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Original Research

Growth and Yield Response of Different Brinjal Cultivars to Irrigation Deficit Conditions

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ABSTRACT

Brinjal is an important vegetable crop having low fat content and high nutritional value. Brinjal is considered moderately sensitive to water deficit conditions. A study was conducted to investigate growth and yield potential of different brinjal cultivars i.e. 'Black Long', 'Nirala', 'Bemisal' and 'Purple Queen' in response to various levels of water stress by providing 100, 80 and 60% of the required irrigation. The results revealed that growth and yield characteristics of brinjal cultivars varied to a great extent in response to water stress. As expected, 100% irrigation level showed the highest plant growth and fruit yield, while a gradual decrease in growth and yield of brinjal was observed with increasing water stress, the lowest being at 60% irrigation level. 'Black Long' and 'Nirala' produced significantly better results for most of the parameters such as plant height, number of leaves, root length, number of flowers and fruits, fruit length and fruit yield per plant in response to varying degree of water stress. It is concluded from the results that 'Black Long' and 'Nirala' are best suited for arid areas which are facing water deficit conditions during most of the time in the year, but full potential of the crop can be achieved by managing the irrigation.

Keywords: *Fruit yield, moisture stress, plant growth, Solanum melongena, water deficit conditions.*

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INTRODUCTION

Brinjal (*Solanum melongena* L.), also known as aubergine or egg-plant, is an important vegetable crop. It is thought to be originated from India and China but is cultivated throughout tropical and subtropical areas of the world (Amiri et al., 2012; Kaushik et al., 2016). Optimum temperature for brinjal cultivation ranges between 22 to 30 °C but it can tolerate drought and high temperature. Thus, it is considered a profitable crop for arid and semi-arid areas (Ali et al., 2014; Adamczewska-Sowińska and Krygier, 2013). In Pakistan, brinjal is used as a common vegetable in culinary due to its availability at reasonable price round the year. Total area in the country under brinjal cultivation is 8,427 hectares with a total annual production of 84,255 tons (Anonymous, 2019). Province of Punjab leads in area and production of this crop followed by Sindh and Baluchistan (Ashfaq et al., 2014; Hassan et al., 2015; Javed et al., 2017).

Brinjal is considered moderately sensitive to drought stress (Bsoul et al., 2016). In countries like Pakistan, drought or moisture stress is considered as an important production limiting factor. It is important to understand the response of different brinjal cultivars to moisture stress, considering the increasing water shortage for agriculture sector (Akinci et al., 2004). Water stress affects plant growth directly by reducing nutrients and water uptake and indirectly by adversely affecting physiological processes such as photosynthesis, respiration, carbohydrate metabolism and translocation and especially by reducing the production of different plant growth promoting hormones (Farooq et al., 2008). An important and common method to estimate the effects of water stress on plant growth and yield is to grow the plants under different levels of moisture stress and study their morphological, yield and quality parameters. Therefore, any effort to find out brinjal cultivars tolerant to water deficit conditions will be helpful to the farming community of the area. To the best of our knowledge a very limited research was focused to understand the varietal response of brinjal to drought or water stress under the arid and semi-arid conditions of Potohar, Punjab (Pakistan). Therefore, a trial was designed to assess the influence of water stress on growth, yield and fruit quality of four different brinjal cultivars under agro-climatic conditions of Rawalpindi, Pakistan.

MATERIALS AND METHODS

Study area

A field trial was conducted at the research area of Department of Horticulture, Pir Mehr Ali Shah Arid Agriculture University, Rawalpindi, during the year 2017-18. The study area lies at a 33.65° latitude and 73.08° longitude. Height from sea level is 510 meters, while average annual rainfall in the area is 380-510 mm (Akram et al., 2019).

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Table 1: Soil physicochemical properties of the experimental area from three depths.

