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Comparative Study of Surface Irrigation and Drip Irrigation for Tomato crop

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Abstract: - Estimating irrigation water requirements accurately is important for water project planning and management also maximum yield per unit water applied should be more efficient use of irrigation water that mean the provision of additional quantities of water to increase the irrigated area with optimum crop production.

A comparative study has been made at Etkhedi and Dhamaniya village, near Bhopal, India which is at Latitude of 23°15'00'N and Longitude of 77°25'00'E for tomato crop considering four irrigation systems. The first is a surface irrigation system (Furrow irrigation) adopted by farmer, the second one is also a surface irrigation but consider irrigation scheduling, third one is drip irrigation system adopted by farmer and fourth one is a drip irrigation system, designed for the same field. The result concluded that water might have been used efficiently under drip irrigation system. When compared with traditional surface irrigation method adopted by farmer and considering irrigation scheduling for tomato crop.

Drip irrigation system demand least quantity of water as well as minimum cost of water as compared to other system. Water saved in designed drip irrigation system in 37.33%, 65.32% and 68.22% with respect to furrow irrigation (farmer's method), irrigation scheduling and drip adopted by farmer respectively.

***Keywords*:-** Drip irrigation system, irrigation scheduling, yield, root zone depth, furrow irrigation, application efficiency.

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1. Introduction

In the paper four different irrigation water application methods have been studied for tomato crop cultivation at Etkhedi and Dhamaniya near Bhopal. The first is the surface irrigation method (furrow irrigation) adopted by farmer. The second one is also a surface irrigation method but it considers irrigation scheduling. The third one is drip irrigation used by farmer and forth one is designed drip for same filed. The irrigation water requirements, cost of water, yield of crop, expenditure, gross and net return, water application efficiency, field water use efficiency, and crop water use efficiency have been calculated, studied and analysed for all the four methods.

The farmer has applied water by furrow irrigation using his long experience. The total volume of water applied by farmer, his cultivation expenses, the actual yield of tomato crop and the return were collected.

The cost of cultivation for surface irrigation system is collected on the basis of data collected from the farmer. It includes cost of ploughing, seeding, planting, weeding, irrigation, manuring, fertilizers, insecticides and harvesting.

Irrigation scheduling is done on assumption that soil water is full at emergence date. Incremental soil water storage is calculated for incremental root growth.

Based on this incremental root growth ant total available soil water, available soil water at time over the root depth D calculated.

Ground water contribution is neglected but effective rainfall considered. Whenever the available soil water at the t over the root zone depth D becomes less than the remaining available water, irrigation is to be applied so that soil water is full. According to the irrigation scheduling, adequate quantity of water is to be applied whenever required. Therefore, the actual evapotranspiration is equal to maximum evapotranspiration resulting in no soil moisture stress during the entire crop seasons. This results in maximum potential yield. The yield is calculated by using the Agro Ecological Zone Method.

The drip irrigation system was designed after determining the infiltration rate by double infiltrometer and selecting the emitter discharge, emitter spacing was determined. The percentage wetted area was determined from the number of emitters per plant, the emitter spacing and plant and row spacing. Net irrigation depth was then determined from the soil moisture holding capacity, root, zone depth and percentage wetted area and desired depletion level.

The application efficiency was assumed at 98% and gross irrigation depth was calculated. The duration of application was determined from gross volume of water to be applied and the application rate.

2. Literature Review

Hartz T.K. (1999) Drip irrigation offers the potential for precise water management and divorces irrigation from the engineering and cultural constraints that complicate furrow and sprinkler irrigation. It also provides the ideal vehicle to deliver nutrients in a timely and efficient manner. There are two basic approaches to scheduling drip irrigation: soil-moisture-based scheduling and a water-budget-based approach that estimates crop evapotranspiration.

K. K. Shashidhara Et Al. (2003) The study was conducted among areca nut and banana growers of Shimoga and Davanagere districts of Karnataka. The results revealed that majority of drip irrigation farmers had expressed the advantages like saving of water (95.55%), saving in labours cost for irrigation (92.22%) and uniform application of water (91.11%). Drip irrigation had shown increased yield in are cannot and banana to the extent of 5.94 and 3.54 per cent, respectively as compared to surface irrigation. Similarly, the returns were increases to the extent of 5.92 and 3.54 per cent, respectively. Drip irrigation had resulted in higher B:C ratio (1:3.36) as compared to surface irrigation (1:2.81).

