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Impact of mulching and fertigation on growth and yield of grafted brinjal (*Solanum melongena* L.) under drip irrigation system

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Abstract
The aim of this investigation was to study the impact of mulching and fertigation on growth and yield of grafted brinjal (*Solanum melongena* L.) under drip irrigation system. There were 18 treatments replicated thrice in a Strip Plot Design with three factors viz., plastic mulching, fertigation levels and irrigation levels. The result unveiled that, application of plastic mulching and fertigation treatments showed significantly enhanced plant height, number of branches, fruit weight, number of fruits and yield. Application of fertilizers through drip ensures proper utilization and results in better yield. Plastic mulching along with drip fertigation, control weeds and further increases the efficiency of the system.

Keywords: Grafted brinjal, Plastic mulching, Fertigation, Drip irrigation, Yield

Introduction
Brinjal (*Solanum melongena* L.) is an important vegetable crop cultivated throughout India. It is popular amongst small-scale farmers and low income consumers due to its wider adaptability and low price often described as poor man's vegetable. India is the second largest producer of brinjal after China with the production of 15.57 million tons production from an area of 0.71 m ha (NHB 2014). In Tamil Nadu, it is grown over an area of 10,300 ha with 0.11 million tons during the year 2012-2013. Grafting technology has been utilized to obtain plants with higher fruit quality and yield (Lee, 1994) [11]. Grafting represents a viable alternative to solve the issues related to biotic and abiotic stresses in vegetable cultivation (Lee and Oda, 2003; Davis *et al.*, 2008) [12, 4].

Desirable effects of plastic mulching are Weed control, temperature moderation, salinity reduction, which increases the utilization of plastic mulching in vegetable cultivation. The notable advantage of the use of plastic mulch is its impermeability which prevents direct evaporation of moisture from the soil and thus reduces the water losses. Plastic like HDPE, LDPE and LLDPE materials has been used as plastic mulch.

Water is a major input for agricultural production. In the current situation, it is a scarce resource and there exists a large gap in terms of water available and its requirement for irrigation of crops. Adoption of innovative irrigation techniques can increase the efficiency of water usage. Drip irrigation is the most effective way to supply water and nutrients to the plant, which not only saves water but also increases yield of fruits and vegetable crops (Tiwari *et al*., 1998; Hatami *et al*.,2012; Nadiya *et al*., 2013; Iqbal *et al*., 2014) [20, 6, 15, 8]. This water saving is because maximum amount of water is stored in the root zone and deep percolation losses are minimized (Bhogi *et al*., 2011) [3].

The adequate management of fertilizers is one of the main factors that affect the cultivation of eggplant to meet the requirements of the crop. An incorrect fertilization management leads to contamination of underground water and it is not possible to attenuate the salinization of the soils. Fertigation allows nutrient placement directly into the plant root zone during critical periods in the required dose (Singandhupe *et al.*, 2003; Jat, *et al*., 2011) [18, 9]. Application of high dose of fertilizers not only causes economic loss but also leads to chemical changes in the soil and reduces the yield. Fertilizer requirement can be reduced by 15-25 percent with fertigation through drip without affecting the yield (Hongal and Nooli, 2007) [7].

Based on the above, this study was aimed to evaluate the response of the grafted brinjal, with respect to growth and yield under mulch with different fertigation and drip irrigation levels.

Materials and Methods

The field experiment was conducted during 2016 -17 at PFDC research farm in the Eastern block of Tamil Nadu Agricultural University, Coimbatore, to find out the impact of mulching and fertigation on growth and yield of grafted brinjal (*Solanum melongena* L.) under drip irrigation system. The grafted seedlings are planted at a spacing of 1.2 x 1.2 m. The experiment was laid out in strip plot design with three factors. 1. Mulching levels *viz.,* 25 micron black plastic mulch and no mulch. 2. Irrigation levels *Viz.,* 60 per cent, 80 per cent and 100 per cent. 3. Fertigation levels *Viz.,* 80 per cent, 100 per cent and 120 percent RDF. There were 18 treatments and replicated thrice. Plants were tagged in each treatment for biometric observation and the data were statistically analyzed and interpreted.

