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Vinuta M Betageri
PhD. Scholar (SWCE), College of Agricultural Engineering, Raichur, UAS Raichur, Karnataka State, India

Dr. SV Kottiswaran
Professor (SWCE) Agriculture Engineering College and Research Institute, TNAU Coimbatore, Tamil Nadu, India

Corresponding Author:
Vinuta M Betageri
PhD. Scholar (SWCE), College of Agricultural Engineering, Raichur, UAS Raichur, Karnataka State, India

Variability in water requirement of grafted brinjal (*Solanum melongena* L.) with plastic mulching under drip irrigation system

Vinuta M Betageri and Dr. SV Kottiswaran

Abstract
Field studies were conducted at PFDC farm, of Tamil Nadu Agricultural University, Coimbatore to evaluate the effect of plastic mulching on grafted brinjal under drip irrigation. The experiments were laid in Strip Plot Design with twenty seven treatments which included three mulching levels such as 25 µ thickness plastic mulch, 50 µ thickness plastic mulch and control; three Irrigation levels at 60 per cent ET_0, 80 per cent ET_0 and 100 per cent ET_0 and three fertigation levels with 80 per cent, 100 per cent and 120 per cent RDF which were replicated thrice. Daily water requirement was calculated based monthly average evaporation the results showed that total water requirement for the growth period under drip irrigation was 396.00 mm with mulch at 80 per cent ET_0 level and 495.00 mm without mulch at 100 per cent ET_0 level. It's observed that treatment gave highest yield of 83.3 $t.ha^{-1}$ under 25 µ thickness plastic mulch at 80 per cent ET_0 level and 100 per cent RDF and lowest yield of 18.1 $t.ha^{-1}$ in control plot with 60 per cent ET_0 and 80 per cent RDF. It can be concluded drip irrigation can save 16.17 per cent of water with mulch as compared without mulch condition.

Keywords: Grafted brinjal, plastic mulch, water requirement, ET_0, Yield

1. Introduction
Water is considered as liquid gold and land is one of the platforms for survival of many living things for performing several activities. Both are the important factors for the survival of life. It is necessary to go for the adaptation of technologies which puts hand in conserving and managing scarce resources in agriculture by giving more importance to production quality as well as quantity. Micro irrigation technology is rapidly expanding all over the world, especially in the water scarce areas of developing countries. The application of irrigation water by traditional method causes 27 to 42 per cent loss of water through deep percolation depending on the soil type **(**Agarwal and Khanna, 1983) [1]. Drip irrigation is an effective tool for conserving water resources and studies have revealed significant water saving ranging ranging between 40 per cent and 70 per cent compared with surface irrigation. Drip irrigation helps to increase water use efficiency by reducing soil evaporation and drainage losses, maintain soil moisture conditions that are favorable to crop growth and helps to sustain the productivity of the land. Productivity can be increased by adopting improved package of practices, particularly *in situ* moisture conservation by mulching.

Brinjal (*Solanum melongena* L.) is a staple vegetable also known as Eggplant (Kantharajah and Golegaonkar, 2004) [6]. India is the second largest producer of brinjal after China with the production of 11.89 million tons production from an area of 0.68 m ha. In Tamil Nadu, it is grown over an area of 12,400 ha with 0.2 million tons during the year 2010-2011 (www.nhb.gov.in).

The technology of vegetable production with grafts was originated in Japan and Korea to avoid serious loss caused by soil borne diseases aggravated by successive cropping (Lee *et al*, 2010) [8]. Grafting is also high effective in ameliorating crop losses caused by adverse environmental conditions (Dimitrios *et al*., 2010) [4]. Cultivation of vegetable grafts is widely recognized and has advantages of disease tolerance and high crop yields (Sakata *et al*, 2007, Lee *et al*., 2010) [10, 8]. This practice is now rapidly spreading and expanding over the world. The number and size of commercial vegetable seedling and grafted plants producers have increased among the farmers (Rouphael *et al*., 2010) [9].

The use of grafting as an integrated pest management tool to manage biotic stress will be most successful when complemented with sustainable farming system practices (Kubota, 2008; Frank *et al*., 2010) [5]. Grafting of brinjal cultivars on perennial and wild species increased the yield and availability period of the fruits.

2. Materials and Methods

The experiment was conducted to study the water requirement on grafted brinjal (*Solanum. melongena* L.) under mulching and drip irrigation system. The materials used, experimental techniques and analytical methods adopted in the investigations are enumerated.

