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Effects of Barley Mulch on Weed infestations Sugar beet yield

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ABSTRACT

The effect of barley mulch on weed infestation and crop yield of sugar beet was tested in strip split plot design with randomized complete block design arrangement in four replications at Motahari Research Satation in Karaj, Iran in 2012 and 2014. The treatments consisted of five different cropping systems including sole cropping in autumn (a1), barley mulch applied in furrow in autumn-sown sugar beet cropping (a2) and both in furrow and hill (a3), sole cropping in spring (a4), and barley mulch applied in furrow in spring-sown sugar beet cropping (a5)in main plots and three weed control methods including hand weeding (b1), no control (b2), and chemical control (a3)in split plots. In treatment a1, Paraquat herbicide was used for weed control. Results showed that the highest weed mass fresh weight and the lowest sugar beet root yield were obtained in a3 treatment. Sugar beet root yield, sugar yield and white sugar yield were influenced by weed population. Weed population was also influenced sugar yield and white sugar yield as a function of root yield in control treatment compared with b1 treatment. It can be concluded that barley mulch is more effective than herbicide application.
Keywords: *Barley mulch, cropping system, sugar beet, weed control*

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INTRODUCTION

Sugar beet planting is particularly important for sugar production and food supply, especially in Iran. Weeds are a major obstacle in the development of sugar beet planting. Unlike most pests and diseases, weeds are a perennial problem in sugar beet fields which may significantly decrease both root and sugar yield [3]. Weed competition is one of the yield-limiting factors of sugar beet production in Iran which may reduce the crop yield by 80-100% depending on weed density and the time of weed emergence [5].

Sugar beet planting in autumn accompanied by mulch crop intercropping reduces weed infestation. Field preparation in autumn, allows resistant sugar beet cultivars planting in April[7]. Although winter weed emergence may occur but spring weed emergence is minimum Mulch crop planting can prevent weed germination, reduce herbicide application, improve soil properties, and result in better sugar beet growth. As a consequence, sugar beet competitive capacity will increase against weeds. Previous studies showed that the plant debris can prevent weed growth with no effect or a positive effect on crop growth. Moreover, weed response to plant debris depends on the volume of plant debris and the biology of the plant [8].

More often, legumes are used as a cover crop to immobilize nitrogen, but other species such as narrow leaf plants and Brassica family species are also used for this purpose [6]. Cover crops can be used in the absence of main crop for the management of weed infestation. Cover crops influence the weed growth in different ways. The cover crop reduces the amount of light and moisture needed for autumn weed germination. In addition, the weeds grown beside cover crop may not develop properly in winter [6].Cover crop debris also influences weed germination rate and its its regeneration in spring through changing soil temperature and structure, increasing soil moisture content, and releasing allelochemicals, and [4]. In fact, cover crops fill empty farming system periods and in the absence of them, the land will be occupied by the weeds. Fisk *et al*. [4] showed that winter cover crops can reduce spring- annual weed dry weight to 70%. In another study, Vasilakoglou *et al.* (2006) indicated that weed emergence decreased to 80% in cotton fields intercropped with cover crop compared with sole cropping. However, cotton seed germination was not influenced by crop mulch and In addition to weed germination reduction, stems number and weed fresh weight was also lower in crop mulch treatment. Allelopathic properties of some plants secrete substances capable of inhibiting the growth of the weeds [9]. The aim of this study was to evaluate the effect of sugar beet cropping system in autumn and spring on weed infestation.

METHODOLOGY

This study was conducted at Motahari Research Station in Karaj (35°59´N and Longitude 51°6´E with 1300 m elevation above sea-level), Iran. The experiment was carried out in split plot design with randomized complete block design arrangement in four replications for three years period starting from 2012. The region has a warm and dry Mediterranean climate with 150–180 days rainless period. It has considered as a dry moisture regime due to its cold and moist winters and warm and dry summers. In this study, the effect of barley mulch on weed infestation and sugar beet growth was evaluated in both spring and autumn sugar beet planting.

The treatments consisted of five different cropping systems including sole cropping in autumn (a1), barley mulch applied in furrows in autumn-sown sugar beet cropping (a2) and both in furrows and hills (a3), sole cropping in spring (a4), and barley mulch applied in furrows in spring-sown sugar beet (a5) in main plots and three weed control methods including hand weeding (b1), no control (b2), and chemical control (a3) in split plots. Individual plots included 8 rows spaced 50 cm apart, with a length and width of 25 and 4 m, respectively. For chemical control treatment, Betanal Progress herbicide was used at 2-4 leaf stage of sugar beet (2 L ha^{-1}). Perennial weeds were also controlled by manual removal.

