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Effect of Different Tillage Methods on Soil Physical Properties, Quantitative and Qualitative Yield of Two Forage Maize Cultivars

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Abstract
One of the factors affecting the physical properties of soil and crops is tillage systems. The experiment was conducted in summer 2012 at the research farm of Islamic azad university. This study was performed by experiment a split plot in a randomized complete block design with three replications. The main factors in this study, four different tillage methods as a main factors and sub factors includes two maize varieties, including single cross 704 and maxima were considered. Also for soil physical properties statistical analysis, randomized complete block design was used. based on the results، different tillage methods on soil physical properties and yield of plants showed significant differences at 1%. Most of the yield was related to corn single cross 704 and twice of disc tillage in depth of 15-10 cm, with 88/18 tons per hectare. The greatest amount of soluble sugars and protein was obtained from corn single cross 704 with cultivator with blade and light disk with depth of 8 to 10 cm. thus it can be concluded that reduced tillage methods in dry and warm regions through Improve soil structure and retain moisture, resulting the yield of quantitative and qualitative of diffrent agricultural products will Increase.
Keywords: soil, corn, physical properties, tillage methods, quantitative and qualitative yield.

Introduction

When peoples was dependent to a group of animals for supply some of own needed nutrients, produced some useful and valuable forage plants for animal feeds, Was more noteworthy. One of these plants is corn. This valuable product of agricultural, provides nearly 70 percent of the poultry feed, useful grain to produce edible oil, starch, glucose, and raw material in the industry and many other products (Hosseini and Abedi, 2007). Studies show that each year a large area of arable land in the world due to compaction and soil erosion disappears. For this reason, use of appropriate strategies to reduce nutrient loss and soil erosion is necessary. Conservation tillage include reduced tillage and no-tillage is one of the useful methods to avoid these problems (Limousin and Tessier, 2007). on the other hand adopt special measures to address the concerns of due to lack of food, For a growing world population, it seems necessary. In this regard, proper land preparation and tillage operations, one of the issues that are important to increase production. Research results indicate that tillage systems Is effective on yield of the different crops. Wright and colleagues in year 2007 reported that cotton yield in reduced tillage system compared with conventional tillage system increases. They stated that the reduced tillage systems soil phosphorus and nitrogen availability in the soil increases that associated with higher performance (Wright *et al*., 2007). Another study that was conducted in 5 years, observed that cotton yield in the first three years in conservation tillage systems was significantly higher than conventional tillage while the last two years, cotton yields in the system of protective tillage with conventional tillage was equivalent (Blaise and Ravindran, 2003). Conservation tillage can with increase soil moisture and reduce soil temperature, lead to increased performance yield of corn (Afzalinia *et al*., 2011). Keep soil in good physical condition is one of the aspect protective of it that depends heavily on the proper use of agricultural machinery management and soil conditions. the tillage systems with effect in the rate of previous crop residue on soil surface and pores soil, are important role in maintaining moisture and yield in arid and semiarid regions (De Vita *et al*., 2007).

Materials and Methods

This research in crop year 2012 at agricultural research station, university of varamin located in the city of varamin (tehran province), with longitude 51 degrees 39 seconds and latitude 35 degrees and 19 seconds and elevation 1000 meters above sea level and features loam soil - clay loam (Table 1), was conducted and during that effect of different methods of tillage on soil physical properties and yield and forage maize cultivars were evaluated. this research was conducted By split-plot experiments design was a randomized complete block with three replications. The main factors of this project, four different tillage methods including**:** 1-tillage with ***rotary*** tiller in depth of 8 to 10 cm **(**S_1), 2-cultivator with blade and light disk with depth of 8 to 10cm(S_2), 3-twice disk with depth of 10 to 15 cm (S_3), 4- moldboard ***plow and light*** disk ***with depth of 8 to 10 cm*** *(*S_4). On the other hand, other sub factors in this research were considered two cultivars of silage corn including: corn with single

cross of 704 (SC 704) and corn with cultivar of Maxima. for statistical analysis of physical properties of soil, completely randomized block design was used.

Table 1. physical and chemical soil analysis.

