INTERNATIONAL JOURNAL OF SCIENCE AND NATURE

www.scienceandnature.org

EFFECT OF DIFFERENT TILLAGE METHODS ON SUGAR BEET CROP WEEDINESS UNDER SEMI-ARID CONDITION

Majid Rashidi and Saeed Abbassi
Department of Agricultural Machinery, Faculty of Agriculture, Islamic Azad University, Takestan Branch, Iran

ABSTRACT
A two-year study was carried out at the Research Site of Hamedan Province, Iran to investigate the effect of different tillage methods on sugar beet crop weediness under semi-arid condition during 2008 and 2009 growing seasons. Tillage treatments were moldboard plow + two passes of disk harrow (MDD) as conventional tillage method; moldboard plow + one pass of rotavator (MR), chisel plow + one pass of rotavator (CR) and two passes of disk harrow (DD) as reduced tillage methods; one pass of rotavator (R) and one pass of tine cultivator (C) as minimum tillage methods and no-tillage (NT). Sugar beet crop weediness indexes, i.e. number of weeds (NUMW) and dry mass of weeds per square meters (DRMW) were determined for different tillage treatments. Statistical results of study indicated that although effect of different tillage methods on NUMW and DRMW was not significant ($P \leq 0.05$); tillage operations were useful in decreasing sugar beet crop weediness. The lowest values of NUMW (6.30 m^{-2}) and DRMW (6.70 g m^{-2}) were recorded in the MR treatment, while the highest values of NUMW (14.0 m^{-2}) and DRMW (21.2 g m^{-2}) were noted in the NT treatment. Results also showed that tillage method affected sugar beet crop weediness in the order of MR < CR < R < MDD < DD < C < NT. Therefore, the reduced tillage treatments MR and CR, and the minimum tillage treatment R were considered as more beneficial and suitable tillage methods in decreasing sugar beet crop weediness. These treatments can also be recommended as appropriate tillage operations for organic farming system.

KEYWORDS: Tillage method, Weediness, Weed population, Sugar beet, Hamedan, Iran.

INTRODUCTION

Weeds compete with the crop plants for nutrients, water and light. Tall weeds that grow on top of the crop plants and shade the crop canopy are very harmful to yield. Conversely, short weeds become very aggressive if allowed to grow uninterrupted when the crop plants are small (Draycott, 2006).

Herbicides are important agricultural chemicals used to control weeds in modern farming systems (Jafari *et al.*, 2006; Mohammadzamani *et al.*, 2009). To reduce the adverse effects of herbicides on the environment and agricultural products, the system of organic agriculture has become popular in the world. This system adopts non-chemical weed control approaches. The main productions of such farms are cereals and vegetables. However, sugar beet is still grown in chemical conditions of intensive farming (Romaneckas *et al.*, 2009). In organic farming system the most serious problem is effective weed control due to high weed concurrence in the sugar beet crop. The increase in weed infestation in conservationally tilled soil is the second challenge (Munkholm *et al.*, 1988). Although for most situations, conventional tillage methods have been the main tillage methods for establishing sugar beet since the first part of the 20th century (Ecclestone, 2004), the costs, as well as the environmental concerns have leaded farmers and researchers to adopt conservation tillage methods, i.e. reduced tillage, minimum tillage and no-tillage methods (Ecclestone, 2001). Conservation tillage methods have been used for sugar beet (Romaneckas *et al.*, 2006; Adamaviciene *et al.*, 2009; Romaneckas *et al.*, 2009; Jabro *et al.*, 2010). However, the results of these methods may be contrary (Iqbal *et al.*, 2005). Conservation tillage methods may lead to raised diversity of weed species and population (Carter & Ivany, 2006; Ozpinar, 2006) and have a harmful effect on crop yield (Borresen, 1993). But, other studies have confirmed the opposite (Campbell *et al.*, 1998).

In Iran, most of the cultivated area is under conventional tillage methods, and effect of conservation tillage methods on sugar beet crop weediness has not been studied enough. Therefore, the main aim of this study was to investigate the effect of different tillage methods on sugar beet crop weediness under semi-arid condition. Results of this study can also help adopting the suitable tillage method(s) in organic farming system.