Sengar S.H. and Khothari S. (2008) The main objective of their study to economic evaluation of greenhouse for the cultivation of rose nursery. Greenhouse is an effective solution to nursery grower who would be able to recover his investment on greenhouse within a period of 2.2 years. Suitability of the economics of greenhouse, four economic indicators such as net present worth, internal rate of return, benefit cost ratio and pay back period were calculated for rose nursery.

Bahirat J.B. and Jadav H.G. (2011) This study was conducted for Per hectare human labours required for rose garden were 1914. Per hectare input utilization was 1.90 lakh. It was observed that, per hectare cost of harvesting and packaging is highest. It is because of labour requirement and cost of transportation. Per hectare cost of cultivation of rose was worked out to Rs.2,94,791. Among the various items of cost, maximum cost was incurred on family labours (30.41%), followed by rental value (21.50%). Cultivation of rose was profitable at all the levels of cost. Per hectare yield of rose was 2,24,166. The gross value received was Rs. 380242. Benefit: cost ratio was 1:1.29

Martínez and Reca (2014) proposed study on water use efficiency of surface drip irrigation versus an alternative subsurface drip irrigation method. Recently, an alternative subsurface irrigation method that is able can keep away from most of the aforementioned drawbacks has been introduced in southern Spain. The goal of this work is to assess the performance of this method and to compare it to a surface drip-irrigation system. To accomplish this goal, a three-year field experiment was carried out in an organic olive orchard (Olea europaea L.) located in the province of Almería, Spain. The water-use efficiency of both irrigation methods was analyzed under three different irrigation water supplies. The results show that the alternative subsurface irrigation method seems to perform better than the drip irrigation one because the yield and the irrigation water use efficiency were higher for the first one.

3. Proposed Work

The data has been collected from the farmers, using surface irrigation and drip irrigation, from Etkhedi village, Bhopal. Cost of cultivation has been

calculated using the information collected, for both the above methods.

Table 1 Information Collected from the Farmers Using Surface Irrigation Method or Farmer Method

S. No	Information	Detail
1	Village	Etkhedi
2	Taluka and District	Bhopal
3	Latitude	23°16ˈN
4	Longitude	77°36ˈE
5	Altitude	527m
6	Climate	Humid subtropical
7	Mean temperature	23°C
8	Land area	1Acre
9	Crop	Tomato
10	Method of application of water	Border
11	Source of water	Well
12	Date of plantation	03 Nov 2015
13	Date of last harvesting	21 April 2016
14	Crop period	170 days
15	Spacing of plant	0.4572 m
16	Spacing of row	1.06m
17	Total pumping hours	360 hr
18	Charge of pumping	60/ hr
19	Flow rate of irrigation	15 l/sec
20	Number of plant	8000
21	Yield of plant	3.75 kg
22	Yield of crop	30000kg
23	Gross return	Rs.300000
24	Net return	Rs.209600
25	Net return per acre	Rs.209600

Table 2.Cost of Cultivation by Surface Irrigation Method or Farmer Method

S. No	Item	Expenditure in Rupees
1	Ploughing	3000
2	Seeding	2800
3	Planting	5000
4	Weeding	3000
5	Earthing up	5000
6	Irrigation cost	15000
7	Traching +Labour	30000
8	Manuring, Fertilizer, Insecticide	20000
	Total cost of cultivation	**83800**

Table 3 Information Collected from the Farmers Using Drip Irrigation Method

S. No	Information	Detail
1	Village	Dhamaniya
2	Taluka and District	Bhopal
3	Latitude	23°16ˈN
4	Longitude	77°36ˈE
5	Altitude	527m
6	Climate	Humid subtropical
7	Mean temperature	26°C
8	Land area	1Acre
9	Crop	Tomato
10	Method of application of water	Drip
11	Source of water	Well
12	Date of plantation	03 Nov 2015
13	Date of last harvesting	21 April 2016
14	Crop period	170 days
15	Spacing of plant	0.3 m
16	Spacing of row	1.5m
17	Total pumping hours	255 hr
18	Charge of pumping	35/ hr
19	Flow rate of irrigation	5.2 l/sec
20	Charge for pumping	Rs.9000
21	Number of plant	13600
22	Cost of per plant	Rs.10
23	Cost of crop	Rs.136000
24	Yield of plant	8.25kg
25	Yield of crop	112500kg
26	Gross return	Rs.1125000
27	Net return	Rs.500075
25	Net return per acre	Rs.500075

