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Study of Single and Combination Application of Cover Crops and Their Removal Time on Weed Suppression in Sugar Beet Fields

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Abstract In order to study the effect of different combinations of cover crops and time of their removal on weeds population in sugar beet fields, an experiment was conducted at the Iranian Research Institute of Plant Protection, Karaj, Iran. The study was based on two factorial experiments with randomized complete blocks design with four replications. Treatments in first experiment were type of cover crop including: 1) X Triticosecale *wittmack*, 2) *Hordeum vulgare*, 3) *Trifolium alexandrium*), 4) *Raphanus sativus* and removal times including: 1) at four-leaf sugar beet stage, 2) at eight-leaf stage of sugar beet. In the second experiment, different combinations of cover crops were evaluated. Treatments were cover crop combination including: 1) *Hordeum vulgare* & *Raphanus sativus*, 2) X Triticosecale *wittmack* & *Raphanus sativus*, 3)*Hordeum vulgare* & *Trifolium alexandrium*, 4) X Triticosecale *wittmack* & *Trifolium alexandrium* and removal time of cover crops (as the same of the first experiment). The results showed significant effects of different cover crops and their removal times on weeds dry weight and population. Between treatments, combination of X Triticosecale *wittmack* & *Trifolium alexandrium* had the lowest weed dry weight and population when removed at four-leaf stage of sugar beet.

Keywords: *non-chemical control, weed control, cover cro*

1. Introduction

One of the main obstacles in developing and improvement of sugar beet planting is the existence of weeds. Since Sugar beet is one of the weakest plants against weeds, it hurts a lot at the beginning of growing because of weeds in the farm. However chemical control in modern agriculture is one of the ways for weeds preventing, but using herbicide not only causes weeds to be resistant but also make ecosystem perils and intense side effects on the life chains in the natural and farming ecosystem and also causes increasing in production price [1]. Using common methods of tillage and herbicide whilst are expensive, they will have a negative effect on the soil structure and agriculture crops yield [2]. Anyhow despite applying herbicide such as Gallant supper, Betanal Progress AM and etc, which irregular using of them is a threat for human health and biology environment, we see weeds growing in the sugar beet farms again. So it is need experts fighting against weeds by applying other secondary ways and methods and integrating them with each other. One of these methods is using of cover crop. It can be used from various plants for cover cropping like *Vicia villosa, Secale cereale, Triticum aestivum, Hordeum vulgare, Sorghum bicolor, Avena sativa, Vigna sinensis* and different *trifolium species* [3]. Cover crops are planted for different reasons among: them it can be refer to their prevention from developing of weeds population, controlling soil disease, soil enrichment through nitrogen stabilization, improving soil structure, prevention from nitrogen leaching, enhancing soil organic material and decreasing soil erosion [4]. In recent years using of cover crops and biologic fertilize as suitable method for soil management and reach of sustainable agricultural purposes are increasing [5]. Some of cover crops prevent weeds from growing by using allelopathic effects [6]. In another study in America by using from two species of *Raphanus sativus* (*pegletta* & *adagio*), as a trap plants, it was seen that in alternation in all of the cases, had a noticeable effect on the decreasing of nematodes population and increasing of the sugar beet yield [7]. Weeds control in sustainable agriculture and organic is very difficult and should use from germination inhibitor and weed growth methods, that cover crops are the most effective [8]. Increasing planting density of winter cover crops led to quickly formation of crop canopy and more control on weeds [9]. Residue of cover crops mulch were indicated good known effects on decreasing water evaporate, increasing soil water content, and decreasing daily temperature of soil and weeds suppression [10].

The purpose of this experiment were management of the sugar beet's weeds with reliance on Non – chemical methods, reduction of using the herbicide in sugar beet, and selecting the best cover crop plants mixture for weeds management in the sugar beet farm.

