American-Eurasian Journal of Scientific Research 12 (5): 296-299, 2017
ISSN 1818-6785

DOI: 10.5829/idosi.aejsr.2017.296.299

Crop Yield and Yield Components of Cantaloupe under Drought Stress

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Abstract: Field experiments were conducted to study the response of crop yield and yield components of cantaloupe to drought stress during 2013 and 2014 growing seasons. Four irrigation treatments based on 10, 30, 50 and 70% available water deficit (AWD) were applied to cantaloupe in the two consecutive growing seasons. Irrigation treatments were designed to induce a range of drought stress from emergence to harvest. Yield components, i.e. number of plants per hectare (NPPH), number of fruits per plant (NFPP), fruit weight (FW) and fruit thickness (FT) were measured and consequently crop yield (CY) was determined for all treatments. The statistical results of study showed that drought stress significantly ($P \leq 0.01$) affected CY, NPPH, NFPP and FW, but there was no significant difference in FT. The maximum values of CY (29.10 t ha^{-1}) and NPPH (8255) were obtained in case of 10% AWD treatment and the minimum values of CY (17.26 t ha^{-1}) and NPPH (4645) were recorded in case of 70% AWD treatment. Moreover, the maximum values of NFPP (3.77) and FW (1520 g) were obtained in case of 30% AWD treatment and the minimum values of NFPP (2.03) and FW (1030 g) were recorded in case of 70% AWD treatment.

Key words: Drought stress · Cantaloupe · Crop yield · Yield components · Iran

INTRODUCTION

Cantaloupe (*Cucumis melo* sp.) is one of the most important vegetable crops of Iran and it ranks fifth in cultivated area and production after tomato, cucumber, watermelon and melon. The average production of cantaloupe has been 750 thousands tones during the last five years. The soil and climatic conditions of Iran are ideal for cantaloupe production but aridity is a dominant factor for limiting the economical crop production in this country [1].

Water is a major constituent of living organism. It comprises about 80-90% of fresh weight of herbaceous plants and over 50% of woody plants. Water furnishes a suitable medium for many biochemical reactions. Also, sufficient water must be present in active crop root zone for germination, evapotranspiration, nutrient absorption by roots, root growth and soil microbiological and chemical processes that aid in the decomposition of organic mater and mineralization of nutrients. These factors are all necessary for sustaining crop growth on a particular field [2].

Under limited water supply conditions the farmer tends to increase the irrigation interval, which creates drought stress [3]. Drought stress is one of the most important factors affecting every aspect of plant growth [4]. Physiological changes in plants, which occur in response to drought stress conditions decrease photosynthesis and respiration [5] and as a result overall production of the crop is decreased. As deficit irrigation results in crop drought stress and reduced crop yields, water must be applied frequently to avoid crop drought stress and adequately to recharge the active plant root zone [6].

Although the effects of drought stress on growth and yield of some crops have been studied during the last years [4, 7-12] meager work has been done to study the response of crop yield, yield components and water use efficiency of cantaloupe to drought stress.

MATERIALS AND METHODS

Research Site: Field experiments were conducted at the Agricultural Research Site, Garmsar, Iran on a clay loam

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soil for two consecutive growing seasons (2013 and 2014). The research site is located at latitude: 35° 13' N, longitude: 52° 19' E and altitude: 873 m in arid climate (136 mm rainfall annually) in the center of Iran.

Weather Parameters: The mean temperature and monthly rainfall of the research site from sowing (May) to harvest (July) during the study years (mean of 2013 and 2014) are indicated in Fig. 1.

Soil Sampling and Analysis: The soil of the research site is classified as an Aridisol (fine, mixed, active, thermic, typic haplocambids). A composite soil sample (from 12 points) was collected from 0-30 cm depth 30 days prior to planting during the years of study and was analyzed in the laboratory for pH, EC, OC, P, K, Fe, Zn, Cu, Mn, B and particle size distribution. Details of soil chemical and physical properties of the research site are shown in Table 1.