Type of test	pH	Clay (%) Hydrometer	Silt (%) Hydrometer	Sand (%) Hydrometer	Texture Hydrometer	N (%) Kjeldahl	K (ppm) Flame hotometer	P (ppm) Spectrophotometer
Optimum range	6.5	25	25	50	loam loam clay	> 0.2	400	15
Results	7.78	22	36	42	Loam	0.06	406.6	12.8

According to soil test rates of nitrogen fertilizer, 350 kg per hectare, was calculated. nitrogen fertilizer in three phases: growing phase (50%), three to five leaves (25%) and the crown of flowers (25%) were given to the plant. The first irrigation after tillage and were performed before planting drip method this procedure until complete plant establishment after planting was continued and then once every 8 to 10 days with conventional methods and practices of local farmers were done. plantation was performed by worker and planting with hand. In this method, a furrow by foca along the longitudinal of each plot with depth of 2.5 cm was induced and Then the seeds were poured in furrow and compacted. humidity at two time after tillage and after harvest In depth 10-15 cm three points of each main plot was measured. The sampling by a special cylinder that also were used to calculate the bulk density was performed. In all cases, soil samples at 105 ° C, in the oven were dried for 24 hours. meanwhile, wet and dry weight of soil before and after placing the sample in the oven was measured. Weighing by digital scale accurately 0.01 and then for moisture content measurement was calculated from equation 1.

$$\Theta m = \frac{A - B}{B - C}$$

equation 1- content humidity measurements

Where: Θm= moisture content, A= weight of empty container and wet soil weight, B= weight of empty container and dry soil weight, C= weight of the empty container.

For sampling and determination of bulk density of the soil after tillage, from three points of each main plot randomly in depth of 10-15 cm as undisturbed soil, by a special cylinders was conducted. In order to calculate the bulk density from equation 2 was used.

$$Pb = \frac{\text{Weight of dry soil}}{\text{Undisturbed soil volume}}$$

equation 2- Soil bulk density measurements

Soil fragmentation measurements at the end of tillage before planting was done. the index that commonly used In this case mean weight diameter (MWD) is hunk. for measuring a frame with dimensions 15 × 15 × 30 cm in depth of 15 cm was inserted in the soil. the frame removed and the soil was transported to the laboratory in plastic bag after pouring. this work was carried out randomly in each plot three times. by equation 3 was used for to calculate the mean weight diameter (MWD) hunk.

$$MWD = (1/W)\ (0.25A + 0.75B + 1.25C + 1.25D + 1.75E) + NE)$$

equation 3- measurement of mean weight diameter (MWD) hunk

Where: W= weight of soil comminuted in per sample from experiment, A= weight of soil transmission from sieve 0.5 inch, B= weight of clod between sieve of 0.5 and 1 inch, C= weight of the clod between sieve of 1 and 1.5 inch, D= weight of clod between sieve of 1.5 and 2 inch, E= weight of the clod on sieve of 2 inch, N= mean of clod diameter on the upper sieve according to millimeters.

Weight of 100 seeds averaging from sampling 10 sample of each sub plot were measured. Also, the equation 4 In order to calculate the total number of grains per ear was used.

Total number of seeds= Average number of rows per ear × Number of seeds per row

equation 4- measurement total number of grains per ear

To measure fresh forage yield, whole shoot, leaf and corn from the soil surface were harvested, and weight of the fresh forage as yield of forage fresh weight was considered. for this purpose, ten plants per subplot cut from the soil surface, and was immediately transported to the laboratory. in laboratory with separating the leaves and stalks of corn, Each were measured separately. and thus the yield of forage fresh weight was calculated.

Bradford method for measurement of total protein was used (Bradford, 1979). also soluble sugars according to the method of dubois were measured and The amount of xylose, arabinose, glucose and mannose were measured by this method (Dubois, 1956).

Statistical analysis was performed for all traits using SAS software and for draw the graphs and tables excel software was used also all mean comparison using duncan's multiple range test was performed. for the analysis traits related to yield and yield components of maize varieties, tested split plot In a randomized complete block design was used. But for the analysis of soil physical properties, randomized complete block design was used. and data were collected and analyzed separately.

