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Effects of Different Tillage Methods on Soil Physical Properties, Grain and Forage Yield of Two Cultivars Maize

Hamid Reza Ghanbaryan Alavijeh
Department of Agronomy, Faculty of Agriculture, Islamic Azad University, Varamin-Pishva Branch, Iran
Emails: hghanbaryan@yahoo.com

Hossein Ahmadi Chenarbon
Assistant Professor, Department of Agronomy, Varamin - Pishva Branch, Islamic Azad University, Varamin, Iran

Behnam Zand
Member of Scientific Staff, Varamin Agricultural and Natural Resources Research Center, Iran

Mohsen Hamidi
Department of Agronomy, Faculty of Agriculture, Islamic Azad University, Varamin-Pishva Branch, Iran

Abstract **– The most important factors affecting on 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 are four different tillage methods and sub factors includes two maize varieties; single cross 704 and maxima. 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 have shown 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 using cultivator with blade and light disk with depth of 8 to 10 cm.**

Keywords **– Soil Physical Properties, Grain Yield, Forage Yield, Cultivars Maize, Tillage Methods.**

I. Introduction

According to studies, about 60% of the mechanical energy is used in mechanized farming for tillage. (Hemmat *et al*., 2004). When peoples were dependent on a group of animals to supply some of their own necessary nutrients, producing some useful and valuable forage plants for animal feeds, was more noteworthy. One of these plants is corn. This valuable product of agriculture, provides nearly 70 percent of the poultry feed. It is a 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 disappears due to compaction and soil erosion. For this reason, application of appropriate strategies is necessary to reduce nutrient loss and soil erosion. Conservation tillage which includes reduced tillage and no-tillage is one of the useful methods to avoid these problems (Limousin and Tessier, 2007). On the other hand adopting special measures seems necessary to address the concerns regarding lack of food, for growing world population. In this regard, proper land preparation and tillage operations, are the two important issues for increasing production. Research results indicate that tillage systems Is are effective on yield of the different crops. Wright *et al* in 2007 reported that cotton yield in reduced tillage system increases compared with conventional tillage system. They stated that phosphorus and nitrogen availability increases in the soil of reduced tillage systems which leads to higher performance (Wright *et al*., 2007). Another study conducted in 5 years, observed that cotton yield in the first three years in conservation tillage systems was significantly higher than conventional tillage while in the last two years, cotton yields in the system of protective tillage was equivalent to conventional tillage (Blaise and Ravindran, 2003). Conservation tillage can lead to increased performance yield of corn by increasing soil moisture and reducinge its temperature, (Afzalinia *et al*., 2011). Keeping soil in good physical condition is one of the protective aspects of it that depends heavily on the proper use of agricultural machinery management and soil conditions. The tillage systems affect on the rate of previous crop residue on soil surface and pores soil. Thus, they play a prominent role in maintaining moisture and yield in arid and semiarid regions (De Vita *et al*., 2007).

II. Materials and Methods

This research was conducted in year 2012 at agricultural research station crop, the University of Varamin located in Varamin city (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). During this research, effect of different methods of tillage on soil physical properties, yield and forage maize cultivars were evaluated. This research was conducted by split-plot. The design of experiments was a randomized complete block with three replications. The main factors of this project are four different tillage methods including: 1- tillage with rotary tiller in depth of 8 to 10 cm (S1), 2- cultivator with blade and light disk with depth of 8 to 10cm (S2), 3- twice disk with depth of 10 to 15 cm (S3), 4- moldboard plow and light disk with depth of 8 to 10 cm (S4). Moreover, two cultivars of silage corn were considered as sub-factors in this research which are as follows: 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 utilized.

Table 1: Physical and chemical soil analysis.

Type of test	pH	Clay (%) Hydrometer	Silt (%) Hydrometer	Sand (%) Hydrometer	Texture Hydrometer	N (%) Kjeldahl	K (ppm) Flame Photometer	P (ppm) Spectrophoto-meter
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 tests, rate of nitrogen fertilizer, was calculated 350 kg per hectare. Nitrogen fertilizer was given to the plant in three phases: growing phase (50%), three to five leaves (25%) and the crown of flowers (25%). The first irrigation was performed after tillage and before planting drip method. This procedure continued until complete plant establishment after planting. Subsequently, once every 8 to 10 days they were done with conventional methods and practices of local farmers. 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. Then, the seeds were poured in furrow and compacted. Humidity was measured twice, after tillage and after harvest, in depth of 10-15 cm and three points of each main plot. The sampling was performed by a special cylinder that also was used to calculate the bulk density. In all cases, soil samples were dried at 105 ° C, in oven 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 it was accurately calculated 0.01. Afterwards, moisture content measurement was derived from equation 1.