Results and Discussion

The observations on plant height, Number of branches, Number of fruits per plant, fruit weight and yield parameters were recorded and analyzed statistically. The data recorded on plant height under different treatments at 15, 30, 60 and 90 days are presented in Table 1. Plant height was recorded at 15 days after transplanting (DAT) showed that the maximum plant height of 17.21 cm was observed under 25 µ thickness plastic mulch at 80 per cent ET_0 level with 100 per cent RDF (T_5) and 120 per cent RDF (T_6) and lowest height of 11.76 cm was recorded in the control treatment $T_{10.}$ Irrigation and fertilizer levels on the plant height and they are significant in their interaction. The results indicated that at 30 days after transplanting, the mulch treatment was significantly maximum (34.80 cm) as in case of 15 DAT than the without mulch treatments. The minimum height (19.50 cm) was observed in control treatment at irrigation level of 60 per cent ET_0 with fertigation level of 100 per cent RDF.

Similar trend were observed in 60 DAT and at the time of harvest and also they were significant in their interactions. The better plant growth was due to favorable moisture conditions and these results are in agreement with the findings of Muthuchamy *et al.* (1993) [14]. This might be due to more transpiration from the broader leaf area in plastic mulch and even it suppresses the evaporation of water (Zhong-kuiXie *et al.*, 2005) [21]. Also the mulch plots showed less weed growth and soil moisture was maintained throughout the crop period thus reducing quantum of water.

The most important growth parameters which determined the productivity was directly related to canopy of crops. The treatments under mulch had higher plant height, number of leaves and Leaf Area Index than the without mulch plot under different levels of irrigation and fertilizer. Thus the mulch treatment exhibited better plant growth parameters. The results were concord with the findings of Ashrafuzzaman *et al.* (2011) [1].

Table 1: Plant height under different treatments

Treatments	15DAT		30DAT		60DAT		90DAT	
T_1	13.50		27.51		39.54		48.98	
T_2	15.20		29.30		45.54		82.00	
T_3	13.67		27.35		43.52		75.89	
T_4	16.50		33.60		53.23		61.64	
T_5	17.21		31.35		51.50		92.38	
T_6	17.11		34.80		55.00		94.25	
T_7	15.50		31.00		50.20		88.21	
T_8	16.30		32.55		51.20		90.00	
T_9	15.98		31.58		48.89		86.66	
T_{10}	11.76		19.50		33.05		38.45	
T_{11}	12.66		23.95		35.90		39.98	
T_{12}	13.55		23.78		33.90		38.57	
T_{13}	13.00		23.96		35.98		42.12	
T_{14}	14.45		25.89		37.65		44.00	
T_{15}	14.54		24.98		36.80		43.00	
T_{16}	13.69		26.60		39.55		50.05	
T_{17}	15.30		29.80		46.01		80.00	
T_{18}	14.98		28.58		45.00		82.15	
Mean	**14.82**		**28.11**		**43.47**		**65.46**	
Effects	**S. Ed**	**CD (0.05)**	**S. Ed**	**CD (0.05)**	**S. Ed**	**CD (0.05)**	**S. Ed**	**CD (0.05)**
M	0.11	0.50**	0.26	1.13**	0.59	2.58**	0.38	1.67**
I	0.12	0.35**	0.20	0.56**	0.15	0.42**	0.87	2.42**
M x I	0.10	0.28**	0.31	0.88**	0.47	1.30**	1.27	3.52**
F	0.11	0.22**	0.23	0.49**	0.38	0.78**	0.51	1.05**
M x F	0.15	0.32**	0.33	0.69**	0.53	1.11**	0.72	1.49**
I x F	0.19	0.39**	0.41	0.85**	0.66	1.36**	0.88	1.83**
M x I x F	0.27	0.55**	0.58	1.20**	0.93	1.92**	1.25	2.59**

