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Research Article

EFFECT OF LOW PRESSURE GRAVITY FED DRIP IRRIGATION SYSTEM ON THE YIELD AND WATER USE OF COWPEA FOR HOMESTEAD FARMING FOR SUSTAINABLE VEGETABLE PRODUCTION

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Abstract: The comparative study was conducted to evaluate the performance of low pressure drip irrigation system and manual hose irrigation in cowpea. Irrigation time optimized at 30minutes provided 500 ml of water per plant. Based on the growth stage, crop water requirement of vegetables was estimated to be 1 to 2.2 litre/day. To meet this crop water requirement, irrigation was done at 4 times intervals *i.e.*, morning twice and evening twice in such a manner 2.2 litre water was irrigated per plant. Thus, drip irrigation conserved 70% water compared to manual hose irrigation. It was found that drip irrigation gave 33% higher yield than the yield obtained with the manual drip irrigation system. Overcoming severe drought, 1.18q/ha-cm water use efficiency was recorded in DIS. Low pressure DIS increased irrigation efficiency up to 95% than that of conventional method of irrigation.

Keywords: *Drip irrigation, Water Use Efficiency, Hose Irrigation, Consumptive water use*

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Introduction

Thiruvananthapuram, Capital of Kerala receives tremendous amount of rainfall during South-West monsoon. But during North-East monsoon and summer, farmers face severe drought receiving low amount of water. The district receives 33% deficit rainfall against annual average rainfall of 1774 mm. The Per capita landholding of farmers in Thiruvananthapuram is less than 0.12ha. Many small and marginal farmers do not own their own land and generally carry out farming in leased land. Apart from unpredictable climatic condition, labour shortage and high labour cost have made farming the last choice for people of Kerala. Availability of fresh vegetables (chemical free) at affordable price is an uphill task in cities like Thiruvananthapuram. An easy way to get fresh vegetables is by carrying out homestead farming. To promote homestead farming in a big way, and to overcome the difficulties of lack of adequate water for irrigation purposes, we introduced low pressure DIS in various operational areas of Thiruvananthapuram district as a part of KVK Front Line Demonstration.

Objectives of study

- To do Front Line Demonstration on "Low pressure DIS "in homestead farming.
- To evaluate labour savings
- To evaluate water savings
- To calculate increased yield
- To calculate the Water Use Efficiency

According to Varghese *et al.*, (2014) [1] for cowpea the highest water use efficiency was recorded in drip irrigation 2.52 q/ha/cm. With the WUE of 1.15kg ha mm^{-1} cowpea produced highest grain yield of 1411.6kg/ha [2]. According to Sivanappan *et al.*, (1987) effect of low cost DIS on the water use and yield for various vegetables indicated that water required in the drip system was only ¼ to 1/3 of that required under surface method and the yield was invariably more in drip system.

According to Jarwar, *et al.*, (2019) [3] conducted a study on the performance and evaluation of drip irrigation system and its future advantages.

The concluded that drip with fertigation saved amount of water and fertilizer, increased yield, high WUE and high benefit –cost ration compared to conventional irrigation practices. Evaluation of an emitter with a low-pressure drip-irrigation system for sustainable eggplant production study was conducted. In this study, the performance of the new emitter with the low-pressure (gravity) drip-irrigation system was found better for a 2 m operating head with a 0% and 1% slope. The uniformity of water application was more than 80%, indicating that the emitter was designed on the basis of proper dimensions and locally available materials. Field validation of the drip-irrigation system increases yield, water use, and substantially improves water productivity by 4.6%, 38%, and 70%, respectively, compared to farmers' irrigation practices [4].

Karthikeyan and Suresh (2019) [5] conducted a study on understanding the adoption of water saving technology. The findings are about the factors that drives the adoption of drip irrigation in Erode district in Tamil Nadu, India. Despite many advantages in the drip irrigation many farmers in the district have not adopted to the drip irrigation, so the findings also analyses the reasons for the farmers to not adopt drip irrigation, including financial constraints, water scarcity, no subsidy from the government, damages by the animals, high maintenance cost, lack in technical skills, *etc*.

An experimental study on drip irrigation system to produce rock melon grown inside the netted rain house shelter and the results indicate that the operating pressure of the drip irrigation system tested varied from 0.8 to 3.0 psi with a discharge rate between 0.14 and 0.25 $Lmin^{-1}$. Water application uniformity between laterals varied from 66.06 to 89.72%. The WP of rock melon was around 7.93 kg/m^3, which is considerably high and in similar range as demonstrated in previous literature [6].

