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Effect of Drip Irrigation and Plastic Mulch on Crop Yield and Yield Components of Cantaloupe

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ABSTRACT

Field experiments were conducted to study the influence of three irrigation methods corresponding to conventional (surface), drip and drip in combination with plastic mulch on cantaloupe (*Cucumis melo*) during 2004 and 2005. Three different irrigation methods i.e., conventional (CI), drip (DI) and drip in combination with plastic mulch (DI + PM) were applied to cantaloupe between emergence and harvest. Number of fruits per plant, fruit weight and fruit thickness (yield components) were measured and consequently crop yield and water use efficiency (WUE) were determined for all treatments. Data suggested that irrigation method significantly ($P \leq 0.01$) affected the fruit weight and fruit thickness, but not the number of fruits per plant. The highest fruit weight and fruit thickness was obtained for the DI + PM treatment and lowest for the CI treatment. The results of the study also indicated that irrigation method significantly affects cantaloupe yield in the order of DI + PM > DI > CI owing to differences in fruit weight and fruit thickness in the same order. The crop yield was highest (27.07 t ha^{-1}) for the DI + PM treatment. The yield from DI treatment was intermediate but lowest (22.47 t ha^{-1}) from CI treatment. The highest WUE (0.91 t ha^{-1} cm^{-1}) was obtained from DI + PM treatment and lowest (22.47 t ha^{-1} cm^{-1}) from CI treatment. The DI + PM treatment was found to be more effective irrigation method in improving WUE and increasing cantaloupe yield.

Key Words: Drip Irrigation; Plastic mulch; Cantaloupe; Yield; Water use efficiency

INTRODUCTION

Cantaloupe (*Cucumis melo*) 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. Iran has abundant land resources but the supply of surface irrigation water is much less for adequately exploiting the soil potentials. This calls for adoption of advanced methods of irrigation like drip irrigation for improved and effective water management.

Irrigation is an important determinant of crop yield, 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. Consequently any degree of water stress may produce deleterious effects on growth and yield of the crop (Saif *et al.*, 2003).

Surface irrigation method is most widely used all over the world (Mustafa *et al.*, 2003). In Iran cantaloupe is generally grown under conventional (surface) method of irrigation too. In this method, the major proportion of irrigation water is lost by surface evaporation, deep percolation and other loses, resulting in lower irrigation efficiencies. Moreover, there is a tendency of farmer's to apply excess water when it is available (Jain *et al.,* 2000).

Under limited water supply conditions farmers tend 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 plant root zone has created interest, because of decreased water requirement and possible increase in production (Jain *et al.,* 2000).

As the world become increasingly dependent on the production of irrigated lands, irrigated agriculture is faces serious challenges that threatens 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 (Zaman *et al.*, 2001).

Among the water management practices for increasing water use efficiency WUE one of them 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, grass, wood, sand etc. are used as mulches. They moderate soil temperature and increase water infiltration during intensive rain (Gajri *et al.,* 1994; Khurshid *et al.,* 2006).

A large number of experiments have been conducted to study the response of drip irrigation and plastic mulch on yield improvement of other crop in different agro-climatic region and soil condition. About 20 - 60% higher yields were obtained with drip irrigation in some studies (Sivanappan *et al.,* 1974), while in other studies yield was reported to be slightly lower or equal to that of conventional irrigation (Doss *et al.,* 1980) along with reduction in irrigation requirement of 30 - 60%.

Cantaloupe is also suited to drip irrigation in combination with plastic mulch, but little work has been done to study the effects of drip irrigation and plastic mulch on crop yield and yield component of cantaloupe in arid lands of Iran. The present investigation was planned to determine the effects of drip irrigation and plastic mulch on crop yield and yield components of cantaloupe.

