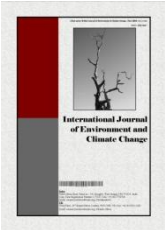

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Performance Evaluation of Drip Irrigation System in Grapes Field

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A commercial drip irrigation system was evaluated at farmer's field under grapes to study the various parameters viz emission uniformity, emitter flow variations and statistical uniformity during the year 2019. The soil characteristics of the experiment field at different profile depths was analyzed and sandy loam soil is available at 0 to 15 cm depth and sandy clay loam is available from 15 cm to 60 cm depths, Irrigation was given daily based on potential evaporation. The soil moisture status during the crop growth period at various depths under the emitter was studied. The soil moisture in the field was maintained in a range of 21 to 23% under drip irrigation in the 60 cm depth irrespective of the duration. During the rainy season when no irrigation was given, the soil moisture fluctuated depending upon the intensity of rainfall. The system performance was good as indicated by high uniformity coefficient (93%) which indicates that the field is irrigated in a highly uniform manner. The yield was estimated as 27500 kg/ha and water use efficiency was found to be 566 kg.ha/cm The study revealed that superiority of drip irrigated soil regime and moisture content in the soil in 60 cm depth was more or less maintained constantly during the irrigation period.

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Keywords: Drip irrigation; soil moisture; uniformity coefficient; water use efficiency.

1. INTRODUCTION

Drip irrigation is based on delivering low water volume through pressurized pipe network. Drip Irrigation Method is the best method that has been used in the world among the other irrigation methods because of its good and high uniformity. This method distributes water to the field using the pipe network and transforms it from the pipe network to the plant by emitters. In spite of the advantages of drip Irrigation method, the traditional network in drip irrigation method has many problems. The main problem is the drop in pressures and discharges distribution in the network resulting from the amount of pressure losses between the head of the lateral as compared with that in the end of the lateral. This drop affects the discharge distribution of emitters and uniformity [1]. Field evaluation of drip irrigation unit is important. It is important to establish whether desired emitter discharge uniformity specifications are being met and to decide whether the system can be operated efficiently [2,3,4]. In Tamil Nadu, grapes is cultivated in an area of 2800 ha under drip irrigation and now a days it becomes cash crop. In order to know the actual performances of the drip system in the field conditions, a study was taken up in the farmer's field for Grapes crop. The various parameters viz emission uniformity, emitter flow variations, uniformity coefficient and soil moisture distribution was studied.

2. MATERIALS AND METHODS

2.1 About the Study Area

In order to study the performance of drip irrigation system under field condition and soil moisture status in a drip field, the experiment was conducted in a farmer field for grapes in Kalampalayam village, which is located 10 km away from Coimbatore. Muscat variety was selected for the study. The adopted spacing of the crop was 1.5 m x 1 m . The study area was 0.6 acre. The period of the crop was 120 days. The study was made for one season from October 2018 to January 2019. Last pruning was done on 1st October 2018.

2.2. Field Layout

The drip system layout includes 15 HP motor, screen filter, pressure gauge, 63 mm main (PVC) , 30 mm sub main(PVC), 16 mm laterals (LDPE) and turbo key emitter of 4 lph. The emitter were fitted in the lateral pipe at 0.75 m interval and laterals were fitted in the sub main at 1.5 m interval for accommodating the row to row spacing in the field. The layout is shown in Fig.1. The system operates at 1kg/cm^2. The soil and water characteristics are given in Table 1

Table 1. Physical properties of soil profile and water quality (need to format the table)

Soil properties	**Profile depths(cm)**			
	0-15	**15-30**	**30-45**	**45-60**
Texture	Sandy Loam	Sandy clay Loam	Sandy clay Loam	Sandy clay Loam
Bulk density gm/cm	1.42	1.46	1.52	1.56
Ks(cm/hr)	6.50	3.50	2.50	2.00
F.C (%)	23.56	27.50	28.40	29.00
W.P (%)	12.46	13.80	14.70	15.20
Porosity (%)	34.56	37.89	40.00	41.00
pH	7.20	7.40	7.40	7.40
EC (ds/m)	0.46	0.56	0.56	0.56
Water quality				
pH	8.3			
EC (ds/m)	0.06			

