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Response of Yield and Yield Components of Watermelon to Different Tillage Methods in the Arid Lands of Iran

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Abstract: A two year field experiment was conducted to investigate the response of yield and yield components of watermelon to different tillage methods in the arid lands of Iran. Tillage treatments in the study were moldboard plow + two passes of disk harrow as conventional tillage (CT), two passes of disk harrow as reduced tillage (RT), one pass of disk harrow as minimum tillage (MT) and no-tillage (NT) as direct drilling method. The statistical results of the study indicated that tillage method significantly ($P \leq 0.05$) affected yield, fruit weight (FW), fruit length (FL), fruit diameter (FD) and total soluble solids (TSS), but there was no significant differences in other components such as number of plants per hectare (NPPH) and number of fruits per plant (NFPP). The maximum value of yield (21.11 t ha^{-1}), NPPH (2730), FW (5.15 kg) and FD (20.3 cm) was observed in case of CT treatment, while maximum value of NFPP (1.56), FL (23.0 cm) and TSS (7.8%) was noted in case of RT treatment. On the other hand, the minimum value of yield (12.26 t ha^{-1}), NPPH (2590), NFPP (1.40), FW (3.38 kg), FL (20.7 cm) and FD (17.9 cm) was obtained in case of NT treatment, while the minimum value of TSS (6.6%) was noted in case of MT treatment. Accordingly, moldboard plow followed by two passes of disk harrow (CT) was found to be more appropriate and profitable tillage method in improving yield and yield components of watermelon in the arid lands of Iran.

Key words: Watermelon · Yield · Yield components · Tillage method · Arid lands · Iran

INTRODUCTION

Watermelon (*Citrullus vulgaris*) is one of the most important vegetable crops of Iran and is well adapted to its soil and climatic condition. Watermelon ranks second in cultivated area and production after tomato. Although the use of improved varieties and fertilizers has increased watermelon production to much extent, the full potential of crop production has not yet been achieved [1].

Soil tillage is among the important factors affecting soil physical properties and crop yield. Among the crop production factors, tillage contributes up to 20% [2]. Tillage method affects the sustainable use of soil resources through its influence on soil properties [3]. The proper use of tillage can improve soil related constrains, while improper tillage may cause a range of undesirable processes, e.g. destruction of soil structure, accelerated erosion, depletion of organic matter and fertility and disruption in cycles of water, organic carbon and plant nutrient [4]. Use of excessive and unnecessary tillage operations is often harmful to soil. Therefore, currently there is a significance interest and emphasis on the shift to the conservation and no-tillage methods for the purpose of controlling erosion process [5]. Conventional tillage practices modify soil structure by changing its physical properties such as soil bulk density, soil penetration resistance and soil moisture content. Annual disturbance and pulverizing caused by conventional tillage produce a finer and loose soil structure as compared to conservation and no-tillage method which leaves the soil intact [6]. This difference results in a change of number, shape, continuity and size distribution of the pores network, which controls the

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ability of soil to store and transmit air, water and agricultural chemicals. This in turn controls erosion, runoff and crop performance [7]. On the other hand, conservation tillage methods often result in decreased pore space [8], increased soil strength [9] and stable aggregates [10]. The pore network in conservationally tilled soil is usually more continues because of earthworms, root channels and vertical cracks [11]. Therefore, conservation tillage may reduce disruption of continues pores. Whereas, conventional tillage decreases soil penetration resistance and soil bulk density [12]. This also improves porosity and water holding capacity of the soil. Continuity of pore network is also interrupted by conventional tillage, which increases the tortuosity of soil. This all leads to a favorable environment for crop growth and nutrient use [7]. However, the results of no-tillage are contradictory [5]. No-tillage methods in arid regions of Iran had an adverse effect on crop yield [13]; while Chaudhary *et al.* [14] comparing conventional tillage method to no-tillage method concluded that higher moisture preservation and 13% more income was obtained in case of no-tillage.

At the present time, a wide range of tillage methods is being used in Iran without evaluating their effects on crop yield. Therefore, the present investigation was planned to study the response of yield and yield components of watermelon to different tillage methods in the arid lands of Iran.