MATERIALS AND METHODS

Research site

This study was conducted at the Research Site of Hamedan Province, Iran for two successive growing seasons (2008 & 2009). The research site is located at latitude of 34° 52' N, longitude of 48° 21' E and altitude of 1730 m in semi-arid climate (298 mm rainfall annually) in the west of Iran. Mean temperature and monthly rainfall of the experimental site from sowing to harvest during study years (2008 & 2009) are indicated in Fig. 1.

Soil sampling and analysis

A composite soil sample (from 21 points) was collected from 0-30 cm depth during the study years and was analyzed in the laboratory for pH, EC, OC, N, P, K, Fe, Zn, Cu, Mn, B and particle size distribution. Details of soil physical and chemical properties of the research site during both years (2008 & 2009) are given in Table I.

Field methods

The experiments were laid out in a RCBD with four replications. Tillage treatments were moldboard plow + two passes of disk harrow (MDD) as conventional tillage method; moldboard plow + one pass of rotavator (MR),

chisel plow + one pass of rotavator (CR) and two passes of disk harrow (DD) as reduced tillage methods; one pass of rotavator (R) and one pass of tine cultivator (C) as minimum tillage methods and no-tillage (NT). During the study years, tillage treatments were carried out on the same plots. The size of each plot was 20.0 m long and 6.0 m wide. There were 12 rows of sugar beet in each plot with 50-cm row spacing. In both years of study, one of the commercial varieties of sugar beet cv. Zarghan was planted on April 3, 2008 and April 5, 2009 using a 6-row sugar beet drill. Recommended levels of urea (300 kg ha^{-1}) in both years and triple super phosphate (50 kg ha^{-1}) only in the first year of study were used. For all treatments, irrigation scheduling was based on the basis of evaporation from A-class pan installed close to the experimental plots. Also, pest and weed control operations were performed based on common local practices and commendations. All other essential operations were kept identical for all the treatments.

FIGURE 1. Mean temperature and monthly rainfall during crop growth (mean of 2008 & 2009)

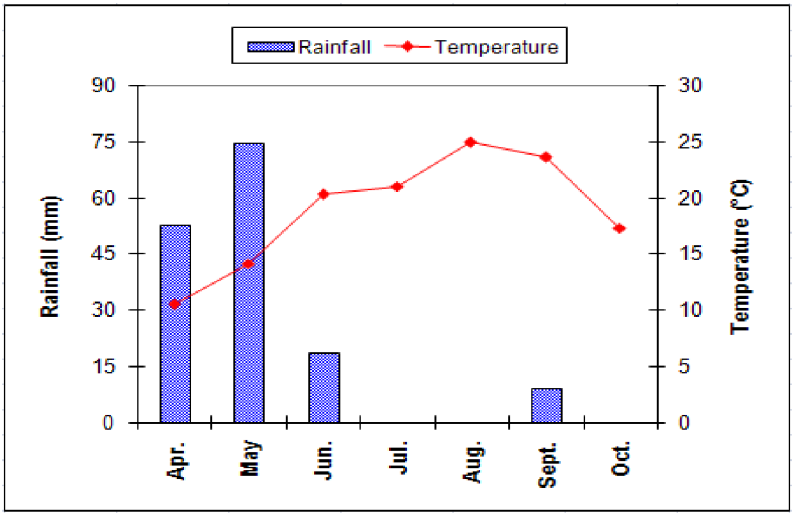

TABLE 1. Soil physical and chemical properties of the experimental site (0-30 cm depth), 2008 & 2009

Date	pH	EC (dS m^{-1})	OC (%)	N (%)	P (ppm)	K (ppm)	Fe (ppm)	Zn (ppm)	Cu (ppm)	Mn (ppm)	B (ppm)	Soil texture
2008	7.9	0.72	0.92	0.09	10.5	280	6.2	0.8	2.3	16.2	0.7	Loam
2009	8.3	0.55	0.36	0.04	25.6	310	6.4	1.0	2.4	14.4	0.7	Loam

Observation and data collection

At harvest, the dry mass of weeds was evaluated by the weighing method. Five samples were taken at random from each plot using wooden frames 50 cm × 50 cm (2500 cm^2). The same samples were also used for counting weed plants. The mean results of sugar beet crop weediness for each plot were recalculated into square meters to determine sugar beet crop weediness indexes, i.e. number of weeds (NUMW) and dry mass of weeds (DRMW) per square meters.

