

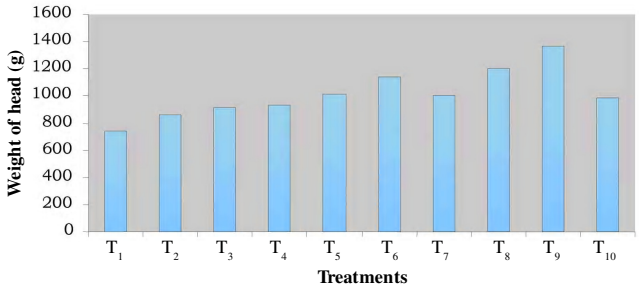

Fig. 1 : Effect of various irrigation levels and fertilizer levels on head weight (g) at harvest

Effect of irrigation methods on weight of head of cauliflower (g):

Data presented in Table 2 reveal that application of water by drip method recorded numerically higher weight head than surface method of irrigation. The head weight difference between surface and drip methods was non significant.

Effect of surface method against drip irrigation treatments on weight of head cauliflower (g) :

From the Table 1, It is clear that the results were significant and I_3F_3 treatments was superior over all the treatments of drip irrigation and surface method of irrigation remaining all other drip irrigation treatments and surface method of irrigation were at par to each other.

Effect of drip irrigation levels on weight of head (g):

Effect of drip irrigation levels on weight of head of cauliflower was statistically significant The treatment I_3 was significantly superior over other levels of irrigation treatments I_1 and I_2 which were at par to each other.

Table 1 : Effect of various irrigation levels and fertilizer level on head weight (g)

Treatments	Head Weight (g)
Effect of irrigation method on head weight (g)	
Drip	1276.66
Surface	987.15
S.E.±	34.90
C.D. (P=0.05)	NS
Effect of drip irrigation against surface irrigation method on head weight (g)	
I_1F_1	740.0
I_1F_2	856.66
I_1F_3	916.60
I_2F_1	933.33
I_2F_2	1016.05
I_2F_3	1136.66
I_3F_1	1003.33
I_3F_2	1203.33
I_3F_3	1368.23
Surface	987.15
S.E.±	18.04
C.D. (P=0.05)	NS
Effect of irrigation levels on head weight	
I_1	901.67
I_2	1042.50
I_3	1254.42
S.E.±	18.04
C.D. (P=0.05)	NS
Effect of fertilizer levels on mean head weight	
F_1	837.70
F_2	1232.20
F_3	1262.25
S.E.±	22.10
C.D. (P=0.05)	69.53

NS=Non-significant

Effect of fertilizer levels on weight of head (g):

Effect of fertilizer levels on weight of head was statistically non significant but average head weight of I_3 was more than I_1 and F_2 treatments.

Interaction effect of (I x F) on weight of head (g):

From Table 2 it is clear that the interaction effect on weight of head was statistically significant. The interaction treatment I_3F_3 was significantly superior over other interaction treatments

Table 2 : Effect of interaction of (I x F) on head weight(cm^2)

Treatments	F_1	F_2	F_3
I_1	740.09	856.62	916.63
I_2	933.30	1016.50	1136.66
I_3	1003.33	1203.3	1363.32
S.E.±	0.47	C.D. (P=0.05)	1.49

remaining all other interaction treatments were at par to each other.

Circumference of curd (cm):

Data on circumference of curd of cauliflower as influenced by different irrigation level and fertilizer level are presented in Table 4. and depicted in Fig. 2.

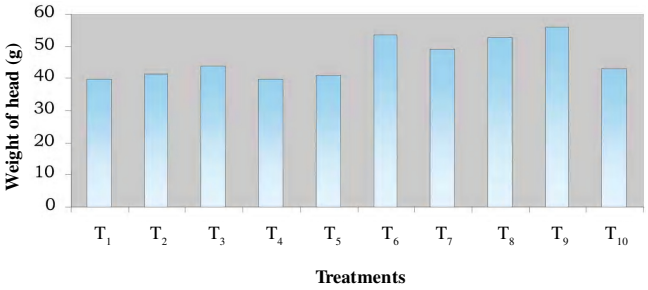

Fig. 2 : Effect of various irrigation levels and fertilizer levels of circumstance of curd at harvest

Data presented in Table 3 reveals that the mean circumference of curd was increased at every stages of crop growth.

Effect of irrigation method on mean circumference of curd (cm):

Effect of irrigation method shows that the mean circumference of curd of plant in all treatments irrigated by drip method was numerically higher as compared to surface irrigation method. These circumference of curd of plant was higher in surface irrigation method than drip method but at every stage of crop growth results were statistically non significant.