Number of primary branches was collected on 30th, 60th and 90th DAT of crop period and it is presented in the Table 2. Mulching had a significant effect on the number of primary branches per plant. The number of structural branches increased with plant age. All mulch treatments had positive effect on generating and retaining higher number of branches per plant. Highest number of branches were found in T_5 (6, 13, 22) i.e. 25µ thickness plastic mulch at 80 per cent ET_0 with 100 per cent RDF followed by T_6 (5, 10, 17) under 25µ thickness plastic mulch at 120 per cent RDF. Least number of primary branches was found in without mulch (2, 4, 6) i.e. without mulch at 60 per cent ET_0 with 80 per cent RDF. Interaction of all as irrigation, fertilizer and mulching the three factors showed significant effect on the number of primary branches per plant.

The highest number of structural branches per plant was observed in treatments under 25µ plastic than without mulch. Highest number of branches per plant was obtained due to

favorable environmental conditions and higher moisture of soil condition around root zone. This was in corroboration with the studies of Srivastava *et al.* (1994) [19] that mulched plants had more number of branches than without mulch.

Table 2: Number of branches per plant under different treatments

Treatments	30DAT		60DAT		90DAT	
T_1	2		5		8	
T_2	3		6		9	
T_3	3		6		9	
T_4	4		8		14	
T_5	6		13		22	
T_6	5		10		17	
T_7	3		7		10	
T_8	4		8		9	
T_9	3		7		10	
T_{10}	2		4		6	
T_{11}	2		4		7	
T_{12}	2		4		8	
T_{13}	2		4		7	
T_{14}	2		5		9	
T_{15}	2		4		7	
T_{16}	2		5		7	
T_{17}	3		7		9	
T_{18}	3		6		9	
Mean	2.94		6.27		9.83	
Effects	S. Ed	CD (0.05)	S. Ed	CD (0.05)	S. Ed	CD (0.05)
M	0.02	0.10**	0.00	0.02**	0.06	0.27**
I	0.01	0.03**	0.34	0.09**	0.07	0.21**
M x I	0.02	0.06**	0.08	0.23**	0.11	0.30**
F	0.02	0.05**	0.04	0.10**	0.07	0.16**
M x F	0.03	0.08**	0.06	0.14**	0.11	0.22**
I x F	0.04	0.09**	0.08	0.17**	0.13	0.28**
M x I x F	0.06	0.14**	0.12	0.24**	0.19	0.39**

The data regarding highest individual fruit weight (85. 62 g) was found in T_5 i.e., 25 µ plastic mulch at 80 per cent ET_0 level with 100 per cent RDF which was followed by T_6 (80.00 g) and the lowest individual fruit weight was recorded in T_{10} (38. 00 g). Statistical analysis showed that all the three factors had a significant effect on the individual fruit weight in there interaction.

A maximum of 265 fruits per plant (T_5) were obtained for the treatment 25µ thickness at 80 per cent ET_0 level with 100 per cent RDF followed by T_6 (25µ thickness at 80 per cent ET_0 level with 120 per cent RDF) and the least number of fruits per plant (55) was recorded in control at 60 per cent ET_0 with 80 per cent RDF. Treatments under mulch produced more fruits per plant compared to control.

The statistical analysis depicted that all the three factors i.e., mulching, irrigation and fertilizer levels and there interaction showed significant effect on the total number of fruits. This increase in the number of fruits per plant was probably associated with the conservation of moisture, reduced number of weeds and improved microclimate both beneath and above the soil surface. These results were similar to studies conducted by Awodoyin *et al.* (2007) [2] and Narendra Agrawal *et al.* (2010) [16] where the yield attributing characteristics like number of fruits per plant, fruits per cluster, diameter of fruits and weight of fruits under polythene mulch were found to be highest and same characters were lowest in control.

