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Comparative Study of Porous Pipe and Drip Irrigation Systems

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ABSTRACT

An experiment was conducted on the comparative study of porous pipe and drip irrigation systems in tomato with five irrigation levels sub treatments (80%, 70%, 60%, 50% and control) with three replications. The total area under experiment, about 249 m^2 was divided into two equal portions. One portion about 8.3 m X 15 m was occupied by porous pipe and other portion about 8.3 X 15m by drip irrigation system. The soil in the experimental site was silt loamy in texture for 0-30 cm depth, average dry bulk density and field capacity were 1.38 g/cm^3 and 29.1 % respectively. The results revealed that the porous pipe irrigation system with all irrigation levels save water and gave more yield as compared to that of drip irrigation method with all irrigation levels. Higher yield attributes, water use efficiency 51.2 kg/ha/mm was obtained in porous pipe system. Whereas lower water used efficiency about 23.9 kg/ha/mm was obtained in drip irrigation system. The present study suggest farming community to adopt porous pipe irrigation method instead of drip irrigation method keeping in view of declining water resources.

Keywords: *Porous pipe and drip irrigation methods, Water use efficiency, Yield*

Water is an important resource for growth of the crops and their survival. The development or advancement in the field of the irrigation is not comparable to any other field of agricultural development. Irrigation is the artificial supply of water to the crop for its better crop growth in the field. India is one of the countries in major production of agricultural commodities. The present population of India is increasing day by day and it is more than 1200 millions. Increasing food demand and declining water resources are challenges for food security. Water being a limited natural resource, there is a need to increase agricultural production by efficiently utilizing the available water resources of its countries. Irrigation water is becoming scarce day by day and the world is looking for water efficient agriculture. The other systems apply it beneath the soil surface, by spraying it under pressure over surface in the raindrop form or by applying it in drops near to plant. All these factors increased pressure on natural resources, particularly water and land that leads to complex challenge with land- water energy which cannot be achieved with traditional approaches and thus needs a multi-dimensional approach.

In India, generally drip irrigation are used to irrigate crops, wherein the entire soil surface is clogging up easily and poor water distribution uniformity compared to other emitter types. It will create a problem used to reduce the flow and pressure. Therefor it is dried need to adopt modern efficient irrigation methods like porous pipe, sprinkler. The sprinkler irrigation method offers several advantage over surface irrigation methods, including higher water use efficiency, better fertilizer application and high yield (Tagar *et al.*, 2012). However, high wind velocity and use of saline water may restrict its application in semiarid regions. Porous pipe per length, and only using 50 metres in total per irrigation zone. This can be limiting, but does irrigation system is not affected by high wind velocity as it applies water directly to the root zone of plants. Its major advantage as compared to other methods include higher crop yield, saving in water, increased fertilizer use efficiency, reduced energy consumption, tolerance to windy atmospheric conditions, reduced labour cost, and improved tolerance to salinity. The study area reported that porous pipe irrigation generally achieves better crop yield and balanced soil moisture in the active root zone with minimum water losses. On the average, porous pipe irrigation saves about 70% water as compared drip irrigation system (Akhoond *et al.*, 2008). It allows water to gently trickle directly to the root zone, delivering a constant deep watering through its porous openings. Porous pipe irrigation saves money by significantly lowering the cost of system components compared to conventional irrigation systems. There are some disadvantages inherent with this technology such as; porous pipe is that the release of water is unregulated. This causes issues when installing for a larger irrigation system or when you require precision watering. The reason is because as the water travels through the pipe it is losing pressure and flow. Further the water travels through porous pipe, less water is available to be released until a point

that there is no more water left to release. Typically recommended using up to 20-30 metres per not detract the usefulness of porous pipe (Asharif *et al.*, 2002). In past many studies have been conducted on porous pipe irrigation system, even this so many farmer and scientist prefer to adopt porous pipe irrigation system. Therefore this technology needs extensive publicity among the local farmers in the country for future adoption. Keeping the above facts in view the present study was conducted on comparative study on porous pipe and drip irrigation system in tomato with objective of this study to compare yield, water use efficiency and to suggest guidelines for farming community.

MATERIAL AND METHODS

Location of experimental site

An experiment was carried out at College of Agricultural Engineering, Madakasira, Anantapuramu district, Andhra Pradesh State which is geographically situated at 13°94È56" N latitude and 77°18È42 E longitude at an altitude of 676 m above mean sea level as shown in Fig 1. The present research has been conducted during the year, 2018-2019 for the crop period of tomato i.e. from November to March in *rabi* season. This experimental has been conducted treatment combinations viz., porous pipe and drip irrigation systems with irrigation levels of 80%, 70%, 60%, 50% and control.