Results and Discussion

The results showed that tillage methods had significant effect on seed weight and number of grains per ear, wet weight of leaf, stem and grain quality traits such as soluble sugars and protein. also the effect of tillage on soil physical properties such as soil moisture after tillage and after harvest, soil bulk density and the mean weight diameter (MWD), was meaningful. result analysis of variance for the study are reported in tables 2 and 3.

Table 2. Analysis of variance, yield and yield components of two maize varieties under different tillage methods (mean square)

Sources of change	Degrees of freedom	The total number of grains per ear	100 Seed weight	wet weight of leaves	wet weight of stem	wet weight of corn	yield
Repeat (R)	2	34455.792	2.040	4.530	4.530	9.960	0.179
Tillage (S)	3	13744.50**	9.854**	5131.250**	86678.125**	12460.250**	420.000**
Error (E)	6	22.125	0.327	0.163	0.163	3.702	0.0001
cultivar (v)	1	3901.500**	46.204**	2109.375**	119709.375**	1683.375**	565.996**
Interaction of tillage and cultivar (s×v)	3	54832.50**	26.104**	465.625**	6753.125**	1184.625**	62.962**
Error (E)	8	33.875	0.245	0.245	0.245	2.506	0.0001
The coefficient of variation (c.v%)	-	10.74	4.17	6.71	10.06	8.87	9. 01

continued of Table 2. Analysis of variance for yield and yield components of two maize varieties under different tillage methods (mean square)

Sources of change	**Degrees of freedom**	**Glucose**	**Arabinose**	**Xylose**	**Mannose**	**Protein**
Repeat (R)	2	1.761	0.143	0.001	0.142	0.001
Tillage (S)	3	58.599**	77.504**	164.943**	0.332 **	23.000**
Error (E)	6	1.303	0.123	0.0001	0.123	0.0001
cultivar (v)	1	14.260**	112.234**	0.375**	2.933 **	3.256**
Interaction of tillage and cultivar (s×v)	3	15.625**	7.494**	18.641**	5.135**	0.081**
Error (E)	8	1.434	0.123	0.0001	0.123	0.0001
The coefficient of variation (c.v%)	-	5.78	1.91	1.72	7.86	11.02

ns ,*,**: No Significant at 0.05 and 0.01 Probability levels , respectively

Fresh weight of leaf, stem, ear and yeild

According to the results of mean comparisons (Fig. 1, 2, 3 and 4), the highest fresh weight of leaf, stem and corn from cultivation of maize single cross 704 with type 3 of tillage methods (S3) respectively to amount of 113.43, 521.81 and 166.45 gr and the corn yield with type 3 of tillage methods and cultivation of maize single cross 704 with 88.18 tons per hectare, was obtained. with reduced tillage methods can the crop water requirement during the growing season and especially at the end of the growing season be provided (Robert., *et al* 2006). generally, water is the main limiting factor for agriculture in arid and semi-arid regions. Tillage and crop rotation, and storage management methods that are effective in moisture absorption impact. in reduced tillage methods possibly through more reserve of soils moisture and reduction of evaporation that performance will increas.

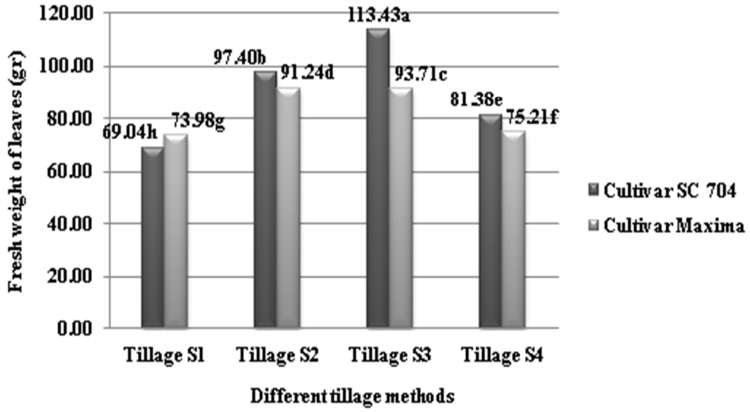

Fig 1. Effect of interaction between cultivars and tillage on leaf fresh weight (gr)

