Weed Population Response to Different Tillage Methods in a Sugar Beet Cropping System under Semi-Arid Conditions

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Abstract: Filed experiments were carried out to study the weed population response to different tillage methods in a sugar beet cropping system under semi-arid conditions 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). Two indices of weed population, 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 indices of weed population was not significant ($P \leq 0.05$); tillage operations were useful in decreasing both indices.

Key words: Weed population · Tillage methods · Sugar beet · Semi-arid conditions · 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 population indices for sugar beet crop has not been studied enough. Therefore, the main objective of this study was to study the weed population response to different tillage methods in a sugar beet cropping system under semi-arid conditions.

MATERIALS AND METHODS

Research Site: This study was conducted at the Research Farms of Hamedan Province, Hamedan, Iran for two successive growing seasons (2008 and 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.

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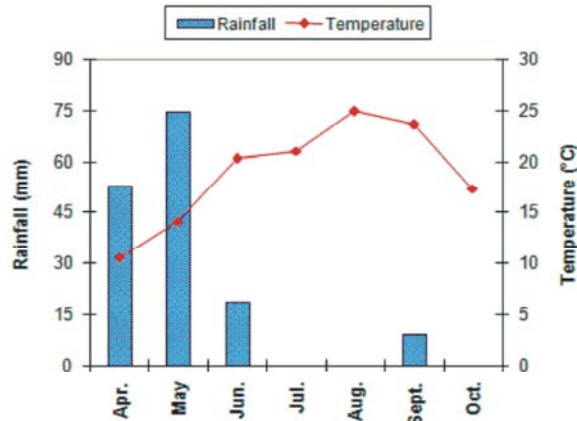
Fig. 1: Mean temperature and monthly rainfall during crop growth (mean of 2008 and 2009)

Mean temperature and monthly rainfall of the experimental site from sowing to harvest during study years (2008 and 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 and 2009) are given in Table 1.

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 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 indices of weed population, 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 $P \leq 0.05$.

RESULTS AND DISCUSSION

In this study, number of weeds and dry mass of weeds per square meters were studied to investigate the effect of different tillage methods on weed population indices for sugar beet crop. Results of ANOVA and means comparison for both indices of weed population among different tillage methods during the years of study (mean of 2008 and 2009) are presented in Table 2 and Table 3, respectively.

Statistical results of study indicated that effect of different tillage methods on both indices was not significant ($P \leq 0.05$). Although there was no significant difference in both indices of weed population for sugar beet crop during the study years, results showed that tillage operations were useful in decreasing both indices. 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

Table 1: Soil physical and chemical properties of the experimental site (0-30 cm depth), 2008 and 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

Table 2: Analysis of variance for both indices of weed population for sugar beet crop under different tillage methods (mean of 2008 and 2009)

Source of variation	Df	Mean square	
		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 indices of weed population for sugar beet crop between different tillage methods (mean of 2008 and 2009)

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.

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 indices of weed population 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 different tillage methods on both weed population indices, i.e. number of weeds and dry mass of weeds per square meters was not significant, tillage operations were useful in decreasing both indices.

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