MATERIALS AND METHODS

The field experiments pertaining to the effects of different irrigation methods on the crop yield and yield components of cantaloupe were carried out during 2004 and 2005 growing seasons in the Garmsar, Iran. The site was located at 873 m altitude, 35°N latitude and 52°E longitude, in arid climate in the center of Iran, where the summers are dry and hot, while winters are cool. The soil of the experiment site was fine, mixed, thermic, Typic Haplacambids clay-loam soil with field capacity of 23% and wilting point of 9.5% (dry basis weight).

The experiments were laid out in a randomized complete block design (RCBD) having three replications. The size of each plot was 10.0 m × 6.0 m wide. Each plot had four rows of crop and a buffer zone of 3.0 m spacing was provided between plots. The irrigation treatments were conventional (surface) irrigation (CI), drip irrigation (DI) and drip irrigation + plastic mulch (DI + PM). In the CI 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 to 50 cm. In 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 and laterals of 12 mm diameters were kept 15 cm apart along each row of cantaloupe. The emitters of 4 L per h capacity were spaced at 50 cm. The emitters operate at a pressure of 100 KPa. The pressure in the lateral was controlled with bypass arrangement. In the DI + PM treatment, the black plastic mulch of 25 µm was laid at the time of crop sowing.

In both growing seasons, moldboard plow and disk harrow were used for tillage operations and furrower for making furrows in the CI treatment. Cantaloupe variety Varamin Samsoori was sown manually at the rate of 2.5 kg ha^{-1}. 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. All other necessary operations such as pest and weed controls were performed according to general local practices and recommendations.

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. Calculation assumed the soil to be at field capacity after establishing irrigation being applied to all treatments.

The main components observed in this study were number of fruits per plant, fruit weight and fruit thickness. In all three pickings of cantaloupe were taken. The weight and thickness of fruits from each plot were recorded at each peaking, and total crop yield and water use efficiency were determined for all treatments. The effectiveness of any crop to use water at all growth period was generally described in terms of WUE and was expressed as ratio of total crop yield to total depth of water applied to crop including effective rainfall at all complete growth period.

Data on crop yield and yield components were recorded by using standard procedures. All the data were subjected to analysis of variance as proposed by Steel and Torrie (1984) and treatment means were compared by Duncan's Multiple Range test at 1% probability. The SPSS software was used for statistical analysis.

RESULTS

Number of fruits per plant. A non-significant effect of different irrigation treatments on number of fruits per plant was found during both the years of study (Table I). However, the highest number of fruits (4.77 $plant^{-1}$) was obtained for the DI + PM treatment and lowest (3.90 $plant^{-1}$) for the CI treatment (Table II).

Fruits weight. All irrigation treatments significantly affected fruit weight during the years of study (Table I). The highest fruit weight (1383 g) was obtained for the DI + PM treatment and lowest (1213 g) for the CI treatment (Table II).

Fruits thickness. Different irrigation treatments significantly affected fruit thickness during both the years (Table I). The highest fruit thickness of 4.10 cm was obtained for the DI + PM treatment and lowest (3.40 cm) for the CI treatment (Table II).

Crop yield of cantaloupe. A significant effect of irrigation treatment on crop yield of cantaloupe was also found during the years of study (Table I). The mean crop yield of cantaloupe in different irrigation treatments (mean of 2004 & 2005) are presented in Table II. The highest crop yield of 27.07 t ha^{-1} was obtained for the DI + PM treatment and lowest (22.47 t ha^{-1}) for the CI treatment.

Water applied and water use efficiency (WUE). The total amounts of irrigation water applied to each irrigation treatment during both the years of study (mean of 2004 & 2005) indicated that the highest amount of irrigation water 39.1 cm was applied for the CI treatment and lowest (29.9 cm) for the DI + PM treatment (Table III). Also, the WUE of the DI and DI + PM treatments were markedly higher than that of the CI. The highest WUE (0.91 t ha^{-1} cm^{-1}) was obtained for the DI + PM treatment and lowest (0.57 t ha^{-1} cm^{-1}) for the CI treatment (Table III).

