



The Effect of Conservation Tillage Practices on Consumed Water Volume and Yield in Irrigated Wheat Crop

A.Hedayatipour^{1*}, F.Keikhaee², M.Dadivar³

¹Member of Scientific board of Agricultural Engineering Research Department, Markazi Agricultural and Natural Resources Research and Education center, AREEO, Arak, Iran.

²Researcher of Agricultural Engineering Research Department, Markazi Agricultural and Natural Resources Research and education center, AREEO, Arak, Iran.

³Soil & Water Department, Razavi Province Agricultural and Natural Resources Research and education center, AREEO, Mashhad, Iran.

ABSTRACT

In order to comparison of conservatoin tillage treatment on wheat yield and water consumption a split plot experiment base on RCBD design with 3 replication was carried out at experimental farm of Agricultural and Natural Resources Reserch Center of Markazi Province. Main plots were: T1: using of moldboard with disk (conventional methods), T2: using of chisel packer, T3= using of combined plow, T4= Direct planting (no-tillage). Irrigation intervals containe: I1= 20 days, I2= 25 days and I3=30 days were considered as subplots. Tillage operation was done on basis of experiment treatments in a farm that Corn had planted last year. Yield and Water consumption was measured. The results showed the effect of conservation tillage had no effect on dry grain yield ($p < 0.05$). The amount of consumed water was 60% higher than in first irrigation at conventional treatment in comparison with conservation treatments. In conservation treatments, yield differences between I1 and I2 was not significant ($p < 0.05$). However significant reduction was observed between I1 an I2 in conventional treatment. In conservation tillage by increasing of irrigation interval from 20 days to 25 days, Water use efficiency (WUE) increased 14%. However WUE decreased 17% by increasing of irrigation interval from 20 days to 25 days.

Key words: Consevation tillage, Water Consumption- Water Use Effeciency- Wheat

Corresponding author: A.Hedayatipour

INTRODUCTION

Tillage operation is the most important operation in the crop production. In addition, the most consumption of the mechanical energy in the production of crops is the tillage operation (Kiatani, 1999). In addition to the enormous energy consumption, the great problem in recent decades is the incidence of serious environmental consequences due to indiscriminate and unprincipled increase in the soil use. Following increased soil erosion, lack of soil organic matter has become a major challenge in the agricultural sector. According to report of Soil and Water Institute of the country, 62% of the Iran's lands have organic matter less than 1%, while 9% of the Iran's lands have organic matter higher than 1.5%, which it leads to irreparable consequences (Khademi *et al*, 2011). Plowing with moldboard plow plays crucial role in the reduction of organic matter of the soil. The consequences of loss of soil organic matter are reduced water permeability, increased soil bulk density, and soil and water erosion. One of the major considerations in assessing the consequences of the increased soil fertility and increased crop yield is considering the long-term effects of the implementing tillage practices. In addition, reduced operation time, increasing the life of tractors, low cost

of agricultural implements and improvement of environmental conditions are advantages that should be considered (Sayadian, K. & Alagha, 2011). Based on the findings of Tessi *et al* (1990), conservation tillage significantly increases soil moisture holding capacity. However, although direct seeding increases water holding capacity increases, it does not increase crop yield. Results of 10-year study showed in loamy-clay soil showed that saturated hydraulic conductivity and water holding capacity at a depth of 30 to 60 mm increase using conservation tillage practices. However, the observed difference in depth of 0 to 30 mm and 90 to 120 mm was not significant (Chunk and Lendval 1990). The most important factor in increased preventing direct evaporation of water from the soil surface is the presence of plant residues on the soil surface (Unger & Parker, 1976). It seems that in no-tillage practice or in low-tillage practice, the root development is higher compared with moldboard practice (Osuji, 1984). Khirul Alam *et al* (2014) studied the effect of tillage practices on soil physical properties in the Bangladesh Agricultural Research Institute (BARI) during a 4-year experiment. The treatments were: (1) low-tillage practices, (2) deep tillage (3) no-tillage, and (4) conventional tillage. At the end of fourth year, permeability tests were measured. Results showed that the greatest increase in soil permeability was observed in no-tillage practice, followed by treatments of low-tillage, conventional tillage, and deep tillage practices,

