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Laxmikanth
College of Agricultural Engineering, UAS Raichur, Karnataka, India

Mallikarjun
College of Agricultural Engineering, UAS Raichur, Karnataka, India

Rubeena Tarranum
College of Agricultural Engineering, UAS Raichur, Karnataka, India

Kavitha
College of Agricultural Engineering, UAS Raichur, Karnataka, India

Correspondence
Laxmikanth
College of Agricultural Engineering, UAS Raichur, Karnataka, India

Effect of Colour plastic mulching and different levels of drip irrigation on plant growth parameters of Okra (*Abelmoschus esculentus*) Crop

Laxmikanth, Mallikarjun, Rubeena Tarranum and Kavitha

Abstract
An experiment were conducted on the effect of colour plastic mulches on plant height, days to fifty per cent flowering, leaf area index under different irrigation levels. The treatments were laid out in split plot design with three replications and a non-mulched treatment as control. The plastic coloured mulches used were white on black, silver on black and black. The irrigation levels used were 60, 80, 100 and 120 per cent ET. The results indicated that the growth components of plant height, days to fifty per cent flowering and leaf area index were significantly influenced by drip irrigation levels. The maximum plant height (125.54 cm), least days to 50 per cent flowering (41.78days), highest leaf area index (3.20)80 per cent ET with white on black plastic colour mulch when compared to other treatments throughout the growing period.

Keywords: colour plastic mulching, drip irrigation, plant growth parameters

Introduction
Enhanced early season production and improved quality are important factors for warm season vegetable crop growers. Agricultural production in the urban environment is becoming ever more popular and prevalent in the developing world as well as the United States because of increased abandoned property. However, as local food costs are increasing, the bases of food security issues dealing with equity, community, accessibility, and affordability are being ignored (DeLind, 2002).
Drip irrigation has proved its superiority over other conventional method of irrigation, especially in the cultivation of fruits and vegetables due to precise and direct application of water in root zone. A considerably saving in water, increased growth, development and yield of vegetables under drip irrigation has been reported (Bhella, 1988). The use of black polyethylene mulch in vegetable production has been reported to control the weed incidence, reduces nutrient losses and improves the hydrothermal regimes of soil (Ashworth and Harrison, 1983); Chakarborty and Sadhu, 1994; Singh, 2014).There are three different mulches are used namely white, silver ,black and white. Plastic mulch was first noted for its ability to increase soil temperature in the 1950s. It is beneficial to adjust the soil microclimate to prolong the growing season and increase plant growth (Tarara, 2000)

Okra
Okra (*Abelmoschus esculentus*) commonly known as Lady's finger or Bhendi belongs to the family Malvaceae. It is considered to be a native of tropical and subtropical Africa, South Africa, West Indies and India.Okra is considered as heat loving plant. Okra fruits also have nutritional and medicinal value as the fruit contain 6.4g carbohydrates, 2.2g protein, 0.2g fat, 66g. Calcium, 50 mg phosphorus, 15 mg iron and 13 mg vitamin-C per 100 g of edible portion similarly, okra fruit is excellent source of iodine, which is necessary for the resistance against throat disease like goiter. It is a tropical to subtropical crop and is sensitive to frost, low temperature, water logging. It is rich in vitamins, calcium, potassium and other mineral matters. Okra seed oil is rich in unsaturated fatty acids such as linoleic acid, which is essential for human nutrition. It is a mature fruit and stems contain crude fibre, which is used in the paper industry. Okra is a popular health food due to its high fiber, vitamin-c, and foliated content. Okra is also known for being high in antioxidants. Afield trial was conducted at research plot, College of Agricultural Engineering, Raichur during 2016-17.

Materials and methods
A field experiment was undertaken to observe the effect of different colour plastic mulches on

the growth yield of okra (*Abelmoschus esculentus*, hybrid) against without mulch. This experiment was conducted at UAS-Raichur, which is situated in Karnataka of India.The highest maximum temperature of 37.6 °C was recorded in the month of Febrauary, 2017 and lowest temperature of 28.4 °C was recorded in the month of december, 2016.The Treatments were tested in split plot design with three replications. Each replication has 16 beds. The main treatments were I_1- Water application at 60 per cent ET using drip irrigation, I_2- Water application at 80 per cent ET using drip irrigation, I_3- Water application at 100 per cent ET using drip irrigation and I_4- Water application at 120 per cent ET using drip irrigation and sub treatments were M_0 – Without mulch (control), M_1 – White on black plastic mulch, M_2 – Silver on black plastic mulch and M_3 – Black plastic mulch.