2. Materials and Methods

In order to investigate the effect of different mixture of cover crops and their removal time on the population of weeds in sugar beet farms, two separated experiments were conducted in research field of Iranian Research Institute of Plant Protection, Karaj (35° 46' N, long 50° 49' E; elev., 1,360m) Iran in 2011. Field soil was silt loam with EC*10/573. The study was based on two factorial experiments with randomized complete blocks design with four replications. Factors which examined in first experiment were A- type of cover crop including: 1)X Triticosecale *wittmack*, 2)*Hordeum vulgare*, 3)*Trifolium alexandrium*, 4)*Raphanus sativus* and B- removal time of cover crops at two levels including: 1) four-leaf stage of sugar beet, and 2) eight-leaf stage of sugar beet. In the second experiment, different combinations of cover crops and their removal time were evaluated. Treatments were 1) *Hordeum vulgare* & *Raphanus satvus* 2) X Triticosecale *wittmack* & *Raphanus sativus* 3) *Hordeum vulgare* & *Trifolium alexandrium* 4) X Triticosecale *wittmack* & *Trifolium alexandrium*, and removal times were similar to the first experiment. In order to better determination of the treatments effects, in each block, we had three plots as controls including: 1) hand weeding 2) No weeding, and 3) conventional and recommended weed control (herbicide application). The experimental plots dimension were 2*6m and beds width 50cm. number of experimental plots in the first experiment were 44 plots and in second experiment were 28 plots, the seeds were used as follows: in first experiment, each of X Triticosecale *wittmack* and *Hordeum vulgare* 100kg/ha, *Trifolium alexandrium* 15kg/ha and *Raphanus sativus* 30kg/ha, in the second experiment: X Triticosecale *wittmack* & *Trifolium alexandrium* 7+5kg/ha, *Hordeum vulgare* & *Trifolium alexandrium* 7+50kg/ha, X Triticosecale *wittmack* & *Raphanus sativus* 15+50kg/ha, *Hordeum vulgare* & *Raphanus satvus* 15+50kg/ha. Also GDD amount received for each of cover crops as following: X Triticosecale *wittmack* 104GDD, *Hordeum vulgare* 115GDD, *Trifolium alexandrium* 210GDD and *Raphanus sativus* 167GDD. The preparation operation of the field is consisting of tillage, disking and furrow has been done in an appropriate time and before cover crops planting. Cover crops planted after germination test and ensuring from seeds germination power of cover crops at the first time just after the winter cold in middle of the planting rows(march 31) .The planting of cover crops has been done by hand. The planting date of sugar beet (*Rasul* cultivar at 10 plant m^{-2} density) was done thirty two days after the planting of cover crops on the four ridges of every plot by hand and in one row. Irrigation was done at every four day at the first weeks of experiment and has been changed to every seven days and has been done every seven days till the end of experiments, overall time of experiment was 5 month (planting to harvesting). Irrigation method was done with furrow and ridge irrigation. With regard to the sugar beet sensitiveness at the beginning of growing period, one phase fertilization (N application to the measure of 150kg/ha) has been done. Cover crops were removed by herbicides at four and eight leaf stages of sugar beet. Haloxyfop-R-methyl (Gallant supper, EC 18% at 1.5L/ha) and Phenmedipham + Desmedipham + Ethofumesate (Betanal Progress AM, EC 27.4% at 4L/ha) were used for grasses and broad leaf weeds respectively. For determining the effects of experimental treatments on weed population and dry weight, sampling were done at removal time of cover crops, thirty days after cover crops removal and sixty days after cover crops removal. Moreover, the dry weigh of weeds were evaluated at the end of growing period. Data were analyzed by SAS (version 9.1) and means comparing has been done with Duncan's multiple range tests and normalization was done by taking the square root.

3. Results and Discussion

Analysis variance of data indicated that cover crops in both cover crops planting systems, single and mixture had different effects on weed dry weight significantly ($P \leq 0.01$). The effects of cover crops removal times on weeds abundance and dry weight were the same in single planting system of cover crops, but it had significant effects in mixture planting system ($P \leq 0.01$). Interaction of cover crops and their removal times were significant only in single planting system for dry weight of weeds ($P \leq 0.05$) (Table 1 and Table 2). Based on the results of this study, the effects of cover crops in state of single and mixture planting on dry weight of weeds was significant ($p \leq 0.05$) (Figure 1 and Figure 2). The results of this study showed that in the first experiment and in single cover crops system, X Triticosecale *wittmack* & *Hordeum vulgare* will have the maximum effect on the decreasing of weed dry weight. The results showed that *Gramineae*'s cover crops, with high biomass production, a lot of weeds to prevent seed germination and growth [11]. Therefore, the studies had shown that some of these cover crops hinder the growing of weeds by using effect of allelopathic. Agricultural plants like wheat, barley, rice, tea, coffee, soybean, alfalfa, sunflower are allelopathic [6].The effects of these two plants on weed dry weight wasn't statistically significant (Figure 1), But in the treatments of mixed X Triticosecale *wittmack* & *Raphanus sativus* was better than the other cover crops mixtures (Figure 2). Studies in various regions has shown that in special environments, X Triticosecale *wittmack* has a more potential power in comparison with the other cereals of an area, and it can be regarded as a new cereal [12].

