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Response of brinjal (*Solanum melongena* L.) to drip irrigation and plastic mulching

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Brinjal is an indigenous vegetable crop grown in the subtropics and tropics. It is one of the most important, widely grown and mostly consumed with distinct preferences for their types and is being commercially cultivated in almost all frost free areas. Being indigenous to India and wide popularity, a number of brinjal hybrids and cultivars are under cultivation throughout the country, including Punjab which differ based on yield, fruit quality (taste, seed to pulp ratio, shelf life, moisture content, blossom-end scar size, etc.) and consumers' preference (colour, shape, size and shining of fruit, spininess, calyx colour, etc.) (Prasad et al. 2010). In Punjab, it was grown on an area of 3370 ha with average yield of 21.2 t/ha (Anonymous 2015). In Punjab, brinjal can be transplanted at four different times i.e. first fortnight of November, first fortnight of February, end of April and in mid August. Most of the vegetable crops require light but frequent irrigations. In rainy season application of light irrigation is difficult, when irrigation is applied and subsequently it is followed by rainfall and leaching of applied fertilizer also occurs. Weed growth is another major problem in rainy season crop. Water availability for agricultural use is decreasing due to increasing population and industrialization particularly in developing countries. Drip irrigation is one such technology which can help to increase the irrigation potential by optimizing use of available water. It is a method of watering the plants frequently and with optimum volume of water to meet the consumptive use of plants, resulting in minimum conventional losses such as conveyance, deep percolation, runoff and soil evaporation (Bhogi et al. 2011). Similarly, Aujla et al. (2006) reported that under drip irrigation maximum fruit yield of eggplant was obtained at 75% of the cumulative pan evaporation with 100% of the recommended dose of fertilizer nitrogen (120 kg N/ha). Drip irrigation resulted in 23 % higher yield than that obtained under furrow irrigation with saving of 25% water and 30 kg N/ha. Awasthi et al. (2006) reported that use of black as well as white polyethylene mulch recorded better soil moisture content 30 cm below the mulch as compared to control (no mulch) plots. Brinjal crop grown with use of both these mulches produced more number of fruits per plant and significantly higher fruit yield (832 g/plant in black, 536 g/plant in white mulch) as compared to control plot (135 g/plant). Hence, keeping these points in view an experiment was planned with the objectives to study the effect of mulching and drip fertigation on the performance of brinjal.

A field experiment on brinjal crop was conducted during *kharif* season of 2013 and 2014 at the Research Farm, Department of Soil and Water Engineering (30°56' N, 75°56' E and 247 m above mean sea level), Punjab Agricultural University, Ludhiana. The soil of the experimental site was loamy sand in texture with normal soil pH (7.9) and electrical conductivity (0.20 d Sm^{-1}), low in organic carbon (0.30%), available N (108.5 kg ha^{-1}) and K (121.5 kg ha^{-1}) but high in available P (20.3 kg ha^{-1}). The experiment was laid out in split plot design with three replications. The main plot treatments comprised plastic mulch and no-mulch and sub-plot treatments included three drip irrigation levels viz. 1.0 time crop evapotranspiration {ETc} (DI_1), 0.8 time ETc (DI_2) and 0.6 time ETc (DI_3). The crop was sown during the fourth season i.e. seeds were sown in nursery beds in mid July and transplanting was done in mid August. Crop was harvested in 27 pickings, the first picking was done on 27th September 2013 while last picking was done on 24th December 2013 and during the second year crop was harvested in 28 pickings with last picking on 31st December 2014. Manually transplanted crop on ridges with furrow irrigation and fertilizer application 62.5 kg N, 62.5 kg P_2O_5 and 30 kg K_2O/ha applied as basal (at the time of transplanting) and 62.5 kg N /ha applied after two pickings of fruit were taken, was

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considered as conventional treatment as practiced by the farmer. All the NPK 80 % of recommended dose of fertilizer (RDF) was applied through fertigation with 20 % in the first month after transplanting and rest of the fertilizer was applied in split doses till first week of December. The drip irrigation was carried out on every 2nd day and fertigation was done on every 4th day. The row to row and plant to plant spacing was 45 and 40 cm, respectively on a bed. For collection of data on plant height and plant spread five plants were tagged in each plot. The data on plant growth parameters viz. plant height and plant spread in East–West (E-W) and North–South (N-S) direction is presented in Table 1.

The plant height was significantly affected by plastic mulching. The plants grown with plastic mulch recorded significantly higher plant height during both the years. However, mulching failed to affect the plant spread in either E-W or N-S direction of the measurement during both the years. Among the irrigation treatments plant height was significantly influenced during the first year. However, plant spread in E-W direction was significantly influenced during second year (Table 1). The plant spread in N-S direction was not significantly influenced by different irrigation regimes during the two year of study. The data revealed that fruit yield was significantly influenced by plastic mulching. During both the years plastic mulch application recorded significantly higher yield (716.7 and 777.4 q/ha) as compared to no mulch plot (655.2 and 708.5 q/ha). On the basis of mean yield data it was observed that brinjal crop planted with plastic mulch recorded 9.6 percent higher yield than no mulch plot. The higher yield obtained was because of reduced weed growth, thereby reducing competition for water and nutrients between crop and weeds. Less fruit damage to crop by borer which resides below the soil was also observed under plastic mulch conditions. Awasthi et al. (2006) also reported significant increase in fruit yield under plastic mulching as compared to no mulch or control plot. Among the different irrigation regimes also significant differences were observed for fruit yield. All the drip fertigated plots recorded significantly higher fruit yield as compared to conventional furrow irrigated brinjal crop. Among the drip fertigation plots DI_1 treatment recorded highest fruit yield, which was statistically at par with DI_2. However, further reduction in irrigation water applied (DI_3) resulted in significant reduction in the fruit (640.5 q/ha). On the basis of two year mean of the data, the increase in fruit yield under drip fertigation was 46.9, 63.6 and 69.7 percent in DI_3, DI_2 and DI_1 irrigation regimes as compared to conventional furrow irrigated crop (435.9 q/ha).

