



Performance of okra (*Abelmoschus esculentus*) to different irrigation levels and mulches under drip irrigation system

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Received: 16 January 2023; Accepted: 14 February 2023

Keywords: Crop yield, Cropwat model, Drip irrigation, Mulching, Okra

Okra (*Abelmoschus esculentus* L.) locally familiar as bhindi is amongst oldest vegetables in India as well as world. As per the report of National Horticulture Board (Anonymous 2018), okra is cultivated in 0.52 million ha which is 5.16% out of total vegetable area (10.07 million ha) with the total production 6.18 million metric tonnes. The area coverage under micro irrigation is about 10.3 mha and the irrigation potential is somewhat higher (69.5 mha) reported by Jain *et al.* (2019). Research studies on okra cultivation under drip irrigation reveal that drip irrigation increased productivity by 20–30% and water saving by 40–60% (Pawar *et al.* 2002, Narayana moorthy and Devika 2018). Cropwat 8.0 model suggested by FAO based on Penman Monteith Equation having higher accuracy, user friendly, easily available software compared to other temperature based, radiation based and other complex equation, used to estimate the crop water requirements. Drip irrigation along with mulching increases the productivity and is a good water saving technique. The film mulch along with drip irrigation increased water use efficiency up to 30% compared with non-mulch drip irrigation system (Zhang *et al.* 2022). Mulching technique is the spreading of organic or inorganic material over the seed bed to conserve the moisture, retard the weed growth, increase the microbial activity and to maintain the proper water air ratio in root zone. By considering the above points and looking at the success of the combine effect of mulching and drip irrigation methods, the present research is carried out to evaluate effect of irrigation levels and mulching on biological and yield parameter of okra under drip irrigation system.

The field experiment was conducted during 2019 at research field of School of Agriculture, Lovely Professional University, Phagwara, Kapurthala, Punjab. The treatment consisted of 3 irrigation levels laid out in main plots, viz. I₁,

I₂, 0.80 ETc; I₃, 0.60 ETc and subplots consisted of different mulches like M₁, black plastic mulch; M₂, silver plastic mulch; M₃, straw mulch; M₄, soil mulch (20 cm soil depth); and M₅, no mulch. The experiment was laid out in split plot design and replicated thrice. The biometric observations of crop were statically analyzed by the method of ANOVA by using SPSS software. Decade wise evapotranspiration (ET₀) was determined by Cropwat model. Highest ET₀ (64.51 mm) was recorded in third decade of July and the highest ETc (63.21 mm) was recorded in the second decade of July month. It was observed that, out of total ET₀, 31.68% ET₀ and out of total ETc, 35.18% ETc was recorded in the month of July.

Among the irrigation levels, I₂ (0.8 ETc) recorded the maximum plant height (100.45 cm) which was significantly 11.75% more than irrigation level I₃ (0.6 ETc). Black plastic mulching (110.42 cm) showed the maximum plant height followed by silver plastic mulch which was significantly superior to other mulching methods. This may be due to the fact that plastic mulch conserves the moisture and absorbs large amounts of solar radiation and maintains the desirable soil temperature for plant growth. Bahadur *et al.* (2009) recorded maximum plant height at 4-day irrigation level and pea straw mulch over no mulch treatment. Similar observations have been reported by Birbal *et al.* (2013). The interaction of mulching and irrigation level showed non-significant effect on plant height but superior plant height was observed in interaction of irrigation levels with both plastic mulch.

Data on number of branches (Table 1) revealed that the irrigation level I₂ (0.8 ETc) showed significantly higher number of branches (1.77) per plant compared to I₁ (1.49) and I₃ (1.29) whereas irrigation level I₁ and I₃ are at par to each other. This is may be due to proper amount of water which maintained the required favorable environment to promote the good vegetative growth of the plant. Among the mulch treatments, black mulch (M₁) recorded significantly higher mean number of branches (2.00) than other mulch treatments. Maximum number of branches per plant in

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plastic mulch may be because it absorbs large amounts of solar radiation and maintains the moisture up to field capacity compared to other organic mulch and no mulch.

The irrigation levels showed significant difference on number of pods per plants at 5% significant level but the interaction effect of irrigation and mulching did not show significant effect on pod per plants. The maximum number of pods (17.11) per plants were recorded in irrigation level I_1 (1.0 ETc) which was at par with I_2 (0.8 ETc) and 5.2% more than I_3 (14.24). Thokal *et al.* (2020) also supported the results and observed maximum number of pods per plant in 0.8 ETc irrigation level followed by 1.0 ETc. The mulch treatment significantly affected number of pods per plant. The highest number of pods per plant was recorded in black plastic mulch (18.23) which is at par with silver plastic mulch (18.03) and significantly 28% more than the non mulch (14.16). Olabode *et al.* (2007) who recorded the higher number of pods per plants under plastic mulch. Birbal *et al.* (2013) also reported that plastic mulch showed highest number of fruits per plant compared to hessian cloth and indigenous material mulch. Maximum number of pods per plant may be due to maximum number of picking the pods from plants (Thakur *et al.* 2020).

