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RESEARCH ARTICLE

IMPACT OF TILLAGE AND PLASTIC MULCHING ON SOME SOIL PHYSICAL PROPERTIES IN RELATION WITH TOMATO YIELD (*LYCOPERSICON ESCULENTUM* L.)

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ABSTRACT

Field experiment was carried out during spring season 2012 in a private field located at 50 km west of Baghdad, to investigate the effect of tillage and plastic mulching on some physical properties of silt loam soil and tomato yield. Split plots with R.C.B.D were used with three replications. The study included four treatments, conventional tillage, no tillage and both have been in sub plots treated with and without plastic mulching. Results indicated that interaction between tillage method and plastic mulching affected physical properties of the soil significantly ($P \leq 0.05$). The value of bulk density, soil penetration resistance, hydraulic conductivity, mean weight diameter, and yield of tomato were 1.02-1.37 $Mgm.m^{-3}$, 0.743-1.847 $kg.m^{-2}$, 5.50-9.48 $cm.hr^{-1}$, 0.701-1.724 mm and 54.937-93.217 t ha^{-1} respectively. Lowest bulk density and soil penetration resistance were observed in conventional tillage with mulching was used, whereas highest bulk density and soil penetration resistance were observed in no tillage × no mulching treatment. Highest values of hydraulic conductivity, mean weight diameter and yield of tomato were obtained conventional tillage × mulching treatment, whereas lowest hydraulic conductivity, mean weight diameter and yield of tomato were obtained in no tillage × no mulching treatment.

INTRODUCTION

Soil tillage is the most important factor affecting soil physical and mechanical properties. It is one of the most influential management practice affecting soil physical and hydraulic characteristics (**Lal and Shulka, 2004; Khurshid *et al*., 2006**). It has been a popular agricultural practice throughout the world due to initial improvement of crop productivity, weeds control and ease with which crops can be planted. Tillage creates improved physical conditions of soil, which bring increase soil fertility and mixing of crop residues into soil (**Hossain *et al*., 2004**). Tillage method affects the sustainable use of soil resources through its influence on soil properties (**Hammel, 1989**), i.e. proper tillage practices can improve soil related constrains, while improper tillage may cause a range of undesirable processes such as destruction of soil structure, accelerated erosion, depletion of organic matter and fertility, and disruption in cycles of water, organic carbon and plant nutrients (**Lal, 1993**). Conventional tillage practices modify soil structure by changing its physical properties such as soil bulk density, soil penetration resistance, and soil moisture content (**Keshavarzpour and Rashidi, 2008**). Any material spread on the surface of soil to protect it from rain drop, solar radiation or evaporation is called mulch. Different types of materials like wheat straw, rice straw, plastic film, grass, wood, sand,… etc. are used as mulch (**Khurshid *et al*., 2006**). Mulch provides a favorable soil environment, moderates soil temperature, increases soil porosity, water infiltration during intensive rain, controls of runoff and soil erosion (**Anikwe *et al*., 2007; Sarkar and Singh, 2007; Glab and Kulig, 2008; Bhatt and Khera, 2006**). Plastic mulches directly affect the microclimate around the plant by modifying the radiation budget of the surface and decreasing the soil water losses (**Liakatas *et al*., 1986**). In the last three decades plastic film mulch cultivation has gradually become a great break through in agricultural production protected cultivation normally represented by plastic film. So, mulching has greatly improved crop production (**Liang *et al*., 1999; Guo and Gu, 2000**).

Tomato (*Lycopersicon esculentum* L.) is the largest vegetable crop in the world in terms of agricultural surface (**Ho, 1996**). Although considerable amount of research have been done on many crops, but information about the response of tomato to different farming systems like tillage methods and mulching are meager. In addition, a wide range of farming systems are being used in Iraq without evaluating their effects on physical properties and yield of many crops including tomato. Therefore, the present study was aimed to determine the combined effect of tillage methods and mulching practice on some physical properties of soil and yield of tomato yield.