Fig 1. Satellite View of Experimental Site College of Agricultural Engineering, Madakasira

Preparation of Land

The study area was prepared by ploughing twice for fine tilth. Before transplanting, the soil was pulverized thoroughly by rotavator. The final preparation of raised beds, well decomposed FYM @50 t/ha was applied to the field and mixed thoroughly. The field was uniformly levelled and plots were laid out as per the design. After layout, raised beds was prepared at 5 cm depth and sub-mains, laterals of irrigation levels randomly spread into the plots as per the treatments. A 10 ft height of stand was prepared for keeping syntax tank to supply water to the porous pipe irrigation system. The aim of the study was to compare the porous pipe and drip irrigation systems with regards to water saving, increase in yield and water use efficiency of porous pipe and drip irrigation systems. For this purpose the total area under experiment about 249 m^2 was divided into two portions with five irrigation levels equally.

Experimental details

The porous pipe irrigation system with soaker hose and drip system consisting of head control unit (10ft stand for keeping syntax tank for supplying of water, control valves, air release valve, throttle valve, pressure gauge), water conveyance system (including PVC main pipe line, and sub main pipe line, control valve, flush valve etc.), water distribution system (integral soaker hose pipe line 13 mm diameter and dripper line 16 mm diameter with end caps) irrigation system. The two irrigation systems were laid out in the experimental field. The Porous pipe lines, drip lines with level of irrigation (80%, 70%, 60%, 50% and control irrigation) were laid at 1.2 m apart with porous pipe to porous pipe and dripper to dripper spacing of 40 cm on lateral. The distance between row to row and plant to plant was kept 0.45 and 0.4 m, respectively.

Treatments

In the present study, two treatments have been considered for irrigation management of test plot according to soil type and weather condition of the present study area which is depicted in Table 1.

Table 1. Detail of experimental treatment combinations

Treatments	Sub treatments
I1	IL1, IL2, IL3, IL4 and control
I2	IL1, IL2, IL3, IL4 and control

In present study, treatment comprised of two irrigation systems with five irrigation levels (IL) at 80%, 70%, 60%, 50% and control with three replication. Harvesting started at 65-70 days after transplanting. Harvesting of tomato crop was done manually depending upon the maturity of the tomato and marketable immature fruit were harvested in 8-10 days and then weighed. The number of fruits were also counted. Statistical analysis of the data was performed using a factorial RBD (randomized block design) with three replications. The analysis of variance was also accounted for factors. The level of the significant difference (LSD at $p<0.05$) was used

in the ANOVA to test the effect of irrigation systems on different response variable. The field water use efficiency of each treatment combinations was conducted.

Plant material

Planting material 25 days old seedlings of 448 Sweaker hybrid variety of tomato were transplanted in the field on 28th of November, 2018 at a spacing of 45 × 40 cm. holes were dug slightly wider and the planting materials were planted deeper than their normal level in the bed.

Soil of the experimental site

The soil of the experimental site was silt loam with sand content (21%) and low clay content (19%). The soil sample were collected at 0-30 cm soil depth. The meteorological data (average temp, humidity, sunshine duration, wind velocity, rainfall, and evaporation) of year 2018-19 were collected from the Agricultural Research Station, Pavugada, Anantapuramu district, AP as shown in Fig.2.

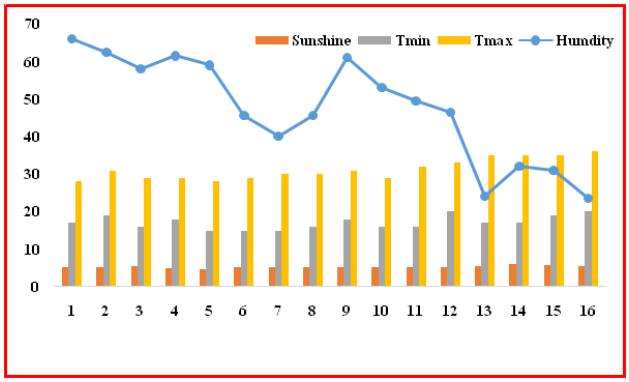

Fig 2. Weekly climate data during crop growth period

Crop Attributes

Various key observations of practical significances were recorded over the growing period of tomato crop, which encompasses plant height and fruit yields per plot, physical dimensions of fruits.