Parameters	Soil depth		
	0-30 cm	30-60 cm	60-90 cm
Organic carbon (%)	0.71	0.32	0.32
Silt (%)	23	20	20
Sand (%)	56	55	55
Clay (%)	22	25	25
Texture	Sandy clay loam	Sandy clay loam	Sandy clay loam
Bulk density (g cm^{-3})	1.6	1.6	1.73
SLL (mm mm^{-1})	0.08	0.08	0.08
SDUl (mm mm^{-1})	0.19	0.19	0.18
Saturated SW (mm mm^{-1})	0.33	0.33	0.28

SLL, Soil lower limit; SDUL, Soil drain upper limit and Saturated; SW, Saturated soil water.

Soil analysis

Prior to initiation of the experiment, soil samples were collected and analyzed according to the published methods of Al-Solaimani et al. (2009). Results of the analysis for experimental soil are given in Table 1.

Field experiment

A field trial was conducted to assess the impact of different irrigation levels on growth, yield and quality of brinjal cultivars. Seed of brinjal cultivars 'Black Long', 'Nirala', 'Bemisal' and 'Purple Queen' was purchased from Awan Seed Store, Rawalpindi and sown in the nursery on 2nd February 2017 in plastic trays filled with 1:1 (w/w) mixture of coco-peat and sand.

Field was prepared by ploughing and planking. About 10 tons of well rotten farmyard manure, 55 kg of nitrogen in the form of urea, 50 kg of phosphorus in the form of single super phosphate and 75 kg of potash in the form of sulphate of potash per hectare were applied. The complete dose of farmyard manure was applied in the soil at the time of first ploughing. Potassium and phosphate fertilizers were mixed in the soil at the time of ridge preparation. Two third of nitrogenous fertilizer was also given at the time of ridge preparation while one third was applied two and half month after transplanting. On 15th March 2017, six weeks old seedlings with 4-5 healthy leaves were selected and transplanted on one side of ridges prepared 60 cm apart, keeping seedling to seedling distance of 50 cm. All the agronomic practices were uniform for all the subplots except irrigation levels. Bifenthrin 10% EC (Jaffer Agro Services) was applied time to time for chewing and sucking insects' control, while Copper oxychloride 50 WP (Green Crop Pvt. Ltd.) and Thiram 75 WP (Arysta LifeScience) were applied to control different diseases.

The experiment was arranged in a two-factor randomized complete block design with 3 replications. There were 3 main plots (irrigation levels), each divided into 4 subplots (cultivars). The treatments (irrigation levels) used in the experiment included 60, 80 and 100% of the field capacity. The main plots contained three moisture levels (based on soil water content / field capacity, FC), i.e. 100% FC; 80% FC and 60% FC. Water stress was given to the plants from transplanting to harvest (0 to 15 weeks after transplanting). When severe wilting persisted overnight, the plants in the water stress treatments were re-watered at the rate of the control plants. For determination of soil water content, gravimetric method was used and calculated with the following formula.

Ka1 =100% (Bt – BtKON)/BtKON

The weight of soil + water in each treatment was as follows:

100% FC = (Ka2 × BtKON) + BtKON
80% FC = Bt + [(80% × Ka2) – Ka1] × BtKON
60 % FC = Bt + [(60% × Ka2) – Ka1] × BtKON

Where, Ka1 is the first soil water content; Ka2 is water content at field capacity (100% FC); Bt is soil weight/pot at the first soil water content and BtKON is soil dry weight.

Data collection

During the course of the experiment, the plants were analyzed for different growth, yield and quality parameters. The growth parameters included were: plant height, number of branches per plant, number of leaves per plant and root length. Effect of irrigation levels on yield and quality of different cultivars of brinjal was estimated by measuring parameters including number of flowers per plant, number of fruits per plant, fruit size (length and width), fruit yield per plant and ascorbic acid content in brinjal fruits. A total of five pickings were made to estimate the yield of the plants. Ascorbic acid was measured by the method described by Han et al. (1990). Briefly, a 5 g sample was taken randomly from five fruits and blended with 1.0% (w/v) HCl (5 mL) and centrifuged (10 min.) at 10,000 rpm. Supernatant fluid from centrifuge tubes was taken to evaluate ascorbic acid content. Absorbance (at 243 nm) of the extracted supernatant was read in a spectrophotometer (Optima, SP 3000-plus). Ascorbic acid content was measured as mg/100 g of the fresh fruit.