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

Equation 1- content humidity measurements

Where Θm: is moisture content, A: stands for weight of empty container and wet soil weight, B: denotes weight of empty container and dry soil weight and C: is weight of the empty container.

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

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

Equation 2- Soil bulk density measurements Soil fragmentation measurements were done at the end of tillage before planting. The index, which is commonly used in the case, is mean weight diameter (MWD) hunk. In order to measure it a frame with dimensions of 15 × 15 × 30 cm in depth of 15 cm was inserted in the soil. The frame removed and after pouring, the soil was transported to the laboratory in plastic bag. This work was carried out randomly in each plot three times. We used equation 3 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: is weight of soil comminuted in per sample from experiment, A: shows weight of soil transmission from sieve 0.5 inch, B: denotes weight of clod between sieve of 0.5 and 1 inch, C= is weight of the clod between sieve of 1 and 1.5 inch, D: represents weight of clod between sieve of 1.5 and 2 inch, E: stands for weight of the clod on sieve of 2 inch and N: is mean of clod diameter on the upper sieve in term of millimeters.

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

$$Total\ number\ of\ seeds = Average\ number\ of\ rows\ per\ ear \times Number\ of\ seeds\ per\ row$$

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 was considered as yield of forage fresh weight. For this purpose, ten plants per subplot were cut from the soil surface, and were immediately transported to the laboratory. In laboratory, each of them was measured separately with separating the leaves and stalks of corn, and the yield of forage fresh weight was calculated.

Statistical analysis was performed for all traits using SAS software. For drawing the graphs and tables excel software was utilized. Also, all mean comparisons were performed using Duncan's multiple range tests. For the analysis traits related to yield and yield components of maize varieties, tested split plot was used in a randomized complete block design. But for the analysis of soil physical properties, randomized complete block design was used. Data were collected and analyzed separately.

III. 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 is reported in tables 2 and 3.

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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

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

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

A. Fresh weight of leaf, stem, ear and yield

According to the results of mean comparisons (Fig. 1, 2, 3 and 4), the highest fresh weight of leaf, stem and corn, which was obtained from cultivation of maize single cross 704 with type 3 of tillage methods (S3), equals to 113.43, 521.81 and 166.45 gr respectively and the corn yield with type 3 of tillage methods and cultivation of maize single cross 704 with 88.18 tons per hectare. With reduced tillage methods the crop water requirement can be provided during the growing season and especially at the end of the growing season (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 are effective in moisture absorption impact. in reduced tillage methods performance will increas possibly due to more reserve of soils moisture and reduction of evaporation.

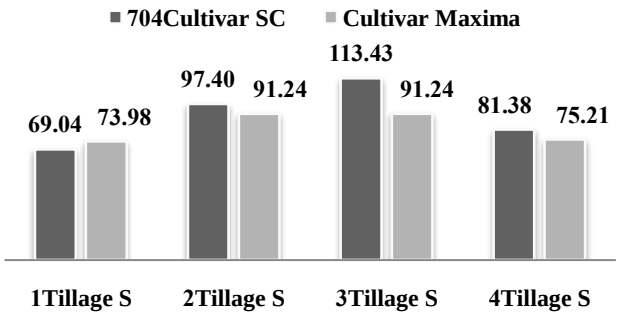

Fig.1. Effect of interaction between cultivars and tillage on leaf fresh weight (g)

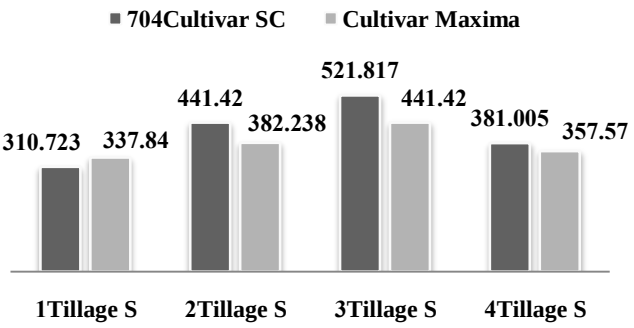

Fig.2. Effect of interactions between cultivar and tillage on shoot fresh weight (g)

