

Study respond on yield of muskmelon to different soil tillage and management

A. Rahnavard*, S.Sadeghi**, Z.Y. Ashrafi*** and M. Rashid***

Department of Medicinal Plant, Islamic Azad University, Tonekabon Branch, Iran

ABSTRACT

A two year field experiment was conducted to investigate the effect of different tillage methods on soil physical properties and crop yield of muskmelon. 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 ($P < 0.05$) affected crop yield, fruit weight, fruit length, fruit diameter and total soluble solids, but there was no significant differences in other components such as number of plants per hectare, number of fruits per plant, root length and root dry matter. The maximum value of crop yield (18.5 t ha^{-1}), number of plants per hectare (2100), fruit weight (5.15kg), fruit diameter (20.3cm), root length (42.0cm) and root dry matter (54.1%) was observed in case of CT treatment, while maximum value of number of fruits per plant (1.56), fruit length (23.0cm) and total soluble solids (8.8%) was noted in case of RT treatment.. The statistical results of the study also indicated that tillage method significantly affected soil physical properties. The soil of the CT treatment had consistently the highest moisture contents (17.6%) and the lowest bulk density (1.21g) and penetration resistance (560kPa); while the soil of the NT treatment had the lowest moisture contents (16.8%) and the highest bulk density (1.52g) and penetration resistance (1120kPa). Accordingly, moldboard plow followed by two passes of disk harrow was found to be more appropriate and profitable tillage method in improving soil physical properties and crop yield of muskmelon.

Keywords: muskmelon, tillage, soil, properties, crop, yield.

INTRODUCTION

Muskmelon (*Cucumis melo reticulatus*) is one of the most important vegetable crops of Iran and is well adapted to its soil and climatic condition. Muskmelon ranks second in cultivated area and production after tomato. The average production of muskmelon has been 3.2 million tons during the last two years. Although the use of improved varieties and fertilizers has increased muskmelon production to much extent, the full potential of crop production has not yet been achieved.

Soil tillage is among the important factors affecting soil physical properties and crop yield. Among the crop production factors, tillage contributes up to 20% (11). Tillage method affects the sustainable use of soil resources through its influence on soil properties (4). 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 (12). 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 (8).

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 (14). This difference results in a change of number, shape, continuity and size distribution of the pores network, which controls the ability of soil to store and transmit air, water and agricultural chemicals. This in turn controls erosion, runoff and crop performance (13).

On the other hand, conservation tillage methods

*Corresponding author's Email: zoheir1980@gmail.com

Department of Agronomy, Agricultural Paradise (Karaj) University of Tehran, Iran; *Payame Noor University, Tehran, Iran

often result in decreased pore space (6), increased soil strength (1) and stable aggregates (7). The pore network in conservationally tilled soil is usually more continuous because of earthworms, root channels and vertical cracks (2). Therefore, conservation tillage may reduce disruption of continuous pores. Whereas, conventional tillage decreases soil penetration resistance and soil bulk density (9). 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 (9, 10, 13). However, the results of no-tillage are contradictory (8). No-tillage methods in arid regions of Iran had an adverse effect on crop yields (5); while Ghuman and Lal (3) 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 this time, a wide range of tillage methods is being used in Iran without evaluating their effects on soil physical properties and crop yield. Therefore, the present investigation was planned to determine the effect of different tillage methods on soil physical properties and crop yield of muskmelon in the arid lands of Iran.

MATERIALS AND METHODS

A two year field experiment was conducted to evaluate the effect of different tillage methods on soil physical properties and crop yield of muskmelon during 2007 and 2008 growing seasons at Research Site of Karaj Agricultural Research Center, Iran. The site is located at latitude of 35°- 19' N and longitude of 51°- 39' E and is 1000 m above mean sea level, in arid climate in the center of Iran, where the summers are dry and hot while the winters are cool. The soil of the experimental site was a fine, mixed, thermic, Typic Haplacambids clay-loam soil. Details of soil physical and chemical characteristics are given in Table 1. The experiments were laid out in a randomized complete block design (RCBD) having three replications. The size of each plot was 10.0m long and 6.0m wide. A buffer zone of 5.0m spacing was provided between plots. There were two furrows in each plot. The furrows had 10.0m long, 75cm wide and 50cm depth and crop was sown manually on the both sides of each furrow by keeping row to row and plant to plant distance 3.0m and 50cm, respectively. The treatments were applied to the same plots during the 2 year (2007 -2008) 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 (Table 2).