Statistical analysis

All the statistical analyses were performed with Statistix 8.1 (Analytical Software, 2105. Miller Landing Rd, Tallahassee, FL 32312). The data collected were subjected to two-way analysis of variance (ANOVA), while the means were compared using least significant difference test (LSD) at 5% level of probability (Steel et al., 1997).

RESULTS

Growth characteristics

Plant height of all the cultivars significantly differed from each other (Table 2a). The maximum height was attained by the plants of 'Black Long' cultivar (83.81 cm) that was followed by 'Nirala' (79.98 cm) and 'Bemisal' (72.76 cm). The plants of 'Purple Queen' attained the least height (58.96 cm). The data regarding the effects of different irrigation levels on plant height of brinjal cultivars is presented in Table 2b. It is clear from the data that plant height was reduced with the increase in moisture stress. Among irrigation levels, the treatment where 100% of the

Table 2a: Effect of different irrigation levels on vegetative growth (average) of four brinjal cultivars.

Cultivars	Plant height (cm)	Number of branches	Number of leaves	Root length (cm)
Black Long	83.81a	6.27a	86.21a	16.95a
Nirala	79.98b	4.54b	83.84a	16.59a
Bemisal	72.76c	4.29b	74.48b	12.97b
Purple Queen	58.96d	3.61c	70.02b	11.27c
LSD ($p < 0.05$)	2.82	0.59	5.02	0.74

Table 2b: Effect of different irrigation levels on vegetative growth (interaction) of four brinjal cultivars.

Cultivars	Irrigation level	Plant height (cm)	Number of branches	Number of leaves	Root length (cm)
Black Long	100%	88.08a	7.08a	88.10ab	18.49a
Nirala	100%	81.08bcd	4.92cd	93.73a	16.91ab
Bemisal	100%	75.58cde	4.30cde	76.23cde	13.22cd
Purple Queen	100%	60.12gh	4.00de	74.93cde	10.98e
Average		76.22A	5.08A	83.25A	14.90A
Black Long	80%	81.40bc	6.30ab	83.57abc	15.89b
Nirala	80%	84.28ab	4.80cd	84.47abc	16.19b
Bemisal	80%	73.73ef	4.27cde	77.80bcd	13.64c
Purple Queen	80%	54.63h	3.70de	68.75de	11.87de
Average		73.51B	4.77B	78.65B	14.40AB
Black Long	60%	81.95abc	5.43bc	81.33bc	16.47b
Nirala	60%	74.57def	3.90de	78.97bcd	16.66b
Bemisal	60%	68.97f	4.30cde	69.40de	12.03cde
Purple Queen	60%	62.13g	3.12e	66.37e	10.95e
Average		71.91C	4.19B	74.02C	14.03B
LSD ($p < 0.05$)		2.52	1.33	11.38	1.72
Cultivars		**	**	**	**
Irrigation level		**	**	**	**
Cultivars × Irrigation level		**	NS	NS	**

irrigation requirement was fulfilled, the maximum plant height (76.22 cm) was produced. It was significantly reduced with increasing water stress and at 80% and 60% irrigation levels plant height was reduced to 73.51 and 71.90 cm, respectively. Regarding the interaction among brinjal cultivars and irrigation levels, the plants of 'Black Long' cultivar attained significantly taller height at 100% irrigation level, followed by the same cultivar at 60% irrigation level. Both the treatment combinations were statistically similar. The plants of 'Purple Queen" attained significantly shorter height at the irrigation level of 80%, followed the same cultivar at 100% irrigation level. These two treatment combinations also behaved statistically alike (Table 2b).