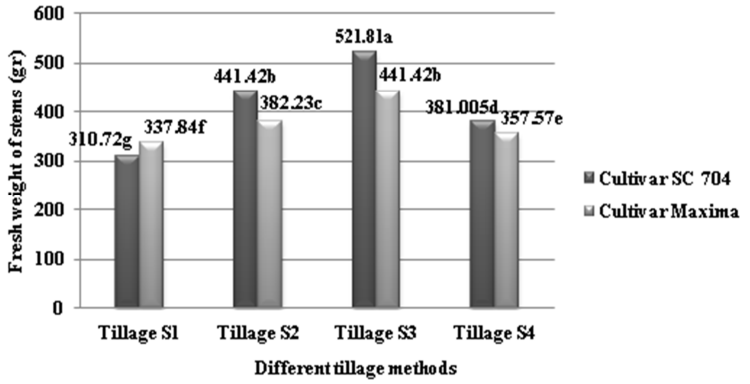

Fig 2. Effect of cultivar and tillage interactions on shoot fresh weight (gr)

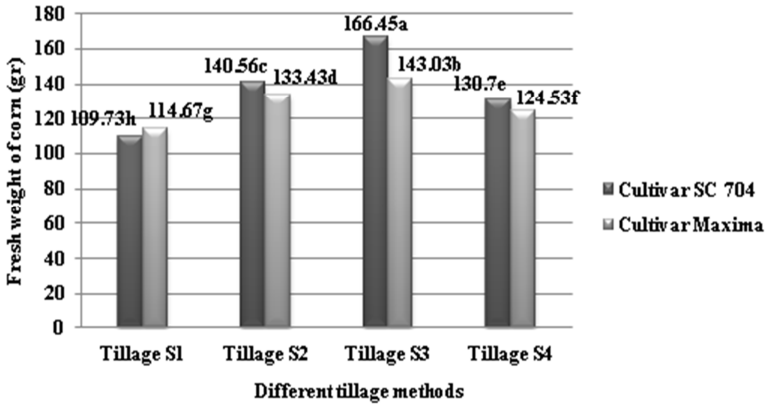

Fig 3. Effect of interaction between cultivars and tillage on fresh weight of corn (gr)

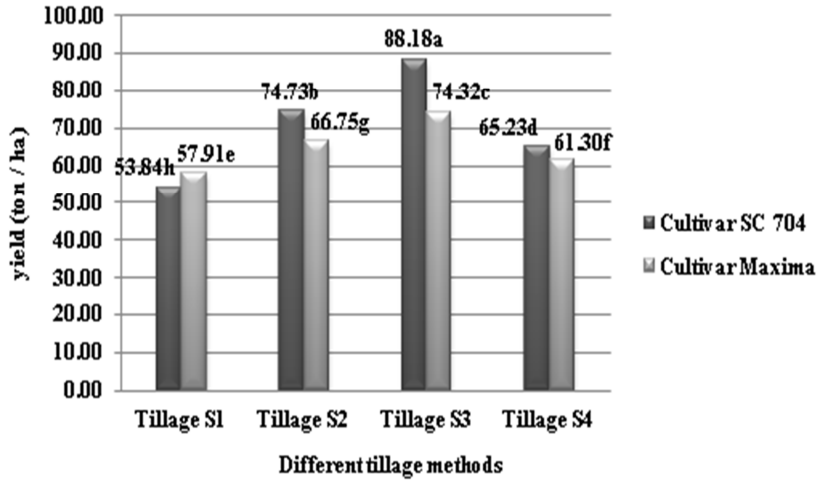

Fig 4. Effect of different levels of interaction between tillage and cultivars on yield (ton/ha)

Soluble sugars (glucose, arabinose, xylose and mannose) and protein

According to the comparison results of mean (Fig.s 5, 6, 7, 8 and 9) highest amount of glucose, arabinose, xylose, and protein, from cultivation of maize single cross 704 with type 2 of tillage methods (S2) respectively to amount of 26.04, 25.70, 31.24 and 13.58 percent was obtained. also the highest rate of mannose with type 3 of tillage method (s3) and cultivation of maize single cross 704 and the the amount of 6.1 percent was calculated. Can be said cultivator with blade with infiltration in the soil provides conditions for absorption of water and nutrients in the soil. and it can be attributed to growth of root and optimal use of environmental (HajiBabayi, 1997). overall forage quality is affected by the interaction of water and nitrogen and reduce tillage operations with increased moisture stored in soil that is always has been a critical factor in increase ability of quantitative and qualitative yeild of products.

