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Effect of Conservation Tillage Methods on Weed Control in Sugar Beet Cropping

[1]Majid Rashidi and [2]Saeed Abbassi

[1]Greenhouse Cultivation Research Department, Tehran Agricultural and Natural Resources Research and Education Center, AREEO, Varamin, Iran
[2]Agricultural Engineering Research Department, Hamedan Agricultural and Natural Resources Research and Education Center, AREEO, Hamedan, Iran

Abstract: Filed experiments were carried out to study the effect of conservation tillage methods on weed control in sugar beet cropping during 2012 and 2013 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). Two indexes of weed control, i.e. number of weeds and dry mass of weeds per square meters were determined for different tillage treatments. Statistical results of study indicated that although effect of different tillage methods on both indexes of weed control was not significant ($P = 0.05$); tillage operations were useful in decreasing both indexes. The lowest values of number of weeds (6.30 m^{-2}) and dry mass of weeds (6.70 g m^{-2}) were recorded in the MR treatment, while the highest values of number of weeds (14.0 m^{-2}) and dry mass of weeds (21.2 g m^{-2}) were noted in the NT treatment. Results also showed that tillage method affected both indexes of weed control 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 methods.

Key words: Conservation tillage · Weed control · Sugar beet · Semi-arid · 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 [1]. Herbicides are important agricultural chemicals used to control weeds in modern farming systems [2, 3]. 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 [4]. 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 [5]. 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 [6], 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 [7]. Conservation tillage methods have been used for sugar beet [4, 8-10]. However, the results of these methods may be contrary [11]. Conservation tillage methods may lead to raised diversity of weed species and population [12, 13] and have a harmful effect on crop yield [14]. But, other studies have confirmed the opposite [15].

In Iran, most of the cultivated area is under conventional tillage methods and effect of conservation tillage methods on weed control in sugar beet cropping has not been studied enough. Therefore, the main

Corresponding Author: Dr. Majid Rashidi, Ph.D., Greenhouse Cultivation Research Department, Tehran Agricultural and Natural Resources Research and Education Center, AREEO, Varamin, Iran.
E-mails: majidrashidi81@yahoo.com & m-rashidi@areeo.ac.ir.

objective of this study was to investigate the effect of conservation tillage methods on weed control in sugar beet cropping.

MATERIALS AND METHODS

Research Site: This study was conducted at the Research Site of Hamedan Agricultural and Natural Resources Research and Education Center, AREEO, Hamedan, Iran for two successive growing seasons (2012 and 2013). 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 (2012 and 2013) 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 (2012 and 2013) are given in Table 1.

Field Methods: The experiments were laid out in a randomized complete block design (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, 2012 and April 5, 2013 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 general local practices and recommendation. All other essential operations were kept identical for all the treatments.

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. The same samples were also used for counting weed plants. The mean results for each plot were recalculated into square meters to determine two indexes of weed control, i.e. number of weeds and dry mass of weeds per square meters.

Statistical Analysis: All data were subjected to the Analysis of Variance (ANOVA) following Gomez and Gomez [16] using SAS statistical computer software. Moreover, means of the different treatments were separated by Duncan's Multiple Range Test (DMRT) at P = 0.05.

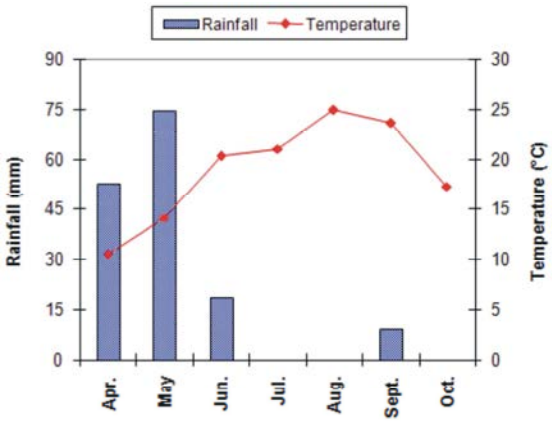

Fig. 1: Mean temperature and monthly rainfall during crop growth (mean of 2012 and 2013)

RESULTS

Results of ANOVA and means comparison for both indexes of weed control, i.e. number of weeds and dry mass of weeds per square meters between different tillage methods during the years of study (mean of 2012 and 2013) are presented in Table 2 and Table 3, respectively.

Table1: Soil physical and chemical properties of the experimental site (0-30 cm depth)

Date	pH	EC (dS m^{-1})	OC (%)	N (%)	P (ppm)	K (ppm)	Fe (ppm)	Zn (ppm)	Cu (ppm)	Mn (ppm)	B (ppm)	Soil texture
2012	7.9	0.72	0.92	0.09	10.5	280	6.2	0.8	2.3	16.2	0.7	Loam
2013	8.3	0.55	0.36	0.04	25.6	310	6.4	1.0	2.4	14.4	0.7	Loam

Table 2: Analysis of variance for both indexes of weed control in sugar beet cropping under different tillage methods (mean of 2013 and 2013)

		Mean square	
Source of variation	Df	Number of weeds	Dry mass of weeds
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

Table 3: Means comparison for both indexes of weed control in sugar beet cropping between different tillage methods (mean of 2012 and 2013)

Treatment	Number of weeds (m^{-2})	Dry mass of weeds (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.

Statistical results of study (Table 2) indicated that effect of different tillage methods on both indexes was not significant (P = 0.05).

DISCUSSIONS

In this study, the most important indexes of weed control, i.e. number of weeds and dry mass of weeds per square meters were studied to investigate the effect of conservation tillage methods on weed control in sugar beet cropping. Although there was no significant difference in both indexes of weed control in sugar beet cropping during the study years, results showed that tillage operations were useful in decreasing both indexes. The lowest values of number of weeds (6.30 m^{-2}) and dry mass of weeds (6.70 g m^{-2}) were recorded in the MR treatment, while the highest values of number of weeds (14.0 m^{-2}) and dry mass of weeds (21.2 g m^{-2}) were noted in the NT treatment (Table 3). Moreover, tillage method affected both indexes of weed control in the order of MR < CR < R < MDD < DD < C < NT. These results are in line with the results reported by Romaneckas *et al.* [4, 8], Adamaviciene *et al.* [9], Jabro *et al.* [10], Iqbal *et al.* [11], Khurshid *et al.* [17], Rashidi and Keshavarzpour [18], Rashidi *et al.* [19] and Rashidi and Khabbaz [20] that tillage practices can be associated with superior weed control. These results are also in agreement with those of Carter and Ivany [12], Ozpinar [13], Borresen [14], Bauder *et al.* [21], Hill [22] and Horne *et al.* [23] who concluded that conservation tillage methods may be associated with raised diversity of weed species and population.

CONCLUSION

Although effect of conservation tillage methods on both indexes of weed control in sugar beet cropping, i.e. number of weeds and dry mass of weeds per square meters was not significant (P = 0.05); tillage operations were useful in decreasing both indexes. Also, tillage method affected both indexes 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.

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