Almost similar trend was observed for number of branches per plant. The highest number of branches was produced by 'Black Long' where on an average 6.27 branches per plant were observed. 'Nirala' and 'Bemisal' produced 4.54 and 4.29 branches per plant and both were statistically similar to each other. The minimum number of branches (3.61) was produced in 'Purple Queen' (Table 2a). Water stress also reduced number of branches significantly and 100, 80 and 60% of required irrigation levels produced 5.08, 4.77 and 4.19 branches per plant, respectively; each being significantly different from others (Table 2b). Concerning the interactive effect of brinjal cultivars and irrigation levels, significantly greater number of branches per plant was produced in the cultivars 'Black Long' at 100% irrigation level, which was statistically at par with the same cultivar at 80% irrigation level. Significantly lower number of branches was recorded in 'Purple Queen' cultivars at 60% irrigation level, followed in the same cultivar at 80 and 100% irrigation levels, in 'Bemisal' cultivar at 60, 80 and 100% irrigation levels and in 'Nirala' cultivar at 60% irrigation level. These seven treatment combinations stood statistically at par with each other (Table 2b).

Number of leaves was also highest in 'Black Long' (86.21) that was followed by 'Nirala' (83.84), both being statistically at par. 'Bemisal' and 'Purple Queen' produced least number of leaves i.e. 74.48 and 70.02 leaves per plant, respectively and were statistically similar (Table 2a). Irrigation levels also showed significant variation for number of leaves as well. The maximum number of leaves (83.25) was produced at 100% irrigation level. A significant reduction in number of leaves with increasing water stress was observed and 78.65 and 74.02 leaves were produced at 80 and 60% irrigation levels, respectively (Table 2b). As far as the combined effect of these two factors (cultivars and irrigation levels) is concerned, the highest number of leaves was produced in the cultivars 'Nirala' and 'Black Long' at both 100 and 80% irrigation levels, all being statistically similar with each other. The lowest number of leaves was produced in 'Purple Queen' at all the irrigation levels and in 'Bemisal' at 60 and 100% irrigation levels. These all treatment combinations were statistically similar to each other (Table 2b).

Root length was also significantly affected due to moisture stress and varied greatly among the cultivars as well (Table 3a and 3b). The cultivars 'Black Long' and 'Nirala' produced statistically longer roots with root lengths of 16.95 and 16.59 cm, respectively; both being statistically at par. The cultivars 'Bemisal' and 'Purple Queen' showed significant shorter root length with 12.97 and 11.27 cm, respectively. However, these

Table 3a: Effect of different irrigation levels on flowering and yield (average) of four brinjal cultivars.

Cultivars	Number of flowers	Number of fruits	Fruit yield/ plant (kg)
Black Long	13.97a	11.90 a	1.54b
Nirala	12.44b	11.19ab	1.86a
Bemisal	12.12b	11.14ab	1.55b
Purple Queen	11.86b	10.59b	1.50b
LSD ($p < 0.05$)	1.25	1.11	0.16

two cultivars significantly differed from each other as well as from other two cultivars (Table 3a). Significant reduction in root length of brinjal plants was also observed with increasing moisture stress. The irrigation levels of 100, 80 and 60% produced 14.90, 14.40 and 14.03 cm long roots, respectively, the latter two being statistically at par with each other (Table 3b). The interaction means indicated that the plants of 'Black Long' at 100% irrigation level resulted in significantly longer roots, followed by the plants of 'Nirala' cultivar at the same irrigation level. On the other hand, the plants of 'Purple Queen' at all the irrigation levels produced significantly shorter roots, followed by the plants of 'Bemisal' at 60% irrigation level; all being statistically at par with each other (Table 2b).