2.1.1 Location

The experiment was conducted at PFDC research farm in the Eastern block of Tamil Nadu Agricultural University, Coimbatore at 11.0183^0 N latitude and 76.9725^0 E longitude with mean altitude of 426 m above the mean sea level, topography of the experimental plot was uniform.

2.1.2 Climate

The mean annual rainfall of the study area is 720 mm. About 55 per cent of annual rainfall is received during North-East monsoon season and 30 per cent during South-West monsoon. The annual maximum and minimum mean temperatures were 32.50 ºC and 20.10 ºC respectively and the average relative humidity of the area is 56.8 per cent the mean daily evaporation ranges from 3.14 mm to 7.05 mm.

The monthly average climatic data of significant weather parameters as maximum and minimum temperature, maximum and minimum relative humidity, pan evaporation (E_{pan}) and rainfall of last 22 years from 1991 to 2013 were collected from Agro Climate Research Centre, Tamil Nadu Agricultural University, Coimbatore.

2.1.3 Crop

The grafted brinjal which was developed by Department of Vegetable Crops at TNAU, Coimbatore by using two *Solanum* species *S. torvum*, known as Turkey berry, was a wild species used as rootstock and the scion was COBH2 and Ravaiya which exhibit the tolerance to shoot and fruit borer incidence and cultivated in all types of soils under water stress conditions in semi-arid regions, got better yield performances and has a vibrant market potential in domestic market. The harvested crop can be used as ratoon crop for the next season.

2.1.4 Soil

The texture of soil is sandy clay loam soil with mechanical composition of clay 30.8 per cent, silt 28.7 per cent, fine sand 19.5 per cent, and coarse sand 20.5 per cent with pH of 8.07, EC of 0.78 dS m^{-1}, available N of 185.6 kg ha^{-1}, available P of 9.0 kg ha^{-1} and available K of 356.7 kg ha^{-1} with water holding capacity of 39.41per cent, Pore space of 42.73 per cent, hydraulic conductivity 0.38cm hr^{-1} and Infiltration rate of 0.73 cm hr^{-1}.

2.1.4.1 Water

Bore well water was used for irrigating the crop which was moderately saline with pH of 7.56 and EC of 1.93 dS m^{-1}.

2.1.5 Drip system

The layout was taken up forming 81 strips of 6 m X 1.2 m size and drip system was installed. The drip system was laid out with 75 mm diameter PVC main pipe line and 63 mm diameter PVC sub main with fertigation tank and venturi. LLDPE laterals of 16 mm diameter were connected to sub main. Each lateral was provided with individual taps for controlling irrigation and fertigation. Along the laterals, online drippers of 4 lph were fixed at the spacing of 1.2 m. Sub mains and laterals were plugged at the end with end caps. After installation, trial run was conducted to assess mean dripper discharge and uniformity coefficient. Morning time was preferred for irrigation since evaporation was less at that time.

2.1.6 Mulching

Black Polythene Mulch (BPM) of 25 µ thickness LLDPE, 50 µ thickness LLDPE were used for the study. Over the drip line, according to the treatment, mulching sheets were spread in each plot and both ends of the plastic sheet were buried into the soil up to a depth of 10 cm and holes were punched.

2.2 Water requirement of grafted brinjal

2.2.1 Water requirement

The daily water requirement was calculated using the equation.

Daily Water Requirement (DWR) =

$$Ep \times Kp \times Kc \times Wp \times A \ldots\ldots\ldots \quad (2.1)$$

Where,

DWR = Computed daily water requirement (lit $plant^{-1}$)
Ep = Average pan evaporation of the day (mm)
Kp = Pan factor (0.8)
Kc = Crop factor
Wp = Wetted percentage (80 per cent)
A = Area per plant

The crop factor values were taken as 0.6 at Initial stage upto 1-10 days, 1.05 for Vegetative stage and Flowering stage for 11-70 days and 0.9 at harvesting stage from 71-180 days.

