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Effect of Different Tillage Methods on Yield and Yield Components of Forage Corn

[1]Majid Rashidi, [2]Fereydoun Keshavarzpour and [1]Mohammad Gholami

[1]Department of Agricultural Machinery, Faculty of Agriculture,
Islamic Azad University, Takestan Branch, Iran
[2]Faculty of Agriculture, Islamic Azad University, Shahr-e-Rey Branch, Iran

Abstract: A field experiment was conducted for two consecutive years to study the effect of different tillage methods on yield and yield components of forage corn. 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 dry biological yield, dry grain yield and number of plants per hectare, but there was no significant differences in other yield components such as number of ears per plant, number of rows per ear, number of grains per row, 1000-grain weight, plant height and stem diameter. The maximum value of dry biological yield (13.22 t ha^{-1}), dry grain yield (4.15 t ha^{-1}), number of plants per hectare (39830) and number of ears per plant (0.92) was obtained in case of CT treatment, while maximum value of number of grains per row (37.0), plant height (178.0 cm) and stem diameter (2.0 cm) was observed in case of RT treatment. Also, maximum value of number of rows per ear (14.7) and 1000-grain weight (244.3 g) was noted in case of NT treatment. On the other hand, the minimum value of dry biological yield (7.40 t ha^{-1}), dry grain yield (2.39 t ha^{-1}) and number of plants per hectare (20390) was obtained in case of NT treatment, while minimum value of number of ears per plant (0.89), plant height (167.4 cm) and stem diameter (1.7 cm) was observed in case of MT treatment. Also, minimum value of number of rows per ear (13.7), number of grains per row (35.2) and 1000-grain weight (234.7 g) was noted in case of CT treatment. Accordingly, moldboard plow followed by two passes of disk harrow was found to be more appropriate and profitable tillage method in improving dry biological yield of forage corn.

Key words: Tillage · forage corn · yield · yield components

INTRODUCTION

Corn (*Zea mays*) is one of the most important cereal crops and it ranks forth in cultivated area and production after wheat, barley and rice in Iran. Although the use of improved varieties and fertilizers has increased corn production to much extent, the full potential of crop production has not yet been achieved.

Corn has greater nutritional value as it contains about 72% starch, 10% protein, 4.8% oil, 8.5% fiber, 3% sugar and 17% ash. Due to higher yield potential, short growing period, high value for food, forage and feed for livestock, poultry and a cheaper source of raw material for agro-based industry, it is increasingly gaining an important position in the cropping system [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

Corresponding Author: Dr. Majid Rashidi, Department of Agricultural Machinery, Faculty of Agriculture, Islamic Azad University, Takestan Branch, Iran

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 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 tortuousity 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 yields [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 this time, a wide range of tillage methods is being used in Iran without evaluating their effect on crop growth. Therefore, the present investigation was planned to determine the effect of different tillage methods on yield and yield components of forage corn in the arid lands of Iran.

MATERIALS AND METHODS

Two field experiments were conducted to evaluate the effect of different tillage methods on yield and yield components of forage corn during 2004 and 2005 growing seasons at the Agronomic Research Area, Varamin, 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 summer season is dry and hot while the winter is 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 20.0 m long and 9.0 m wide.

Table 1:Physical and chemical characteristics of soils of the experimental site

Soil characteristics	Values
Sand (%)	24.60
Silt (%)	38.00
Clay (%)	37.40
Texture	Clay-loam
Bulk density (mg kg^{-1})	1.15
Organic carbon (%)	0.60
SP (%)	45.00
pH	7.50
EC (dS m^{-1})	2.30
Available P (mg kg^{-1})	40.40
Available K (mg kg^{-1})	460.00
Available Fe (mg kg^{-1})	2.84
Available Mn (mg kg^{-1})	12.90
Available Zn (mg kg^{-1})	1.50
Available Cu (mg kg^{-1})	1.13

Table 2: Details of different tillage treatments

Treatment	Description
CT	Moldboard plow+two passes of disk harrow
RT	Two passes of disk harrow
MT	One pass of disk harrow
NT	No-tillage

A buffer zone of 3.0 m spacing was provided between plots. The treatments were applied to the same plots during the 2 year (2004-2005) 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 common commercial variety of forage corn cv. 704 was planted at the rate of 12.5 kg ha^{-1} on 20th April with the help of 4-rows corn planter by keeping row to row and plant to plant distance 75 cm and 30 cm, respectively. The seed moisture and germination percentage were 15 and 95%, respectively. Recommended levels of N (400 kg ha^{-1}), P (200 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.

Standard procedures were adopted for recording the data on various growth and yield parameters. Dry biological yield, dry grain yield, number of plants per hectare and number of ears per plant were determined

Table 3: Comparison of the means for yield and yield components of forage corn between different tillage treatments (mean of 2004 and 2005)

Treatments	Dry biological yield t ha^{-1}	Dry grain yield t ha^{-1}	No. of plants per hectare	No. of ears per plant	No. of rows per ear	No. of grains per row	1000-grain weight g	Plant height cm	Stem diameter cm
CT	13.22 a	4.15 a	39830 a	0.92 a	13.7 a	35.2 a	234.7 a	174.5 a	1.9 a
RT	11.27 b	4.02 a	35580 b	0.90 a	14.1 a	37.0 a	240.8 a	178.0 a	2.0 a
MT	9.63 c	3.07 b	26970 c	0.89 a	14.5 a	36.5 a	241.5 a	167.4 a	1.7 a
NT	7.40 d	2.39 c	20390 d	0.90 a	14.7 a	36.3 a	244.3 a	172.5 a	1.9 a

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

by harvesting the two middle rows of each plot. Other parameters, i.e. number of rows per ear, number of grains per row, 1000-grain weight, plant height and stem diameter, were determined from the 10 samples taken randomly from each plot. 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 (Version, 2003).