In both growing season, one of the most commercial variety of muskmelon cv. Crimson sweet was planted at the rate of 1.85 kg ha⁻¹ on 30th April. The seed moisture and germination percentage were 15 and 95% respectively. Recommended levels of N (150 kg ha⁻¹), P (100 kg ha⁻¹) and K (75 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. Standard procedures were adopted for recording the data on various growth and yield parameters. Crop yield, number of plants per hectare, number of fruits per plant, fruit weight, fruit length, fruit diameter and total soluble solids were determined by harvesting fruits of the two middle rows of each plot. Other parameters, i.e. root length and root dry matter, were determined from the 10 samples taken randomly from each plot. Soil bulk density, soil penetration

Table 1. Soil physical and chemical characteristics of the experimental site.

| Soil characteristics | Values |
|---------------------------|-----------|
| Texture | Clay-loam |
| Sand (%) | 26.5 |
| Silt (%) | 35.3 |
| Clay (%) | 36.1 |
| EC (dS m ⁻¹) | 14.7 |
| pH | 7.82 |
| Organic carbon (%) | 1.05 |
| P (mg kg ⁻¹) | 39.8 |
| K (mg kg ⁻¹) | 400 |
| Fe (mg kg ⁻¹) | 2.64 |
| Mn (mg kg ⁻¹) | 11.3 |
| Zn (mg kg ⁻¹) | 1.5 |
| Cu (mg kg ⁻¹) | 1.27 |

Table 2. Details of different tillage treatments.

| Treatment | Description |
|------------------------------|--|
| (1)Conventional tillage (CT) | Moldboard plow + two passes of disk harrow |
| (2)Reduced tillage (RT) | Two passes of disk harrow |
| (3)Minimum tillage (MT) | One pass of disk harrow |
| (4)No-tillage (NT) | Direct drilling method |

resistance and soil moisture content was also determined at crop harvest. The soil bulk density on dry basis was determined for each treatment. For this test 10 undisturbed samples were taken from the plots by core sampler and dried 24h at 105°C in an oven. Soil penetration resistance was measured by 10 insertions in each plot. A penetrometer (SP 1000) was used with 12.83 mm cone diameter and 30 degree angle based on ASAE standard S313.3 FEB04. Soil moisture content was also determined during cone index recording. The data collected were analyzed statistically using Completely Randomized Block Design (RCBD) as described by Steel and Torrie (15). Duncan's Multiple Range test at 5% probability was performed to compare the means of different treatments by using the computer software SPSS 12.0.

RESULTS AND DISCUSSION

Different tillage treatments significantly affected crop yield during both the years of study (Table 3). The highest crop yield of 21.11 t ha⁻¹ was obtained for the CT treatment and lowest (12.26 t ha⁻¹) for the NT treatment (Table 5).

A non-significant effect of different tillage treatments on number of plants per hectare was found during the study years (Table 3). However, the highest number of plants per hectare of 2730 was obtained for the CT treatment and lowest (2590) for the NT treatment (Table

5). The effect of different tillage treatments on number of fruits per plant was also found non-significant during the years of study (Table 3). However, the highest number of fruits per plant of 1.56 was obtained for the RT treatment and lowest (1.40) for the NT treatment (Table 5).

Different tillage treatments significantly affected fruit weight during the study years (Table 3). The highest fruit weight 5.15kg was obtained for the CT treatment and lowest (3.38 kg) for the NT treatment (Table 5).

A significant effect of different tillage treatments on fruit length was also found during both the years of study (Table 3). The highest fruit length of 23.0cm was obtained for the RT treatment and lowest (20.7cm) for the NT treatment (Table 5).

Different tillage treatments significantly affected fruit diameter during the years of study (Table 3). The highest fruit diameter of 20.3cm was obtained for the CT treatment and lowest (17.9cm) for the NT treatment (Table 5).

A significant effect of different tillage treatments on total soluble solids was also found during the study years (Table 3). The highest total soluble solids of 7.8% were obtained for the RT treatment and lowest (6.6%) for the MT treatment (Table 5).