Table 4. Cost of Cultivation by Drip Irrigation Method

S. No	Item	Expenditure in Rupees
1	Planting	136000
2	Weeding	2000
3	Earthing up	3000
4	Irrigation cost	8925
5	Traching +Labour	30000
6	Manuring, Fertilizer, Insecticide	10000
7	Bed making	35000
8	Drip installation	400000
	Total cost of cultivation	**624925**

Based on information provided by the farmers, total pumping hours for surface irrigation and drip irrigation is 360 and 255. Total pumping cost reduced in drip irrigation. 29.2% reduction in total pumping cost has been observed.

Yield of crop is 30000 kg in surface irrigation and 112500 kg in drip irrigation. Yield of crop increased in drip irrigation method.

Net return per acre for surface irrigation and drip irrigation is 209600 and 500075 rupees respectively. Increase in net return has been observed in drip irrigation method. 138.6% increase in net return has been observed in drip irrigation method.

Total cost of cultivation for surface irrigation and drip irrigation is 83800 and 624925 rupees respectively. Increase in total cost of cultivation has been observed in drip irrigation. Increase in the total cost is due to installation of drip system.

4. Result

Based on the information provided by the farmers for surface irrigation or farmer irrigation and drip irrigation, results are arranged in the graphs. Comparative graphs are prepared for yield of crop, volume of water required, cost of water, gross return, expenditure, net return, water application efficiency and crop water use efficiency.

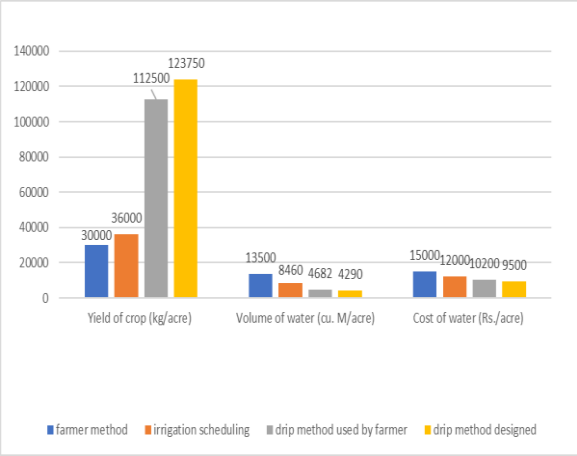

Figure 1. Graph of Yield of Crop/Acre, Volume of Water/Acre, Cost of Water /Acre

Yield of crop is 30000 kg/acre and 112500 kg/acre has been observed in surface irrigation method and drip irrigation method respectively. Increase in yield of crop has been observed.

Decrease in applied volume of water is observed. 13500 cu.m/acre and 4682 cu.m/acre volume of water applied in surface irrigation method and drip irrigation method respectively.

Total expenditure on water is 15000 and 10200 rs/acre for surface irrigation method and drip irrigation method respectively. Reduction on cost of water has been observed in drip irrigation method. 32% reduction in expenditure on water has been observed in drip irrigation method.