Statistical analysis

All data were subjected to the Analysis of Variance (ANOVA) following Gomez & Gomez (1984) using SAS statistical computer software. Moreover, means of the different treatments were separated by Duncan's Multiple Range Test (DMRT) at $P \leq 0.05$.

RESULTS

Results of ANOVA and means comparison for sugar beet crop weediness indexes, i.e. NUMW and DRMW between different methods of tillage during the study years (mean of 2008 & 2009) are presented in Table II and Table III, respectively. Statistical results of study (Table II) showed that effect of different tillage methods on NUMW and DRMW was not significant ($P \leq 0.05$).

TABLE II. Analysis of variance for sugar beet crop weediness indexes, i.e. NUMW and DRMW under different tillage methods (mean of 2008 & 2009)

Source of variation	Df	Mean square	
		NUMW	DRMW
Replication	3	7.664 ^{NS}	20.92 ^{NS}
Treatment	6	35.96 ^{NS}	123.2 ^{NS}
Error	18	7.072	12.65
C.V. (%)	---	26.23	28.96

NS = Non-significant
* = Significant at 0.05 probability level

(NUMW: number of weeds per square meters; DRMW: dry mass of weeds per square meters)

TABLE III. Means comparison for sugar beet crop weediness indexes, i.e. NUMW and DRMW between different tillage methods (mean of 2008 & 2009)

Treatment	NUMW (m^{-2})	DRMW (g m^{-2})
MDD	10.7 a	10.1 a
MR	6.30 a	6.70 a
CR	6.70 a	7.20 a
DD	11.7 a	12.6 a
R	8.70 a	9.80 a
C	13.0 a	18.4 a
NT	14.0 a	21.2 a

Means in the same column with different letters differ significantly at 0.05 probability level according to DMRT.
(NUMW: number of weeds per square meters; DRMW: dry mass of weeds per square meters)

DISCUSSION

In this study, the salient indexes of sugar beet crop weediness, i.e. NUMW and DRMW were studied to investigate the effect of different tillage methods on sugar beet crop weediness under semi-arid condition.

Although there was no significant difference in NUMW and DRMW during the study years, results indicated that tillage operations were useful in decreasing both indexes of sugar beet crop weediness. The lowest values of NUMW (6.30 m^{-2}) and DRMW (6.70 g m^{-2}) were recorded in the MR treatment, while the highest values of NUMW (14.0 m^{-2}) and DRMW (21.2 g m^{-2}) were noted in the NT treatment (Table III). Moreover, tillage method affected both indexes of sugar beet crop weediness in the order of MR < CR < R < MDD < DD < C < NT. These results are in line with the results reported by Iqbal *et al.* (2005), Khurshid *et al.* (2006), Romaneckas *et al.* (2006), Rashidi & Keshavarzpour (2007), Rashidi *et al.* (2008), Adamaviciene *et al.* (2009), Rashidi & Khabbaz (2009), Romaneckas *et al.* (2009) and Jabro *et al.* (2010) that tillage practices can be associated with superior weed control and enhanced soil quality which enable the crop plants to compete with the weeds for nutrients, water and light. These results are also in agreement with those of Bauder *et al.* (1981), Hill (1990), Horne *et al.* (1992), Borresen (1993), Carter & Ivany (2006) and Ozpinar (2006) who concluded that conservation tillage methods may be associated with worse soil quality and raised diversity of weed species and population.

CONCLUSSION

Although effect of different tillage methods on sugar beet crop weediness indexes, i.e. NUMW and DRMW was not significant ($P \leq 0.05$); tillage operations were useful in decreasing sugar beet crop weediness. Also, tillage method affected sugar beet crop weediness in the order of MR < CR < R < MDD < DD < C < NT. Moreover, the reduced tillage treatments MR and CR, and the minimum tillage treatment R were considered as more beneficial and suitable tillage methods in decreasing sugar beet crop weediness. These treatments can also be recommended as appropriate tillage operations for organic faming system.

ACKNOWLEDGEMENT

The authors are very much grateful to the Islamic Azad University, Takestan Branch, Iran for giving all types of support in publishing this study. The financial support provided by the Agricultural Research, Education and Extension Organization of Iran under research award number 3-02-0214-86-010 is gratefully acknowledged.