MATERIALS AND METHODS

Research Site: This study was carried out at the Research Site of Varamin region, Iran on a clay loam soil for two successive growing seasons (2006 and 2007). The research site is located at latitude: 35° 19' N, longitude: 51° 39' E and altitude: 1000 m in arid climate (150 mm rainfall annually) in the center of Iran.

Weather Parameters: The mean monthly rainfall and temperature data of the research site during the years of study (2006 and 2007) are given in Fig. 1.

Soil Sampling and Analysis: To determine soil physical and chemical properties of the research site, a composite soil sample (from 12 points) was collected from 0-30 cm depth 30 days before planting during the study years. Soil sample was analyzed in the laboratory for P, K, Fe, Zn, Cu, Mn, EC, pH, organic carbon, particle size distribution and dry bulk density. Details of soil physical and chemical properties of the research site are given in Table 1.

Table 1: Soil physical and chemical properties of the research site (mean of 2006 and 2007)

Soil characteristics	Values
Texture	Clay loam
Sand (%)	24.6
Silt (%)	38.0
Clay (%)	37.4
Bulk density (Mg m^{-3})	1.15
EC (dS m^{-1})	2.30
pH	7.50
OC (%)	0.95
P (ppm)	40.4
K (ppm)	295
Fe (ppm)	2.84
Zn (ppm)	1.50
Cu (ppm)	1.13
Mn (ppm)	12.9

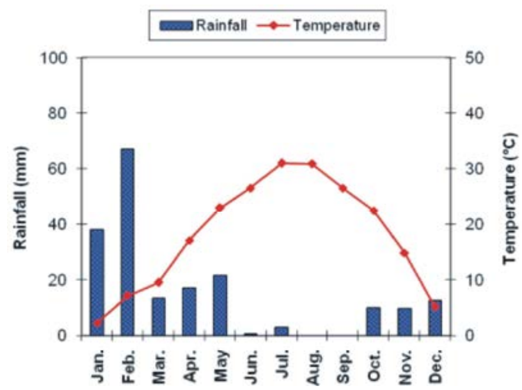

Fig. 1: Mean monthly rainfall and temperature (mean of 2006 and 2007)

Field Methods: The experiments were laid out in a Randomized Complete Block Design (RCBD) having three replications. The size of each plot was 10.0 m long and 6.0 m wide. A buffer zone of 5.0 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 manually on the both sides of each furrow by keeping row to row and plant to plant distance 3.0 m and 50 cm, respectively. The treatments were applied to the same plots during the 2 year (2006-2007) on farm study. Tillage treatments included one pass of moldboard plow followed two passes of disk harrow as conventional tillage (CT), two passes of disk harrow as reduced tillage (RT), one pass of disk harrow as minimum tillage (MT) and no-tillage (NT) as direct drilling method. In both growing season, one of the most commercial variety of watermelon cv. Crimson Sweet was planted at the rate of 2 kg ha^{-1} on 25th April. The seed moisture and germination percentage were 15 and 95% respectively.

Recommended levels of N (200 kg ha^{-1}), P (150 kg ha^{-1}) and K (100 kg ha^{-1}) were used as Urea, TSP and SOP, respectively. Pest and weed controls were performed according to general local practices and recommendations. All other necessary operations except those under study were kept normal and uniform for all the treatments.

Observation and Data Collection: Standard procedures were adopted for recording the data on various growth and yield parameters. Yield, number of plants per hectare (NPPH), number of fruits per plant (NFPP), fruit weight (FW), fruit length (FL), fruit diameter (FD) and total soluble solids (TSS) were determined by harvesting fruits of the two middle rows of each plot.

Statistical Analysis: The data collected were analyzed statistically using Randomized Complete Block Design (RCBD) as described by Steel and Torrie [15]. Duncan's Multiple Range Test (DMRT) at 5% probability was also performed to compare the means of different treatments by using the computer software SPSS 12.0 (Version, 2003).

RESULTS

Yield: Different tillage treatments significantly affected yield during both the years of study. The highest yield of 21.11 t ha^{-1} was obtained in case of CT treatment and lowest (12.26 t ha^{-1}) in case of NT treatment (Table 2).

Number of Plants per Hectare (NPPH): A non-significant effect of different tillage treatments on NPPH was found during the study years. However, the highest NPPH of 2730 was recorded in case of CT treatment and lowest (2590) in case of NT treatment (Table 2).