Flowering and yield

Plant yield depends upon number of flowers, their pollination and subsequent development of fruits. Variation in number of flowers among different cultivars of brinjal and the impact of applied irrigation levels was also clear from the data (Table 3a and 3b). Among the studied cultivars 'Black Long' produced the maximum number of flowers per plant (13.97) that was significantly higher than all other cultivars. It was followed by 'Nirala', 'Bemisal' and 'Purple Queen' cultivars with 12.44, 12.12 and 11.86 flowers per plant, respectively. The latter three cultivars were statistically at par with each other (Table 3a). On the other hand, increasing moisture stress gradually decreased number of flowers per plant and 13.83, 12.77 and 11.19 flowers were produced by the plants receiving 100, 80 and 60% of required irrigation, respectively. All the three irrigation levels were significantly different from each other (Table 3b). Regarding the interactive effect of brinjal cultivars and irrigation levels, cultivar 'Black Long' produced the maximum number of flowers per plant at 100% irrigation level, followed by the same cultivar at 80% irrigation level, 'Bemisal', 'Nirala' and 'Purple Queen' all at 100% irrigation level, 'Nirala' at 80% irrigation level, and 'Black Long' at 60% irrigation level. All these treatment combinations were statistically similar to each other. The minimum number of flowers per plant was recorded in in all the cultivars at 60% irrigation level, in all the cultivars except 'Black Long' at 80% irrigation level and in 'Purple Queen' and 'Nirala' cultivars at 100% irrigation level. All these treatment combinations were statistically at par with each other (Table 3b).

Yield response of brinjal cultivars showed significant variation among themselves and water stress showed a decreasing trend in almost all of the yield characteristics of brinjal plants studied (Table 3a and 3b). 'Black Long' produced the maximum number of fruits per plant (11.90) that was followed by 'Bemisal' (11.19 fruits) and 'Nirala' (11.14). 'Purple Queen' (10.59) produced the least number of fruits (Table 3a). Negative impact of moisture stress was also evident from the data, i.e. 12.77, 11.00 and 9.86 fruits per plant were noted for 100, 80 and 60% irrigation levels, respectively. All these irrigation levels were significantly different from each other (Table 3b). Concerning the interaction among brinjal cultivars and irrigation levels, all the cultivars at 100% irrigation level resulted in the maximum number of fruits per plant, followed by 'Black Long' and 'Bemisal' at 80% irrigation level. The minimum number of fruits per plant was recorded in all the cultivars at 60% irrigation level as well as in all the cultivars except 'Black Long' at 80% irrigation level; all being statistically alike (Table 3b).

Fruit yield is the most important parameter as far as farmer's economics is concerned. It was evident from the results of present work that yield per plant varied significantly among

Table 3b: Effect of different irrigation levels on flowering and yield (interaction) of four brinjal cultivars.

Cultivars	Irrigation level	Number of flowers	Number of fruits	Fruit yield/ plant (kg)
Black Long	100%	15.38a	13.65a	1.72bcd
Nirala	100%	13.26abc	12.50abc	2.12a
Bemisal	100%	13.62ab	12.92ab	1.60b-e
Purple Queen	100%	13.06abc	12.00a-d	1.75abc
Average		13.83A	12.77A	1.80A
Black Long	80%	13.80ab	11.71a-d	1.62b-e
Nirala	80%	12.93abc	10.82b-e	2.00ab
Bemisal	80%	12.30bc	11.56a-e	1.66b-e
Purple Queen	80%	12.06bc	9.89de	1.40cde
Average		12.77B	11.00B	1.67B
Black Long	60%	12.73abc	10.35cde	1.29e
Nirala	60%	11.13bc	10.09cde	1.49cde
Bemisal	60%	10.44c	9.10e	1.38cde
Purple Queen	60%	10.47c	9.91de	1.36de
Average		11.19C	9.86C	1.38C
LSD ($p < 0.05$)		2.83	2.52	0.38
Cultivars		**	**	**
Irrigation level		**	*	**
Cultivars × Irrigation level		NS	NS	*

Table 4a: Effect of different irrigation levels on fruit quality (average) of four brinjal cultivars.