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MATERIALS AND METHODS

This experiment was carried out during growing season 2012 in a private field located at 50 km west of Baghdad-Iraq under arid and semi arid climate, Table 1 shows some climatic data of the study region during the last twelve years. Location of experiment field is at latitude of 33°27′ 42" N and longitude of 43° 88′ 80" E. The soil of the experiment site was Typic Torrifluvent with silt loam texture. Details of soil physical and chemical properties of experimental site are given in Table 2.

Table 1. Climatic data of the study area for the period of 2000-2012

Month	Air temperature			Rain mm/month	R.H,%	Wind speed m sec^{-1}
	Max.	Min.	Average			
January	15.2	4.9	9.3	24.0	79.2	1.79
February	17.7	5.6	11.1	39.90	67.3	2.28
March	22.0	8.9	15.1	13.50	59.4	2.49
April	29.1	14.8	21.7	17.30	51.5	2.43
May	34.8	19.8	27.3	3.50	42.1	2.54
June	39.5	23.5	31.5	0.03	35.0	2.63
July	41.6	26.0	33.7	0.01	32.3	2.79
August	41.6	24.8	32.8	0.00	36.7	2.30
September	38.1	33.7	28.9	0.21	42.4	1.82
October	32.1	16.5	23.3	9.20	53.7	1.62
November	23.0	10.3	15.6	19.10	68.4	1.59
December	17.0	6.3	10.8	28.10	78.7	1.74

Table 2. Soil physical and chemical properties of the experiment site (0-30 cm depth)

Soil properties	Units	Values
Sand	$g.kg^{-1}$	190
Silt	$g.kg^{-1}$	582
Clay	$g.kg^{-1}$	228
Texture	-------	Silt Loam
Bulk density	$Mgm.m^{-3}$	1.35
$EC_{1:1}$	$dS.m^{-1}$	2.5
$pH_{1:1}$	--------	7.5
Available N	$mg.kg^{-1}$	102.2
Available P	$mg.kg^{-1}$	26
Available K	$mg.kg^{-1}$	168.7

A Split plot experiment was laid out in a randomized complete block design with three replicates to randomize the tillage and mulch levels in the main and sub plots treatments, respectively. The experiment was comprised tillage, conventional tillage (one pass of moldboard plow to 30 cm depth) and no-tillage, two mulch levels, i.e. black plastic mulch and no mulching. Each plot area was (4mx4m). A buffer zone of 0.5 m spacing was provided between plots. There were two furrows in each plot, even in no-tillage plots. The furrow had 4 m long, 0.75 m width and 0.5 m depth. On 15 march 2012 when the soil was well irrigated, one of the most commerical varieties of tomato super Rejina was transplanted manually on both sides of each furrow by keeping plant to plant distance 0.5 m. Before transplanting, recommended levels of 200 kg $N.ha^{-1}$, 70.4 kg $P.ha^{-1}$ and 50 kg $K.ha^{-1}$, were applied as urea, super phosphate and potassium sulphate, respectively (**Reja, 2005**). Black plastic film measuring 4 m long × 0.5 widths and 0.25 mm thick was used to cover the experimental beds. Tomato fruits were harvested three times (11 June, 1 July and 15 July). In order to determine soil physical and chemical properties for experimental site, representative composite soil sample was collected from each plot before treatment and immediately after last harvesting date of tomato. Soil samples were analyzed in laboratory to assess the available N ($mg.kg^{-1}$) by Kjeldahl method (**Bremner,1965**), available p($mg.kg^{-1}$) by Bray II method according to **Olsen (1982)**, available K ($mg.kg^{-1}$) by flame photometer methods, soil $pH_{1:1}$ and $EC_{1:1}$ by using a table pH/EC meter (WTW instruments), particles size distribution according to hydrometer method (**Black, 1965**), bulk density by core methods (**Black, 1965**), mean weight diameter by moist sieving method (**Youder, 1936**), penetration resistance by Pocket Penetrometer (**Donald, 1965**) model CL700 and hydraulic conductivity by constant head method (**Klute, 1965**). Total cumulative tomato yield $t.ha^{-1}$ was calculated from successive harvestings. The data were analyzed by using statistical Genstat program.