Effect of surface method against drip irrigation on circumference of curd(cm)

At all the growth stages, the various irrigation treatments and surface method influenced mean circumference of curd. The mean circumference of curd was higher in I_3F_3 treatment than all other treatments at all the growth stages. Theses results were significant and I_3F_3 treatment was superior over all treatments but remaining treatments were at par to each other.

Effect of irrigation levels on circumference of curd (cm):

All the various irrigation levels influenced the circumference of curd. The circumference of curd was increased with an increase at each irrigation level. Results were statistically significant at I_3 (0.8 PE) treatment. I_3 treatment was significantly superior over other treatments and I_1 and I_2 were at par to each other at each growth stages.

Table 3 : Effect of various irrigation levels and fertilizer levels on circumference of curd (cm)

Treatments	Circumference of curd (cm)
Effect of irrigation method on circumference of curd (cm)	
Drip	46.33
Surface	42.96
S.E.±	0.45
C.D. (P=0.05)	NS
Effect of drip irrigation against surface irrigation method on circumference of curd (cm)	
I_1F_1	39.8
I_1F_2	41.23
I_1F_3	43.82
I_2F_1	39.84
I_2F_2	40.96
I_2F_3	53.36
I_3F_1	49.10
I_3F_2	52.86
I_3F_3	56.07
Surface	42.95
S.E.±	1.53
C.D. (P=0.05)	4.60
Effect of irrigation levels on circumference of curd	
I_1	41.61
I_2	44.72
I_3	52.67
S.E.±	0.05
C.D. (P=0.05)	0.128
Effect of fertilizer levels on mean circumference of curd (cm)	
F_1	42.05
F_2	45.08
F_3	51.62
S.E.±	1.47
C.D. (P=0.05)	0.03

NS=Non-significant

Effect of fertilizer levels on circumference of curd (cm):

All the various irrigation levels influenced the circumference of curd. F_3 (100% RDF) fertilizer treatment result was significant and was superior over F_2 (75% RDF) and F_1 (50% RDF) treatments.

Interaction effect of (I x F) on circumference of curd (cm):

The interaction effect was statistically significant in I_3F_3

treatment. This treatment was significantly superior over other treatments as presented in Table 4.

Table 4 : Effect of interaction of (I x F) on circumference of curd (cm)

Treatments	F_1	F_2	F_3
I_1	39.8	41.23	43.82
I_2	39.84	40.96	53.36
I_3	49.1	52.86	56.07
S.E.±	0.47	C.D. (P=0.05)	0.13

Cost economics :

Table presents the economic analysis of cauliflower crop under drip irrigation and surface irrigation method after one season use. The seasonal cost of cultivation includes expenses incurred on ploughing, seedling, planting, inter cultivation application of fertilizer, plant protection measures and laying of drip irrigation system.

From Table 5, it was observed that the benefit cost ratio of drip irrigation system (1.88) was better than the surface irrigation methods (1.62). The greater long term profitability and reduced labour costs favours the use of drip irrigation system over surface irrigation for small land holders or marginal farmers.

Conclusion:

Irrigation applied at I_3 (0.8 PE) level recorded significantly higher yield than other irrigation levels. I_3F_3 (0.8PE with 100% RDF) was significantly superior for yield of cauliflower crop (variety- Hunsa) under drip which was 187.07 q/ha and in surface irrigation it was 157.61q/ha. Drip irrigation system recorded higher water use efficiency than surface irrigation method. It was also observed that the benefit cost ratio of drip irrigation system (1.88) is higher than surface irrigation method (1.62). Greater long term profitability and reduced labour costs favours the use of drip irrigation system over surface irrigation. Similar studies were conducted by popale (2009) in cauliflower.

Table 5 : Economics analysis of irrigation methods after one season use

Sr. No.	Name of components	Cost (Rs.)	
		Drip irrigation	Surface irrigation
1.	Fixed cost	--	--
	Motor	1,100	1,100
	Main	347.10	347.1
	Sub main	757.50	--
	Lateral (inline)	15876	--
	Control valves	196.80	98.4
	End cap	63.840	--
	GTO	90.720	--
	Screen filter	770.52	--
	Elbow (75mm)	8	--
	Tee (63 mm)	8	--
	Elbow (63 mm)	6.17	--
	Flush valve	25.72	--
2.	Total fixed cost	19,250.67	1,545.5
3.	Variable cost	--	--
	Seedling	19,078	19,078
	Fertilizer and pesticides	5000	5000
	Labour		
	Permanent	10,000	20,000
	Weeding	6,250	12,500
4.	Total variable cost	40,328	56,578
	Yield produce(q/ha)	187.40	157.65
	Sealing price (Rs/Kg.)	6	6
	Income from produce (Rs)	11,6,208	9,5190
	Total cost of cultivation	59578.67	58,123.5
5.	B:C ratio	1.88	1.62

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