The experimental plots of 5 m x 1m were prepared for sowing of okra seeds. The plant to plant and row to row spacing were 0.30 and 0.45 m respectively. The different plastic colour mulches of 30-micron thickness are white on black, silver on black and black was cut as per the size of the plots. The data was recorded at intervals of 30,60 and 90 days after sowing (DAS).The observations were recorded on five randomly selected plants in each plot.

Data were recorded on plant height, days to fifty per cent flowering, leaf area index. Plant height was measured in cm from the base of the plant to the top of the plant with the help of metre scale. Number of days taken from the DAS to the initiation of flowering in fifty per cent of the total plants in entire plot was considered as days to fifty per cent flowering and expressed in days. The leaf area index (LAI) was measured with an AccuPAR 80 Ceptometer (Decagon Devices, Inc., Pullman, WA, USA)

Results and Discussion

Plant height

The effect of irrigation levels, mulch colours and their interactions on plant height recorded in different dates i.e. 30, 60and 90 DAS are presented in Table 1(a) and Table 1(b). Among the irrigation levels, drip irrigation at 120per cent ET (107.30 cm) resulted in significantly taller plants followed by drip irrigation at 100 per cent ET (101.92 cm) and 80 per cent ET (100.64 cm). The plant height was markedly lower in case of drip irrigation at 60 per cent ET (98.26 cm). Smaller plants were recorded under the control (no mulch) treatment (92.70cm). In combination of treatment, the maximum plant height (125cm) were recorded under drip irrigation at 120 per cent ET with white on black plastic colourmulch when compared to other treatments throughout the growing period. Positive influence of white on black plastic mulch on plant height might be due to the fact that the incident radiation entered through the white polythene mulch, but very little amount of outgoing radiation could go back to the environments, which slightly improved the soil temperature underneath the white mulch. Similar trend was also reported by Kumar *et al*., (2010).

Days to fifty per cent flowering

The effect of irrigation levels and coloured mulches and their interaction on number of day to 50per cent flowering are presented in Table 2 and shown in Fig.b. Drip irrigation at 80 per cent ET (42.29days) was more effective to induce early flowering as compared to drip irrigation at 120 per cent ET (43.60 days). In combination of treatment, minimum days to fifty per cent flowering (42 days) were recorded under drip irrigation at 60 per cent ET with silver on black plastic colour mulch when compared to other treatments throughout the growing period. Among mulch colours, silver on black plastic mulch was effective for earliness in 50 per cent flowering as compared to control. The results were in agreement with the findings of Chakraborty *et al*., (1994) and Hooda *et al*., (1998)

Leaf area index

The area covered by the crop leaves is known as leaf area index. Leaf area index meter (Ceptometer) was used for recording the readings. The Table showed that the leaf area index values recorded at 30, 60 and 90 DAS were significantly influenced by irrigation levels and mulch colours. Among the irrigation level LAI was more in I2 (0.39, 1.30 and 2.97) followed by I_3, I_4 and I_1. The LAI recorded higher in mulched plot as compared to plot without mulch. The LAI was more in M_1 (0.38, 1.25 and 2.98) followed by M_1, M_2 and M_3 at 30, 60 and 90 DAS respectively.

Table 1(a): Effect of different level of irrigation and plastic mulch colours on plant height, cm.

Treatment	30 DAS					60 DAS				
	I_1	**I_2**	**I_3**	**I_4**	**Mean**	**I_1**	**I_2**	**I_3**	**I_4**	**Mean**
M_0	18.67	31.33	28.00	30.00	27	60.33	61.12	62.14	64.00	61.89
M_1	31.67	32.33	32.33	31.3	31.90	90.23	91.30	90.00	89.56	90.27
M_2	30.67	35.00	34.00	31.00	32.67	89.25	90.26	86.65	86.75	88.22
M_3	29.00	31.33	31.67	29.67	30.41	85.35	89.56	89.66	91.21	88.94
Mean	27.50	32.49	31.5	30.49	30.495	81.29	83.06	82.11	82.88	82.33

	SEM ±	CD at 5 per cent	SEM ±	CD at 5 per cent
Main treatment	0.32	0.87	0.32	0.87
Sub treatment	0.37	0.69	0.37	0.69
I at same M	1.07	3.28	1.07	3.28
M at the same or different I	0.95	2.82	0.95	2.82

Table 1(b): Effect of different level of irrigation and plastic mulch colours on plant height, cm**.**