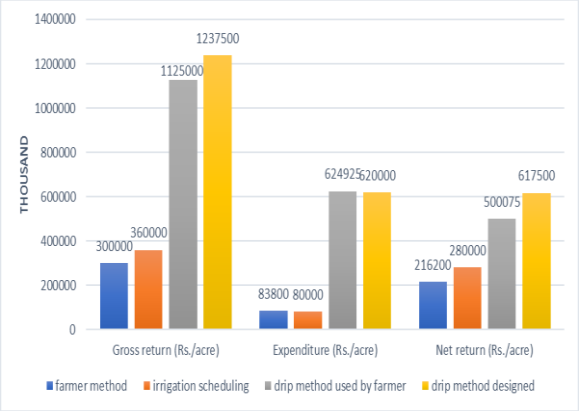

Figure2.Graph of Gross Return/Acre, Expenditure/Acre, Net Return/Acre

Gross return of 300000 and 1125000 rs/acre has been observed in surface irrigation method and drip irrigation method respectively. Increase in gross return has been observed in drip irrigation method,Total expenditure of 83800 and 624925 rs/acre was observed in surface irrigation method and drip irrigation method respectively. Increase in the total expenditure was observed in drip irrigation method. Increase in the expenditure may be due to cost of drip installation.

Net return of 216200 and 500075 rupee/acre for surface irrigation method and drip irrigation method respectively Net return in drip irrigation method has been observed.

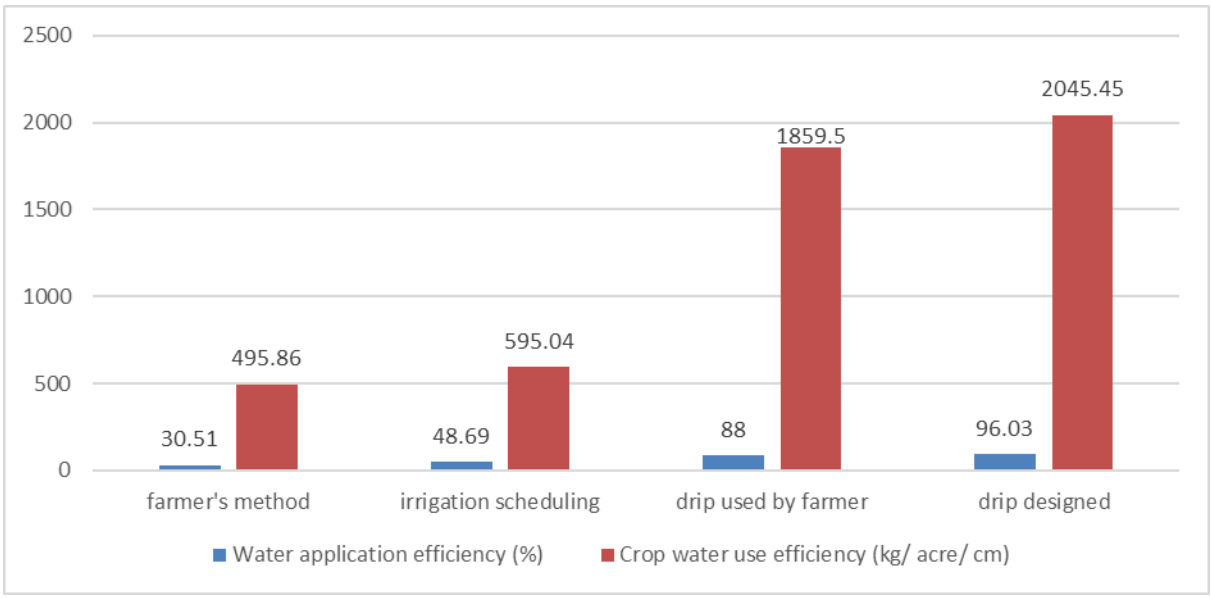

Figure 3. Graph of Water Application Efficiency and Crop Water Use Efficiency

Increase in water application efficiency and crop water use efficiency has been observed in drip irrigation method as compare to farmer's method. Water application efficiency of 30.51% and 88.0% has been observed in farmer's method and drip irrigation method respectively. Since the water application efficiency is higher in drip irrigation method which implies effective use of water.

Similarly increase in crop water use efficiency has been observed in drip irrigation method as compared to farmer's method. Crop water use efficiency of 495.86 and 1859.5 kg/acre/cm has been observed in farmer's method and drip irrigation method respectively. Higher value of crop water use efficiency implies effective use of water by crop in drip irrigation method.