Pod yield per plant was significantly influenced by irrigation levels and mulching treatment. The maximum pod yield per plant (216.59 g) was recorded in irrigation level I_2 (0.8 ETc) which was at par with I_1 (206.89) and 36.48% more than I_3 (158.69). Highest plant yield per plant (243.86 g) was recorded in black mulch followed by silver mulch and lowest yield (141.56 g) was observed in non-mulch treatment. Similar results were observed by Mahadeen (2014) and reported that black plastic mulch

showed maximum pod yield/plant (255.6 g/plant) than no mulch treatments (152.1 g/plant). Kumar *et al.* (2012) reported that the black plastic mulch recorded maximum yield and quality of strawberry. Pod yield per plant is significantly affected by interaction effect of irrigation and mulching levels.

The pod yield significantly affected by irrigation level and mulching methods. Significantly higher pod yield (15.59 tonnes/ha) was recorded in irrigation level I_1 followed by I_2 (15.36 tonnes/ha) and significantly more yield than I_3 . Similar results were observed by Thokal *et al.* (2020) during the study of influence of irrigation regime on okra crop in Konkan region, who reported that maximum okra yield was recorded at irrigation level at 0.80 ETc and 1.00 ETc. The maximum yield was observed in irrigation level I_1 because it maintains the moisture up to field capacity. Chandra and Singh (2019) also recorded that 100% level of irrigation had 61% more okra yield than 80% irrigation levels. The pod yield is significantly influenced by mulching methods. The black plastic mulches recorded significantly higher yield (19.09 tonnes/ha) than other mulch and at par with silver plastic mulch. Black mulch prevent the evaporation and maintain the soil temperature and control the weed which enhance the better crop growth and crop yield. Jha *et al.* (2018) recorded higher yield in plastic mulch over control treatment. No mulch treatment recorded lowest yield which was 41.27% less than black plastic mulch. The total water applied in irrigation level I_1 , I_2 and I_3 was 535.32 mm, 428.26 and 321.9 mm. The water use efficiency was found highest (0.41 tonnes/ha-cm) in irrigation levels I_3 which clearly indicates that, 40% irrigation water can be saved through I_3 to produce the significant crop yield under limited

Table 1 Effect of irrigation levels and mulching methods on growth, yield and water use efficiency of okra

Main plot	Plant height (cm)	No. of branches/plant	No. of pods/plants	Yield/plant (g)	Crop yield (tonnes/ha)	WUE (tonnes/ha-cm)
I_1	95.57b	1.49b	17.11a	206.89a	15.59a	0.29c
I_2	100.45a	1.77a	16.25a	216.59a	15.36a	0.36b
I_3	88.64c	1.29b	14.84b	158.69b	13.25b	0.41a
CD (P=0.05)	8.68	0.21	1.45	15.88	1.39	0.03
F-Test (0.05)	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
<i>Subplot</i>						
M_1	110.42a	2.00a	18.23a	243.86a	19.09a	0.46
M_2	103.02b	1.62b	18.03a	234.42a	19.01a	0.46
M_3	92.13c	1.49b	15.39b	180.45b	13.05b	0.31
M_4	89.53c	1.56b	14.53b	170.01b	11.31c	0.27
M_5	79.33d	0.93c	14.16b	141.56c	11.21c	0.26
CD (P=0.05)	5.40	0.26	1.69	20.64	1.63	0.04
F-Test (0.05)	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
$I \times M$	--	--	--	--	--	--
CD (P=0.05)	7.23	0.46	2.63	35.74	2.82	0.08
F-Test (0.05)	NS	NS	NS	Sig.	NS	Sig.

Refer to methodology for treatment details.

availability of water over treatment I_1 . Kumari *et al* (2021) recorded maximum water productivity at 80% irrigation levels interacted with plastic mulch. The interaction effect of irrigation and mulching significantly affected on water use efficiency.

SUMMARY

The present study was carried out at Lovely Professional university, Phagwara, Punjab during 2019 to study the performance of okra under irrigation levels and mulching methods under drip irrigation. The treatment comprised of 3 irrigation levels (1.0 ETc, 0.8 ETc and 0.6 ETc) and 5 mulch methods (black plastic mulch, silver plastic mulch, straw mulch, soil mulch and no mulch) laid out in split plot design replicated thrice. The growth and yield attributes were significantly influenced by irrigation levels and mulching methods. The irrigation level I_2 (0.8 ETc) significantly exhibited maximum plant height (100.45 cm), number of branches per plant (1.77), and yield per plant (216.59 g) whereas irrigation level I_1 (1.0 ETc) recorded maximum pod yield (15.59 tonnes/ha) which is at par with irrigation level I_2 (15.36 tonnes/ha). The black plastic mulch was found significantly superior over no mulch treatments in terms plant height, number of branches, pod yield per plant, pod yield (19.09 tonnes/ha). The maximum water use efficiency (0.41 tonnes/ha-cm) was recorded in irrigation treatment I_3 and in black plastic mulch (0.46 tonnes/ha-cm). The interaction effect of irrigation and mulching not showed significant difference on pod yield but significantly affected water use efficiency. At interaction effect, the maximum water use efficiency (0.56 tonnes/ha-cm) in combination of I_3 and M_1 . Maximum B:C ratio was recorded in irrigation level I_1 (3.49) which is at par with I_2 (3.40). Black plastic mulch recorded higher B:C ratio (3.40). The interaction effect did not showed significant effect on B:C ratio. Looking the higher yield of crop, water use efficiency and higher B:C ratio, it can be recommended that okra crop showed good performance under irrigation level I_2 and black plastic mulch.

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