Treatment	90 DAS				
	I_1	**I_2**	**I_3**	**I_4**	**Mean**
M_0	90.22	92.12	91.95	96.52	92.70
M_1	110.23	113.25	114.35	125.54	115.84
M_2	102.30	101.60	105.24	108.62	104.44
M_3	90.32	95.62	96.15	98.55	95.16
Mean	98.26	100.64	101.92	107.30	102.03
	SEM ±			CD at 5 per cent	
Main treatment	0.32			0.87	
Sub treatment	0.37			0.69	
I at same M	1.07			3.28	
M at the same or different I	0.95			2.82	

Main treatments:
I_1: Irrigation at 60 per cent ET using drip irrigation
I_2: Irrigation at 80 per cent ET using drip irrigation
I_3: Irrigation at 100 per cent ET using drip irrigation
I_4: Irrigation at 120 per cent ET using drip irrigation

Sub treatments:
M_0: Without mulch condition
M_1: White on black plastic mulch
M_2: Silver on black plastic mulch
M_3: Black on black plastic mulch

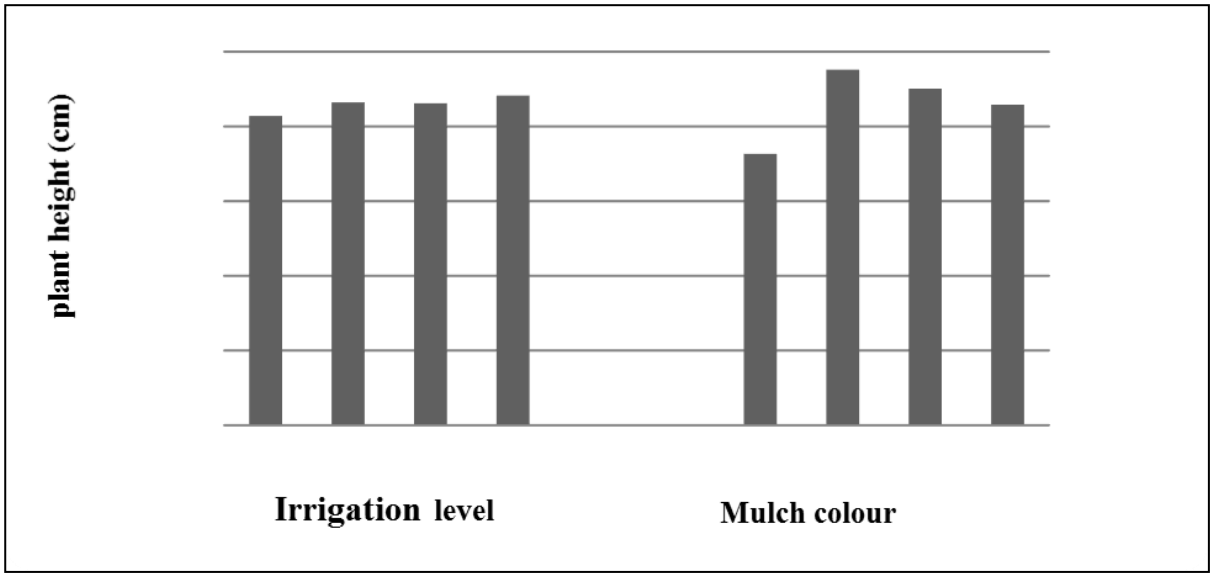

Fig a: Effect of different level of irrigation and plastic mulch colours on plant height, cm.

Table 2(a): Effect of different level of irrigation and plastic mulch colours on number of day to fifty percent flowering

50 percent flowering					
Treatment	**I_1**	**I_2**	**I_3**	**I_4**	**Mean**
M_0	42.51	41.93	43.89	44.33	43.17
M_1	42.07	41.81	43.48	42.35	42.43
M_2	41.78	41.88	42.81	43.44	42.48
M_3	43.13	43.54	42.41	44.30	43.34
Mean	42.37	42.29	43.15	43.60	
	SEM ±			CD at 5 per cent	
Main treatment	0.32			0.87	
Sub treatment	0.37			0.69	
I at same M	1.07			3.28	
M at the same or different I	0.95			2.82	

Main treatments:
I_1: Irrigation at 60 per cent ET using drip irrigation
I_2: Irrigation at 80 per cent ET using drip irrigation
I_3: Irrigation at 100 per cent ET using drip irrigation
I_4: Irrigation at 120 per cent ET using drip irrigation

Sub treatments:
M_0 : Without mulch condition
M_1: White on black plastic mulch
M_2: Silver on black plastic mulch
M_3: Black on black plastic mulch

