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Field evaluation of drip irrigation system for small scale cucumber crop

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ABSTRACT : A commercial drip irrigation system was evaluated for small scale cucumber crop at college of Agricultural Engineering field irrigation laboratory, located at Bapatla, Guntur district, Andhra Pradesh state during February 2013 to April 2013. In the field study, an attempt was made to evaluate the performance of the irrigation system based on the uniformity distribution, wetting pattern, sphericity and root distribution. Emission uniformity was not acceptable range mainly due to clogging of few emitters. However, the statically uniformity and absolute uniformity were within the acceptable limits. It has been revealed that inline emitter used in the study, can wet horizontal distance up to 50 cm from the source, while the depth of wetting increased with the rate of application. The root distribution was observed to be confined mainly to 60 cm sphere and the optimum rate of water application under the prevailing conditions. The average sphericity of cucumber fruit was observed 0.96, which was 3.12% higher than flood irrigated crop.

KEY WORDS : Evaluation, Drip irrigation, Uniformity, Inline emitters

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Water is a precious natural resource, a basic human need and prime national asset. India has 2.4 per cent of land mass and 4 per cent fresh water resource of the world. It is, however, required to support 17% of the world population growing at 2 per cent/annum. Agriculture uses about 70-80 per cent of total available water. So optimum use of these resources is critical intervention at this juncture. Water is recognized as a vital resource for life, human/society development and environmental sustainability. Using water, it is to increase the intensity of cultivation up to 300 per cent or more and large areas of waste lands could be brought under cultivation. This could be achieved by introducing advance systems of irrigation like micro irrigation and other improved water management practices. In micro irrigation, water is applied besides conserving soil at low pressure over a long period of time at frequent intervals directly in to the plant root zone through network of main lines, sub mains and lateral line with emission points spaced along their length. Micro irrigation system save water, increase yields per unit of water, energy, it ensures 30 – 70% per cent saving in water, 25 – 100% increase in yields and 15 - 30 % reduction in operating and crop production costs. Resultantly it could be double the area under micro irrigation as well improve quality of end product. In India drip irrigation was introduced in the early seventies at the Agricultural Universities and other research institutions.

These may be online drip, inline drip, micro tube, pressure compensating, non-pressure compensating and self flushing types. For irrigating widely spaced crops like mango, coconut, banana, grapes and other high value vegetable crops this system is most suitable. Drip irrigation works under low to medium pressures *i.e.* varies from 0.5 to 2 kg/ cm^2. At present most of the vegetables in India are grown using flood methods of irrigation. In these methods major portion of water is lost by evaporation and deep percolation, resulting lower irrigation efficiencies.

Moreover, there is a tendency to apply more water when it is available in large quantities. Due to these reasons, there is a great need to use the micro irrigation systems for growing vegetable crops. By keeping these aspects in view, the experiment was conducted to study the influence of drip irrigation system on cucumber in terms of wetting pattern of cucumber with inline drip irrigation over flood irrigation method, physical dimensions and sphericity, yield, vegetative growth and ultimately water use efficiency. Cucumber gives considerable good income on the part of farming community

during summer season with relatively less farming operations including water requirement if drip system is used.

METHODOLOGY

The experiment was conducted in the Soil and Water Engineering field irrigation laboratory, College of Agricultural Engineering, Bapatla from the second week of February to the second week of April,2013.Geographically Bapatla is located at altitude of 15^0 54^1 N and longitude of 80^0 30^1 E with an altitude of 4.5 m above mean sea level. The experimental site lies in humid sub tropical area. The summers are dry and hot, where as winter is cool. The experimental site consists of sandy soil and well drained soil. The experimental field was divided into two plots of 200 and 100 m^2 area each. The former plot was irrigated by using inline drippers where as the lateral plot was irrigated by flood method or treated control. The plant to plant and row to row spacing for inline drip irrigated plot was 0.4m and 2m whereas for flood irrigated plot was 1m for both plant to plant and row to row.

