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Effect of mulching and drip irrigation levels on growth and yield of chilli (*Capsicum annum* L.)

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Abstract
Field experiment was conducted during the period 2012 to 2015 at JVR Horticulture Research Station Malyal, Mahabubababd, Sri Konda Laxman Telangana State Horticultural University, Rajendranagar. To study the effect of mulching and drip irrigation levels on growth and yield of chilli (*Capsicum annum* L.). The experiment were laid out in factorial randomized block design with irrigation levels 7000, 9000, 11000 lt/Acre/day and two different mulching treatments 50 µ black polythene mulch (BPM) and no mulch which were replicated thrice. The maximum yield of 163.24 no. of fruits per plant which is worked out as 7.79 t/ha was observed for the treatment T_5. (Mulching +9000 lt/Acre/day). The other observations like plant height (124.19 cm), no. of branches (9.00), No. of fruits per plant (163.24), fruit weight (23.88 g), yield per plant (3.90 kg) are also significantly highest recorded in T_5 (Mulching +9000 lt/Acre/day) compared with the other treatments.

Keywords: black polythene mulch, drip irrigation, growth, yield, chilli

Introduction
Chilli (*Capsicum annum* L.) is the source of natural pungent compounds capsaicin, coloring compounds capsorubin and vitamin-C. It is known for its commercial and therapeutic value. India stands first in chilli cultivation covering 45 % of the world, but the productivity of dry chilli in lower (0.9 t/ha) as compared to world average (2.0 t/ha). There in tremendous demand for Indian cultivars in the international market that provides wide scope to increase export.
In recent trends in our nation, the irrigated area consists of about 36 per cent of the net sown area. Presently the agricultural sector accounts for about 83 per cent of all water uses. Increasing competition with the other users in the future would be limiting the water availability for expanding irrigated area. Mark *et al.* (2002) [5] reported that by the year 2025, 33 per cent of Indian's population will live under absolute water scarcity condition. The per capita water availability in terms of average utilizable water resources in the country was 6008 m^3 in 1947 and in expected to dwindle to 760 m^3 by 2025 (Kumar, 2003) [4].
Drip irrigation involves supplying water to the soil very close to the plants at very low flow rates (0.5 to 10 lph) from a plastic pipe fitted with outlets (emitters). Drip irrigation results in a very high water application efficiency of about 90 to 95 %.
Mulching is the process of covering the soil to make more favourable conditions for plant growth, development and efficient crop production. Black plastic mulch is used most widely because it show down weed growth, resulting in less chemical usage, recorded the lowest number of weeds in black plastic mulch (Ashrafuzzamm *et al.*, 2011). Black plastic mulch raise soil temperature quickly, so the plants can increase growth resulting in earlier and higher yields (possibly up to 15 per cent or more) compared to bare ground production (Wallace *et al.*, 1996).

Materials and Methods
Present investigation carried on "Effect of mulching and drip irrigation levels on growth and yield of chilli (*Capsicum annum* L.)" at JVR Horticultural Research Station, Mahabubabad (Dist.), Sri Konda Laxman Telangana State Horticultural University, Rajendranagar, Hyderabad. The proposed research work was laid out during 2012-2015 under irrigated condition to study the effect mulching and drip irrigation levels on growth and yield of chilli (*Capsicum annum* L.) on sandy clay loam soil.
The experimental plot was thoroughly ploughed with disc plough and tilled with cultivator to bring optimum soil tilth. The plot size is 3 x 1.2 m according to the treatments the spacing of 60 x 60 cm. the recommended package of practices of chilli is adopted.

Design and treatments
The experiment was laid out in factorial randomized block design having six treatments

combination consists of three irrigation levels and two mulching treatment and was replicated thrice.

Details of Experiment

Design : FRBD
Replications : 3
Spacing : 60 x 50 x 50 cm (Paired row system)
Plot size : 3 x 1.2 mt
Variety : Teja

Treatment Details

Treatment	Code	Treatment details
T_1	M_0I_1	Without mulching+7000 lit/Acre/day
T_2	M_0I_2	Without mulching+9000 lit/acre/day
T_3	M_0I_3	Without mulching+11000 lit/Acre/day
T_4	M_1I_2	25 micron Mulch+7000 lit/Acre/day
T_5	M_1I_2	25 micron Mulch+9000 lit/Acre/day
T_6	M_1I_3	25 micron Mulch+11000 lit/Acre/day

Irrigation scheduling

Irrigations were scheduled on the basis of climatologically approach on mulch and control plots. Life saving irrigation was given immediately after transplanting and the field was regularly irrigated continuously for ten days. After the tenth day, subsequent irrigations were scheduled once in three days based on the following formula and applied each time as per the treatment schedule. The discharge rate of single dripper is 4 lph at nominal operating pressure of 50.66 kpa.