REFERENCES

Adamaviciene, A., Romaneckas, K., Sarauskis, E. and Pilipavicius, V. (2009) Non-chemical weed control in sugar beet crop under an intensive and conservation soil tillage pattern: II. Crop productivity, *Agronomy Res.* 7, 143-148.

Bauder, J.W., Randall, G.W. and Swan, J.B. (1981) Effects of four continue tillage systems on mechanical impedance of a clay-loam soil. *Soil Sci. Soc. Amer. J.* 45, 802-806.

Borresen, T. (1993) The long-term effect of tillage practices on soil properties and crop yields. *Soil Tillage and Environment. The 228th Seminar of NJF*. Finland.

Campbell, C.A., Thomas, A.G., Biederbeck, V.O., McConkey, B.G., Selles, F., Spurr, D. and Zentner, R.P. (1998) Converting from no tillage to pre-seeding tillage: Influence on weeds, spring wheat grain yields and soil quality. *Soil Till. Res.* 46, 175-185.

Carter, M.R. and Ivany, J.A. (2006) Weed seed bank composition under three long-term tillage regimes on a fine sandy loam in Atlantic Canada. *Soil Till. Res.* 90, 29-38.

Draycott, A.P. (2006) Sugar Beet. Blackwell Publishing Ltd., Oxford, UK.

Ecclestone, P. (2001) Minimum tillage, options for economic sugar beet production. *Brit. Sugar Beet Rev.* 69, 24-29.

Ecclestone, P. (2004) To plough or not to plough? *Brit. Sugar Beet Rev.* 72, 7-11.

Gomez, K.A. and Gomez, A.A. (1984) Statistical Procedures for Agriculture Research. A Wiley-Inter Science Publication, John Wiley and Sons Inc., New York, USA.

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

Horne, D.J., Ross, C.W. and Hughes, K.A. (1992) Ten years of maize/oats rotation under three tillage systems on a silt-loam soil in New Zealand. 1. A comparison of some soil properties. *Soil Till. Res.* 22, 131-143.

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.

Jabro, J.D., Stevens, W.B., Iversen, W.M. and Evans, R.G. (2010) Tillage depth effects on soil physical properties, sugar beet yield, and sugar beet quality. *Comm. Soil Sci. Plant Anal*. 41, 908-916.

Jafari, A., Mohtasebi, S.S., Jahromi, H.E. and Omid, M. (2006) Weed detection in sugar beet fields using machine vision. *Int. J. Agri. Biol*., 8: 602-605

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.* 8, 593-596.

Mohammadzamani, D., Minaei, S., Alimardani, R., Almassi, M., Rashidi, M. and Norouzpour, H. (2009) Variable rate herbicide application using the global positioning system for generating a digital management map. *Int. J. Agric. Biol.* 11, 178-182.

Munkholm, L.J., Schjonning, P. and Rasmussen, K.J. (1998) Non-inverting soil tillage as an average of optimizing soil tilth. *Soil tillage and biology. The 286th Seminar of NJF*. Norway.

Ozpinar, S. (2006) Effects of tillage systems on weed population and economic for winter wheat production under the Mediterranean dry land conditions. *Soil Till. Res.* 87, 1-8.

Rashidi, M. and Keshavarzpour, F. (2007). Effect of different tillage methods on grain yield and yield components of maize (*Zea mays L.*). *Int. J. Agri. Biol.* 9, 274-277.

Rashidi, M., Keshavarzpour, F. and Gholami, M. (2008) Effect of different tillage methods on yield and yield components of forage corn. *American-Eurasian J. Agric. and Environ. Sci.* 3, 347-351.

Rashidi, M. and Khabbaz, B.G. (2009) Response of crop yield and yield components of tomato to different tillage methods in the arid lands of Varamin, Iran. *Biennial Conference of the Australian Society for Engineering in Agriculture (SEAg)*. September 13-16, Brisbane, QLD, Australia.

Romaneckas, K., Romaneckiene, R. and Sarauskis, E. (2006) The effect of primary soil tillage methods on sugar beet growth on a light loam luvisol. *Zemdirbyste/Agriculture*, 93, 81-87.

Romaneckas, K., Romaneckiene, R. and Pilipavicius, V. (2009) Non-chemical weed control in sugar beet crop under intensive and conservation soil tillage: I. Crop weediness, *Agronomy Res.*, 7, 457-464.