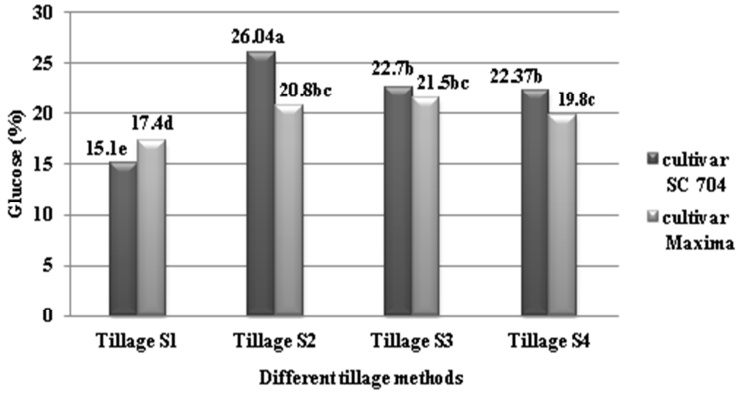

Fig 5. Effect of interaction between cultivars and tillage on glucose (%)

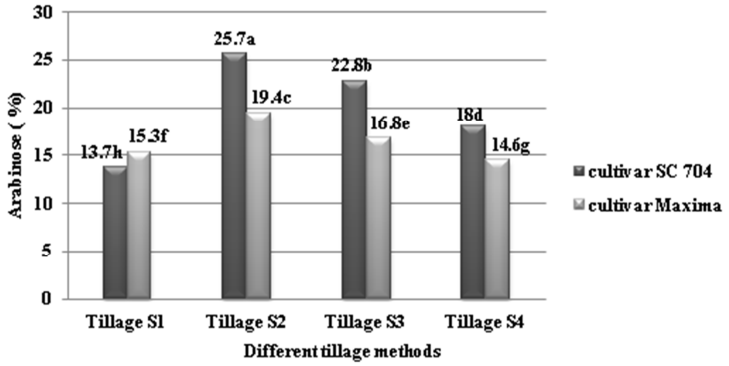

Fig 6. Effect of interaction between cultivars and tillage on arabinose (%)

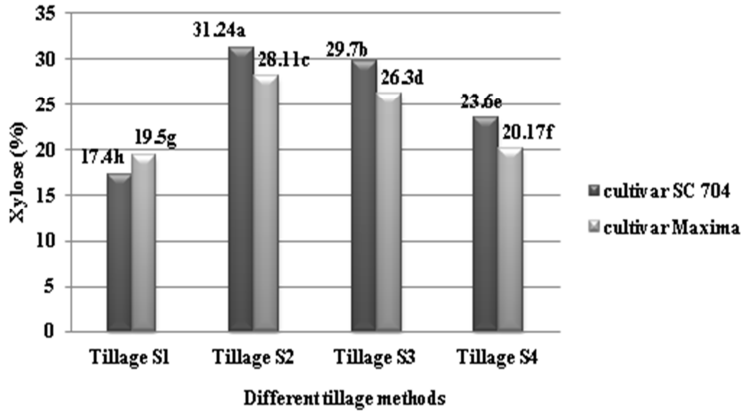

Fig 7. Effect of interaction between cultivars and tillage on xylose (%)

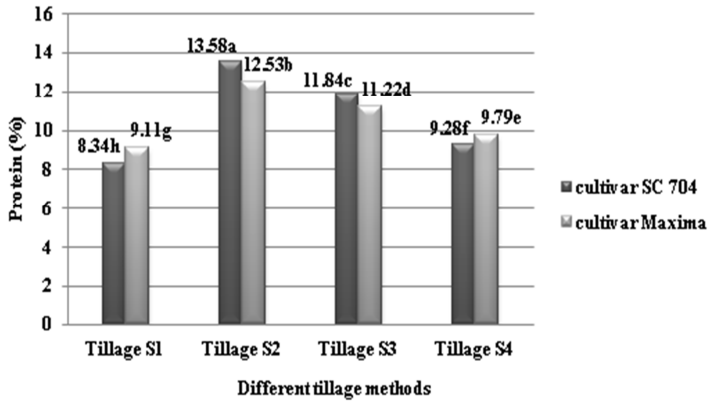

Fig 8. Effect of interaction between cultivars and tillage on protein (%)