Number of Fruits per Plant (NFPP): The effect of different tillage treatments on NFPP was also found non-significant during the years of study. However, the highest NFPP of 1.56 was obtained in case of RT treatment and lowest (1.40) in case of NT treatment (Table 2).

Fruit Weight (FW): Different tillage treatments significantly affected FW during the study years. The highest FW of 5.15 kg was recorded in case of CT treatment and lowest (3.38 kg) in case of NT treatment (Table 2).

Fruit Length (FL): A significant effect of different tillage treatments on FL was also found during both the years of study. The highest FL of 23.0 cm was obtained in case of RT treatment and lowest (20.7 cm) in case of NT treatment (Table 2).

Fruit Diameter (FD): Different tillage treatments significantly affected FD during the years of study. The highest FD of 20.3 cm was recorded in case of CT treatment and lowest (17.9 cm) in case of NT treatment (Table 2).

Total Soluble Solids (TSS): A significant effect of different tillage treatments on TSS was also found during the study years. The highest TSS of 7.8% was obtained in case of RT treatment and lowest (6.6%) in case of MT treatment (Table 2).

DISCUSSION

In this study, response of yield and yield components of watermelon to different tillage methods was investigated. The salient components of yield such as NPPH, NFPP, FW, FL, FD and TSS were studied to analyze the effect of different tillage methods on growth and yield of watermelon. Results showed a significant response in the growth and yield of watermelon in the arid land of Iran.

The statistical results of the study indicated that tillage method significantly ($P \leq 0.05$) affected yield, FW, FL, FD and TSS, but there was no significant differences in other yield components such as NPPH and NFPP matter among the different tillage treatments during the study years (Table 2). The maximum value of yield (21.11 t ha^{-1}), NPPH (2730), FW (5.15 kg) and FD (20.3 cm) was observed in case of CT treatment, while maximum value of NFPP

Table 2: Means comparison for yield and yield components of watermelon between different tillage methods (mean of 2006 and 2007)

Treatment	Yield*(t ha^{-1})	NPPH ^{NS}	NFPP ^{NS}	FW*(kg)	FL*(cm)	FD*(cm)	TSS*(%)
CT	21.11 a	2730 a	1.50 a	5.15 a	22.5 b	20.3 a	7.1 b
RT	18.99 b	2685 a	1.56 a	4.53 b	23.0 a	18.5 b	7.8 a
MT	14.26 c	2650 a	1.43 a	3.76 c	21.4 c	18.0 c	6.6 c
NT	12.26 d	2590 a	1.40 a	3.38 c	20.7 d	17.9 c	6.8 c

NS = Non-significant

* = Significant at 0.05 probability level

Means in the same column with different letters differ significantly at 0.05 probability level according to DMRT.

(NPPH: number of plants per hectare; NFPP: number of fruits per plant; FW: fruit weight; FL: fruit length; FD: fruit diameter; TSS: total soluble solids)

(1.56), FL (23.0 cm) and TSS (7.8%) was noted in case of RT treatment (Table 2). These results are in agreement with those of Khan *et al.* [7], who concluded that conventional tillage method produces a favorable environment for crop growth and nutrient use. These results are also in line with the results reported by Rashidi and Keshavarzpour [6] that annual disturbance and pulverizing caused by conventional tillage method produce a finer and loose soil structure which in turn affect the seedling emergence, plant population density and consequently crop yield. On the other hand, the minimum value of yield (12.26 t ha^{-1}), NPPH (2590), NFPP (1.40), FW (3.38 kg), FL (20.7 cm) and FD (17.9 cm) was obtained in case of NT treatment, while the minimum value of TSS (6.6%) was noted in case of MT treatment (Table 2). These results are in agreement with those of Hemmat and Taki [13], who concluded that no-tillage methods in arid regions had an adverse effect on crop yield. These results are also in line with the results reported by Iqbal *et al.* [5] that no-tillage method can not compensate the adverse effect of fine texture, very low organic matter and an overall initial weak structure of the soil.

CONCLUSION

Among tillage treatments, moldboard plow followed two passes of disk harrow (CT) was found to be more appropriate and profitable tillage method in improving yield and yield components of watermelon in the arid lands of Iran.

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