$$WR_c = CPE \times K_p \times K_c \times W_p \times A$$

Where,
WR_c = Computed water requirement (litre/plant)
CPE = Cumulative pan evaporation for three days (mm)
K_p = Pan factor (0.8)
K_c = Crop factor
W_p = Wetted fraction (0.8)
A = Area per plant. m^2

$$\text{Time of operation} = \frac{\text{Volume of water required x irrigation interval}}{\text{Emitter discharge}}$$

Results and Descussions

Effect of mulching and irrigation levels on Biometric Observations

The data on plant height, number of branches of chilli at 90 days after transplanting as influenced by mulching and irrigation levels. The results revealed that 90 days after transplanting. The maximum plant height of 124.19 cm was recorded under T_5 (25 micron thickness mulch+9000lit/ Acre/day irrigation) which on par with the T_1 and T_6) and lowest plant height of 106.43 cm was recorded T_1 (without mulch+7000 lit/Acre/day irrigation). The results are in agreement with the findings of Tiwari *et al.* (1998a), Tiwari *et al.* (1998b), Pattanaik *et al*. (2003) [8] and Paul *et al.* (2013) [9] who reported that the availability of adequate soil moisture and temperature positively influenced the microbial activity thereby improving cellular growth and development of the plant in bell pepper.

The maximum no. of branches (3.00) recorded in treatment T_5 (25 microns thickness plastic mulching with 9000 lit/Acre/day irrigation) at 90 days after transplanting. The maximum 5.34 of branches per plant was observed in T_1 treatment of 7000 lit/Acre/day irrigation level with no mulch. It may be due to prolonged vegetative growth along with increased photosynthetic rate accelerated maximum number of branches per plant. Godara *et al.* (2013) [3] also studied progressive and vigorous plant growth and development due to drip irrigation and mulching in fennel.

Mulching significantly produced more no of fruits per plant compared to other treatments. A maximum of 163.24 no. of fruits per plant was recorded in the treatment T_5 (25 microns thickness+9000 lit/acre/day irrigation level and the minimum no of (12.43) fruits was observed in treatment T_1 (without mulch and 7000 lit/Acre/day irrigation level).

The results are similar with findings of Paul *et al.* (2013) [9] who reported that favorable environmental condition generated via drip irrigation and mulching leads to higher vegetative growth contributing more number of fruits per plant. Drip irrigation together with mulching leads to better weed control, less nutrient loss through leaching creates favorable soil temperature because of soil cover and enhances activities of micro organisms in the soil thereby resulting in better plant growth, increased physiological activities and fruit bearing nodes. Similar results are reported by Siti *et al.* (1994) in bell pepper, Nagalakshmi *et al.* (2002) [6] in chilli and Sharma *et al.* (2015) [12] in tomato.

The pod weight significantly highest (23.88 g) in the treatment T_5 (mulching with 9000 lit/acre/day irrigation level) and minimum pod weight was recorded in T_1 (without mulch and 7000 lit/Acre/day irrigation level). The pod yield per plant and pod yield per hectare significantly highest in the T_5 (mulching with 9000 lit/acre/day irrigation level) and the minimum in T_1 (without mulch and 7000 lit/Acre/day irrigation level).

The increase in pod weight may be due to increased biochemical activities in the soil. High uptake of nutrients, reduction of evaporation leading to higher soil moisture content reduction in weed growth, buildup of sufficient photosynthates and better nutrient availability to the plants. Similar findings were also recorded by Oguttu (2006) and Belel (2012) in bell pepper; Rajablariani *et al*. (2012) [10] and Sharma *et al.* (2015) [12] in tomato. Sankar *et al.* (2008) [11] also concluded that more nutrient availability, especially near the root zone might have increased the translocation of photosynthates to steerage organ increased resulting in an increased pod weight (50.30 g) was recorded in T_1 (flood irrigation).

Conclusion

The maximum total yield of 7.79 t/ha was recorded under T_5 (25 microns thickness+9000 lit/acre/day irrigation level).

Plant height																				
Treatment	2012-13				2013-14				2014-15				2015-16				Pooled			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
M_0	92.39	102.61	93.45	96.15	113.67	116.46	115.42	115.18	114.71	116.83	115.79	115.78	104.95	115.56	113.59	111.37	106.43	112.87	109.56	109.62
M_1	121.72	125.89	105.56	117.72	117.61	122.99	119.27	119.96	117.56	124.44	118.17	120.06	116.18	123.43	119.53	119.71	118.27	124.19	115.63	119.36
Mean	107.06	114.25	99.51		115.64	119.73	117.35		116.14	120.64	116.98		110.57	119.50	116.56		112.35	118.53	112.60	
	SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)	
M	0.13		0.40		0.41		1.22		0.41		1.24		0.36		1.07		1.66		4.99	
I	0.16		0.48		0.50		1.49		0.51		1.52		0.43		1.30		2.03		6.10	
MxI	0.23		0.69		0.70		2.10		0.72		2.15		0.62		1.85		2.88		8.63	