Feasibility of low cost family drip irrigation to efficiently utilize the water and maximize the crop yield for small holder farmers in Metekel zone. For that full drip irrigation kits with its all accessories have been installed on well prepared fields of 10m length, and 10m width that was $100m^2$ areas.

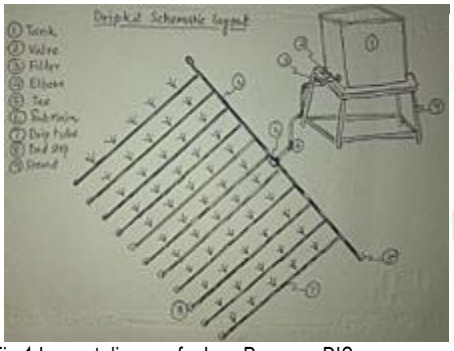

Fig-1 Lay out diagram for Low Pressure DIS

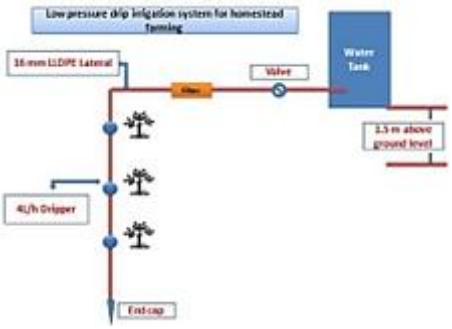

Fig-2 Sectional view for Low Pressure DIS

Irrigation water was harvested from wells. The spacing between laterals and emitters were 0.6mand 0.4m respectively. The result shows that drip irrigation system is economical for smallholder farmers. Cost of accessing and operating of water should be managed. An experimental study on drip irrigation system to produce rock melon grown inside the netted rain house shelter and the results indicate that the operating pressure of the drip irrigation system tested varied from 0.8 to 3.0 psi with a discharge rate between 0.14 and 0.25 $Lmin^{-1}$. Water application uniformity between laterals varied from 66.06 to 89.72%. The WP of rock melon was around 7.93 kg/m^3, which is considerably high and in similar range as demonstrated in previous literature.

Table-1 *Weather details of Nedumangad Block*

Month	Rainfall (mm)	Highest Temperature	Lowest Temperature
September	850 mm	30°C	23°C
October	250 mm	31°C	23°C
November	230 mm	34°C	23°C
December	65 mm	36°C	12°C
January	6 mm	35°C	20°C
February	30 mm	35°C	21°C

Materials and Methods

The study was conducted over two year period during 2014-2016 covering 5 units among various parts of Thiruvananthapuram district. Each unit consisted of 2.5 cent area covering a total area of 0.05 ha. For an experimental study, the system was introduced among homestead farmers who did not have own land and did not have electricity supply. The ease of the technology encouraged people to use this technology. Affordable price attracted more people to practice the same in their fields. Thus 20 more units had been installed in All Kerala level. Gravity fed MI system consists of a reservoir kept at higher elevation than the cropped field. From the bottom of reservoir a pipe is connected to supply the water into water delivering system [7].The details of components used in gravity fed irrigation system are given as under [Fig-1]. The lateral lines are connected to a main line that receives water from a head source. The trickling rate, in the range of 2-4 litres/hour per emitter.

Installation of Low Pressure DIS

• The land where farming is to be practiced is to be divided it into rows being 60cm apart.

• Plants were planted 60cm apart in each row so that in a 2.5 cent land, 220 plants can be planted and taken care of.

• The overhead tank is to be kept at 1.5m above the ground to get a minimum pressure of 0.15 kg/cm^2.

• Connect the 16mm lateral to tank outlet and connect a control valve to the main line.

• Attach a screen filter to the mainline to remove unwanted foreign matter and debris from the water flow path so that the tube does not get clogged.

• Join 16 mm Tee to the main line

• Connect 16 mm lateral to the tee ends and extend it up to the last row in both directions and close it with end cap.

• On each row in the main lateral, drill a hole with puncher and fit a connector

• Insert a drip tape to the connector and extend it to the end of the row. Lock the end by using end cap.

• Sow cowpea seeds at 60cm apart. [Fig-2] clearly describes the lay out pattern of drip system.

Irrigation Scheduling

Drip irrigation is most suitable to the crop as it provides uniform moisture throughout the season. Early morning and evening; the valve is to be kept open for 30 minutes. Dripper discharge rate is 1lph for tank kept at 1.5m elevation from the ground. The daily water requirement of Cowpea crop is 2.2 l/day/ plant. The irrigation system should be operated daily for 30minutes during initial growth stage and for 75 minutes during peak growth. The system operates by water gravity from a tank placed at 1.5m high.