The effect of different tillage treatments on root length

Table 3. Mean squares from the analysis of variance of crop yield and yield components of muskmelon under different tillage treatments (mean of 2007 and 2008).

| Source of variation | d.f. | Crop yield | No. of plants /ha | No. of fruits /plant | Fruit weight | Fruit length | Fruit diameter | Root dry matter | Root length | Total soluble solids |
|---------------------|------|-------------------|----------------------|----------------------|--------------------|--------------------|--------------------|--------------------|---------------------|----------------------|
| Replications | 2 | 332 ^{NS} | 88541 ^{NS} | 0.57 ^{NS} | 0.03 ^{NS} | 0.02 ^{NS} | 0.04 ^{NS} | 41.4 ^{NS} | 209.1 ^{NS} | 0.02 ^{NS} |
| Treatments | 3 | 29.2* | 223958 ^{NS} | 0.02 ^{NS} | 0.85* | 1.99* | 3.56* | 31.9 ^{NS} | 58.9 ^{NS} | 0.76* |
| Error | 6 | 0.480 | 203125 | 0.09 | 0.008 | 0.003 | 0.015 | 92.0 | 24.6 | 0.019 |
| CV (%) | — | 7.6 | 5.9 | 8.2 | 6.3 | 11.2 | 7.1 | 8.7 | 6.4 | 10.6 |

* = Significant at 0.05 probability level; NS = Non-significant.

Table 4. Mean squares from the analysis of variance of soil bulk density, soil penetration resistance, and soil moisture content under different tillage treatments (mean of 2007 and 2008).

| Source of variation | d.f. | Soil bulk density | Soil penetration resistance | Soil moisture content |
|---------------------|------|---------------------|-----------------------------|-----------------------|
| Replications | 2 | 0.042 ^{NS} | 0.092 ^{NS} | 0.272 ^{NS} |
| Treatments | 3 | 0.028* | 8.084* | 1.09* |
| Error | 12 | 0.009 | 2.761 | 0.57 |
| CV (%) | — | 12.7 | 14.36 | 10.2 |

* = Significant at 0.05 probability level; NS = Non-significant

was found non-significant during the years of study (Table 3). However, the highest root length of 42.0cm was obtained for the CT treatment and lowest (37.1cm) for the NT treatment (Table 5).

A non-significant effect of different tillage treatments on root dry matter was also found during the study years (Table 3). However, the highest root dry matter of 54.1% was obtained for the CT treatment and lowest (46.5%) for the NT treatment (Table 5).

Different tillage treatments significantly affected soil bulk density during both the years of study (Table 4). The highest soil bulk density of 1.52 g cm⁻³ was obtained for the NT treatment and lowest (1.41 g cm⁻³) for the CT treatment (Table 6).

A significant effect of different tillage treatments on soil penetration resistance was also found during the years of study (Table 4). The highest soil penetration resistance of 1250 kPa was obtained for the NT treatment and lowest (560 kPa) for the CT treatment (Table 6).

Different tillage treatments significantly affected soil moisture content during the study years (Table 4). The highest soil moisture content of 19.6% was obtained for the CT treatment and lowest (16.8%) for the NT treatment (Table 6).

In this study, effect of different tillage methods on soil physical properties and crop yield of muskmelon was investigated. The salient components of crop yield such as number of plants per hectare, number of fruits per plant, fruit weight, fruit length, fruit diameter, total soluble solids, root length and root dry matter were studied to analyze the effect of different tillage methods on growth and yield of muskmelon. Also, data regarding soil bulk density, soil penetration resistance and soil moisture content were studied to analyze the effect of different tillage methods on soil physical properties. Results showed a significant response in the growth and yield parameters of muskmelon and physical properties of soil.

The statistical results of the study indicated that tillage method significantly (Pd^{0.05}) affected crop yield, fruit weight, fruit length, fruit diameter and total soluble solids, but there was no significant differences in other yield components such as number of plants per hectare, number of fruits per plant, root length and root dry matter among the different tillage treatments during the study years (Table 3). The maximum value of crop yield (21.11 t ha⁻¹), number of plants per hectare (2730), fruit weight (5.15kg), fruit diameter (20.3cm), root length (42.0cm) and root dry matter (54.1%) was observed in case of CT treatment, while maximum value of number of fruits per plant (1.56), fruit length (23.0cm) and total soluble solids (7.8%) was noted in case of RT treatment (Table 5). These results are in agreement with those of Khan *et al.* (2001), 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 (14) 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 crop yield (12.26 t ha⁻¹), number of plants per hectare (2590), number of fruits per plant (1.40), fruit weight (3.38kg), fruit length (20.7cm), fruit diameter (17.9cm), root length (37.1 cm) and root dry matter (46.5%) was obtained in case of NT treatment, while the minimum value of total soluble solids (6.6%) was noted in case of MT treatment (Table 5). These results are in agreement with those of Hemmat and Taki (5), who concluded that no-tillage methods in arid regions had an adverse effect on crop yields. These results are also in line with the results reported by Iqbal *et al.* (8) 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.