DISCUSSION

In this study, there was significant difference in fruit weight and fruit thickness but there was no significant

Table I. Mean squares from the analysis of variance of crop yield and yield components of cantaloupe under different irrigation treatments (mean of 2004 & 2005)

Source of variation	Degree of freedom	Crop yield	Number of fruits per plant	Fruit weight	Fruit thickness
Replications	2	3350266^{NS}	0.245^{NS}	1077.78^{NS}	0.10^{NS}
Treatments	2	15926169**	0.655^{NS}	21677.78**	0.37**
Error	4	533874	0.230	344.44	0.02
CV (%)	---	2.90	10.80	1.40	3.80

** = Significant at 0.01 probability level
^{NS} = Non-significant

Table II. Comparison of the means for crop yield and yield components of cantaloupe between different irrigation treatments (mean of 2004 & 2005)

Treatments	Crop yield t ha^{-1}	Number of fruits per plant	Fruit weight g	Fruit thickness cm
Conventional Irrigation	22.47 a	3.90 a	1213 a	3.40 a
Drip Irrigation	24.54 ab	4.63 a	1300 b	3.70 ab
Drip Irrigation + Plastic Mulch	27.07 b	4.77 a	1383 c	4.10 b

Means in the same column with different letters differ significantly at 0.01 probability level according to Duncan's Multiple Range test

Table III. Water applied and water use efficiency (WUE) of different irrigation treatments (mean of 2004 & 2005)

Treatments	Water applied cm	Water use efficiency t ha^{-1} cm^{-1}
Conventional Irrigation	39.1	0.57
Drip Irrigation	33.9	0.72
Drip Irrigation + Plastic Mulch	29.9	0.91

difference in number of fruits per plant among the different irrigation treatments. However, drip irrigation alone or in combination with plastic mulch affected yield components in the order of DI+PM>DI>CI. Also, drip irrigation and drip irrigation in combination with plastic mulch significantly affected crop yield of cantaloupe in the order of DI+PM>DI>CI due to increase in number of fruits per plant, fruit weight, and fruit thickness in the same order. The highest value of crop yield (27.07 t ha^{-1}), number of fruits per plant (4.77), fruit weight (1383 g), and fruit thickness (4.10 cm) was obtained in case of DI+PM method, while lowest value of crop yield (22.47 t ha^{-1}), number of fruit per plant (3.90), fruit weight (1213 g), and fruit thickness (3.40 cm) was noted for CI method. The higher value of crop yield, number fruits per plant, fruit weight, and fruit thickness obtained in the DI+PM method 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 negligible infestation of weeds. For CI method, low crop yield obtained due to low moisture availability cased by losses due to evaporation and deep percolation, weed infestation and infrequent irrigation. Similar data were reported by Gajri *et al.* (1994), Jain *et al.* (2000) and Khurshid *et al.* (2006).

In the present study, effects of drip irrigation and plastic mulch on water applied and WUE was investigated. The results of the study indicated that DI and DI+PM methods markedly decreased water applied in the order of DI+PM<DI<CI and increased WUE in the order of DI+PM>DI>CI. The DI+PM method attained the highest WUE of 0.91 t ha^{-1} cm^{-1} because this treatment consumed about 24% and 12% less water than the CI and DI methods respectively, and produced comparatively higher yield. The lowest WUE (0.57 t ha^{-1} cm^{-1}) realized for the CI method can be ascribed to the fact that the 31% more water was applied to this treatment than the DI+PM method, while yield of the CI method was 17% less than that of the DI+PM method. These results are also in agreement with those of Jain *et al.* (2000), who concluded that drip irrigation and plastic mulch markedly affects applied water and water use efficiency.

CONCLUSSION

Drip irrigation significantly increased crop yield of cantaloupe and improved WUE due to consumption of less water. However, integrated use of drip irrigation and plastic mulch was more appropriate and profitable. Therefore, drip irrigation in combination with plastic mulch was found to be more effective irrigation method in improving WUE and increasing crop yield of cantaloupe.

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