No of Branches																				
Treatment	2012-13				2013-14				2014-15				2015-16				Pooled			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
M_0	4.67	6.00	5.00	5.22	5.00	6.67	5.67	5.78	5.67	6.33	6.00	6.00	6.00	6.67	6.33	6.33	5.34	6.42	5.75	5.83
M_1	7.33	8.33	8.00	7.89	7.00	9.00	8.00	8.00	7.33	9.33	9.00	8.55	8.00	9.33	9.00	8.78	7.42	9.00	8.50	8.30
Mean	6.00	7.17	6.50		6.00	7.84	6.84		6.50	7.83	7.50		7.00	8.00	7.67		6.38	7.71	7.13	
	SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)	
M	0.24		0.73		0.32		0.97		0.40		1.21		0.30		0.90		0.08		0.24	
I	0.30		0.89		0.37		1.12		0.49		1.47		0.36		1.09		0.10		0.29	
MxI	0.43		1.28		0.56		1.69		0.70		2.10		0.52		1.55		0.14		0.41	

No of Fruit																				
Treatment	2012-13				2013-14				2014-15				2015-16				Pooled			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
M_0	97.50	106.18	98.75	100.81	121.62	126.37	122.69	123.56	146.45	151.51	148.89	148.95	131.80	141.87	140.20	137.96	124.34	131.48	127.63	127.82
M_1	110.55	121.35	112.30	114.73	141.32	152.26	149.43	147.67	163.45	199.64	172.44	178.51	155.60	179.72	169.05	168.12	142.73	163.24	150.81	152.26
Mean	104.03	113.77	105.53		131.47	139.32	136.06		154.95	175.58	160.67		143.70	160.80	154.63		133.54	147.36	139.22	
	SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)	
M	0.35		1.06		0.11		0.34		0.11		0.34		1.27		3.81		1.77		5.31	
I	0.43		1.30		0.13		0.41		0.13		0.41		1.55		4.66		2.17		6.51	
MxI	0.62		1.86		0.19		0.57		0.19		0.57		2.20		6.60		3.07		9.20	

Fruit weight																				
Treatment	2012-13				2013-14				2014-15				2015-16				Pooled			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
M_0	18.50	19.67	18.92	19.03	18.17	20.00	18.75	18.97	17.60	19.95	18.92	18.82	19.17	19.67	19.58	19.47	18.36	19.82	19.04	19.08
M_1	20.33	24.00	21.00	21.78	21.00	23.67	22.00	22.22	20.44	23.83	21.83	22.03	21.00	24.00	22.00	22.33	20.69	23.88	21.71	22.09
Mean	19.42	21.84	19.96		19.59	21.84	20.38		19.02	21.89	20.38		20.09	21.84	20.79		19.53	21.85	20.38	
	SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)	
M	0.26		0.79		0.35		1.05		0.39		1.16		0.67		2.00		0.10		0.31	
I	0.32		0.97		0.43		1.29		0.47		1.42		0.82		2.46		0.13		0.38	
MxI	0.45		1.37		0.61		1.82		0.67		2.02		1.16		3.47		0.18		0.54	

Yield /Plant																				
Treatment	2012-13				2013-14				2014-15				2015-16				Pooled			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
M_0	1.80	2.09	1.87	1.92	2.21	2.53	2.30	2.35	2.58	3.02	2.82	2.81	2.53	2.79	2.75	2.69	2.28	2.61	2.44	2.44
M_1	2.25	2.91	2.36	2.51	2.97	3.60	3.29	3.29	3.34	4.76	3.76	3.95	3.27	4.31	3.72	3.77	2.96	3.90	3.28	3.38
Mean	2.03	2.50	2.12		2.59	3.07	2.80		2.96	3.89	3.29		2.90	3.55	3.24		2.62	3.25	2.86	
	SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)	
M	0.03		0.11				0.15		0.06		0.20		0.10		0.30		0.06		0.17	
I	0.04		0.12				0.19		0.08		0.24		0.12		0.37		0.07		0.20	
MxI	0.06		0.18				0.25		0.11		0.34		0.18		0.53		0.09		0.28	

Yield (t/ha)																				
Treatment	2012-13				2013-14				2014-15				2015-16				Pooled			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
M_0	36.07	41.78	37.36	38.40	44.18	50.56	46.01	46.92	51.58	60.45	56.33	56.12	50.54	55.84	54.92	53.77	45.59	52.16	48.66	48.80
M_1	44.96	58.25	47.18	50.13	59.33	72.07	65.73	65.71	66.84	95.15	75.27	79.09	65.36	86.23	74.36	75.32	59.12	77.93	65.64	67.56
Mean	40.52	50.02	42.27		51.76	61.32	55.87		59.21	77.80	65.80		57.95	71.04	64.64		52.36	65.04	57.15	
	SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)		SEM±		CD(P=0.05)	
M	0.98		2.95		0.98		2.95		1.31		3.94		2.05		6.15		1.10		3.30	
I	1.21		3.63		1.21		3.63		1.61		4.84		2.51		7.53		1.35		4.04	
MxI	1.71		5.13		1.71		5.13		2.28		6.84		3.55		10.65		1.91		5.72	

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