The maximum yield was observed in the treatment T_5 (12.45 kg) followed by T_6 (11.97 kg) and the lowest fruit yield of 2.9 kg was observed in T_{10} i.e., control at 60 per cent ET_0 with 80 per cent RDF. The three factors and interactions showed significant effect on the fruit yield per plant. Among the treatments at different irrigation levels the 80 per cent ET_0 with 100 per cent RDF was recorded the maximum yield and the minimum yield was recorded in control plot at irrigation level 60per cent ET_0 and fertigation level of 80 RDF. The complimentary soil moisture which was easily available through drip by directly to the root zone, improves growth and productivity of the crop. The results are in line with the findings of Jinhui *et al.* (1999) [10].

Table 3: Fruit weight, Number of fruits and yield per plant under different treatments

Treatments	Fruit weight (g)		Number of Fruits per plant		Yield per plant (kg)	
T_1	46.50		140		6.50	
T_2	47.98		172		7.86	
T_3	48.22		161		7.25	
T_4	68.21		230		11.00	
T_5	85.62		265		12.45	
T_6	80.00		256		11.97	
T_7	58.00		208		10.00	
T_8	63.00		212		11.50	
T_9	56.54		205		9.85	
T_{10}	38.00		55		2.9	
T_{11}	38.33		80		4.00	
T_{12}	36.67		69		3.24	
T_{13}	41.00		94		4.50	
T_{14}	45.00		109		4.84	
T_{15}	41.33		105		4.61	
T_{16}	46.33		136		6.65	
T_{17}	54.25		178		8.03	
T_{18}	42.52		175		7.88	
Mean	52.08		158.3		7.50	
Effects	S. Ed	CD (0.05)	S. Ed	CD (0.05)	S. Ed	CD (0.05)
M	0.54	2.35**	0.63	2.72**	0.02	0.08**
I	0.45	1.26**	0.96	2.67**	0.07	0.20**
M x I	0.35	0.97**	2.74	7.63**	0.03	0.09**
F	0.34	0.72**	1.35	2.80**	0.07	0.15**
M x F	0.49	1.02**	1.92	3.96**	0.10	0.22**
I x F	0.60	1.24**	2.35	4.85**	0.13	0.27**
M x I x F	0.85	1.76**	3.32	6.86**	0.18	0.39**

The drip fertigation treatments with 100 per cent RDF showed a statistically significant higher yield compared with other drip fertigation treatments. This can be explained by the fact that water and nutrients are supplied directly to the root zone of the crop in drip fertigation. Hence leaching is reduced thereby increasing the availability of nutrients to the plants. Hagin *et al.* (2002) [5] had reported that in a fertigation system, the timing, amount, concentration and ratio of the nutrients are easily controlled and higher crop yield is achieved than those produced by conventional fertilizer application and irrigation. Studies by other investigators had reported on different crops higher yields in drip fertigation on comparison with conventional irrigation and fertigation.

The yield of plants which are grown in control was significantly lower than those grown in mulch. Increased temperature inside the soil and efficient utilization of water, fertilizers and nutrients resulting from the use of the plastic mulch may be an important reason for higher yield. The results are in corroboration with the studies conducted by Mukherjee *et al.* (2010) [13].

Conclusion

The present study indicated that drip irrigation 80% ET_0 level, 100% RDF with 25µ plastic mulch condition resulted in higher yield. Combination of drip irrigation with plastic mulch enhance the soil moisture availability, was achieved by the prevention of water loss through evaporation. This was employed to achieve higher water use efficiency in mulch condition than control. The fertilizer use efficiency also increased considerably under drip fertigation than direct application. This can be due to improved distribution of fertilizer with minimum leaching beyond the root zone. Hence, drip fertigation with mulch was appropriate and efficient method for grafted brinjal cultivation than conventional.

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