Cultivars	Fruit length (cm)	Fruit diameter (cm)	Ascorbic acid (mg/100 g)
Black Long	14.19a	19.41c	0.27 b
Nirala	10.44b	31.76b	0.33a
Bemisal	9.94bc	32.07ab	0.15d
Purple Queen	9.55c	33.17a	0.25c
LSD ($p < 0.05$)	0.85	1.11	0.012

brinjal cultivars as well as for the applied irrigation levels (Table 3 and 3b). 'Nirala' produced the significantly higher yield per plant (1.86 kg) as compared to other cultivars. 'Bemisal' (1.55 kg), 'Black Long' (1.54 kg) and 'Purple Queen' (1.50 kg) were statistically similar with lower fruit yield (Table 3a). On the other hand, the effects of drought stress on fruit yield per plant illustrated the negative effects of moisture stress on yield of brinjal. It was quite clear from the results that 100% irrigation level produced higher yield per plant (1.80 kg). Fruit yield was severely reduced due to moisture stress and decreased to 1.67 kg at 80% irrigation level and 1.38 kg per plant at 60% irrigation level (Table 3b). The combined effect of brinjal cultivars and irrigation levels (interaction) indicated that 'Nirala' cultivar gave the maximum yield per plant at 100% irrigation level, followed by the same cultivar at 80% irrigation level and 'Purple Queen' at 100% irrigation level. These three treatment combinations behaved statistically alike. The minimum number of fruits was recorded in 'Black Long" at 60% irrigation level followed by in all other cultivars at this irrigation level, in all the cultivars except 'Nirala' at 80% irrigation level and in 'Bemisal' at 100% irrigation level. All these treatment combinations stood statistically at par with each other (Table 3b).

Quality attributes

Fruit size is another important parameter that has a great impact on total fruit yield of a crop. It was clear from the data that fruit length and fruit diameter varied significantly among the cultivars. 'Black Long' showed the maximum fruit length (14.19 cm) and the minimum fruit diameter (19.41 cm), while the maximum fruit diameter (33.17 cm) and the minimum fruit length (0.55 cm) was attained by 'Purple Queen' (Table 4a). Water stress also showed significant impact on fruit size and greater fruit length and fruit diameter were produced at 100% irrigation level; both were reduced gradually with increasing moisture deficit (Table 4b). As far as the interaction between these two factors is concerned, significantly greater fruit length was recorded in 'Black Long' at all the irrigation levels, while significantly lesser fruit length was found in 'Purple Queen' at all the irrigation levels and in 'Nirala' at 60% irrigation level. On the other hand, the maximum fruit diameter was attained in 'Purple Queen' and 'Bemisal' at 100 and 80% irrigation levels, whereas the minimum was recorded in 'Black Long' at 100 and 80% irrigation levels (Table 4b).

All the brinjal cultivars significantly differed from each other for their ascorbic acid content. Fruits of 'Nirala' (0.33 mg/ 100 g) and 'Bemisal' (0.15 mg/ 100 g) had significantly higher and lower ascorbic content, respectively (Table 4a). Detrimental effects of moisture stress were not pronounced on ascorbic acid content of brinjal fruits as it varied from 0.25 to 0.26 mg per 100 g of fruit fresh weight among the applied irrigation levels (Table 4b). However, the interactive effect of brinjal cultivars and irrigation levels was found statistically significant. Significantly higher ascorbic acid content was noted in the fruits of 'Nirala' cultivar at all the irrigation levels and significantly lower in 'Bemisal' at 80 and 60% irrigation levels, indicating supremacy of cultivars over irrigation levels (Table 4b).

DISCUSSION

Growth, development and yield of a crop depends on various factors, among those the most important are crop genetic makeup, prevailing environmental conditions, soil fertility status, cultural practices and the ability of a particular crop or cultivar to withstand any stress. In the present work, growth, yield and quality characteristics not only varied among the brinjal cultivars studied but also depicted significant differences

Table 4b: Effect of different irrigation levels on fruit quality (interaction) of four brinjal cultivars.

