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Effect of Solarization and Polyethylene Thickness Cover Type on Weeds Seed Bank and Soil Properties

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ABSTRACT

To investigation the effect of soil solarization and thickness plastic cover on weed seed bank and soil properties, an experiment based on randomized complete block design with three replications was carried out in experimental farm in 2013 were conducted in the research and education of Islamic Azad University of Karaj. Examined factors include solarization period at seven levels (0, 1, 2, 3, 4,5 and 6 weeks) and polyethylene thickness in two levels(100 and 200 microns).According to preliminary result 11 species is ultimately distinguished; the analysis variance result indicated the effect of solarization period, plastic thickness and their interaction on weeds seed bank was significant; So that the highest value of weeds seed bank associated to 6 weeks of solarization, which statistically had no difference with 5, 4 and 3 weeks of solarization. Also the highest value of weed populations pertained to evidence treatment (without plastic cover). By increasing the plastic thickness, the weed seed bank increased through the soil pattern. So that the number of weed seeds per kilogram was 233 and 186 unites when the thickness of the cover was about 200 and 100 micron. The solarization period length on acidity and soil moisture content had no significant effect, but leads a significant effect on soil organic matter at level of 5%. The thickness of the plastic cover had no effect on either of the measured parameters.

KEY WORDS: Solarization, polyethylene, weed seed bank, organic matter

INTRODUCTION

The study of weeds seed bank alternation is a general and novel prospect in the term of weed science, which helps arable management systems to control weeds and especially distinguished as an effective entity in integrated weed management (IWM). Seed bank plays a major role in weeds durability through the time. Not only is the seed bank recognition essential in ecological aspects, but also a pivotal entity of long time weeding management programs. Indeed seed bank is a rather memory, which stores the region revolutions and explains the arable history, earlier regional plant cover and greatly figure the next regions plant canopy [1]. Seed species and density compositions differ greatly in the soil pattern and immensely associated to the earlier cropping in the region [2]. Seed bank perusing makes us able to know valuable information about species, which develop in arable lands. The obtained information from seed bank like diversity and composition of seed bank, anticipating the composition and density of different weed species ease and provided right management in this term [3]. Solarization is one of the non-chemical ways to manage weeds seed bank. The most current way of solarization is to use a plastic layer on the soil surface [4]. In this way along a period soil is covered with plastic sheet to trap the sun waives and ultimately to increase the top soil layer temperature to 40-55°C. Indeed the thermal reaction is the main reason which leads weeds seed bank decrease [4]. Investigation of solarization effect on weeds seed bank showed that the light plastic solarization treatment significantly reduces the weeds seed bank. Increasing soil temperature Known as a main reason of weeds seed bank reduction [5]. Seed bank reduction is essential for two reasons; first, seeds transmission from the beneath soil layers to the top (by agriculture operations) and second for conveying temperature to the subterranean soil layers and weeds seed devastation (by solarization method) [4]. In Ethiopia to investigate the light and darkness plastic covers on controlling seed bank of *Orobanche ramose* and *Orobanch ecernu* showed use of these colored covers significantly decreased weeds seed bank; So that this reduction rate in light and dark covers

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was about 87 and 93% compared to evidence treatment (without plastic cover) [6]. They added, not only soil solarization decrease the soil weeds seed bank by increasing the soil temperature, but also can alter the soil characteristics [5, 6]. By increasing the soil temperature the rate of decomposition and mineralization of soil organic matter will increase, which increases the soluble electric conduction index (EC) of the soil after solarization [7,8]. Acidity decreased in the solarized soil [9]. Solarization treatment anticipated reduction in carbon content of organic matter due to organic matter decomposition, but the solarization had no significant effect on before mentioned trait; since, the soluble organic matter density increased in solarized soils [10].

MATERIAL AND METHODS

To investigation the effect of soil solarization and thickness plastic on weed seed bank and soil properties, an experiment based on randomized complete block design with three replications was carried out in experimental farm in 2013 were conducted in the research and education of Islamic Azad University of Karaj. Examined factors include solarization period length at 7 levels (0, 1, 2, 3, 4, 5 and 6 weeks) and polyethylene thickness in 2 levels (100 and 200 microns). Plough, harrowing and flatting encompassed the land preparing operation. Plot dimension was about 4×5 $m^2$and there was respectively 1 and 2 m length between Plots and blocks. The livestock fertilizer spread at the rate of 500 Kg ha^{-1} between Plots. The region′s soil characteristic is determined (Table 1).Clods, stones and excessive materials gathered from field surface before covering the land with plastic layer and then the foliage irrigated. After water absorption to the field capacity level the plastic sheets immediately covered the experimental Plots according to predetermined scheme. Then the light polyethylene plastic sheets, which cut before according to each experimental foliage, placed in such way to cover the foliage. The edges of the plastic sheet vertically buried in the soil at 5 cm depth and covered with soil to interrupt the temperature transmission, which acquired from the sun radiation. Samples of seed bank gathered from 0 to 10 and 10 to 20 cm depth when the plastic sheets are aggregated accurately in late September. Sampling followed a systematic method and accomplished with auger (2.5 cm), so that five sample pull out from different points of either plot (after solarization). Then obtained samples from both depths mixed and separately placed into the plastic pockets. Extraction method used to investigate the seed bank population [11]. Initially, 100 g of each foliage′s soil weighted and treated with different sieves (1, 0.5 and 0.18 micrometer). Afterward the soil content rinsed with water and dried, the maintained seeds distinguished with the help of binocular and counted to the separate species. To assess the soil moisture content, organic carbon and soil acidity after gathering plastic layers, samples aggregated from 5 and 15 cm of soil depth. Determining the soil moisture content was begun by weighting 100 g soil of each sample; they placed in oven at 105°C for 24 hrs and then weighted to calculate the percentage of moisture content.