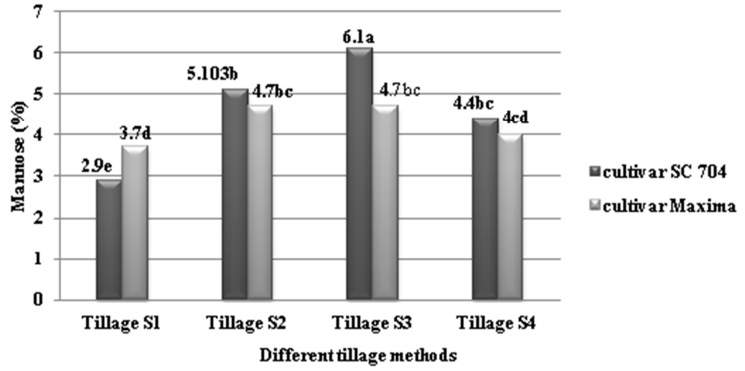

Fig 9. Effect of interaction between cultivars and tillage on mannose (%)

Table 3. Statistical analysis of soil physical properties under different tillage methods (mean square)

Sources of change	Degrees of freedom	Soil bulk density in depth of 10-15 cm	Soil moisture after tillage	soil moisture after harvest	Mean weight diameter
Repeat (R)	**2**	0.0001	0.0001	0.007	0.0001
Tillage (S)	**3**	0.210 **	5.289**	0.110**	0.962**
Error (E)	**6**	0.0001	0.0001	0.005	0.0001
The coefficient of variation (c.v%)	-	5.75	1.05	2.82	4.77

*and**: Significant at 0.05 and 0.01 Probability level, respectively

Changes in soil moisture (after tillage and after harvest)

According to results (Fig. 10 and 11), the maximum amount of moisture after tillage for type 4 of tillage methods

(S4) and lowest amount of moisture for type 2 of tillage methods (S2) and respectively to amount of 16.08 and 13.07 percent, was obtained. also the highest soil moisture after harvest with type 3 of tillage methods (S3) and the lowest of soil moisture from type 4 of tillage methods (S4) and respectively to amount of the 9.10 and 8.69 percent, was calculated. according to the results in dry conditions, reduced tillage, with maintain of soil moisture is the best way to prepare the substrate (Rusu *et al*., 2009). these results indicate that in dry conditions and in areas with limitation of moisture, whatever the soil is less disturbed, moisture losses are lower and the reason is reduce evaporation from the soil surface.