Field Methods: The experiment was laid out in a randomized complete block design (RCBD) with three replications. The experiment comprised of four irrigation treatments based on 10, 30, 50 and 70% available water deficit (AWD) to induce a range of drought stress between emergence and harvest. The treatments were carried out on the same plots in the 2013 and 2014 growing seasons. The size of each plot was 10.0 m long and 6.0 m wide. A buffer zone of 3.0 m spacing was provided between plots. There were two furrows in each plot. The furrows had 10.0 m long, 75 cm wide and 50 cm depth and crop was sown on the both sides of each furrow by keeping plant to plant distance 50 cm. In both growing seasons, one of the most commercial varieties of cantaloupe cv. samsoori daroonsabz was sown manually at the rate of 2.5 kg ha^{-1} on 5th May. The seed moisture and germination percentage were 5 and 95%, respectively. Recommended levels of N (450 kg ha^{-1}), P (100 kg ha^{-1}) and K (100 kg ha^{-1}) were used as Urea, TSP and SOP, respectively. For all treatments, irrigation scheduling was based on the basis of 10, 30, 50 and 70% depletion of the total available soil water. The calculation assumed the soil to be at field capacity after establishment irrigation being applied to all treatments. All other necessary operations such as pest and weed controls were performed according to general local practices and recommendations.

Observation and Data Collection: Cantaloupes were harvested at full maturity. Total three pickings of cantaloupe were taken (15, 20 and 25th July) and standard procedures were adopted for recording the data on crop yield and yield components. The main yield components observed in this study were number of plants per hectare (NPPH), number of fruits per plant (NFPP), fruit weight (FW) and fruit thickness (FT). NPPH and NFPP were determined by counting plants and harvesting fruits of the two middle rows of each plot. Other parameters, i.e. FW and FT were determined from the 10 samples taken randomly from harvested fruits of the two middle rows of each plot. Then, crop yield (CY) was determined for all treatments.

Statistical Analysis: All collected data were subjected to the Analysis of Variance (ANOVA) following Gomez and Gomez [13] using SAS statistical computer software. Moreover, means of the different treatments were separated by Duncan’s Multiple Range Test (DMRT) at $P \leq 0.01$.

RESULTS

Crop Yield (CY): A significant effect of drought stress on CY was found during the years of study. The maximum value of CY (29.10 t ha^{-1}) was obtained in case of 10% AWD treatment and the minimum value of CY (17.26 t ha^{-1}) was recorded in case of 70% AWD treatment (Table 2).

Number of Plants per Hectare (NPPH): Drought stress significantly affected NPPH during the study years. The maximum value of NPPH (8255) was obtained in case of 10% AWD treatment and the minimum value of NPPH (4645) was recorded in case of 70% AWD treatment (Table 2).

Number of Fruits per Plant (NFPP): A significant effect of drought stress on NPPH was also found during both the years of study. The maximum value of NFPP (3.77) was obtained in case of 30% AWD treatment and the minimum value of NFPP (2.03) was recorded in case of 70% AWD treatment (Table 2).

Fruits Weight (FW): Drought stress significantly affected FW during the years of study. The maximum value of FW (1520 g) was obtained in case of 30% AWD treatment and the minimum value of FW (1030 g) was recorded in case of 70% AWD treatment (Table 2).

Fruits Thickness (FT): A non-significant effect of drought stress on FT was found during the study years.

Table 1: Soil chemical and physical properties of the experimental site during study years 2013 and 2014 (0-30 cm depth)

Date	pH	EC (dS m^{-1})	OC (%)	P (ppm)	K (ppm)	Fe (ppm)	Zn (ppm)	Cu (ppm)	Mn (ppm)	B (ppm)	Soil texture
2013	7.40	3.15	0.94	45.8	275	3.15	1.50	1.24	13.6	0.52	Clay loam
2014	7.30	3.05	0.90	44.6	265	2.75	1.46	1.18	12.6	0.46	Clay loam

Table 2: Effect of different drought stress on crop yield and yield components of cantaloupe (mean of 2013 and 2014)

Drought stress treatments	CY ** (t h^{-1})	NPPH **	NFPP **	FW ** (g)	FT ^{NS} (cm)
10% AWD	29.10 a	8255 a	3.60 a	1270 b	3.57 a
30% AWD	26.62 a	6365 b	3.77 a	1520 a	3.60 a
50% AWD	18.78 b	5320 bc	3.07 ab	1150 bc	3.27 a
70% AWD	17.26 b	4645 c	2.03 b	1030 c	3.20 a

NS = Non-significant

** = Significant at 0.01 probability level

Means in the same column with different letters differ significantly at 0.01 probability level according to DMRT.