About 200 kg irrigated barley seed was used per hectare for both manual broadcasting and row planting. In manual seed planting method, after land leveling, barley seeds were broadcasted on the soil, followed by the land roller usage. Barley was seeded using row planter in a width of 30 cm and a distance of about 10 cm from the sugar beet. When barley plants reached to 15-20 cm height (Wilson *et al*., 2001), 3 Lhectare ha^{-1} Paraquat herbicide was used to make dead plant debris. In mixed cropping systems, narrow leaf herbicide (Gallant (Hallux Fop ethyl ethyl-5/12% EC) was used at a rate of L hectare ha^{-1} was used in 4-6 leaf stage of sugar beet. Fertilizers were applied according to the Institute of Soil and Water recommendation. A monogerm variety of sugar beet, Dorothy which is resistant to bolting was used with 100,000 plants per hectare density.

Broad-leaved weed density (plants m^{-2}) and species were counted before and two weeks after herbicide application (Betanal Progress) in 1 m^2 quadrats per plot. For weed biomass determination, before herbicide application, weed samples were taken using a 0.5 × 0.5 m^2 quadrat followed by drying in oven at 75 °C to a constant weight. Weed species dry weight was recorded. In mulch crop treatments, the weight of the cover crop was measured before herbicide application. Paraquat herbicide was used for the removal of both cover crop and weed in autumn and winter cropping. In each, cover crops were sampled and hand harvested using a a 0.5 × 0.5 m^2 quadrat. Their dry weight was measured after drying in oven at 75 °C. To determine the effect of treatments on sugar beet root yield, root samples were taken from 4 m^2 and weighed after cutting the top root. Furthermore, to determine the amount of dry matter produced by aerial parts, the fresh weight of the leaves were measured and then 1 kg of the leaves were put in oven and their dry weight was measured. Data analysis and diagram drawing were done using SAS and Excel software, respectively and for mean comparison duncan's multiple range tests was used.

RESULT AND DISCUSSION

First year

ANOVA results showed that sugar beet root yield, sugar yield, and white sugar yield were significantly influenced by weed management and seed bed preparation time (Table 1). However, weed management and seed bed preparation time interaction had no significant effect on sugar beet quantitative traits (Table 1).

Second year

ANOVA results showed that weed management significantly influenced sugar beet properties including Na, K, amino nitrogen, root yield, sugar yield, and white sugar yield (Table 1). Also, seed bed preparation time and barley mulch had significant effect on Na. However, weed management and seed bed preparation time interaction had no significant effect on sugar beet quantitative traits.

Table 1. ANOVA (MS) results of different cropping systems and weed control methods on sugar beet properties

Source of variation	df	Mean square (first year)				Mean square(second year)			
		Root yield	Sugar content	Sugar yield	White Sugar yield	Root yield	Sugar content	Sugar yield	White Sugar yield
Block	3	246.43	5.78	2.75	0.98	759.51	12.1	21.96	19.8
Cropping system (A)	4	573.59**	1.55*	14.31**	8.89**	180.69ns	3.3ns	2.56ns	1.63ns
Error (a)	11	167.79	2.8	5.77	4.77	76.44	1.4	1.72	1.27
Weed control (B)	2	6615.12**	1.04ns	177.8**	115.2**	6869.27**	6.44ns	120.94**	68.12**
Error (b)	6	1.97	0.33	3.13	2.64	124.93	1.81	1.82	0.84
A×B	8	61.58ns	0.42	1.82ns	1.35	94.11ns	0.78ns	1.61ns	0.94ns
Error (ab)	24	62.18	0.55	1.71	1.9	59.55	0.96	0.88	0.57
C.V.%		12.7	4.6	13.2	13.9	17.6	7.56	16.3	17.73

ns: not significant, *, ** significant at 5 and 1%, respectively.

Weed management effect (First year)

Mean comparison showed that weed competition with sugar beet led to 42% decline in root yield ($P<0.01$). As a function of root yield reduction, both sugar yield and white sugar yield were significantly ($P<0.01$) decreased to 44 and 45%, respectively (Table 2). No significant difference was observed between manual and chemical control methods (Table 2) which may be due to the composition of weed population in the field and chemical control achievement.

Table 2. Mean comparison of the quantitative and qualitative traits of sugar beet in different weed management treatments

Weed management	First year				Second year			
	Root yield ($t.ha^{-1}$)	Sugar (%)	Sugar yield ($t.ha^{-1}$)	White Sugar yield($t.ha^{-1}$)	Root yield ($t.ha^{-1}$)	Sugar (%)	Sugar yield ($t.ha^{-1}$)	White Sugar yield($t.ha^{-1}$)
Mechanical control	69.81a	16.32a	11.4a	9.11a	59.45a	13.08a	7.75a	5.82a
Chemical control	74.46a	15.98a	11.6a	9.29a	48.72a	13.44a	6.54a	4.75a
No control	40.9b	15.9a	6.48b	5.04b	23.35b	12.33a	3.02b	2.22b

Means with same letter in each column are not significance different at 1% level.