The interaction effects revealed that brinjal plants grown on black plastic mulch attained 62.5 cm plant height with irrigation regime of DI_3 while statistically similar plant height (65.6) was recorded under no mulch with irrigation regime of DI_1 (Table 2a). Similarly for fruit yield the interaction effects were significant, which showed that under no mulch condition yield obtained under DI_2 was statistically at par with that obtained with plastic mulch with irrigation regime DI_3. However yield obtained at irrigation DI_3 with plastic mulch application (639.8 q/ha) was also at par with no mulch application under same irrigation regime (616.5 q/ha), indicating that application of mulch did not saved the irrigation water to considerable extent (Table 2b). The results confirm the findings of Bhogi et al. (2011) and Aujla et al. (2006), where it has been reported that brinjal fruit yield was significantly improved with drip fertigation

Table 2a: Interaction effect of mulching and irrigation regimes on plant height

Treatments	Plant height (cm) 2013			
	DI_1	DI_2	DI_3	Mean
Black plastic Mulch	67.2	68.1	62.5	65.9
No mulch	65.6	59.0	57.0	60.5
Mean	66.4	63.5	59.7	
Conventional furrow irrigated		53.3		
CD (p=0.05%)	I = 4.9	M = 2.2	I*M = 3.9	

Table 1: Growth and yield of brinjal as influenced by plastic mulch and different irrigation regimes

Mulch treatment	Plant height (cm)		Plant spread E-W (cm)		Plant spread N-S (cm)		Fruit yield (q/ha)		
Black plastic mulch	2013	2014	2013	2014	2013	2014	2013	2014	Mean
	65.9	68.7	67.7	59.9	73.3	62.9	716.7	777.4	747.1
No mulch	60.5	63.2	65.1	57.9	68.5	60.8	655.2	708.5	681.9
CD (p=0.05%)	2.2	5.4	NS	NS	NS	NS	27.4	46.7	--
			Irrigation treatment						
DI_1	66.4	68.7	66.9	61.7	73.8	63.2	722.7	756.9	739.8
DI_2	63.5	65.9	68.5	60.9	73.5	61.6	706.9	819.2	763.1
DI_3	59.8	63.3	63.9	53.9	65.5	60.7	628.1	652.8	640.5
CD (p=0.05%)	4.9	NS	NS	3.7	NS	NS	42.4	--	--
Conventional furrow irrigated	53.3	48.4	53.0	44.0	53.0	48.0	447.9	423.8	435.9

Table 2b: Interaction effect of mulching and irrigation regimes on fruit yield

Treatments	Yield (q/ha) 2013			
	DI_1	DI_2	DI_3	Mean
Black plastic Mulch	747.1	763.0	639.8	716.7
No mulch	698.3	650.7	616.5	655.2
Mean	722.7	706.9	628.1	
Conventional furrow irrigated	447.9			
CD (p=0.05%)	I = 42.4	M = 27.4	I*M = 47.4	

over furrow irrigated crop. The data in general revealed that depth of irrigation water applied in no mulch plot was less as compared to plastic mulched plot. This was because of the reason that under plastic mulching effective rainfall was negligible, as most of the water flowed as runoff, thus not contributing to consumptive use of the crop. On the contrary, in no mulch plots the rainfall contributed to the consumptive use of water by the crop. The irrigation regime of DI_3 with no mulch application recorded maximum saving in the amount of irrigation water applied as compared to plastic mulch plot, which was to the tune of 17.3% and 13.3% during 2013 and 2014, respectively (Table 3). The other irrigation regime DI_2 under no mulch application also saved irrigation water by 14.7 and 10.3 percent as compared to plastic mulch application in respective years while DI_1 recorded the least saving in irrigation water under same treatments which was 11.1% and 8.4% during 2013 and 2014 respectively.

During 2013, drip irrigation along with use of black plastic mulch saved irrigation water to the tune of 32.5%, 43.8% and 56.5% under DI_1, DI_2 and DI_3 respectively as compared to conventional furrow irrigation. However, under no mulch application drip irrigation under same irrigation regimes enhanced the water saving to 40.0%, 52.0% and 64.0%, respectively as compared to conventional furrow irrigation. Similarly during 2014 use of black plastic mulch with drip irrigation saved the irrigation water to the tune of 28.4%, 41.6% and 54.8% under DI_1, DI_2 and DI_3 as compared to conventional furrow irrigation. But further, drip irrigation with no mulch application the water saving was enhanced to the tune of 34.4%, 47.5% and 60.6% under same irrigation regimes as compared to conventional furrow irrigation. This was so because under no mulch application the effective rainfall component was significantly higher than under plastic mulch application.

Table 3: Comparison of irrigation water applied in different irrigation regimes under plastic mulch and no mulch

Irrigation treatments	Depth of water applied (cm)				Water saving over conventional furrow irrigation (%)			
	2013		2014		2013		2014	
	Mulch	No mulch	Mulch	No mulch	Mulch	No mulch	Mulch	No mulch
DI_1	27.0	24.0	35.8	32.8	32.5	40.0	28.4	34.4
DI_2	22.5	19.2	29.2	26.2	43.8	52.0	41.6	47.5
DI_3	17.4	14.4	22.6	19.6	56.5	64.0	54.8	60.6
Conventional Furrow irrigation	40	50						

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