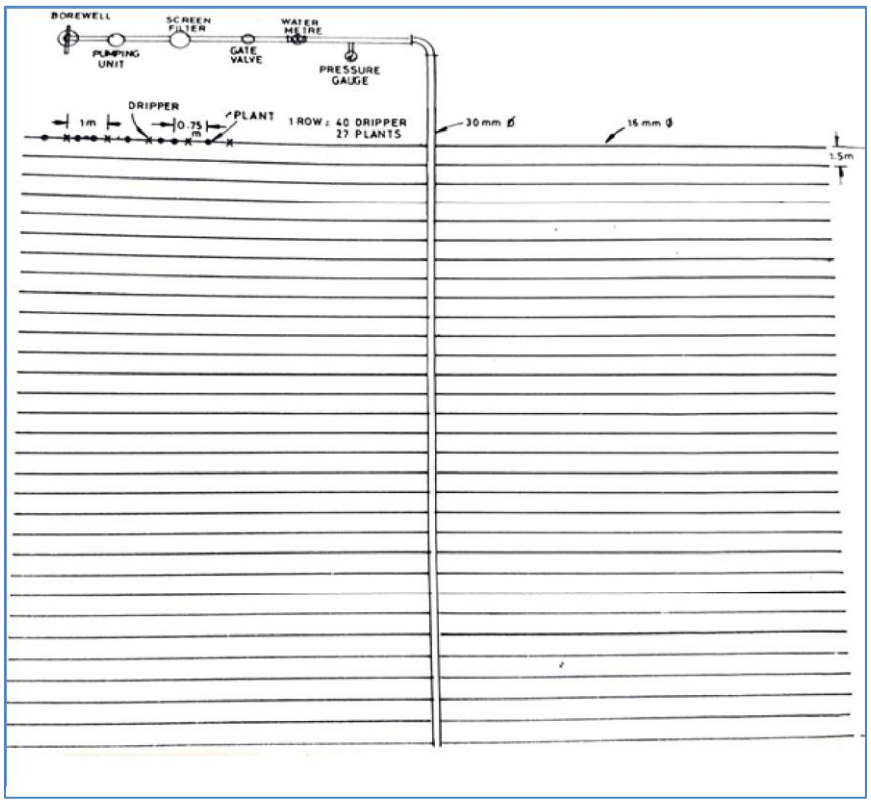

Fig. 1. Field Layout

2.3 Irrigation Details

The study season includes both monsoon season and winter season. No irrigation was given in October and November 2018. From December 2018 irrigation was given. The quantity was worked out based on average pan evaporation value (100 % PE).

2.4 Soil Moisture Status

Soil moisture determination was done for every 15 days during the crop growth period at 15, 30, 45, and 60 cm depth by gravimetric method under the dripper. It was replicated three time. A rain gauge was installed in the field and amount of rainfall was measured daily and all other meteorological parameters of the study area were collected from the nearby meteorological station located 2 km from the study area.

2.5 Field Uniformity Estimation

For the field uniformity estimation, four lateral lines and four emitters on each lateral line in different location were selected. The emitter discharge was measured and calculated the emitter flow rate at two adjacent emitters at each collection point for a fixed time. The average emitter discharge was calculated for each of the 16 locations. Then the emission uniformity was calculated by the following formula [5]:

$$EU_a = 100 [q_{min}/q_{avg} + q_{avg}/q_x] ½$$

Where,

q_{min} = Minimum emitter flow rate (lph)
q_{avg} = Average emitter flow rate (lph)
q_x = Average of the highest $1/8^{th}$ of emitter flow rates (lph)

3. RESULTS AND DISCUSSION

3.1 Field Uniformity

Proper hydraulic design is needed to ensure the successful operation of a drip irrigation system. The emission of uniformity concept, emitter flow variations concept and statistical uniformity concept were the important parameters to evaluate the hydraulic performance of the system. Field evaluation of all these parameters were made at Kalamapalayam village, Thondamuthur block, Coimbatore district for Grapes field.

The absolute field uniformity was estimated as 92.48% (Us>90%) [6] which indicates that the field irrigated in a highly uniform manner. When the Christians uniformity value was 92.7% (Cu>90%) corresponding emitter flow variations was 0.875(EFV =0.83) and these values are above acceptable range.

The value of coefficient of manufacturing variations was found to be 0.08 and the emitter performance in the field was in marginal conditions (CVm=0.08 to 0.10 is marginal). The total coefficient of variations and statistical uniformity were found to be 0.012 and 88% respectively. The statistical uniformity value is between 80 to 90% and it was seen that the statistical uniformity of the drip irrigated field was very high.