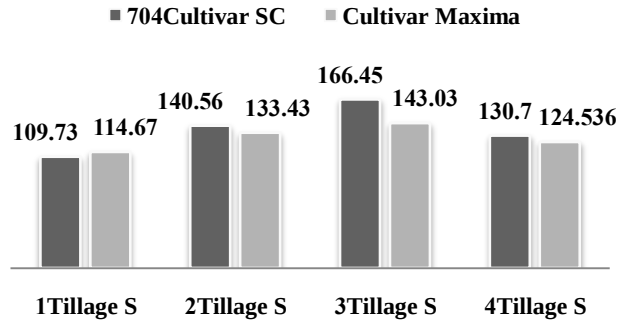

Fig.3. Effect of interaction between cultivars and tillage on corn fresh weight (g)

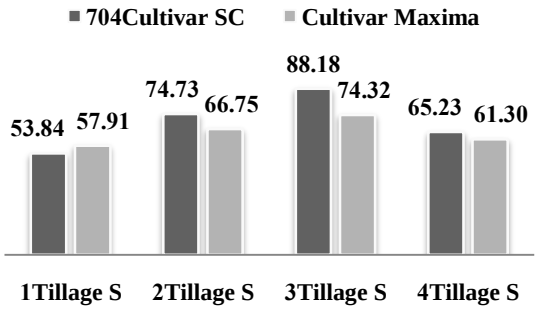

Fig.4. Effect of interaction between tillage and cultivars on yield (ton / ha)

B. The total number of grains per ear and 100 grain weight:

Based on the results (Fig. 5 and 6), the most number of grains per ear was obtained, with cultivation of maize single cross 704 and type 2 of tillage methods (S2) which was 901.7 pcs of grains per ear. Additionally, the highest weight of 100 seed is achieved with cultivation of maize single cross 704 and type 2 of tillage methods (S2) which equals to 17 gr and the lowest amount of this index is obtained from type 1 of tillage methods (S1) and cultivation of maize single cross 704 which was 8 gr. This may lead to reduction in soil compaction, improvement of root growth, uniform distribution of nutrients, increase of organic matter and, savinge and keeping more moisture in the soil (Bauer & Black, 1981). It can be said that reduced tillage methods paly effective role in increasing water storage within the soil. It also seems maize varieties with long growth season have a higher yield in comparison with maize varieties with short growth season.

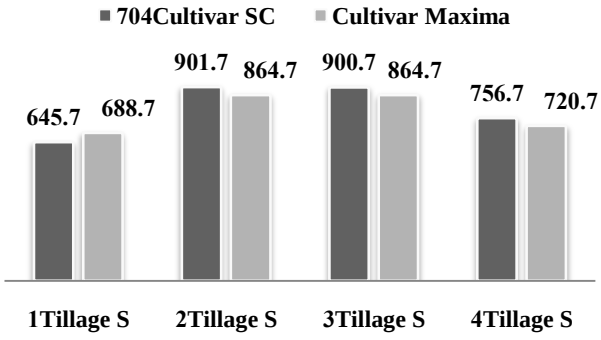

Fig.5. Effect of interaction between cultivars and tillage on the total number of grains per ear

C. Changes in soil moisture (after tillage and after harvest)

According to results (Fig. 7 and 8), the maximum amount of moisture after tillage was obtained from type 4 of tillage methods (S4) and lowest amount of moisture was achieved form type 2 of tillage methods (S2). Their amount respectively equals to 16.08 and 13.07 percent. In addition, the highest soil moisture was calculated after harvest with type 3 of tillage methods (S3) and the lowest of soil moisture was derived from type 4 of tillage methods (S4). They are respectively equivalent to 9.10 and 8.69 percent. 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, the less soil is disturbed, the lower moisture losses are because of reduction in evaporation from the soil surface.