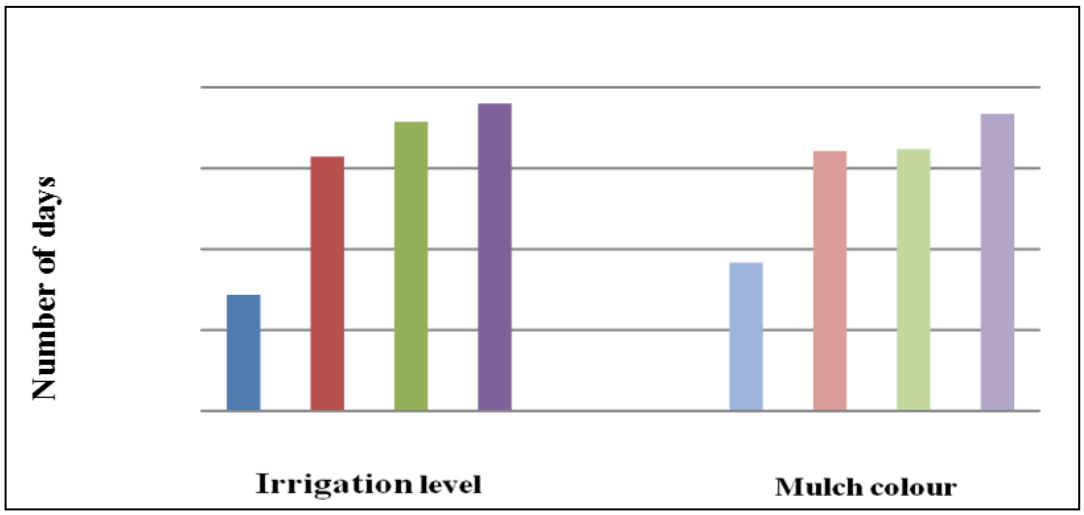

Fig b: Effect of different level of irrigation and plastic mulch colours on number of day to fifty percent flowering.

Main treatments:
I_1: Irrigation at 60 per cent ET using drip irrigation
I_2: Irrigation at 80 per cent ET using drip irrigation
I_3: Irrigation at 100 per cent ET using drip irrigation
I_4: Irrigation at 120 per cent ET using drip irrigation

Sub treatments:
M_0 : Without mulch condition
M_1: White on black plastic mulch
M_2: Silver on black plastic mulch
M_3: Black on black plastic mulch

Table 3(a): Effect of different level of irrigation and plastic mulch colours on leaf area index

Leaf area index											
30 Days						60 Days					
Treatment	**I_1**	**I_2**	**I_3**	**I_4**	**Mean**	**Treatment**	**I_1**	**I_2**	**I_3**	**I_4**	**Mean**
M_0	0.35	0.49	0.39	0.30	0.38	**M_0**	1.03	1.29	1.30	1.25	1.21
M_1	0.32	0.36	0.25	0.35	0.32	**M_1**	1.48	1.35	1.27	1.30	1.35
M_2	0.32	0.41	0.37	0.37	0.36	**M_2**	1.38	1.32	1.30	1.34	1.335
M_3	0.28	0.33	0.32	0.29	0.30	**M_3**	1.28	1.26	1.19	1.29	1.255
Mean	0.31	0.39	0.33	0.32	0.343	**Mean**	1.29	1.30	1.26	1.29	1.289
	SEM ±			CD at 5 per cent			SEM ±			CD at 5 per cent	
Main treatment	0.32			0.87		Main treatment	0.32			0.87	
Sub treatment	0.37			0.69		Sub treatment	0.37			0.69	
I at same M	1.07			3.28		I at same M	1.07			3.28	
M at the same or different I	0.95			2.82		M at the same or different I	0.95			2.82	

Table 3(b): Effect of different level of irrigation and plastic mulch colours on leaf area index

90 days LAI					
Treatment	**I_1**	**I_2**	**I_3**	**I_4**	**Mean**
M_0	2.50	2.50	2.95	2.98	2.73
M_1	3.20	3.10	2.98	3.00	3.07
M_2	3.02	3.09	3.02	2.75	2.97
M_3	3.11	3.19	2.12	2.91	2.83
Mean	2.95	2.97	2.76	2.91	2.90
	SEM ±			CD at 5 per cent	
Main treatment	0.32			0.87	
Sub treatment	0.37			0.69	
I at same M	1.07			3.28	
M at the same or different I	0.95			2.82	

Conclusion

The study concluded that the drip irrigation at 120 per cent ET with white on black plastic mulch enhanced better plant growth, which facilitated in accumulation of more photosynthates and conservation of optimum temperature resulting in increased size and weight of fruits. The maximum plant height (125.54cm), least days to 50 per cent flowering (41.782 days) was recorded at 60 per cent ET highest leaf area index (3.20) were recorded under drip irrigation at 60 per cent ET with white on black plastic colour mulch when compared to other treatments throughout the growing period.

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