Parameter Evaluation

Compared the following parameters which directly affect the cost of cultivation: labour savings, WUE and yield attributes.

Crop yield

Cowpea has been selected as the main crop. The yield was recorded for three crop seasons. Weight of vegetables obtained from 2.5 cent has been measured as the total crop yield and it has been converted to hectare.

Labour savings

Man days taken to complete farming in 1 ha land was evaluated by the study during field observation.

Water use efficiency

Water use efficiency was determined using the formula, Eu = C/Wc

Where C= Crop yield in Kg/Wc

Wc = Water consumed by the crop in ha cm per Unit area

Based on the experimental study conducted by Singh *et al.,* (1961) [8] the consumptive water use for cowpea was 47.3, 516.1 and 575.4 mm under varying irrigation regimes. Here the effective rainfall which was 65mm was added to total moisture use to compute the consumptive use of water.

Economic Analysis

Benefit-Cost ratio and net profit were carried out to determine the economic feasibility of the crop using surface and drip irrigation as carried out by Tiwari *et al.* (1998a) [9]. With The fixed cost of the drip irrigation system being Rs.980/unit and the useful life of the drip system being 5 years, the system cost was evaluated by distributing the fixed cost of system over life period of drip irrigation set. In addition to this; the cost of cultivation includes expenses incurred for grow bags, porting mixture, intercultural operation, fertilizer, crop protection measures, irrigation water and harvesting with labour charge [10].

Results and Discussion

Water use efficiency

Compared to conventional irrigation system, Water use in this study was 50 % less. The amount of water was less than half during rainy seasons. Irrigation was scheduled in 4 intervals of 15 minutes duration each meeting the per day water requirement as2.2ltr/ plant.

Fig-3 hole drilled on the line

Fig-4 Drip installed field

Table-2 *Water used and yield in drip and control method in Cowpea (average data of two years)*

Plots	Water use efficiency (q/ha-cm)		Yield (q/ha)		Percentage increase in yield
	Control	Drip	Control	Drip	
P1	1.01	1.16	55	63	14.5
P2	0.92	1.18	50	64	28.0
P3	0.87	1.14	47	62	31.9
P4	0.83	1.11	45	60	33.3
P5	0.83	1.11	45	60	33.3

Table-3 Economic analysis of various treatments

Plots	Drip			Control		
	Gross cost (Rs./ha)	Gross income (Rs./ha)	BCR	Gross cost (Rs./ha)	Gross income (Rs./ha)	BCR
P1	221400	315000	1.4	271400	248850	0.9
P2	200400	290000	1.5	250400	223850	0.9
P3	180000	278000	1.5	230000	211850	0.9
P4	187500	269000	1.4	237500	202850	0.9
P5	195000	270000	1.4	245000	203500	0.8

The maximum water use efficiency was 1.1q/ha-cm compared to hose irrigation [Fig-5]. The results in [Table-1] show that WUE increased 28% compared to conventional hose irrigation.

Irrigation efficiency

During manual irrigation when we apply 2 litre of water daily, only 1 litre of water was used by each plant and the remaining is lost as runoff, infiltration, seepage and also thorough evaporation. For conventional irrigation, irrigation efficiency was only 50%. For low pressure drip kit system, the result revealed that the quantum of water saved by the drip method was as high as 95%. The quantity of water used for drip irrigations was 1-2 litres/plant against 5-10 litres in the conventional method.

Water savings

It was observed that there was substantial water saving ranging from 70 to 90 per cent compared to conventional hose irrigation

Labour savings

Comparing the manual method, 250 man days savings was observed in drip irrigated method for 1 ha irrigation practice.

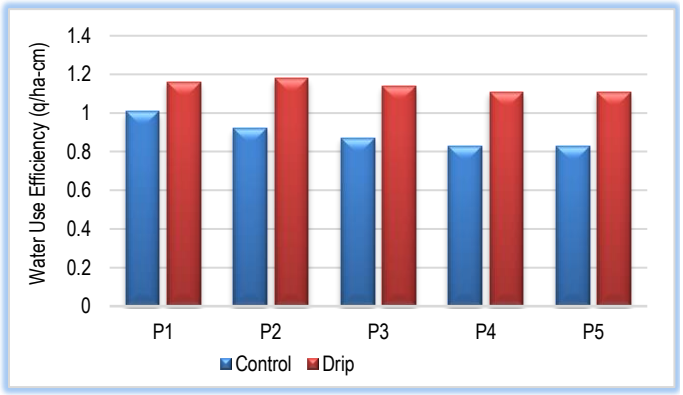

Fig-5 WUE of DIS and HI

Yield

[Table-1] shows the maximum yield obtained was 64q/ha compared to conventional irrigation. As the discharge rate increases yield crop also increases substantially [Fig-6]. The yield of cowpea under drip irrigation gave 14 -33% more yield compared to conventional method of irrigation by overcoming severe moisture stress.