Water application and irrigation scheduling for different irrigation systems:

Water requirement of crop in inline drip irrigation was obtained by estimating the potential evapotranspiration using modified Penman's method. This method was based on the daily data of maximum and minimum temperature, relative humidity, sunshine hours and wind velocity.

Formula used for calculation of potential evapotranspiration by modified Penman method

$$ET_p = C\,[WRn + (1 - W)\, f(u)\, (e_a - e_d)]$$

where, ET p = Potential evapotranspiration in mm/ day

W = Temperature related weighing factor

R_n = Net radiation in equivalent evaporation mm/ day

f (u) = Wind related function

$(e_a - e_d)$ = Difference between the saturation vapor pressure at mean air

C = Adjustment factor to compensate the effect of day and night weather.

Water requirement of plant in lit/plant/day= ETp x Crop co-efficient x Gross area per plant:

$$\text{Water application rate} = \frac{\text{Dipper discharge (L/hr)}}{\text{Emitter spacing (m) x Lateral spacing (m)}}$$

By taking water application efficiency in micro irrigation as 90% amount of water to be applied to a plant in l / day:

$$= \frac{\text{Water requirement of plant}}{\text{Application efficiency}}$$

Time of application:

$$\text{Inline drip irrigation operating period} = \frac{\text{Amount of water to be applied to a plant}}{\text{Discharge of emitting device}}$$

$$\text{Irrigation time (hours)} = \frac{\text{Volume of available water (L)}}{\text{Dripper discharge rate (L/hour)}}$$

In flood method water was applied to plants at rate of 48 l/min by sprinkling water with plastic pipe which is generally followed by local farmers. The irrigation scheduling is assumed in this system was based on 50% depletion of available soil moisture at response of 0 - 40 cm depth of root zone.

Crop details:

Cucumber (*Cucumis sativus*), is a popular vegetable belongs to the family of Cucurbitacea and called as Kamal Kakdi in Hindi, Dosakaya in Telugu. It is known for its high nutritive value. It is the mostly cultivated vegetable in the world after potato. Cucumber grows under wide agro-climatic conditions. High and low temperature causes poor fruit setting. High temperature with low humidity and dry winds damage the floral parts and resulting into poor yield. It is found to be sustainable up to 35^0C.

Sowing time:

The cucumber is cultivated both as a summer and rainy season crop and the seed is sown according to type of crop. The sowing period for summer crop ranges between January to February where as for rainy season crop in between June to July. For hilly regions it is sown in month of April. The seed rate is 2.5-4 kg/ha and selected plot was 300 m^2 ($20\times10=200m^2$ and $10\times10=100$ m^2), 120g/300 m^2 seed rate required. The seed was sown manually and two to three seeds were sown in each pit. Farm yard manure (FYM) was added at the time of soil preparation. 50 kg/ha per super, 25 kg/ha DAP and 50 kg/ha phosphorus was given at the time of sowing and remaining half amount was given after 30 days of sowing. The irrigation was given daily for both 200 m^2 and 100 m^2 plot with an application rate of 1000 l/day and 800 l/day. Picking of fruits was done at light yellow stage when fruits are fully developed to be disposed of at distant markets.

– For local markets fruits are harvested at green stage when some portion is yellow and fruit is not fully ripe.

– For processing purposes picking be done at ripe or full ripe stage when fruits have developed maximum color and turns soft.

Details of observations:

Wetting pattern:

In determination of wetting pattern, 10 emitter points of cucumber cultivation with known discharge rates were selected randomly. Water was applied continuously at 0.5, 1, 1.5 and 2

litres and same treatments were given to two emitters at a time. From the strickle source, sampling points were marked laterally with 5 cm intervals as 5, 10 and 15 cm, respectively at either side of trickle source. In each point soil samples were taken at depths of 5, 10 and 15 cm using an auger at 6 hr after irrigation. Moisture content was measured by gravimetric method.