The water was supplied to the plant daily as per the treatments. Time of operation of drip system to deliver the required volume of water per treatment was calculated using the equation.

$$\text{Time of operation (min)} = \frac{\text{Volume of water require}}{\text{Emitter discharge x No. of emitters}} \quad \ldots. (2.2)$$

2.2.2 Water Use Efficiency

Water Use Efficiency (WUE) was calculated for each treatment, which is the ratio of yield of the crop in Kg ha^{-1} and total water used in m^3.

$$WUE = \frac{Y}{W.A} \quad \ldots (2.3)$$

Where,

WUE = Water Use Efficiency, kg m^{-3} of water used.
Y = Yield of the crop, kg.
W.A = Total water utilized, m^{-3}

3. Results and Discussion

The results of the study on Effect of plastic mulching on water requirement and yield of grafted brinjal under drip irrigation presented and discussed here.

3.1 Water requirement of grafted brinjal

The experiments were conducted with mulch and without mulch condition of under drip irrigation system. The total amount of water applied per plant under different treatments at various crop growth stages of grafted brinjal are calculated by using the equation 2.1 are presented in Table 3.1. Based on soil moisture and plant growth parameters the water requirement was evaluated. The daily water requirement of grafted brinjal at different stages were found to be 1.9 litres per day (Initial stage), 3.6 litres per day (Vegetative stage),

4.2 litres per day (Flowering stage) and 5.2 litres per day (Harvesting stage). It was observed that the water requirement was maximum at harvesting stage.

The rainfall during the crop season was 233.00 mm on 20 rainy days.

On considering the effective rainfall which was for 11 days, the maximum was 44.5 mm. Of the total 180 number of days of irrigation, the water supply to the crop was not given for 13 number of days due to Antecedent Moisture Content.

The studies showed that the total water requirement for growth period in drip irrigation was 396.00 mm for the treatments under mulch and 495.00 mm for the treatments without mulch. On comparing with conventional method of irrigation which consumes 600 mm of water for its growth, with drip irrigation a saving of 33.83 per cent and 17.66 per cent with and without mulch respectively can be achieved.

It can be concluded drip irrigation can save 16.17 per cent of water with mulch as compared without mulch condition, Similar results of increase in saved water for brinjal crop under drip irrigation with different ET levels are in agreement with the findings of Bhogi *et al.* (2011) [3].

Drip irrigation system water utilized was less and this may be due to the fact that maximum amount of water will be stored in the root zone and deep percolation losses will be minimum at lower irrigation levels. These results were in agreement with the findings of Tagar *et al.* (2012) [12].

The water was applied based on monthly average evaporation for last 22 years data from 1991 to 2013, therefore one has to be careful in applying these results because the contributing factors to the water requirement were location specific. If similar conditions exist, one can use these results with suitable allowance so that crop growth and yield are not adversely affected.

3.2 Water Use Efficiency

The effect of mulch, without mulch on water use efficiency are calculated by using equation 2.3 are presented in Table 3.2 and Fig 3.1. The results indicated that mulch treatment T_5 with irrigation level at 80 per cent ET_0 showed the significantly maximum water use efficiency (62.87 kg m^{-3}) as compared to without mulched treatment T_{19} with irrigation at 60 per cent ET_0 (19.38 kg m^{-3}). The minimum water use efficiency was found in treatment under control plot.

It is observed that water use efficiency was more in treatments with irrigation level at 80 per cent ET_0 with under 25µ thickness plastic mulch condition when compared with irrigation level at 100 per cent ET_0 and also irrigation level at 60 per cent ET_0 under without mulch condition.

Table 3.1: Amount of water applied under different treatments at various crop growth stages of grafted brinjal.

Stage	Amount water applied at different irrigation levels, (l per plant)					
	Irrigation Levels.	**60 per cent**		**80 per cent**		**100 per cent**	
	25 micron LLDPE mulch	T_1, T_2, T_3,		T_4, T_5, T_6,		T_7, T_8, T_9,	
	50 micron LLDPE mulch	T_{10}, T_{11}, T_{12},		T_{13}, T_{14}, T_{15},		T_{16},T_{17}, T_{18},	
	No mulch	T_{19}, T_{20}, T_{21}		T_{22}, T_{23}, T_{24}		T_{25}, T_{26}, T_{27}	
		Per day	Per stage	Per day	Per stage	Per day	Per stage
Initial stage (0-10 days)		1.20	12.00	1.6	16.00	1.9	19.00
Vegetative Stage (11-40 days)		2.10	63.00	2.9	84.00	3.6	105.00
Flowering Stage (41-70 days)		2.50	76.00	3.4	101.00	4.2	126.00
Harvesting Stage (71-180 days)		3.10	278.00	4.1	371.00	5.2	462.00
Total			429.00		572.00		712.00

Table 3.2: Water Use Efficiency under different treatments.