Table 1. Mean of squares the effects of experiment treatments on the dry weights and the weeds abundance in single planting system of cover crop

Single planting			
Source of variation	Degree of freedom	Dry weight of weeds	Abundance of weeds
replication	3	10.27 ns	11.12 ns
Cover crop (a)	5	132.03 **	12..5 *
Removal time (b)	1	23.1 ns	17.9 ns
a*b	5	39.3 *	7.5 ns
error	33	11.06	1.9
Coefficient of variation	–	29.6	26.1

Ns, *, **, in sequence: non significant, significant in probable level (5%), significant in probable level (1%)

Table 2. Mean of squares the effects of experiment treatments on the dry weights and the weeds abundance in mixture planting system of cover crop

Single planting			
Source of variation	Degree of freedom	Dry weight of weeds	Abundance of weeds
replication	3	4. 99 ns	0.45 ns
Cover crop (a)	5	157.33 **	20.6 **
Removal time (b)	1	85.41 **	44.2 **
a*b	5	7.09 ns	1.2 ns
error	33	5.74	1.8
Coefficient of variation	–	28.22	28.9

Ns, *, **, in sequence: non significant, significant in probable level (5%), significant in probable level (1%)

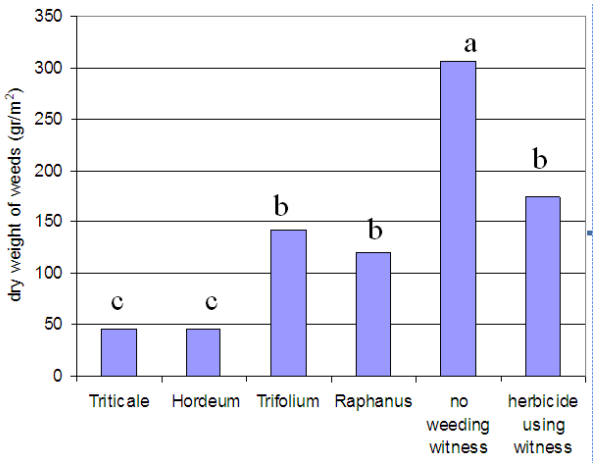

Figure 1. Effect of different cover crops on total weeds dry weight (P≤0.01)

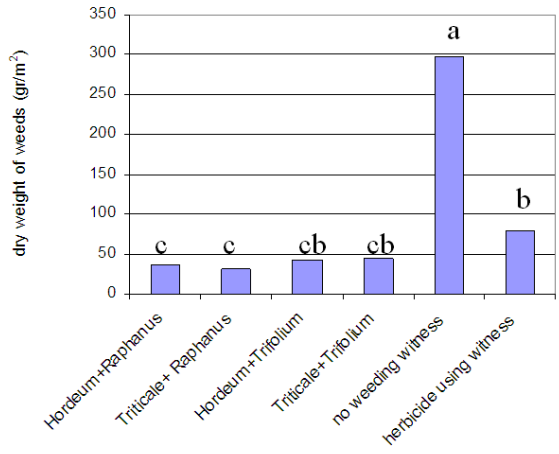

Figure 2. Effect of different combinations of cover crops on total weed dry weight (P≤0.01)

The studies has shown that, the mixture of cover crops that their carbon nitrogen ratio (C/N) is between (20/1) till (30/1), will provide the nitrogen of subsequent plant properly and its straw would control the weed properly [13]. At this study, results of the experiments indicated that the effects of cover crops removal times on weed dry weight in single and mixture cover crop planting systems. In single planting system, there was no significant difference between the removal times of cover crops on weed dry weight, but this effect for mixture planting system of cover crops was significant in eight leaves stage (P≤0.05) and showed the advantage of the removal time of cover crops on decreasing of the weeds dry weight when the sugar beet had four leaves (Figure 3). It has seen that mixture planting system have more effective role in comparison whit single cover crop planting system, because of allelopathic materials of different plants (Figure 1 and Figure 2).

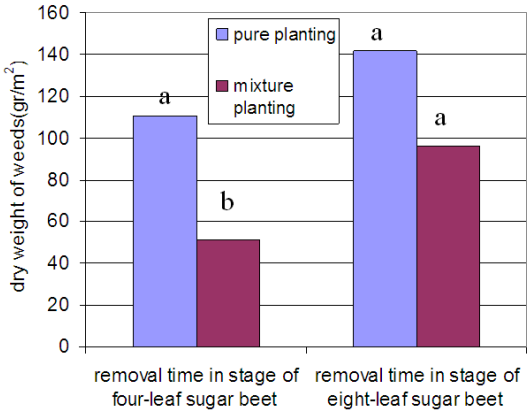

Figure 3. The effect of removal time of cover crop on the weight of the weeds in the single and mixture cover crop planting

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