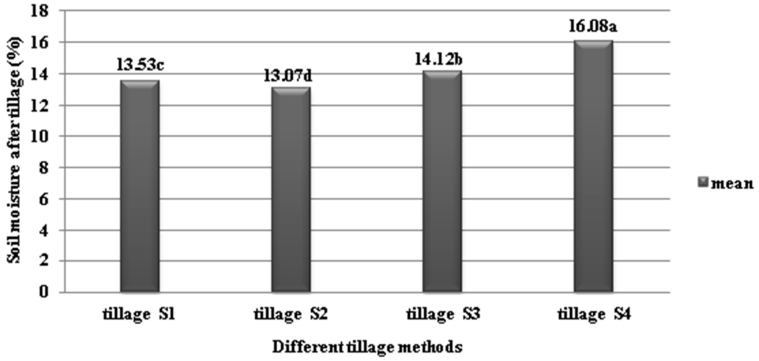

Fig 10. Effect of different tillage methods on soil moisture after tillage

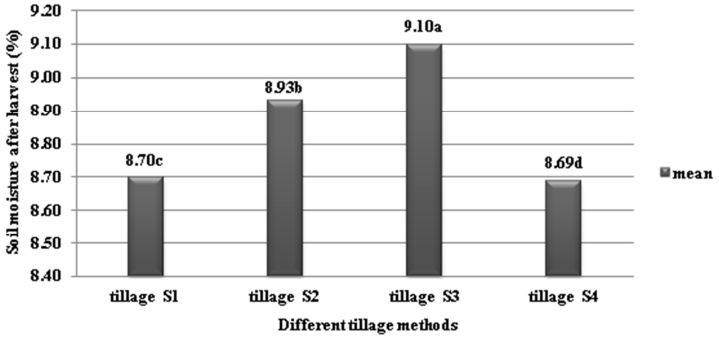

Fig 11. Effect of different tillage methods on soil moisture after harvest

Soil bulk density after tillage

according to the results (Fig. 12), the lowest bulk of density soil with type 4 of tillage methods (S4) and amount of 0.92 g/cm^3 and maximum amounts for type 2 of tillage methods (S2) with amount of 1.06 g/cm^3 was calculated. this result is consistent with the findings of Jin et al in tests that lasted respectively 10 and 11 years corresponded, they reported that by plowing with moldboard plow, the bulk density of soil was reduced (Jin *et al*., 2011). probably in moldboard plow, through making the large of lumps and disarrange of soil also the rotary plow because of complete disruption the soil and increases soil porosity, the bulk density decreased.

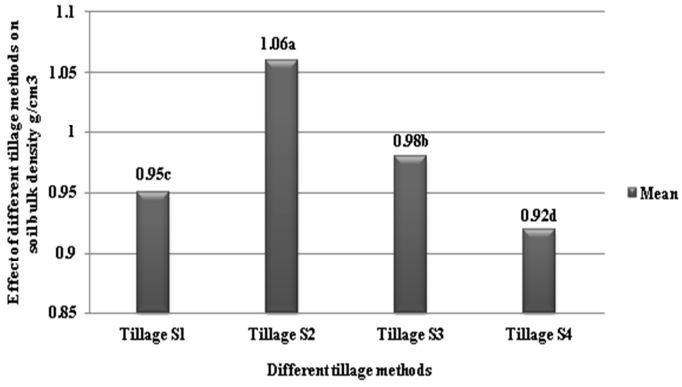

Fig 12. Effect of different tillage methods on soil bulk density

Mean weight diameter of soil

base on the results (Fig. 13), the highest amount of crushed soil with mean diameter 1.81 cm from

type 1 of tillage methods (S1), and lowest amount of crushed soil with mean diameter 3.14 cm by type 4 of tillage methods (S4) was obtained. loghavi and colleagues in their research, compared the rotivator with disk, showed that the rotivator in depth more than 5 cm, aggregate soil with less mean weight diameter and more uniform provides (Rouzbeh and Loghavi, 2006).

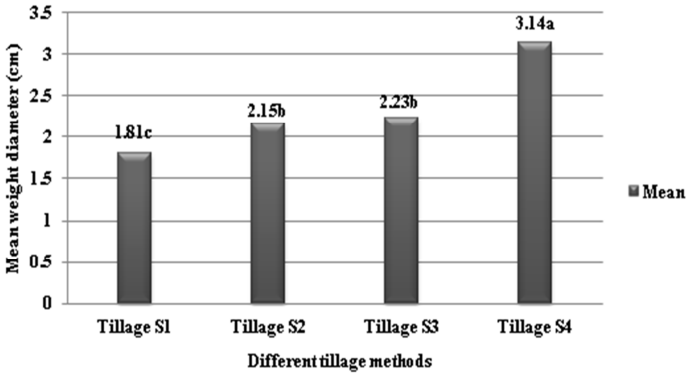

Fig 13. Effect of different tillage methods on mean weight diameter of soil

Conclusion

The results of this research show that though initially, conventional tillage due to the low bulk density and greater porosity of soil, was more water storage space and greater volume of water in its placed but over time and end of the growing season the reduced tillage methods to reason of minimal manipulation and disturbing the soil, caused diminished the rate of moisture evaporation the soil surface and thus will able to prevent the loss of moisture stored in the soil. so with conservation tillage practices, water needed to satisfy various products is stored also the water used in agriculture is reduced.

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