RESULTS AND DISCUSSION

Bulk density (BD): In comparison with the value of no tillage × no mulching treatment (1.37 $Mgm.m^{-3}$) which considered as a control, mulching alone, tillage alone, and combining tillage × mulching treatments reduced soil bulk density by about 11, 14 and 26%, respectively (Table 3). The data showed that the combined effect of tillage × mulching practice was the most efficient in improving bulk density. This improvement resulted from conventional tillage action which could produce hunk pore much topsoil forming large pores and decreasing soil bulk density. These results were in agreement with the results of **Iqbal *et al.* (2005) and Alam *et al.* (2002)**.

Table 3. Effect of tillage and mulching on bulk density $Mgm.m^{-3}$

Tillage methods (T)	Mulching levels (M)		Means
	No mulching	Mulching	
No tillage	1.37	1.22	1.29
Conventional tillage	1.18	1.02	1.10
Means	1.27	1.12	1.19
L.S.D $_{0.05}$ T		0.023	
L.S.D$_{0.05}$ M		0.011	
L.S.D $_{0.05}$ T×M		0.018	

Hydraulic Conductivity (K_s)

The results shown in Table 4 reveal a preferential increase in K_s value from 5.50$cm.hr^{-1}$ for the control to 7.41, 8.47 and 9.48 $cm.hr^{-1}$ for mulching, conventional tillage and combining tillage mulching treatments, which represent an increase by about 26%, 35% and 42%, respectively. Significant highest hydraulic conductivity in case of conventional tillage × mulching treatment was judged to be due to better organic matter mixing in plowed soil profile leading to high aggregate stability index which will be discussed later. These results are consistent with **Iqbal *et al.* (2005)**.

Soil penetration resistance ($Kg.cm^{-2}$)

The results in Table 5 showed that the use of tillage treatment significantly affected soil penetration resistance. The highest value of soil penetration resistance (1.84 $kg.cm^{-2}$) was observed in case of no tillage × no mulching treatment comparing with no tillage × mulching, conventional tillage × no mulching, and conventional tillage × mulching (1.430, 1.182 and 0.743 $kg.cm^{-2}$) with increasing ratio by about 22,36 and 60%, respectively.

Table 4. Effect of tillage and mulching on Hydraulic Conductivity $cm.hr^{-1}$

Tillage methods (T)	Mulching levels (M)		Means
	No mulching	Mulching	
No tillage	5.50	7.41	6.45
Conventional tillage	8.47	9.48	8.98
Means	6.98	8.45	7.71
L.S.D $_{0.05}$ T	0.105		
L.S.D$_{0.05}$ M	0.061		
L.S.D $_{0.05}$ T×M	0.085		

Table 5. Effect of tillage and mulching on soil penetration resistance $kg.cm^{-2}$

Tillage methods (T)	Mulching levels (M)		Means
	No mulching	Mulching	
No tillage	1.847	1.430	1.638
Conventional tillage	1.182	0.743	0.962
Means	1.514	1.086	1.3
L.S.D $_{0.05}$ T	0.045		
L.S.D$_{0.05}$ M	0.014		
L.S.D $_{0.05}$ T×M	0.037		

Table 6. Effect of tillage and mulching on soil mean weight diameter mm

Tillage methods (T)	Mulching levels (M)		Means
	No mulching	Mulching	
No tillage	0.701	0.884	0.792
Conventional tillage	1.436	1.724	1.58
Means	1.068	1.304	1.186
L.S.D $_{0.05}$ T	0.004		
L.S.D$_{0.05}$ M	0.014		
L.S.D $_{0.05}$ T×M	0.014		

Table 7. Effect of tillage and mulching on total tomato yield $t.ha^{-1}$

Tillage methods (T)	Mulching levels (M)		Means
	No mulching	Mulching	
No tillage	54.937	73.983	64.46
Conventional tillage	69.837	93.217	81.52
Means	62.387	83.6	72.99
L.S.D $_{0.05}$ T	0.318		
L.S.D$_{0.05}$ M	0.364		
L.S.D $_{0.05}$ T×M	0.371		

Lowest soil penetration resistance in case of conventional tillage × mulching may also be owing to higher soil moisture content, formation of thin water layer around soil particles would reduce the intra- aggregate attractions causing structure destruction and also mulching save the water. This is in line with the results reported by **Hill (1990)** that soil penetration resistance increase with a decrease in soil moisture content.