respectively. Zeev et al (2006) examined several methods of land preparation on water use efficiency. The treatments consisted of: (1) low-tillage, (2) no-tillage, (3) mulching tillage, and using subsoiler. The results of this study showed that no-tillage practices and use of subsoiler increase water use efficiency (WUE). The results of this research indicate that no-tillage and subsoiler practices increase the water holding capacity of the soil. In an extensive research conducted in North China, it was found that plant residues as mulch increases the WUE by 10 to 20 %. This increase in efficiency is due to the reduction in level of evapotranspiration from soil (Zhang et al, 2006). Josa et al (2005) examined the conservation tillage effects on maintaining the moisture in the soil surface layer in the region of Barcelona in Spain. The researchers compared three common tillage methods including conventional tillage system, minimum tillage system, and no-tillage system. Soil moisture content was recorded using the TDR on the weekly basis. The results of the researchers showed that the amount of soil moisture in no-tillage practice is high in comparison with conventional practice. However, the results of the researchers indicated that this increase does not lead to increased moisture. According to view of Sharma and Behra (2008), the first volume of irrigation water of wheat in the direct wheat seedling is lower compared to conventional practice. These scientists have not mentioned its reduction amount. Abohamed (2004) examined the impact of three methods of the land preparation including use a moldboard plow, tillage using chisel plow, and tillage using disk on the two properties of soil permeability and soil bulk density. The results of the study showed that the type of tillage has a significant impact on two soil properties mentioned above. Based on these results, the rate of penetration in the tillage practice of chisel plow is higher compared with other practices. In addition, soil bulk density using tillage practice of chisel plow was lower compared with other treatments tested. The aim of this study was to investigate the effect of tillage practices on the permeability of the water.

MATERIALS AND METHODS

In order to investigating of the effect of tillage methods on consumed water and WUE, an experiment carried out in experimental station of Agricultural and Natural Resources Research Institute of Markazi province was selected during 2012-2013 and 2013-2014. Corn (variety of Singer Cross 704) was planted in the middle of June. By harvesting corn in late September, the implementation of experimental treatments was done. To compare treatments, an experiment- split-plot in a randomized complete block design with 3 replications was used. The main plots were: T1: using moldboard plow + disk (conventional method), T2: using the chisel Packer, T3: using combined plow, and T4: using direct seeding method. Three irrigation intervals included I1: 20-days, I2: 25-days, and I3: 30-days considered as sub plots. The properties of used tillage devices and direct seeding grain driller are shown in Tables 1 and 2. Some of the physical and chemical properties of soil are given in Table 3.

Table1- Thechnical specifications of tillage tools used in the experiment

Implement type	Number of tillage units	Width(m)	Company
Packer-chisel	5	2	Taka
Combined plow	5	2	Taka
Moldboard plow	3	0.95	Khorasan

Table 2-Thechnical specifications of grain driller used in the experiment

Devisе metering type	number of the planter units	Space between planter units	Furrow opener types	Width
P.T.O driving	13	18	Hoe type	2.5

Table3- Some physical and chemical properties of soil

EC (dS/m)	P (ppm)	K (ppm)	N (ppm)	pH	Organic matter (%)	Elements of soil texture			Depth (cm)	Soil texture
						Clay (%)	Loam (%)	Sandy (%)		
1100	9.5	322	0.04	8.1	0.5	30	30	40	0-30	Sandy loam

Table4- Mean comparison of yield and its components in tillage treatments

Tillage methods	Yield (Kg/ha)	Weight of 1000 grain(g)	Harvest index(%)	Stem length(Cm)	Spike length (Cm)
Conventional(Moldboard and disk)	2860a	34.9a	42.4a	76.9a	8.9a
Chisel packer	2951a	34.7a	41.1a	75.8a	9.4a
Combined plow	3000a	34.6a	42.8a	78a	8.6a
Direct - seeding	3057a	34.4a	46.3a	74.5a	9.8a

The same letters imply that there is not significant difference between treatments($p < 0.5$)

Table5- Mean comparison of yield and its components in irrigation treatments

Irrigation treatments(Irrigation intervals)	Yield (Kg/ha)	Weight of 1000 grain(g)	Harvest index(%)	Stem length(Cm)	Spike length (Cm)
20 Days	3552a	37.6a	47.7a	77.8b	9.1a
25 Days	3145b	36.4b	45.7a	78.2b	9.2a
30 Days	2205c	30c	36.9b	72.3a	9.3a