Crop management practices:

For improving the growth of plants in sandy soil, 5 kg super and 4 kg of 17 - 17 - 17 fertilizers applied on split dose basis 300m^2 cropped area (Khan *et al.*, 1975) at the stages of 30 and 60 days after seedling. Micro nutrients soluble fertilizer of 20 ml of insta and 20 ml of monikam diluted with 5 litres of water and sprayed over crop surface. First spray was used 30 days after sowing and one more sprays with 30 days. This soluble fertilizer improved crop yields both qualitatively and quantitatively and control flower drop and improved disease resistance to plant.

Plant growth:

For studying the effect of irrigation treatment on crop growth characteristics, 10 days interval of systematic observations from selected plants in each plot were made on the growth of crop. The growth was measured by measuring the length of the crop.

Fruit weight:

To study the effect of irrigation on fruit weight, the number of fruits from each plot were collected and average weight of fruit was measured by using the electrical balance.

Sphericity of fruit:

The sphericity of the fruit was calculated by using vernier callipers with least count of 0.001mm.Sphericity may be defined as the ratio of the diameter of a sphere of the same volume as that of the particle and the diameter of the smallest circumscribing sphere or generally the largest diameter of the particle. This parameter shows the shape character of the particle relative to the sphere having same volume.

where, l =largest intercept,

b =largest intercept perpendicular to l and

t =largest intercept perpendicular to both l and b.

Root length and its distribution:

For studying the response of irrigation treatment on root distribution, trench was made around the selected plants in each plot after completing the crop period. After removing the root system from soil, it was carefully arranged on a graph paper and root distribution was measured.

Water use efficiency:

The term water use efficiency denotes the production per unit of water applied. It is expressed as the weight of crop produce per unit depth of water over a unit area, kg/cm per hectare

$$\text{Water use efficiency} = \frac{Y}{WR}$$

where, Y=Yield of the crop (kg/ha),

WR=Water requirement of the crop (cm).

RESULTS AND DISCUSSION

The experimental findings obtained from the present study have been discussed in following heads:

Vegetative growth parameters of cucumber crop under different irrigation methods:

Wetting pattern:

Table 1 and Fig. 2 show the vertical distribution of water in sandy soil (selected plot is of sandy soil). Water applied for inline drip irrigation method for 1 hour interval was of 4 litres and in flood irrigation method for 1 hour is of 6-8 litres, when compared between these, it is quite obvious water given for flood irrigation was more than inline drip irrigation method but the efficiency of water distribution vertically was (the average wetting pattern for inline drip method and flood methods are 1.08 and 1.24) 0.16 times more in inline drip irrigation than flood irrigation method.

Quality characteristics of the fruit:

Weight of fruit:

The fruit weights of cucumber under different irrigation treatment are presented in Table 2 and the average was found to be 185.33 and 174.64 g in inline drip irrigation and flood irrigation method. The value of the percentage increased in fruit weight of cucumber over flood irrigation method was 5.76 % (Table 2).

The growth of cucumber:

The growth of cucumber crop was measured at every 10 days intervals in both inline drip irrigation and flood irrigation method. The mean growth of cucumber crop at the time of harvesting 60 days after seedling was 100.20 and 95.2 cm in both inline drip irrigation and flood irrigation methods, respectively. The maximum plant growth was observed in inline drip irrigation method because of better lateral distribution (0.40 m) of water in the plant root zone. The percentage increase in plant growth was 5% in inline drip irrigation method over flood irrigation method.

Root zone depth and its distribution:

The maximum lateral length of roots is presented in Plate

Table 1 : Wetting pattern for inline and flood irrigation methods

Sr. No	Depth (cm)	Wt of empty box		Wt of empty box +soil sample		Wt of empty box +soil sample (after oven dry method)		Wetting pattern	
		Inline drip	Flood	Inline drip	flood	Inline drip	flood	Inline drip	flood
1.	5	26.28	22.51	46.28	42.51	44.88	39.98	1.4	2.53
2.	10	23.64	21.90	43.64	41.90	42.70	38.24	0.94	3.66
3.	15	22.45	28.20	42.45	48.20	41.12	46.88	1.33	1.32
4.	20	25.96	19.90	45.96	39.90	43.95	38.83	2.01	1.07
5.	25	22.16	21.02	42.16	41.02	40.78	40.39	1.38	0.63
6.	30	29.72	25.37	49.72	45.37	48.33	45.17	1.39	0.2
7.	35	22.76	22.93	42.76	42.93	42.36	42.33	0.4	0.6
8.	40	26.07	24.01	46.07	44.01	45.58	43.41	0.49	0.6
9.	45	22.54	23.41	42.54	43.41	42.15	42.89	0.39	0.52
				Average				1.08	1.24

1 and lateral length of roots was observed to be 31 cm and 30.5 cm in inline drip and flood methods of irrigation, respectively.