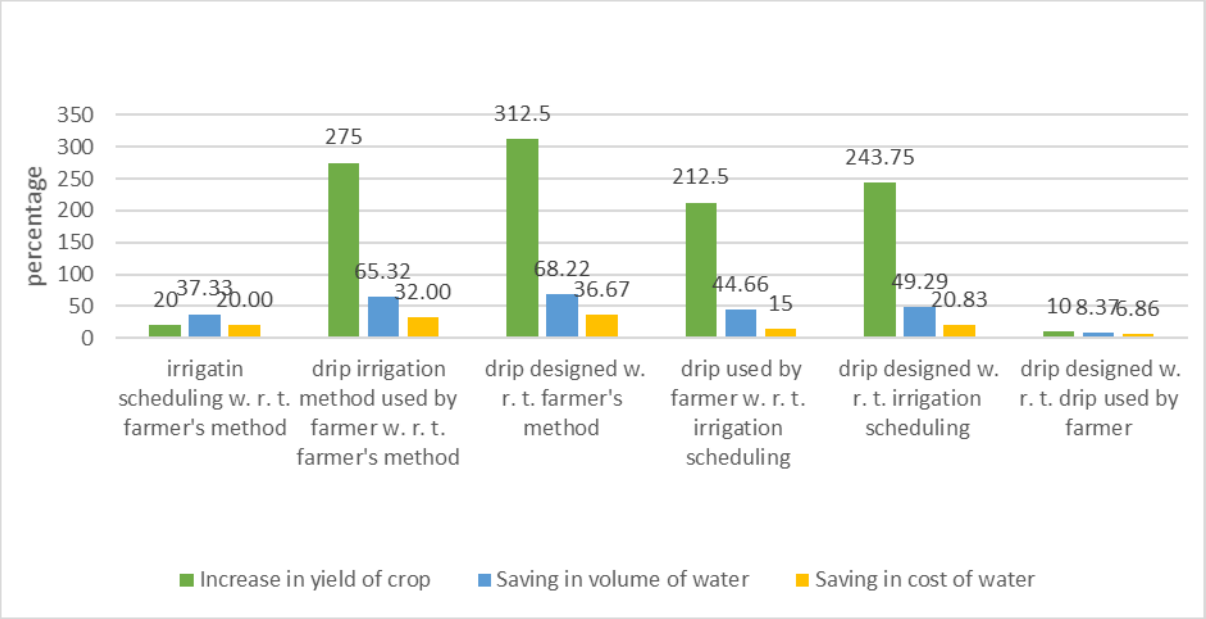

Figure 4. Comparative Results of Increase in Yield of Crop, Saving in Volume of Water and Saving in Cost of Water

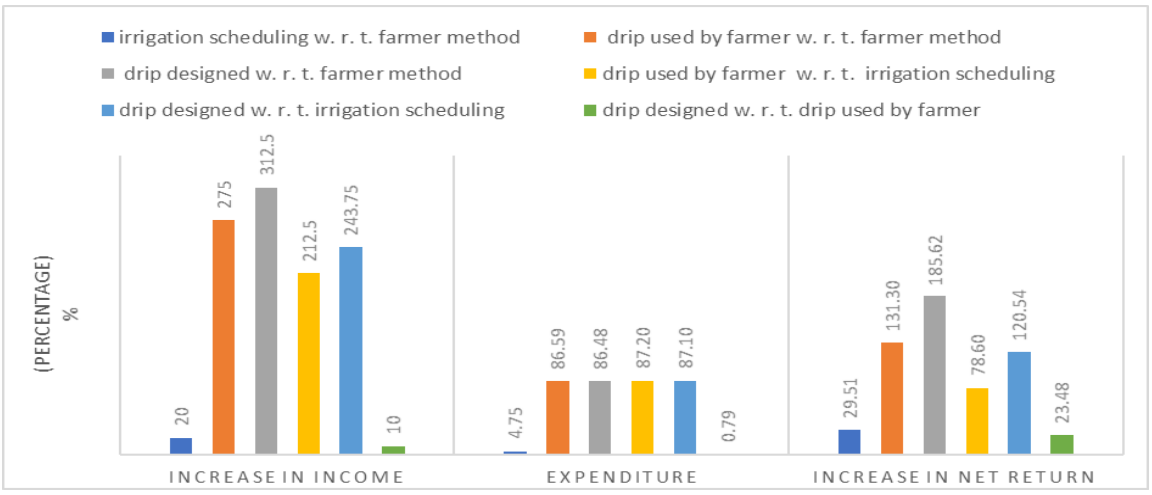

Figure 5. Comparative Results Increase in Income, Expenditure and Increase in Net Return

