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Response of Crop Yield and Yield Components of Cantaloupe to Different Irrigation Methods

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Abstract: Field experiments were conducted to study the effect of different irrigation methods on crop yield and yield components of cantaloupe. Three irrigation methods, i.e. surface irrigation (SI), drip irrigation (DI) and drip irrigation in combination with plastic mulch (DI+PM) were applied to cantaloupe between emergence and harvest during 2013 and 2014 growing seasons. 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 indicated that irrigation method significantly ($P \leq 0.01$) affected CY, NPPH, FW and FT, but there was no significant difference in NFPP. The maximum values of CY (27.1 t ha^{-1}), FW (1383 g) and FT (4.1 cm) were obtained in case of DI+PM treatment and the minimum values of CY (22.5 t ha^{-1}), FW (1213 g) and FT (3.4 cm) were recorded in case of SI treatment. Conversely, the maximum value of NPPH (4756) was obtained in case of SI treatment and the minimum value of NPPH (4082) was recorded in case of DI+PM treatment. Although there was no significant difference in NFPP, the maximum value of NFPP (4.8) was also obtained in case of DI+PM treatment and the minimum value of NFPP (3.9) was recorded in case of SI treatment.

Key words: Cantaloupe · Surface irrigation · Drip irrigation · Plastic mulch · 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].

Irrigation is an important determinant of crop yield and growth because it is associated with many factors of plant environment, which influence growth and development. Availability of adequate amount of moisture at critical stages of plant growth not only optimizes the metabolic process in plant cells but also increases the effectiveness of the mineral nutrients applies to the crop [2]. Surface irrigation methods are widely used throughout the world [3]. In this method, the major proportion of irrigation water is lost by surface evaporation, deep percolation and other loses. Moreover, there is a tendency of farmer's to apply excess water when it is available. In addition, under limited water supply conditions farmer tends to increase irrigation interval, which creates water stress resulting in low yields and poor quality. Drip irrigation, with its ability to provide small and frequent water applications directly in the vicinity of the crop root zone has created interest because of decreased water requirement and possible increase in production [4].

As the world become increasingly dependent on the production of irrigated lands, irrigation agriculture is facing serious challenges that threaten its suitability. It is prudent to make efficient use of water and bring more area under irrigation, through available water resources. This can be achieved by introducing advanced methods of irrigation and improved water management practice [5].

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One of the water management practices for increasing water use efficiency is mulching. Any material spread on the surface of soil to protect it from solar radiation or evaporation is called mulch. Different types of materials like wheat straw, rice straw, plastic film, wood, sand and grass are used as mulch. Mulch moderates soil temperature and increase water infiltration during intensive rain [6, 7].

About 20-60% higher yields were obtained with drip irrigation in some studies [8] while in other studies yield was reported to be slightly lower or equal to that of surface irrigation along with reduction in irrigation requirement of 30-60% [9]. Although many experiments have been conducted to study the effect of different irrigation methods on yield and growth of various crops under different agro-climatic region and soil condition, meager work has been done to study the effect of different irrigation methods on crop yield and yield components cantaloupe in the arid lands of Iran.

MATERIALS AND METHODS

Research Site: Field experiments were conducted at the Agricultural Research Site, Garmsar, Iran on a clay loam 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. Three irrigation treatments, i.e. surface irrigation (SI), drip irrigation (DI) and drip irrigation in combination with plastic mulch (DI+PM) were applied to cantaloupe 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. In the SI treatment, 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 the DI and DI+PM treatments, crop was sown by keeping row to row and plant to plant distance 1.5 m and 50 cm, respectively. Laterals of 12 mm diameters were kept 15 cm apart along each row of cantaloupe. The emitters of 4 L h^{-1} capacity were placed at 50 cm spacing. The emitters operated at a pressure of 100 kPa. The pressure in the lateral was controlled with the helps of bypass arrangement. In the DI+PM treatment, black plastic mulch of 25 micron thickness was laid at the time of crop sowing. 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 the cumulative pan evaporation and calculated as sum of the daily evaporation from standard U.S. weather bureau class-A open-pan installed nearby the experimental plots. 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 [10] 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 irrigation method on CY was found during the years of study. The maximum value of CY (27.1 t ha^{-1}) was obtained in case of DI+PM treatment and the minimum value of CY (22.5 t ha^{-1}) was recorded in case SI treatment (Table 2).

Number of Plants per Hectare (NPPH): Irrigation method significantly affected NPPH during the study years. The maximum value of NPPH (4756) was obtained in case of SI treatment and the minimum value of NPPH (4082) was recorded in case of DI+PM treatment (Table 2).

Number of Fruits per Plant (NFPP): A non-significant effect of irrigation method on NFPP was found during the study years. However, the maximum value of NFPP (4.8) was obtained in case of DI+PM treatment and the minimum value of NFPP (3.9) was recorded in case of SI treatment (Table 2).