Average fruit yields per plot & per rows as well as per treatment were recorded to arrive at kg/ha yields at last.

Water use efficiency (WUE)

Water use efficiency (WUE) is defined as yield of plant product per unit of crop water use, and was important in all areas of plant production. WUE is the outcome of an entire growth of plant and environmental processes operating over the life of a crop to determine both the gross yield and gross amount of water used to produce it. Water use efficiency was worked out for all such combinations and expressed in kg/ha/mm and divided by the gross quantum of irrigation water used consumptively for all the respective treatments.

$$WUE = \frac{\text{Yield (t/ha)}}{\text{Total amount of water used (mm)}}$$

Statistical analysis

The data on various parameters were analysed to statistically using Fisher's method of analysis of variance as suggested by Panse and Sukhatme (1978) for the randomized block design adopted in this study. Statistical significance was tested by applying F-test at 0.05 level of probability. Critical differences at 0.05 levels were worked out for the effects, which were significant.

RESULTS AND DISCUSSION

The results are described below in segments based on different objectives.

Effect of treatment combinations on plant height

The data on the effect of treatment combinations on plant height at 30, 60, 90 DAT and harvest are presented in Table 3 and depicted in Fig.3. It is clear from the data that, the height of tomato plants at 30, 60, 90 DAT and harvest was non-significantly influenced by treatments combination. The data indicated that the highest plant height was recorded under treatment porous pipe irrigation at 60% irrigation level as compared to drip irrigation system with all irrigation levels at 30 DAT. The similar trend was also observed at 60 DAT, 90 DAT, and harvest. The highest plant height was observed at 90 DAT in porous pipe irrigation system and the similar trend was observed at the harvesting also. The collective results indicated that the treatment of porous pipe irrigation with 60% of irrigation level is better than drip irrigation system with all irrigation level of the experiment.

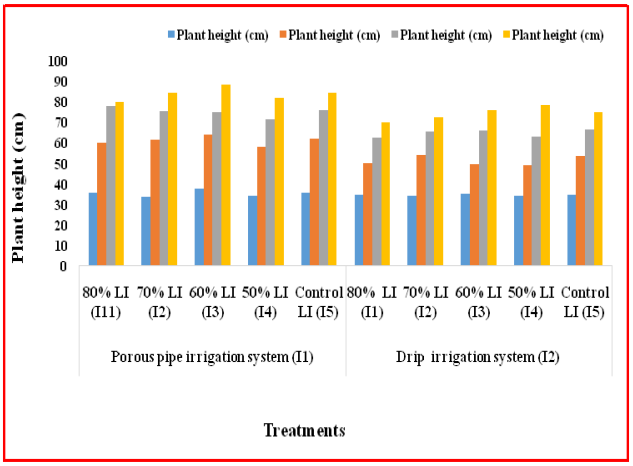

Fig 3. Plant height at different growth periods influenced by treatments

Table 2. Effect of treatments combination on tomato plant height at 30, 60, 90 DAT and harvest

Treatments		Plant height (cm)			
		30 DAT	60 DAT	90 DAT	Harvest
Porous pipe irrigation system (I1)	80% LI (L1)	35.90	60.30	78.30	80.30
	70% LI (L2)	33.90	61.60	75.30	84.60
	60% LI (L3)	37.73	64.10	75.50	88.70
	50% LI (L4)	34.10	58.20	71.80	81.90
	Control LI (L5)	36.00	62.00	75.90	84.40
Drip irrigation system (I2)	80% LI (L1)	34.70	50.30	62.60	70.20
	70% LI (L2)	34.30	54.00	65.90	72.80
	60% LI (L3)	35.50	50.00	66.30	76.20
	50% LI (L4)	34.10	49.20	63.00	78.60
	Control LI (L5)	34.70	53.90	66.50	74.90
Interaction					
SE (d) ±	SE d for I	0.59	0.77	0.78	0.70
	SE d for L	0.77	1.00	1.00	1.01
CD	CD for I	NS	NS	NS	NS
	CD for L	NS	NS	NS	NS
CV (%)		0.11	0.09	0.07	0.06

Table 3. Effect of treatment combinations on tomato plant yield per plot (kg)