$$W_1= A – C \text{ Fresh soil weight}$$
$$W_2= B – C \text{ Dry soil weight}$$
$$Om\% = W_1 - W_2 / W_2 \times 100 \text{ Moisture content}$$

C: beaker weight; A: beaker weight+fresh soil; B: beaker weight+dry soil

To measure the soil acidity, the solvable liquid (2:1) which extracted from the soil prepared and purified with Watman′s filter paper and acidity assessed from extracted liquid by acidometer. The rate of organic carbon assigned according to Byers and associations method [12] after aggregating the plastic covers accurately in late September. The organic carbon percentage calculated by the beneath formula:

$$OC\%= M \times 0.39 \times [(V1-V2)/S] \times 5$$

M: normality of ammonium ferrous sulfate; V1: mount (ml) of utilized ammonium ferrous sulfate in evidence; V2: mount (ml) of utilized ammonium ferrous sulfate in sample; S: dried soil weight in fresh air

Data analysis variance was done with utilizing the SAS software (version 9.1). The comparison means assessed with Duncan's multiple-range test and graphs were draw with Excel software.

RESULTS AND DISCUSSION

Investigating weeds seed bank distinguished 11 species from the entire plots. So that eight species categorized into annual broadleaved types, one placed in perennial broadleaved and two species classified as annual narrow leaf.

Name and general traits of these species is showed in Table 2. According to the table annual broad leaved species comprised the main seed bank composition; So that their population was rather compared to perennial narrow leaf species. Solarization effectively controls most of annual weeds, while perennial weed control is different depending on the species. Solarization effect depending on the species of weeds and perennial weeds reproductive organ placement depth varies [13]. Also, the sole existence of two narrow leaf species indicates the lower numbers of narrow leaf in weeds seed bank composition in the farm. 95% of seed bank population is moderately pertained to annual weeds and solely 4% of this population devoted to perennial species [5, 14]. The result of analysis variance showed effect of solarization period length, plastic thickness and interaction of solarization period and plastic thickness was significant on weeds seed bank (Table 3). The lowest weeds seed bank was dedicated to 6 weeks of solarization, which statistically had no significant difference with 3, 4 and 5 weeks of solarization treatments (Figure 1). It seems that the soils aggregative temperature and the exposing duration of this temperature are two main factors to cut weeds population in the soil. To investigate the solarization effect on controlling weeds seed bank and tomato yield founded by increasing solarization period length from 2 to 8 weeks seed bank had a significant decrease due to the temperature increase and drastic situations for seeds vitality [6].

Table1. Some soil physico-chemical properties of experimental site

Organic matter (%)	E.C ($ds.m^{-1}$)	Silt (%)	Clay	Sand (%)	pH	K (ppm)	P (ppm)	N (%)
0.86	0.54	35	50	15	7. 3	215	5.7	0.09

Table 2- The scientific names and general characteristics of the weed seed bank after removing the plastic cover

Common Name	Scientific Name	Family	Leaf Figure	Growth Cycle
Lambsquarters	*Chenopodium album*	Chenopodiaceae	Broad leaf	**Annual**
Pigweed	*Amaranthus blitoides*	Amaranthaceae	Broad leaf	**Annual**
Redroot Pigweed	*Amaranthus retroflexus*	Amaranthaceae	Broad leaf	**Annual**
Purslane	*Portulaca oleracea*	Portulacaceae	Broad leaf	**Annual**
Rocket	*Sisymbrium irio*	Brassicaceae	Broad leaf	**Annual**
Bindweed	*Convolvulus arvensis*	Convolvulaceae	Broad leaf	**perennial**
Crabgrass	*Digitaria sanguinalis*	Poaceae	Narrow leaf	**perennial**
Knotweed	*Polygonum aviculare*	Polygonaceae	Broad leaf	**Annual**
Stock	*Malcolmia africana*	Brassicaceae	Broad leaf	**Annual**
Nightshade	*Solanum nigrum*	Solanaceae	Broad leaf	**Annual**
Barnyardgrass	*Echinocloa crus-gali*	Poaceae	Narrow leaf	**Annual**
Fumitory	*Fumaria officinalis*	Fumariaceae	Broad leaf	**Annual**