Mean weight diameter (mm)

The results in Table 6 showed that the use of tillage treatment significantly affect mean weight diameter. The lowest mean weight diameter (0.701 mm) was obtained in case of no tillage × no mulching treatment while highest mean weight diameter (1.724 mm) in case of conventional tillage × mulching. Conventional tillage decrease soil bulk density, improves porosity and water holding capacity of the soil. This condition along with probable stimulation of microbial activity, considered the major agent in the aggregate formation, which increase structure stability. This all leads to a favorable environment for crop growth and nutrient uptake. These results agreed with results reported by (**Khan *et al*., 1999 and Khan *et al*., 2001**) that mean weight diameter improve by conventional tillage.

Total yield $t.ha^{-1}$

The results in Table 7 showed that the use of tillage treatment significantly affected tomato yield. The highest yield, (93.217 $t.ha^{-1}$), was obtained in case of conventional tillage × mulching and the lowest (54.937 $t.ha^{-1}$) was obtained with no tillage × no mulching treatment. This high production may be attributed to the improvement in soil environment resulting from the decrease in soil penetration resistance and bulk density (Tables 3 and 5), probable increase in soil moisture, and subsequently organic matter contents. These results are in agreement with those of **Hemmat and Taki (2001), Ghuman and Sur (2001), Iqbal *et al*. (2005) and Keshavarzpour and Rashidi (2008).**

Conclusion

The tillage × mulching treatment has significantly affected soil physical properties and tomato yield: hydraulic conductivity, mean weight diameter, and total yield increased by 42%, 59% and 41% respectively; bulk density and soil penetration resistance decreased by 25.54% and 59.77%, respectively. Improvement of these soil parameters could maintain soil ecosystem through probable increasing in soil organic matter and soil moisture content and subsequent diminution of erosion. As an agricultural practice in dry zone, this treatment appears the most efficient from sustainable development point of view.

REFERENCES

Alam, S. M. K., Matin, M. A., Hossain, M. A., and Uddin, M. K. 2002. Effect of different tillage systems on some physical and chemical properties of a silt loam soil in rice field. *Journal of Biological Sciences*, 2: 524-527.

Anikwe, M. A. N., Mbah C. N., Ezeaku P. I. and Onyia V. N. 2007. Tillage and plastic mulch effect on soil properties and growth and yield of cocoyam (*Colocasia esculenta*) on an Ultisol in southeastern Nigeria. *Soil and Tillage Res*., 93:264-272.

Bhatt, R. and Khera, K. L. 2006. Effect of tillage and mode of straw mulch application on soil erosion in the sub mountainous tract of Punjab. *Soil and Tillage Res*., 88:107-115.

Black , G. R. 1965. Bulk density. In C. A., Black *et al*. (eds.). Methods of soil analysis. Part 1. Agron. Mono. No. 9 (1): 374-390. *Amer. Soc. Agron*. Madison. Wisconsin, USA.

Bremner, J. M. 1965. Nitrogen availability index. In Black, C.A. *et al*., (eds.) Methods of soil analysis. *Am. Soc. Agron*. Inc. Medison, Wisconsin, USA. Pp. 1324-1325.

Donald, T. D. 1965. Pentrometer. In C.A. Black *et al*., (edts.) Method of soil analysis. Mono No. 9: part 1. *Amer. Soc. Agron*, Madison, Wisconsin, USA.

Ghuman, B.S. and Sur, H.S. 2001. Tillage and residue management effects on soil properties and yields of rainfed maize and wheat in asubhumid subtropical climate. *Soil Till. Res.,* 58: 1–10.

Glab, T. and Kulig, B. 2008. Effect of mulch and tillage system on soil porosity under wheat (*Triticum aestivum*). *Soil and Tillage Res*., 99:169-178.

Guo, Z. L. and S. L. Gu, 2000. Effect of film mulching methods on yield and economic efficiency of millet. Agric. Res. Arid Areas, 18(2): 33-39.