The same letters imply that there is not significant difference between treatments($p < 0.5$)

Table6- Mean comparison of yield and its components in irrigation and tillage methods treatments

Tillage methods	Irrigation treatments (Irrigation intervals)	Yield (Kg/ha)	Weigh of 1000 grain (g)	Harvest index(%)	Stem lenth(Cm)	Spike lenth (Cm)
Conventional(M oldboard and (disk)	20 Days	3585a	38.5a	41.1bc	80.2ab	8.8a
	25 Days	2840d	35.9de	47.1b	79.4abc	8.8a
	30 Days	2158e	30.7f	35.4d	70.8c	8.8a
Chisel packer	20 Days	3477ab	37.9a	43.4bc	79.2abc	9.4a
	25 Days	3174e	36.9cde	44.3bc	76.9abc	9.4a
	30 Days	2203a	29.6g	35.5d	71.5bc	9.7a
Combined plow	20 Days	3572a	36.9bcd	48.2ab	75.2abc	9.6a
	25 Days	3292bc	35.6e	46.5ab	82.5a	9.3a
	30 Days	2136e	30.2fg	33.7d	76.2ab	9.1a
Direct - seeding	20 Days	3573a	37abc	53.6a	73.6ab	8a
	25 Days	3276bc	36.4cde	44.4bc	73.2bc	9.3a
	30 Days	3223e	29.5g	39.2cd	73.2bc	9.4a

The same letters imply that there is not significant difference between tratments(p<0.5)

The effect of experiment treatments on water use

One of the important findings of this experiment was that in the conventional tillage practice, the time of the first irrigation was higher about 60%. Large diameter of the hunks as well as the lack of vegetation cause increased water absorption by hunks at the farm level, and the absorbed moisture is lost immediately due to being exposed to air. Consumed Water volume difference in the conventional method compared to conservation tillage methods is due to increased water use in the first irrigation. The duration of the first irrigation about this treatment and other treatments is shown in Table 7. Sharmavbhra (2008) have achieved the same result. However, the irrigation duration of other treatments was almost identical.

Table 7- Consumed time or the first irrigation at one plot

Time of the first irrigation(Minute)	First year	Second year
Conventional tillage method	20.8	28
Conservation tillage and Direct seeding	13	18

Without considering the irrigation treatment (in complete irrigation), The Cosumed water volume in conservation and direct seedling dropped reduced by 12 percent. Table 9 indicates the amount of consumed water (taking into account precipitation according table 8) separately by year.

Table 8- Rainfal amount during 2 years

month	November	December	January	February	March	April	May	June	Total rainfall	Water volume
2012-2013	65.2	26.2	34.2	13.8	43.8	33.3	10.1	0.7	227	2270
2013-2014	47.5	57	40	19.3	66.3	84	12	9.1	335	3350

Table 9- Consumed water and WUE at tillage and irrigation treatments

Tillage methods	Irrigation treatments	First year			Second year		
		Yield (Kg/ha)	Water volumm (m³/ha)	WUE(Kg /m³)	Yield (Kg/ha)	Water volumm (m³/ha)	Water use efficiency(Kg /m³)
Conventional	20 Days	3957	7999	0.49	3212	7650	0.42
	25 Days	3356	7103	0.47	2323	6663	0.35
	30 Days	2584	6268	0.41	1732	5930	0.29
Chisel packer	20 Days	3482	7470	0.47	3471	7150	0.48
	25 Days	3012	6603	0.46	3335	5996	0.55
	30 Days	2150	5736	0.37	2256	5736	0.39
Combined plow	20 Days	3573	7470	0.48	3570	7150	0.46
	25 Days	3253	6603	0.49	3230	5996	0.54
	30 Days	2203	5736	0.38	2067	5736	0.36
Direct - seeding	20 Days	3821	7470	0.51	3323	7150	0.46
	25 Days	3481	6603	0.51	3070	5996	0.51
	30 Days	2226	5736	0.39	2418	5736	0.42