3.2 Soil Moisture Status in the Field

The soil samples were collected to determine the soil moisture content on 1,15,30,45,60,75,90, and 105th days from the date of pruning of grapes. Due to rainfall, no irrigation was given in October and November months. The soil moisture status in the field at four depths both for rainy season and during the irrigation period was measured. From the analysis, during rainy season, it can be seen that there is no significant difference in moisture content between the first 0-15 cm depth (D1) and second 15-30 cm depth (D2). Similarly between third (30-45 cm)(D3) and fourth (45-60 cm)(D4) also the differences was insignificant. During the irrigation season, there is no significant difference in moisture level between D2, D3 and D4 depths and the first depth D1 was having less moisture content compared other depths.

The comparative study of the soil moisture profile in the field while irrigated with drip irrigation and the same under precipitation reveals spectacular variations in the moisture regime. The results are illustrated in Fig 2 to 4, The rainy season considered was of duration of 60 days in which the intermittent rainfall was more or less frequent up to 45th day beyond which there was no rainfall. Hence, in the field subjected to rainfall shows high moisture content with respect to depth up to 45th day in the soil is the result of moisture evaporation. In the field, the moisture content has been found to vary between 23 and 16% as reflected by the soil moisture regime during the rainy period. It is apparent that the soil is more or less uniform up to 60 cm depth as revealed by the linear variation in the soil moisture content. The soil moisture profile during the rainy season shows the following. (a) Maximum rainfall occurred on 45th day followed by Ist day, (b) Maximum moisture profile occurred on 60th day followed by 30th day. (c). Soil moisture was in-between on 15th day.

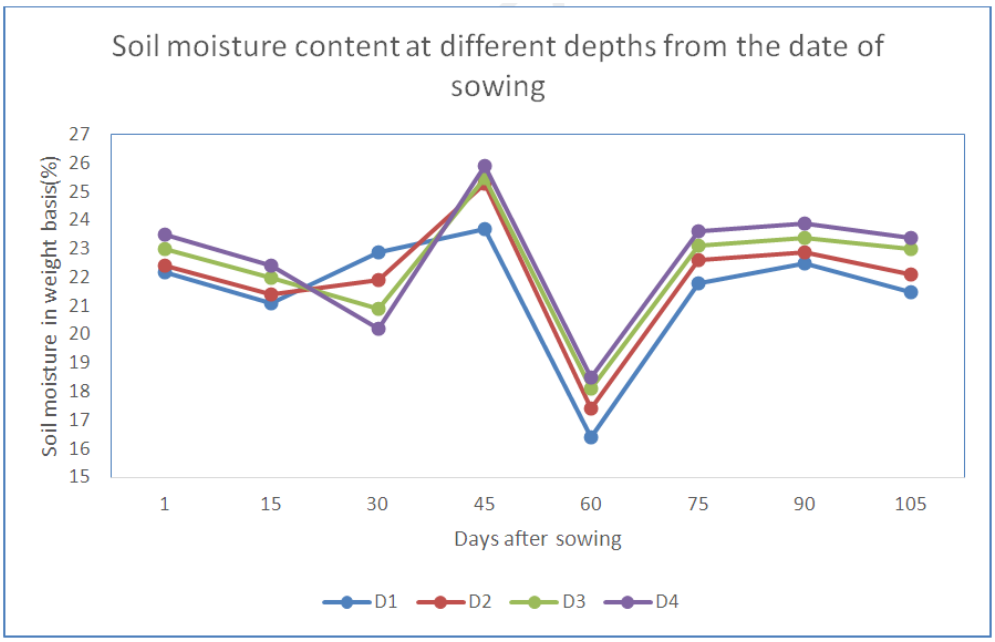

Fig. 2. Soil moisture content at different depths

Table 2. Uniformities of drip irrigation system under Grapes

S.No	Uniformities	Values
1	Absolute field uniformity	92.48%
2	Emitter flow variations	0.875
3	Christians uniformity	92.7%
4	Coefficient of manufacturing variations	0.08
5	Total coefficient of variations	0.012
6	statistical uniformity	88 %