Cultivars	Irrigation level	Fruit length (cm)	Fruit diameter (cm)	Ascorbic acid (mg/100 g)
Black Long	100%	14.26a	18.30g	0.27bc
Nirala	100%	10.52bcd	31.32cde	0.32a
Bemisal	100%	11.41b	33.78abc	0.18d
Purple Queen	100%	8.86de	34.91a	0.26bc
Average		11.26A	29.58A	0.26A
Black Long	80%	14.00a	18.79fg	0.27bc
Nirala	80%	11.26b	31.95b-e	0.34a
Bemisal	80%	11.47b	32.53a-d	0.13e
Purple Queen	80%	8.08e	34.30ab	0.25c
Average		11.20A	29.39A	0.25A
Black Long	60%	14.31a	21.13f	0.28b
Nirala	60%	9.15cde	32.02b-e	0.33a
Bemisal	60%	10.99bc	29.89e	0.14e
Purple Queen	60%	8.05e	30.29de	0.25c
Average		10.63B	28.33B	0.25A
LSD ($p < 0.05$)		1.92	2.54	0.02
Cultivars		**	**	*
Irrigation level		**	**	NS
Cultivars × Irrigation level		NS	**	**

due to water stress as revealed by LSD test. In the present study, these variations among the studied brinjal cultivars may be due to differences in their genetic makeup and interaction with prevailing climatic conditions of the study area.

Plant height is an important parameter to describe its performance as stunted plant growth is the most prominent effect of any stress in plants. Negative impacts of any stress become clear by observing plant height even at early growth stages. Reduction in plant growth in present work with increasing moisture stress might be due to reduction in gaseous exchange due to stomata closure that leads to reduced photosynthesis and consequent reduction in biomass production (Boutraa, et al., 2010). The results of the present study can be confirmed by previous studies on some other cultivars of brinjal (Hussein et al., 2007; Ilahi et al., 2018) where water stress negatively affected plant height.

Number of branches and leaves per plant is important when canopy size and total photosynthesis rate is considered. Plant having more branches with higher number of leaves will accumulate more biomass due to higher photosynthesis rate. In the present study, both number of branches and leaves per plant were decreased as water stress was increased. Similar findings have also been reported in tomato (Pervez et al., 2009), Okra (Kusvuran, 2012), bottle gourd (Sithole and Modi, 2015) and brinjal (Ilahi et al., 2018) cultivars.

Root length is of great importance as longer roots will explore more area resulting in increased plant growth and yields (Nawaz et al., 2018). Reduction in root length under water deficit conditions might be due to retarded cell growth and division. Zayova et al. (2017) also reported similar result for root length of *in vitro* grown eggplant where water stress significantly reduced the root length as compared to control. Altaf et al. (2015) confirmed the results of present study and found severe reduction in root length of okra under drought stress. Shahbaz et al. (2015) reported stunted root growth in bitter gourd plants subjected to different levels of water stress.

Flower number and ultimately number of fruits per plant are important economical parameters as these affect final production and hence farmer's economy, therefore any stress that reduces number of fruits per plant should be managed properly. These reproductive parameters are known to be affected due to water stress as photosynthesis is reduced which results in reduced number of flowers per plant and ultimately the fruit set. The results of the present work are confirmed by previous findings where lesser number of flowers and lower fruit set was reported in plants, which were subjected to drought stress compared with the plants which received normal irrigation during the course of their growth and development (Aujla et al., 2007; Sithole and Modi, 2015). Physical properties of the fruit such as fruit length, diameter, weight and ultimately the yield are considered as the most important parameters for better economic returns to the farmers. Negative effect of irrigation deficit conditions on these physical quality attributes is well established and confirmed by Colak et al. (2015) in brinjal and Pervez et al. (2009) in tomatoes.

CONCLUSION

'Black Long' and 'Nirala' cultivars of brinjal proved better regarding growth, yield and fruit quality parameters. The performance of these cultivars was up-to mark when 100% irrigation was provided. Even under deficit irrigation conditions, these cultivars proved superior compared with other cultivars used in this study. Therefore, 'Nirala' and 'Black Long' are recommended for the areas facing water shortage, but for obtaining higher yields, full irrigation requirements of the crop must be fulfilled, if possible.

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