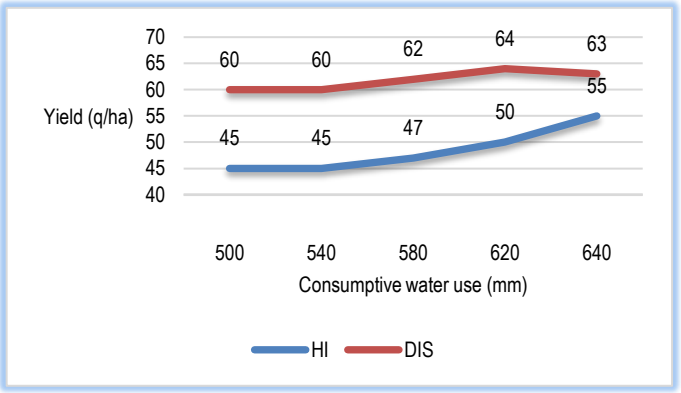

Fig-6 Yield against water applied

Economic feasibility

Maximum net return of Rs.98000/ha with B:C ratio of 1.5 was recorded at P3 and lowest net profit of Rs.75000/ha with B:C ratio of 1.4 in P5 [Table-3]. At the same time for conventional irrigation net income varied drastically down to negative value with B:C ratio 0.8 to 0.9 due to improper irrigation. The same time yield was comparatively lower which leads to low gross income.

Conclusion

Low pressure Drip Irrigation System (DIS) is observed to be user –friendly, economical and cost effective as compared with conventional hose irrigation. Overcoming severe drought, 33% increase in yield was obtained against 1.18q/ha-cm water use efficiency. 70% water savings was observed for drip irrigation by avoiding the over wetting of plot which leads to overrun and water loss.

Application of research: Time savings, low energy consumption and low-pressure low cost DIS had been widely accepted among homestead farmers to promote vegetable cultivation in their own houses.

Research Category: Drip Irrigation System

Abbreviations: DIS-Drip irrigation system
WUE-Water use efficiency, BCR-Benefit cost ratio

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Institute: ICAR-Krishi Vigyan Kendra, Mitraniketan, 695543, Kerala, India
Research project name or number: Research station study

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Thiruvananthapuram district

Cultivar / Variety / Breed name: Cowpea

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

References

[1] Varughese A., Balan M.T., Sajna A. and Swetha K.P. (2014) *International Journal of Engineering Research and Development*, 10(8), 18-21.
[2] Dasila B., Singh V., Kushwaha H.S., Srivastava A. and Ram S. (2016) *SAARC J. Agri*., 14(2), 46-55.
[3] Jarwar A.H., Wang X., Wang L., Mangi N., Ma Q. and Shuli F. (2019) *Journal of Biology, Agriculture and Healthcare*, 9(9), 25-35.
[4] Sarker K.K., Hossain A., Murad K.F.I., Biswas S.K., Akter F., Rannu R.P., Moniruzzaman M., Karim N.N. and Timsina J. (2019) *Agri Engineerin*g, 1, 376–390.
[5] Kaarthikeyan G.M. and Suresh A. (2019) *International Journal of Recent Technology and Engineering*, 7(6), 1123-1130.
[6] Jusoh M.F., Adnan N., Muttalib M.F.A. and Katimon A. (2020) *Conference Paper in IOP Conference Series Earth and Environmental Science. Earth and Environmental Science*, 1-9.
[7] Suresh R. (2010) *Text book on Micro irrigation. First Edition. Standard Publishers Distributors. New Delhi*, 571.
[8] Singh S., Lamba P.S.and Sharma H.C. (1975) *Annals of Arid Zone*, 14(2), 100-108.
[9] Tiwari K.N., Mal P.K., Singh R.M. and Chattopadhya A. (1998a) *Agricultural Water Management*, 38, 91-102.
[10] Krishna Reddy Y.V., Adamala S. and Babu B.H. (2017) *International Journal of current Microbiology and Applied Sciences*, 6(2), 437-445.