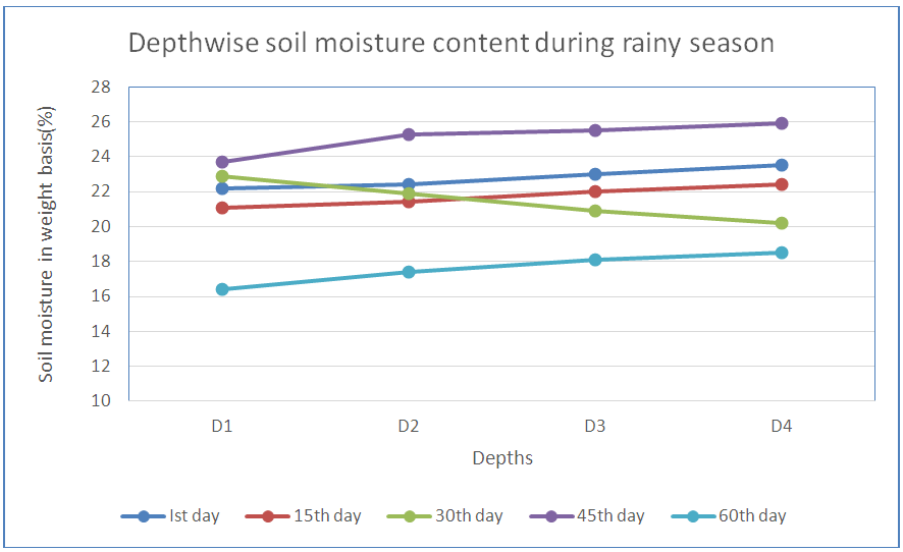

Fig. 3. Depth wise soil moisture content during rainy season

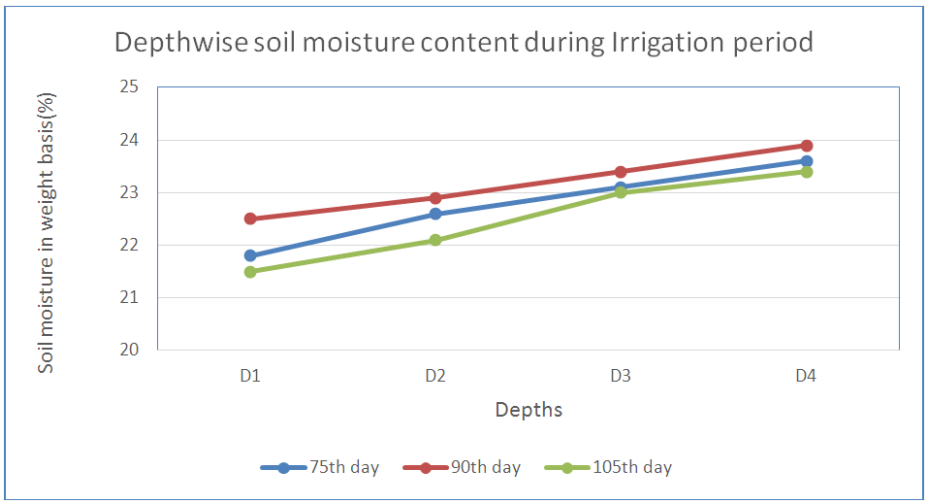

Fig. 4. Depth wise soil moisture content during Irrigation season

In spite of the fact that the rainfall intensity was varying between 2 mm and 21 mm per day, the deep percolation has occurred throughout the depth uniformly. It is to be noted that the hydraulic conductivity of the soil decreased from 6 to 7 cm per hour at the top to 2.3 cm per hour at 60 cm depth uniformly. Hence the gravitational effect is responsible for uniform distribution of moisture in the saturated soil [7].

In the case of the soil moisture profile in the field subjected during drip irrigation shows more or less identical soil moisture content on all 60 days. In contrast to the rainy period, there is

increase in the soil moisture content with respect to depth. And this increase is also identical as reflected by the gradient of soil moisture profile. Secondly in the field under drip irrigation the soil moisture remained in the range of 21 to 23% irrespective of the duration. This reveals that any soil moisture depletion between the intervals either through evaporation or through percolation has not changes the moisture status in the root zone.

3.3 Water Use and Yield

During October and November the rainfall was found to be 13.24 and 7.5 cm respectively. The total water applied during December and January was 15.4 cm and 12.4 cm respectively. The average yield was found to be 27.5 tones/ha and water use efficiency was found to be as 566.00 kg.ha/cm [8].

4. CONCLUSION

The drip field under grapes was taken up to study the system performances. All the uniformity coefficients were found out. They were above acceptable range.

The soil moisture under grape field was monitored at regular intervals. The field was rainfed during the first 2 months (Oct and Nov 2018) and irrigation was given for the next two months (Dec.2018 and Jan. 2019). Then the comparative study of the soil moisture profile in the field for the irrigated and rainy season was made.

The field study has revealed the superiority of the drip irrigated soil regime than that during rainfall season. The moisture retained in the soil in the 60 cm depths ,8was more or less maintained constantly (21-23%) by the drip during the irrigation period whereas the soil moisture fluctuated between 16 and 23% in accordance with the intensity of rainfall during the rainy season. The yield was found at 27.5 tonnes/ha. and water use efficiency was found as 566.00.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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