The statistical results of the study also indicated

Table 5. Effect of different tillage treatments on crop yield and yield components of muskmelon (mean of 2007 and 2008).

| Treatments | Crop yield (t ha ⁻¹) | No. of plants /ha | No. of fruits per plant | Fruit weight plant | Fruit length (cm) | Fruit diameter (cm) | Root dry matter (%) | Root length (cm) | Total soluble solids (%) | Root dry matter (%) |
|------------|----------------------------------|-------------------|-------------------------|--------------------|-------------------|---------------------|---------------------|------------------|--------------------------|---------------------|
| CT | 21.11a | 2730a | 1.50a | 5.15a | 22.5b | 21.3a | 54.1a | 42.0a | 7.1b | 54.1a |
| RT | 18.99b | 2685a | 1.56a | 4.53b | 23.0a | 18.5b | 52.7a | 39.7a | 7.8a | 50.7a |
| MT | 14.26c | 2650a | 1.43a | 3.76c | 24.4c | 18.0c | 48.4a | 38.3a | 6.6c | 48.4a |
| NT | 12.26d | 2590a | 1.40a | 3.48c | 20.7d | 17.9c | 46.5a | 38.1a | 6.8c | 51.3a |

Means in the same column with different letters differ significantly at 0.05 probability level according to Duncan's Multiple Range test.

that tillage method significantly affected soil physical properties as they increased soil moisture content while decreased soil bulk density and soil penetration resistance among the different tillage treatments during both the years of study (Table 4). The soil of the CT treatment had consistently the highest moisture contents of 19.6% and lowest bulk density and penetration resistance of 1.41 g cm⁻³ and 560 kPa, respectively (Table 6). Alternatively, the soil of the NT treatment had the lowest moisture contents of 16.8% and the highest bulk density and penetration resistance of 1.52 g cm⁻³ and 1250 kPa, respectively (Table 6). The soils of the MT and NT treatments had almost the same soil bulk

Table 6. Effect of different tillage treatments on soil physical properties (mean of 2007 and 2008).

| Treatments | Soil bulk density (g cm ⁻³) | Soil penetration resistance (kPa) | Soil moisture content (%) |
|------------|---|-----------------------------------|---------------------------|
| CT | 1.41 c | 560 c | 21.6 a |
| RT | 1.47 b | 815 b | 19.4 b |
| MT | 1.50 ab | 1125 a | 17.1 c |
| NT | 1.52 a | 1200 a | 17.7 c |

Means in the same column with different letters differ significantly at 0.05 probability level according to Duncan's Multiple Range test.

density and moisture content. However, the soil of NT treatment reflected high penetration resistance and showed about 14% more resistance than the resistance offered by the soil of the MT treatment (Table 6). A significantly greater soil moisture content of the CT treatment than other treatments was considered to be due to effect of primary and secondary tillage implements used which improved porosity and water holding capacity of the soil. These results are in agreement with those of Khan *et al.* (10), who reported that conventional tillage method increased tortuosity of the soil. Furthermore, significant lower soil bulk density and penetration resistance of the CT treatment was judged to be due to soil loosening effect of primary and secondary tillage implements used. These results are in line with the results reported by Khurshid *et al.* (11) that soil of the conventional tillage treatment had higher moisture content and lower bulk density and penetration resistance than other treatments. Greater soil penetration resistance of RT, MT and NT treatments may also be due to lower soil moisture contents. This is in line with the results reported by Ghuman and Lal (3) that penetration resistance decreased with increase in soil moisture content and vice versa.

Tillage method significantly affected crop yield of muskmelon in the order of CT > RT > MT > NT. The highest amount of crop yield obtained in the CT method might be due to reduced soil penetration resistance and bulk density, increased soil moisture content, enhanced seed-soil contact, and suppressing weed growth. Where in case of RT, MT and NT methods, the lower amounts of crop yield obtained may be due to significantly greater soil penetration resistance and bulk density, and lower soil moisture content which adversely affect seed emergence, root growth and plant population density. Accordingly, moldboard plow followed by two passes of disk harrow was found to be more appropriate and profitable tillage method in improving soil physical properties and crop yield of muskmelon.

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