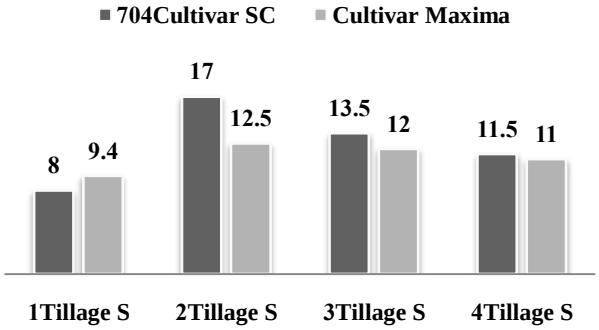

Fig.6. Effect of interaction between cultivars and tillage on 100 grain weight (g)

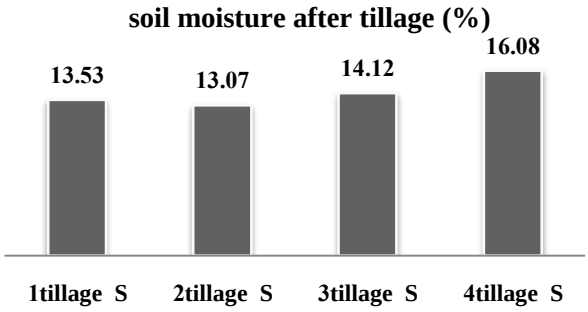

Fig.7. Effect of different tillage methods on soil moisture after tillage (%)

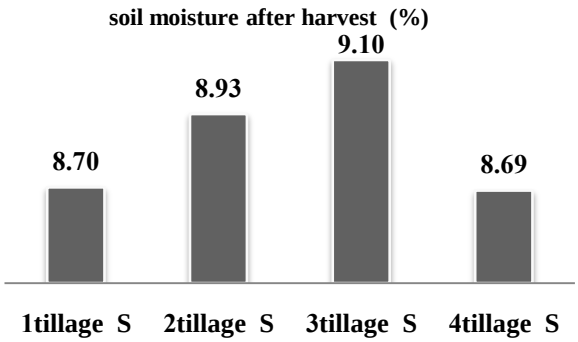

Fig.8. Effect of different tillage methods on soil moisture after harvest (%)

D. Soil bulk density after tillage

According to the results (Fig. 9), the lowest bulk of density soil was calculated with type 4 of tillage methods (S4) which equals to 0.92 g/cm3 and maximum amounts was calculated for type 2 of tillage methods (S2) which was equivalent to 1.06 g/cm3. This result is consistent

with the findings of Jin *et al* in tests that lasted respectively 10 and 11 years. They reported that plowing by moldboard plow, the bulk density of soil was reduced (Jin *et al*., 2011). Probably in moldboard plow, bulk density decreased because of making large of lumps and disarrange of soil. Also the rotary plow results in complete disruption of soil and increases soil porosity.

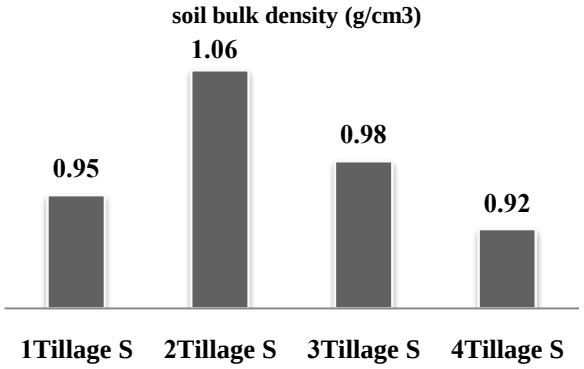

Fig.9. Effect of different tillage methods on soil bulk density (g/cm3)

E. Mean weight diameter of soil

Based on the results (Fig. 10), the highest amount of crushed soil with mean diameter of 1.81 cm was obtained from type 1 of tillage methods (S1), and lowest amount of crushed soil with mean diameter 3.14 cm was achieved by type 4 of tillage methods (S4). Loghavi and colleagues compared the rotivator with disk in their research. They showed that the rotivator in depth of more than 5 cm, aggregates soil with less mean weight diameter and provides more uniform (Rouzbeh and Loghavi, 2006).