(AWD: available water deficit; CY: crop yield; NPPH: number of plants per hectare; NFPP: number of fruits per plant; FW: fruit weight; FT: fruit thickness)

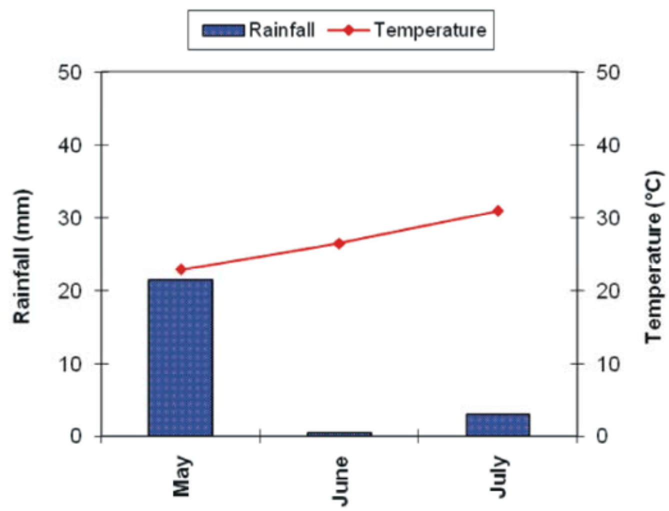

Fig. 1: Mean monthly rainfall and temperature from sowing to harvest (mean of 2013 and 2014)

However, the maximum value of FT (3.60 cm) was obtained in case of 30% AWD treatment and the minimum value of FT (3.20 cm) was recorded in case of 70% AWD treatment (Table 2).

DISCUSSION

In this study, the salient components of CY such as NPPH, NFPP, FW and FT were studied to analyze the response of crop yield and yield components of cantaloupe to drought stress. The statistical results of the study showed that drought stress significantly affected CY, NPPH, NFPP and FW but there was no significant difference in FT (Table 2).

The maximum values of CY (29.10 t ha^{-1}) and NPPH (8255) were obtained in case of 10% AWD treatment, while the minimum values of CY (17.26 t ha^{-1}) and NPPH (4645) were recorded in case of 70% AWD treatment. Drought stress significantly affected CY and NPPH of cantaloupe in the order of 10% AWD > 30% AWD > 50% AWD > 70% AWD. Moreover, the maximum values of NFPP (3.77) and FW (1520 g) were obtained in case of 30% AWD treatment, while the minimum values of NFPP (2.03) and FW (1030 g) were recorded in case of 70% AWD treatment. Drought stress significantly affected NFPP and FW of cantaloupe in the order of 30% AWD > 10% AWD > 50% AWD > 70% AWD.

The higher values of crop yield and yield components obtained in case of 10% AWD and 30% AWD treatments might be due to more frequent application of water resulting in more adequate moisture in active crop root zone, sufficient moisture conservation and better utilization of nutrients. Conversely, the lower values of crop yield and yield components recorded in case of 50% AWD and 70% AWD treatments might be due to infrequent application of water resulting in lack of moisture in active crop root zone, inadequate moisture conservation and poor utilization of nutrients. These results are in agreement with those of Tahir and Mehdi [7], Aslam and Tahir [8], Ahmad *et al.* [9], Kumaga *et al.* [10], Hussain *et al.* [11], Khan *et al.* [12] and Rahman *et al.* [4] who concluded that drought stress adversely affected crop yield and growth.

CONCLUSION

Drought stress significantly affected crop yield (CY), number of plants per hectare (NPPH), number of fruits per plant (NFPP) and fruit weight (FW) of cantaloupe. The maximum values of CY and NPPH were obtained in case of 10% available water deficit treatment. However, the maximum values of NFPP and FW were obtained in case of 30% available water deficit treatment.

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