Treatment		Yield per plot (kg)
Porous pipe irrigation system (11)	80% IL (L1)	11.00
	70% IL (L2)	11.70
	60% IL (L3)	13.40
	50% IL (L4)	11.40
	Control IL (L5)	12.10
Drip irrigation system (12)	80% IL (L1)	8.50
	70% IL (L2)	10.00
	60% IL (L3)	10.90
	50% IL (L4)	9.00
	Control IL (L5)	10.00
Interaction		
SE(d) ±	SE(d) for I	0.39
	SE(d) for L	0.51
CD	CD for I	NS
	CD for L	NS
CV (%)		0.24

Effect of irrigation treatments on yield

The data on the effect of treatment combinations on fruit yield per plot (13.4 kg) was recorded in treatment porous pipe irrigation with 60% of irrigation level as compared to other drip irrigation system with all irrigation levels. It is clear from the data that, the yield of tomato plants at 30, 60, 90 DAT and harvest was non-significantly influenced by treatment combinations. The overall result indicated that the treatment porous pipe irrigation with 60% level of irrigation is better than other treatment are presented in Table 4.

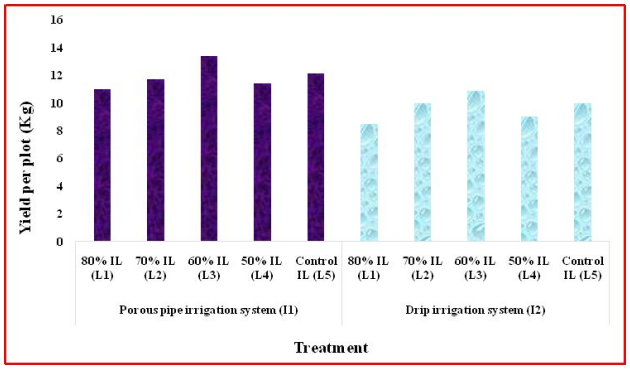

Fig 4. Yield per plot (kg) influenced by treatments combination during *rabi* 2018-19

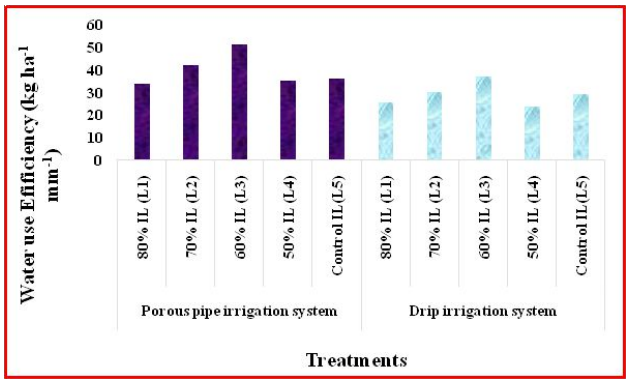

Fig 5. Variability of WUE (Kg/ha-mm) across various treatments

Table 4. Variability of WUE (Kg/ha-mm) across various treatments

Treatments		Total yield (kg/ha)	Total amount of irrigation water applied (mm)	water use efficiency (kg/ha-mm)
Porous pipe irrigation system (I1)	80% LI (I1)	7142.90	210.00	34.00
	70% LI (I2)	7597.40	180.00	42.20
	60% LI (I3)	8701.30	170.00	51.20
	50% LI (I4)	7402.60	210.00	35.30
	Control LI (I5)	7857.10	217.00	36.20
Drip irrigation system (I2)	80% LI (I1)	5519.50	216.00	25.60
	70% LI (I2)	6493.50	215.50	30.10
	60% LI (I3)	7077.90	190.00	37.30
	50% LI (I4)	5844.20	245.00	23.90
	Control LI (I5)	6493.50	220.00	29.50

Water use efficiency

The WUE is considered as one of the major attribute to reflect the overall effectiveness of various treatment combinations. The data on the effect of irrigation treatments on WUE of tomato are presented in Table.5 and graphically depicted in Fig.5. It is clear that, WUE of tomato was influenced by treatment combinations (irrigation systems and irrigation levels). The WUE of tomato (kg/ha-mm) was recorded under treatment porous pipe irrigation with 60% of irrigation level as compared to drip irrigation system with all irrigation levels (51.2 kg/ha-mm).

CONCLUSION

Porous pipe irrigation system with 60% level of irrigation resulted in maximum yield, yield attributing characters. Further, it can be concluded from the above experiment that porous pipe irrigation system is far better in tomato crop as compared to drip irrigation, because it not only resulted higher yield and profit, but also saved lots of irrigation water that is one of the most crucial input for agricultural production.

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