Treatments	Total yield (kgha^{-1})	WUE (kg m^{-3})
T_1	42500	36.14
T_2	53900	39.25
T_3	50400	38.04
T_4	73800	48.03
T_5	83300	62.87
T_6	81100	61.21
T_7	65300	43.06
T_8	69400	45.50
T_9	64000	42.11
T_{10}	37400	35.97
T_{11}	52000	38.81
T_{12}	48500	37.05
T_{13}	57300	40.93
T_{14}	79200	55.70
T_{15}	71000	46.15
T_{16}	59600	42.09
T_{17}	67500	43.25
T_{18}	61100	41.13
T_{19}	18100	19.38
T_{20}	26300	28.16
T_{21}	21900	23.45
T_{22}	29800	31.91
T_{23}	33600	34.26
T_{24}	32000	32.69
T_{25}	43100	36.60
T_{26}	55800	40.04
T_{27}	54500	39.60

Mean	53052		40.12	
Effects	S.Ed	CD (0.05)	S.Ed	CD (0.05)
M	1832.14	5086.92**	1.12	3.13**
I	1425.83	3958.81**	0.97	2.69**
M x I	2286.86	5273.57**	2.42	5.58**
F	1766.82	3583.67**	1.14	2.32**
M x F	2627.85	5955.55*	1.98	5.21**
I x F	2627.85	5955.55*	1.98	5.21**
M x I x F	5024.79	10749.43*	3.44	7.9**

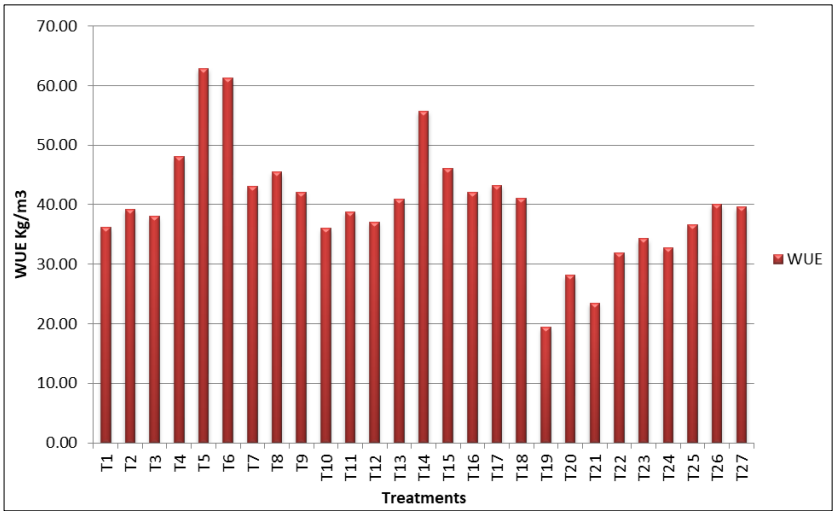

Fig 3.1 Water Use Efficiency under different treatments.

These result was in line with the findings of Seyfi *et al.* (2007) [11], which showed that drip irrigation with black plastic mulch markedly decreased the amount of water applied, increased water use efficiency and increased crop yield due to increase in number of fruits per plant, fruit weight and fruit thickness.

The water use efficiency increased with increase in the yield and decreased with the increase in irrigation level. It was observed that the highest water use efficiency was observed in mulched condition and low in without mulched condition. This was due to the fact that under mulched treatment evaporation losses were prevented which result in higher amount of water available for plant use than the without mulch treatment. The water use efficiency was 12.2 per cent more than the without mulched plot. A similar result had been reported by Baye Berihun (2011) [2].

4. Conclusion

The daily water requirement of grafted brinjal at different stages were found to be 1.9 litres per day (Initial stage), 3.6 litres per day (Vegetative stage), 4.2 litres per day (Flowering stage) and 5.2 litres per day (Harvesting stage). The studies were found the total water requirement for growth period in drip irrigation was 396.00mm with mulch at 80 per cent ET_0 level and 495.00mm without mulch at 100 per cent ET_0 level, so can conclude that drip irrigation can save 16.17 per cent of water with mulch as compared to without mulch condition.

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