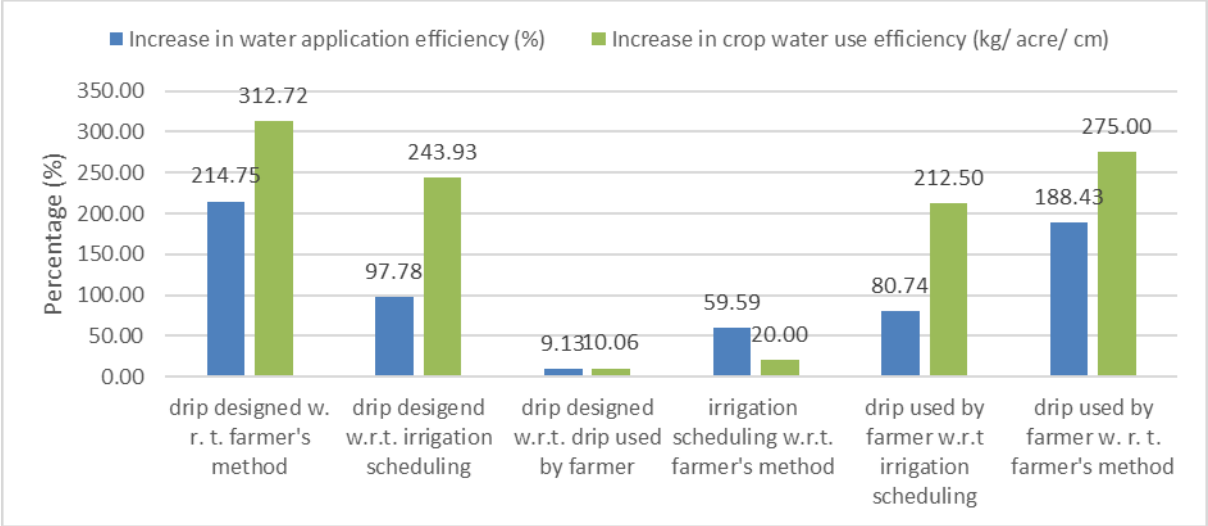

Figure 6. Comparative Results of Increase in Water Application Efficiency and Increase in Water Use Efficiency

5. Conclusion

The result shows that water might have been used efficiently under drip irrigation system. When compared with traditional surface irrigation method adopted by farmer and considering irrigation scheduling for tomato crop. Drip irrigation system demand least quantity of water as well as minimum cost of water as compared to other system. Water saved in drip irrigation system designed in 37.33%, 65.32% and 68.22% with respect to farmer method, irrigation scheduling and drip adopted by farmer respectively. By farmer's method crop yield had been received 20% less than the yield of crop calculated for irrigation scheduling,275% less than the yield of crop calculated for drip irrigation adopted by farmer and 312.5% less than the yield of crop calculated for Designed drip. Quality of crop can be improved by adopting by drip irrigation system better quality will give higher selling price to the farmer. The gross return achieved by the farmer might have been increased by 312.5% by adopting drip irrigation system designed. The efficiencies are highest in case of drip irrigation system followed by irrigation scheduling and farmer's method. Application efficiency of water achieved by farmer was 18.18%, 57.49% and 65.52% less than the irrigation scheduling; drip adopted by farmer and designed drip respectively. Similarly crop water use efficiency achieved by the farmer was 20% Less than the irrigation scheduling, 275%less than the drip adopted by farmer and 312.5% less than the drip designed. Crop water use efficiency achieved by irrigation scheduling was 212.5 %less than the drip adopted by farmer and 243% less than the drip designed. Crop water use efficiency is

achieved by drip adopted by farmer was 10% less than the designed drip.

From the study carried out it is proved that the drip irrigation is suitable for tomato crop and can be introduced on scale in Bhopal and in other states of India. Inspite of higher initial cost, the economics of the method is viable even without subsidy. Further it is possible to produce more yield of better quality as compared to surface irrigation system.

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