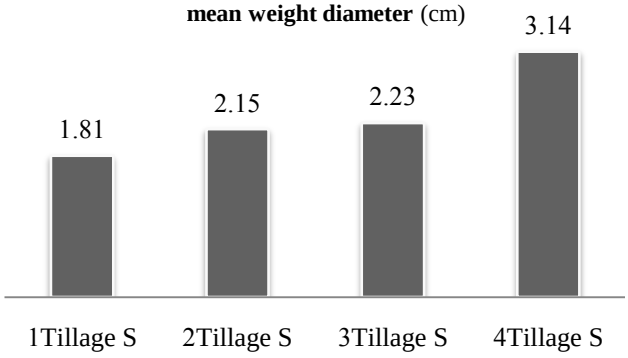

Fig.10. Effect of different tillage methods on mean weight diameter of soil (cm)

IV. Conclusion

The results of this research show that conventional tillage initially provides more water storage space and greater volume of water due to the low bulk density and greater porosity of soil; however, over time and at the end of growing season the reduced tillage methods cause minimal manipulation and disturbing the soil. As a result, they diminish the rate of moisture evaporation from soil surface and thus are able to prevent the loss of moisture stored in the soil. With conservation tillage practices, water needed to satisfy various products is stored; thus, water consumption in agriculture is reduced.

References

[1] Afzalinia, S., Karami, A., Talati, M. H., & Alavimanesh, S. M (2011). Effect of tillageon the soil properties and corn yield. CSAE Paper No. 11-204, July 10-13, Winnipeg, Manitoba.

[2] Alvarez, R., and H. S. Steinbach (2009). A review of the effects of tillage systems on some soil physical properties, water content, nitrate availability and crops yield in the Argentine Pampas. Soil Till. Res. 104: 1–15.

[3] Bauer, A. and A. L. Black. 1981. Soil carbon, nitrogen, and bulk density comparisons in two cropland tillage systems after 25 years and in Virgin grassland. Soil Sci. Soc. Am. J. 45:1166-1170.

[4] Blaise, D., and C.D. Ravindran. (2003). Influence of tillage and residue management on growth and yield of cotton grown on a Vertisol over 5 years in a semi-arid region of india. Soil.Till. Res. 70: 163-173.

[5] De Vita, P., Di Paolo, E., Fecondo, G., Di Fonzo, N., and Pisante, M (2007). Notillage and conventional tillage effects on durum wheat yield, grain quality and soil moisture content in southern Italy. Soil and Tillage Research, 92: 69-78.

[6] Hemmat, A. and A. Eskandari. (2004). Tillage system effects upon productivity of dryland winter wheat-chickpea rotation in the northwest region of Iran. Soil and Tillage Res. 78(1): 37-52.

[7] Hosseini, S And Abedi (2007). Assessment of market factors and government policies in determining the price of corn in Iran. Journal of Agricultural Economics, 1 (2): 33-21.

[8] Jin, H., Li. Hongwena, G. Rabi, A. B. Rasaily, W. Qingjiea, C. Guohuaa, S. Yanboa, Q. Xiaodonga and L. Lnijic (2011). Soil properties and crop yields after 11 years of no tillage farming in wheat–maize cropping system in North China Plain. Soil & Tillage Research 113: 48–54.

[9] Limousin, G., and Tessier, D (2007). Effects of no-tillage on chemical gradients and topsoil acidification. Soil. Till. Res. 92: 167-174.

[10] Robert, C., Schwartz, J., Bell, M., and Louis, R (2006). Tillage Effects on Surface Soil Properties, Crusting, and Sorghum Emergence. Conservation and Production Res. Lab. Experiment Station Rd, Bushland.

[11] Rouzbeh, M. and M. Loghavi (2006). Comparison of different methods of seedbed preparation under dry condition on corn yield followed wheat. J. of Agric. Engineering Res. 7(29): 19-32.

[12] Rusu, T., Gus, P., Bogdan, I., Moraru, P., Pop, A., Clapa, D. and Pop, L (2009). Soil tillage conservation and its effect on erosion control, water management and carbon sequestration. Geophys. Research. *Abs.* 11: 1481.

[13] Wright, A.L., Hons, F.M., Lemon, R.G., McFarland, M.L and Nichols, R.L (2007). Stratification of nutrients in soil for different tillage regimes and cotton rotations. Soil. Till. Res. 96: 19-27.