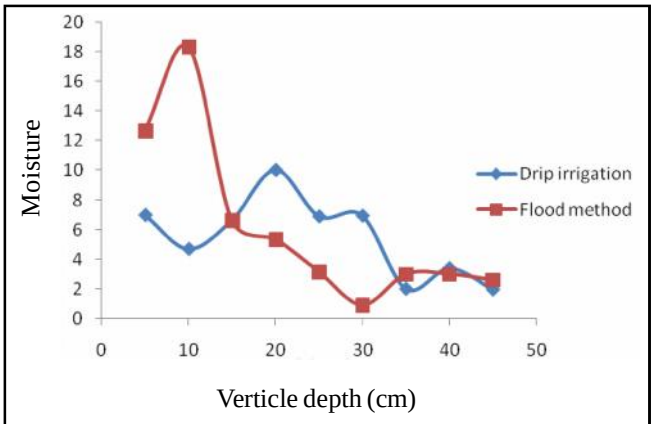

Fig. 1 : Vertical depth vs. moisture content of the soil

Table 2 : Weight of fruit sample (g)

Sr. No	Methods of irrigation	Average fruit weight of cucumber(g)	Percentage increase in fruit weight over flood method
1.	Inline drip	185.33	5.76 %
2.	Flood	174.64	-----

Maximum root population and more number of long roots were observed in inline drip irrigation system because of uniform distribution of moisture in the plant root zone in all directions.

Water use efficiency:

The water utilized by the crop was generally described in terms of water use efficiency. The water use efficiency achieved in different irrigation treatment is presented in Table 4. The total depth of water applied by 300 mm and 240 mm in inline drip irrigation and flood irrigation method, respectively. The depth of water applied in different irrigation methods at different stage of cucumber crop. The percentage of water saving over flood irrigation method was found to be 35.30 %

Table 3 : Growth of cucumber for both drip and traditional method at 10 days interval

Sr. No.	Days after seedling	In line drip irrigation(cm)	Flood method(cm)
1.	10	3.1	2.6
2.	20	28.3	27.7
3.	30	40.5	41.2
4.	40	61.6	62.6
5.	50	90.5	84.4
6.	60	100.20	95.2

Table 4 : Water use efficiency of cucumber crop in different irrigation treatment

Sr. No.	Description	Treatments	
		Inline drop irrigation	Flood irrigation method
1.	Area,m^2	100	100
2.	Plant population	120	150
3.	Irrigation interval, days	daily	Daily
4.	Application rate ,mm/day	5	4
5.	Effective rain fall, mm	-	-
6.	Total depth of irrigation during crop season, mm	300	240
7.	Yield,kg/ha	5.9	5.3
8.	Water use efficiency kg/ha-mm	19.6	22.08

Plate : 1 Root zone of inline drip irrigation and flood irrigation method

in inline drip irrigation method.

Conclusion:

The experiment with cucumber crop was conducted at College of Agricultural Engineering, Bapatla.. Water was applied through inline drip irrigation to the plots on the basis of the water requirement calculated by modified penman method. For flooded plots irrigation was given as per local formers followed. The fertilizers and pesticides were applied according to time and growth of the plants uniformly for control and drip system plots. About 35.3 % of water saved in inline drip over flood method of irrigation. About 10.16 % of higher yields were obtained in inline drip over flood method. The water use efficiency increased in case of inline drip irrigation method than the times the flood method of irrigation systems. Higher vegetative growth was observed in inline drip method than flood method. .Less weed growth was observed in inline drip irrigation system.

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