Fruits Weight (FW): Irrigation method significantly affected FW during the years of study. The maximum value of FW (1383 g) was obtained in case of DI+PM treatment and the minimum value of FW (1213 g) was recorded in case of SI treatment (Table 2).

Fruits Thickness (FT): A significant effect of irrigation method on FT was also found during both the years of study. The maximum value of FT (4.1 cm) was obtained in case of DI+PM treatment and the minimum value of FT (3.4 cm) was recorded in case of SI treatment (Table 2).

DISCUSSION

In this study, the main components of CY such as NPPH, NFPP, FW and FT were analyzed to study the effect of different irrigation methods on crop yield and yield components of cantaloupe. The statistical results of the study indicated that irrigation method significantly affected CY, NPPH, FW and FT but there was no significant difference in NFPP (Table 2).

The maximum values of CY (27.1 t ha^{-1}), FW (1383 g) and FT (4.1 cm) were obtained in case of DI+PM treatment and the minimum values of CY (22.5 t ha^{-1}), FW (1213 g) and FT (3.4 cm) were recorded in case of SI treatment. However, the maximum value of NPPH (4756) was obtained in case of SI treatment and the minimum value of NPPH (4082) was recorded in case of DI+PM treatment. Although there was no significant difference in NFPP, the maximum value of NFPP (4.8) was also obtained in case of DI+PM treatment and the minimum value of NFPP (3.9) was recorded in case of SI treatment. The higher values of CY, NFPP, FW and FT obtained in case of DI+PM treatment might be due to the frequent application of water resulting in more even distribution of soil moisture in active crop root zone, sufficient moisture conservation, proper temperature control owing to presence of mulch, better utilization of nutrients and having negligible weeds infestation. On the contrary, the lower values of

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 irrigation methods on crop yield and yield components of cantaloupe (mean of 2013 and 2014)

Irrigation treatments	CY ** (t h^{-1})	NPPH **	NFPP ^{NS}	FW ** (g)	FT ** (cm)
SI	22.5 b	4756 a	3.9 a	1213 c	3.4 b
DI	24.5 ab	4097 b	4.6 a	1300 b	3.7 ab
DI+PM	27.1 a	4082 b	4.8 a	1383 a	4.1 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.

(SI: surface irrigation; DI: drip irrigation; DI+PM: drip irrigation + plastic mulch; CY: crop yield; NPPH: number of plants per hectare; NFPP: number of fruits per plant; FW: fruit weight; FT: fruit thickness)

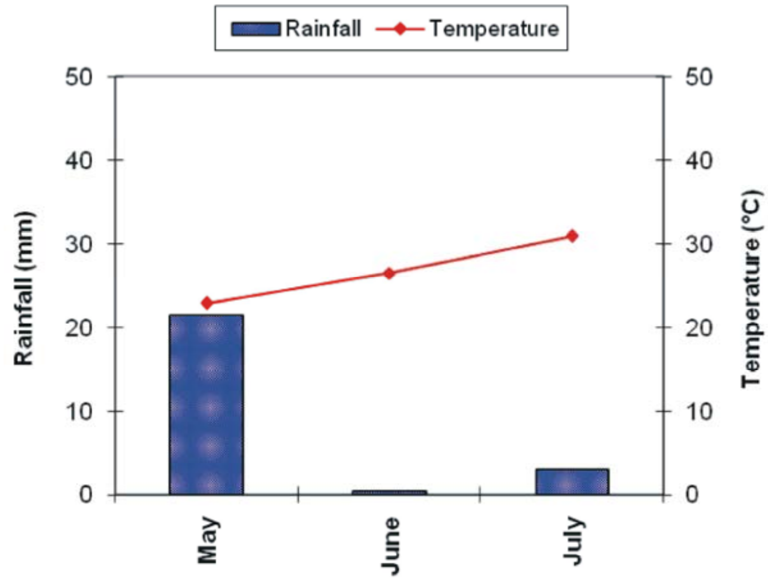

Fig. 1: Mean monthly rainfall and temperature from sowing to harvest (mean of 2013 and 2014)

CY, NFPP, FW and FT recorded in case of SI treatment may be owing to low moisture availability cased by losses due to evaporation and deep percolation, weeds infestation and infrequent irrigation. These results are in agreement with those of Jain *et al.* [4], Gajri *et al.* [6], Khurshid *et al.* [7], Rashidi *et al.* [11] and Rashidi and Gholami [12] who concluded that drip irrigation and/or plastic mulch favorably affected crop yield and growth.

CONCLUSION

Integrated use of drip irrigation and plastic mulch was found to be much more appropriate and profitable irrigation method in increasing crop yield and yield components of cantaloupe in the arid lands of Iran.

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