Hammel, J. E. 1989. Long term tillage and crop rotation effects on bulk density and soil impedance in northern Idaho. *Soil. Sci. Soc. Amer. J*., 53:1515-1519.

Hemmat A. and Taki D. 2001. Grain yield of irrigated wheat as affected by stubble tillage management and seeding rates in central Iran. *Soil and Tillage Res*., 63:57-64.

Hill, R. L. 1990. Long-term conventional and no-tillage effects on selected soil physical properties. *Soil Sci. Soc. Amer. J*., 54:161-166.

Ho, L. C., 1996. Tomato. In: Zemaski, E., Schaffer, A.A. (Eds.), Photoassimilate Distribution in Plants and Crops: Source–Sink Relationships, Marcel Dekker, NY, USA, pp. 709–728

Hossain, M. F., Akter, M.S., Majumder, U. K., Sikder, M. S. I. and Chowdhury, M. M. A. A. 2004. Effect of tillage practices and nitrogen levels on the physical properties of soil. *Pak. J. Bio. Sci.,* 7:1876-1879.

Iqbal, M., Hassan, A. U., Ali. A. and Rizwanullah, M. 2005. Residual effect of tillage and farm manure on some soil physical properties and growth of wheat (*Triticum aestivum* L.) *Int.J.Agri.Biol*.,7:54-57.

Keshavarzpour, F. and Rashidi, M. 2008. Effect of different tillage methods on soil physical properties and crop yield of watermelon (*Citrullus Vulgaris*).*World Appl. Sci. J*., 3:359-364.

Khan, F. U. H., Tahir, A. R. and Yule, I. J. 2001. Intrinsic implication of different tillage practices on soil penetration resistance and crop growth. *Int. J. Agri. Biol*., 1:23-26.

Khan, F. U. H., Tahir, A. R. and Yule, I. J. 1999. Impact of different tillage practices and temporal factor on soil moisture content and soil bulk density. *Int. J. Agri. Biol*., 3:163-166.

Khurshid, K., Iqbal, M., Arif. M.S. and Nawaz, A. 2006. Effect of tillage and mulch on soil physical properties and growth of maize. *Int. J. Agri. Biol*., 5:593-596.

Klute, A. 1965. Laboratory measurement of hydraulic conductivity of saturated soil. In Black, C.A. *et al*., (eds.). Method of soil analysis. Agron. Mono. No. 9(1): 253-261. *Amer. Soc. Agron*. Madison, Wisconsin, USA.

Lal, R., 1993. Tillage effects on soil degradation, soil resilience. Soil quality and sustainability .*Soil and Tillage Res*., 51:61-70.

Lal, R. and Shukla, M. K. 2004. Principles of soil physics (Marcel Dekker, Inc. New York, NY).

Liakatas, A. J., Clark, A. and Monteita, J. L. 1986. Measurements of the heat Balance under plastic mulches. Part 1. Radiation balance and soil heat Flux. *Agric. Meteorol*., 36:227-239.

Liang, Y. C., Hu, F. and Yang, M. C. 1999. Mechanisms of high yield and irrigation water use efficiency of rice. *Sci. Agric. Sin*., 32(1): 26-32.

Olsen, S. R.1982. Phosphorus. In: page, A.L., Miller, R.H. and Keeny D.R. (eds.). Methods of soil analysis .part. 2, 2nd Ed. Agronomy monograph No.9.ASA and SSSA Madison, WI.pp.403-430.

Reja, A. M. 2005. The effect of interaction between two chemical fertilization methods and peatmos levels on some properties of soil, growth tomato yield under drip irrigation system. A thesis presented to College of Agriculture, Al-Anbar University, Iraq.

Sarkar, S. and Singh, S.R. 2007. Interactive effect of tillage depth and mulch on soil temperature, productivity and water use pattern of rained barley (*Hordium vulgare* L.). *Soil and Tillage Res*., 92:79-86.

Youder, R. 1936. A direct method of aggregate analysis of soils and a study of the physical nature of erosion losses. *J. Am. Soc. Agron*., 28: 337-351.

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