Effects of different seedbed preparation methods (First year)

about the highest root yield (69 t ha^{-1}) and lowest (4.52 t ha^{-1}) root yield was recorded in a1 and a2 treatments, respectively. Meanwhile, the highest sugar yield and white sugar yield was obtained from a1 treatment (Table 3).

Effectiveness of weed management methods (Second year)

Mean comparison showed that weed competition with sugar beet resulted in 55% reduction in root yield ($P<0.01$). Both sugar yield and white sugar yield were decreased to 52 and 53%, respectively in control treatment compared with manual control treatment (Table 2).

Table 3. Mean comparison of the quantitative and qualitative traits of sugar beet in different seedbed preparation treatments

Cropping system	First year				Second year			
	Root yield ($t.ha^{-1}$)	Sugar content(%)	Sugar yield ($t.ha^{-1}$)	White Sugar yield ($t.ha^{-1}$)	Root yield ($t.ha^{-1}$)	Sugar content(%)	Sugar yield ($t.ha^{-1}$)	White Sugar yield ($t.ha^{-1}$)
Sole cropping in autumn (a1)	68.9a	15.98b	11a	8.64a	46.19a	12.95a	6.16a	4.61a
Barley mulch applied in furrow in autumn-sown sugar beet cropping (a2)	61.74ab	16.27a	9.99ab	7.84b	38.64a	13.59a	5.27a	4.06a
Barley mulch applied in both furrow and hill in autumn-sown sugar beet cropping both in (a3)	52.38b	15.77b	8.23c	6.42c	40.97a	13.13a	5.5a	4.14a
Sole cropping in spring (a4)	67.8ab	15.73b	10.72ab	8.4a	45.45a	12.14a	6.35a	3.83a
Barley mulch applied in furrow in spring-sown sugar beet cropping (a5)	57.79ab	16.58a	9.62bc	7.77b	47.94a	12.95a	6.35a	4.69a

Fresh and dry weight of weeds (First year)

Weed biomass results showed that both fresh and dry weight of weeds were not influenced by seed bed preparation methods (Table 4). In general, the highest weed fresh weight (19.2 t ha^{-1}) (Table 5) and the lowest root yield (52.4 t ha^{-1}) were achieved in a3 treatment (Table 3). In the other words, 50% root yield reduction was observed in a3 treatment compared with control treatment.

Weeds fresh and dry weights (Second year)

Weed biomass results showed that only weeds fresh weight was influenced by seed bed preparation at harvest (Table 4). Mean comparison results showed that the lowest weed weight was obtained in a4 treatments which had significant difference with a3 treatment ($P<0.05$, Table 5). The highest weed fresh weight (16.50 t ha^{-1}) and as a result the lowest sugar beet root yield was achieved in a3 treatment (Table 3). In the other words, more precisely determined root yield of sugar beet in treatment b3 with weed through all season weed competition compared to the weed control of approximately 50 percent decreased. Root yield loss up to 90% has also been reported by Abdollahyan because of broadleaf weed competition with sugar beet (1). According to the results of this study, it seems that seed bed preparation in autumn may result in effective crop much impact compared to chemical control

Table 4. Analysis of variance of weed fresh and dry weight

SOV	df	Mean square (first year)		Mean square (second year)	
		Fresh weight	Dry weight	Fresh weight	Dry weight
Block	3	11.97	7.13	2.77	5.41
Cropping system	4	75.6ns	18**	16.82*	4.1ns
Error	12	45.76	14.4	1.61	4.71
C.V.%		49.9	45.6	20.7	22.64

Table 5. Mean comparison of weed fresh and dry weight in different cropping systems

Seedbed preparation method	First year		Second year	
	Fresh weight (t/ha)	Dry weight (t/ha)	Fresh weight (t/ha)	Dry weight (t/ha)
Sole cropping in autumn (a1)	15.25ab	9.58a	16.46a	8.09a
Barley mulch applied in furrow in autumn-sown sugar beet cropping (a2)	13.55ab	7.9a	14.94a	6.8a
Barley mulch applied in both furrow and hill in autumn-sown sugar beet cropping both in (a3)	19.2a	11.02a	16.5a	8.8a
Sole cropping in spring (a4)	7.25b	5.42a	11.57b	6.08a
Barley mulch applied in furrow in spring-sown sugar beet cropping (a5)	12.5ab	7.58a	15.21a	8.04a

Means with same letter in each column are not significance different at 1% level

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