According to this table, in conventional tillage, water volume in 25-day treatment was reduced 11% in the first year of implementation of the experiment and 13% in the second year compared with 20-day irrigation. However conservation practices, the reduction in volume of water in the first year was about 15% and in the second year, it was 16% compared with 20-day irrigation. water volume in 30-day treatment reduced significantly. As mentioned earlier, by increasing the gap of irrigation turn from 20 to 25 days, the crop yield does not reduce in the conservation practice. There by, in the conservation tillage practices, by increasing the irrigation gap from 20 to 25 days, WUE in the conservative tillage practices increases by 14%. However,WUE reduced by 17% when the irrigation interval increased from 20 to 25 days the in the conventional tillage practice. It is recommended that to reduce of the consumed water volum, conservation tillage practices (especially chisel packer plow) to be used .

CONCLUSION

- 1- In the conservation tillage and direct seeding practice, by increasing the irrigation intervals, significant reduction was not observed in the crop yield. In addition, water use is saved highly by doing such work.
- 2-The first irrigation volume in the conservation tillage and direct seeding practice reduces by 40% compared with conventional practice, followed by high saving in consumed water volume.
- 3- In general, the use of conservation tillage practices while reducing production costs and energy consumption causes consumed water volume reduction by 10%.

REFERENCES

1. Abouhamed,N.H.2004.the effect of tillage treatments on soil water holdingcapacity and soil physical properties. 13 th International soil consertvation organization conference.Brisbone, July, 2004.
2. Chang,C.and C.W.Lindwall.1990.Comparison of long term tillage on corn and soybean growth and grain yield.A.S.A.E.paper no. MCR-88-111st.Joseph MT.

3. Josa,R, and Hereter.A.2005.Effects of tillage systems in Dry Land farming on near surface water content during the late winter period.*Soil&Tillage Research* .Vol 82: Issue2:June 2005
4. Khademi,Z. Balali,M.,Asadi,F.,Shahbazi,K., Rezaee,H., Feizollahzadeh,M., Bazargan,K&Tehrani,M.M. (2011). Increasing of high- consumed fertilizers and study of the role of on yield increasment and improvement wheat quality. Final Report of Soil& Water Institute.
5. KhirulAlam,M.D.,Monirulislam,M.D.,Salahin,N., and Hassanuzzaman,M. 2014. Effect of tillage practices on soil properties and crop productivity in Wheat-Mungbean-Rice cropping system under subtropical climatic conditions. *The Scientific World Journal*, Volum 2014, Article ID 437283,15 pages.<http://dx.doi.org/10.1155/2014/437283>
6. Kiatani,o,T.Junghbluth,,R.M.Peart, and Ramdani,A.1990. CIGR Handbook of Agricultural Engineering.V5. Energy annnd Biomass Engineeering. Published by the American Society of Agricultural Engineers.
7. Osuji, G.E.1984.Water storage use and maize yield for tillage systems on a tropical alfsoil in Nigeria, *Soil.Tillage. Res:* 4: 339-348
8. Sayadian,K.&Alagha,A.(2011). No-Tillage and its Challenges.(2005). Razi University Press.pp. 58-60,
9. Sharma,A.r. and Behra,U.K.2008.Modern consepts of agriculture: Conservation tillage.Indian Agricultural Reserch Institute. New Dehli- No:110012,2008.
10. Tessie,S.,Perru,M.,Dyck,F.B.Zentener,R.P. and Compbell,FC.A.1990.Conservation tillage for spring wheat production in semi-Arid Saskatchewan.*SoilTillage Research*.15:73-89
11. Unger,P.W.,and J.J.Parker.1976.Evaporation reduction from Soil with wheat, Sorghum and Cotton.residues.*Soil. Sci,So.Am.J.*40:938-942
12. Xi,P.D.,Zhang.L.H. and Turner.T. 2006. Improving Agricultural water use efficiency in Arid and Semi arid of China.4th international crop sciencose Congress.
13. Ziyu,Su.JZ.,Weliang.W.D.,Jungie.L.V.,Guaghi,J. and Jiang Hung,J.G.2006.Effects of conservation tillage practices on winter wheat water- use efficiency and crop yield on loss plateau.China.Agricultural Water Management.Volum 87,Issue 3.16 February 2007.