RESULTS

Dry biological yield: Different tillage treatments significantly affected dry biological yield during both the years of study. The highest dry biological yield of 13.22 t ha^{-1} was obtained for the CT treatment and the lowest (7.40 t ha^{-1}) for the NT treatment (Table 3).

Dry grain yield: A significant effect of different tillage treatments on dry grain yield was also found during the study years. The highest dry grain yield of 4.15 t ha^{-1} was obtained for the CT treatment and the lowest (2.39 t ha^{-1}) for the NT treatment (Table 3).

Number of plants per hectare: The effect of different tillage treatments on number of plants per hectare was also found significant during the years of study. The highest number of plants per hectare of 39830 was obtained for the CT treatment and the lowest (20390) for the NT treatment (Table 3).

Number of ears per plant: A non-significant effect of different tillage treatments on number of ears per plant was found during both the years of study. However, the highest number of ears per plant of 0.92 was obtained for the CT treatment and the lowest (0.89) for the MT treatment (Table 3).

Number of rows per ear: The effect of different tillage treatments on number of rows per ear was also found non-significant during the study years. However, the highest number of rows per ear of 14.7 was obtained for the NT treatment and the lowest (13.7) for the CT treatment (Table 3).

Number of grains per row: A non-significant effect of different tillage treatments on number of grains per row was also found during the years of study. However, the highest number of grains per row of 37.0 was obtained for the RT treatment and the lowest (35.2) for the CT treatment (Table 3).

1000-grain weight: The effect of different tillage treatments on 1000-grain weight was also found non-significant during both the years of study. However, the highest 1000-grain weight of 244.3 g was obtained for the NT treatment and the lowest (234.7 g) for the CT treatment (Table 3).

Plant height: A non-significant effect of different tillage treatments on plant height was also found during the study years. However, the highest plant height of 178.0 cm was obtained for the RT treatment and the lowest (167.4 cm) for the MT treatment (Table 3).

Stem diameter: The effect of different tillage treatments on stem diameter was also found non-significant during the years of study. However, the highest stem diameter 2.0 cm was obtained for the RT treatment and the lowest (1.7 cm) for the MT treatment (Table 3).

DISCUSSION

In this study, effect of different tillage methods on yield and yield components of forage corn was investigated. The salient components of yield such as dry grain yield, number of plants per hectare, number of ears per plant, number of rows per ear, number of grains per row, 1000-grain weight, plant height and stem diameter were studied to analyze the effect of different tillage methods on growth and yield of forage corn.

The statistical results of the study indicated that tillage method significantly (P=0.05) affected dry biological yield, dry grain yield and number of plants per hectare, but there was no significant differences in other yield components such as number of ears per plant, number of rows per ear, number of grains per row, 1000-grain weight, plant height and stem diameter among the different tillage treatments during the study years (Table 3). The maximum value of dry biological yield (13.22 t ha^{-1}), dry grain yield (4.15 t ha^{-})[, number of plants per hectare (39830) and number of ears per plant (0.92) was obtained in case of CT treatment, while maximum value of number of grains per row (37.0), plant height (178.0 cm) and stem diameter (2.0 cm) was observed in case of RT treatment. Also, maximum value of number of rows per ear (14.7) and 1000-grain weight (244.3 g) was noted in case of NT treatment (Table 3). These results are in agreement with those of Rashidi and Keshavarzpour [6], who concluded that annual disturbance and pulverizing caused by tillage practices produce a finer and loose soil structure which in turn affect the seedling emergence, plant population density and consequently crop yield. These results are also in line with the results reported by Khan *et al.* [7] that tillage practices produce a favorable environment for crop growth and nutrient use.

On the other hand, the minimum value of dry biological yield (7.40 t ha^{-1}), dry grain yield (2.39 t ha^{-1}) and number of plants per hectare (20390) was obtained in case of NT treatment, while minimum value of number of ears per plant (0.89), plant height (167.4 cm) and stem diameter (1.7 cm) was observed in case of MT treatment. Also, minimum value of number of rows per ear (13.7), number of grains per row (35.2) and 1000-grain weight (234.7 g) was noted in case of CT treatment (Table 3). These results are in agreement with those of Hemmat and Taki [13], who concluded that no-tillage method in arid regions had an adverse effect on crop yields. 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.

The results of the study also indicate that number of plants per hectare is the major yield component explaining dry biological yield of forage corn under different tillage methods and dry biological yield differences among different tillage treatments occur owing to significant differences in number of plant per hectare. Besides, the highest number of plants per hectare obtained in the CT treatment might be due to reduced soil compaction, enhanced seed-soil contact, increased soil moisture storage and suppressing weed growth. Where, in case of NT treatment, the lowest number of plants per hectare obtained may be due to significantly greater soil bulk density and soil penetration resistance, which adversely affect seed emergence, root growth and plant population density. These results are in agreement with those of Rashidi and Keshavarzpour [16], who concluded that tillage practices significantly affect soil physical properties as they increased soil moisture content while decreased soil bulk density and soil penetration resistance. These results are also in line with the results reported by Keshavarzpour and Rashidi [17] that soil of the conventional tillage treatment had higher moisture content and lower bulk density and penetration resistance than other treatments.

CONCLUSSION

Among tillage treatments, moldboard plow followed by two passes of disk harrow proved to be most effective in promoting the forage corn yield in the arid lands of Iran.

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