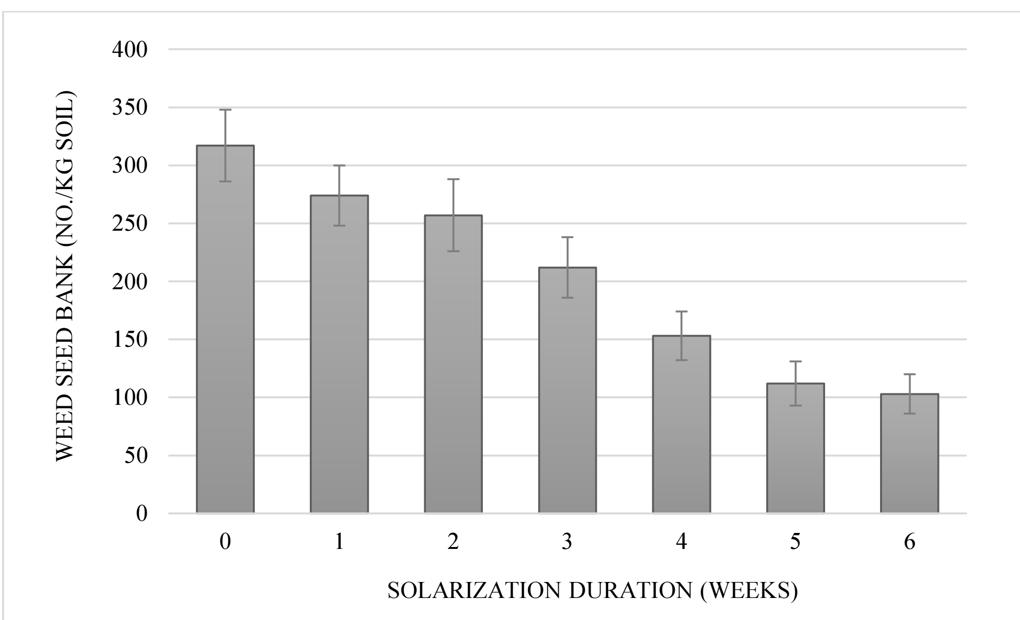

Figure 1- Compression mean result of different solarization levels on weeds seed bank

It is indicated increasing the soil temperature and then increasing the available weeds seed bank temperature leads a direct damage to seed cells construction and metabolism and ultimately made a high rate of mortality for weeds seed. Furthermore, the soil temperature increasing leads organic matter decomposition, also anticipates metabolic process in the seed which increases the poisonous gases concentration in the soil [15]. On the other side; the soil temperature increasing duplicate microorganism's activity and it's invade to seeds and weeds stable organs. All of these consequences made the higher mortality and seed density reduction in weeds species. The highest weed seeds population devoted to evidence treatment (Figure 1). It is reported by decreasing the solarization period length (from 6 weeks to one time) weeds seed density significantly increased in the soil [16]. Effect of polyethylene cover thickness showed by increasing the plastic thickness, weeds seed bank content of the soil increased (Figure 2). The number of weeds seed per kilogram was about 233 and 186 unite at thickness of 200 and 100 micron. It is indicated that the plastic thickness made the less light transmission and so the less seeds germinated and there will be rather seeds number in the soil. The result of current study paralleled with [5, 17] and [6] achievements. Cause of this can be increase of light passing from the thinner cover and therefore reduce of weed growth and germination. Also it is showed the soil temperature under solarization treatment with thin plastic plates was more than the thicker plastic [13]. With increasing temperature, hydrogen and disulfide bonds proteins and fats have changed and will affect the membrane structure [18]. Ancillary mechanisms of thermal death or reducing the number of seeds are resulting from inactivation of respiratory enzymes, Protein synthesis degradation and also damaging to nucleic acids [19].

By investigate the effect of two different thicknesses of transparent polyethylene plastic on weed control it is founded that the dry matter accumulation of weeds density was decreased in 15 days after solarization treatment. Furthermore, there was no significant difference between the two thicknesses of the polyethylene [20]. Evaluating the effect of solarization with black polyethylene plastic and transparent plates on control of Orobanche was showed that the 97 and 89% of weeds were controlled respectively, with transparent and black polyethylene plastic [21]. Also better control of weeds achieved under solarization with transparent plates compared with black mulch because of the higher temperature reported [22].

Table 3- Analysis of variance from different solarization levels and plastic thickness on weed seed bank

S.O.V	d.f.	Weed seed bank
Replication	2	328.15*
Solarizaton	6	5124.13*
Thickness	1	108179.72*
Thickness×Solarizaton	6	11278.46*
Error	26	114.73
C.V (%)	-	12.71

Ns,*, ** no significant and significant at 5 and 1% levels

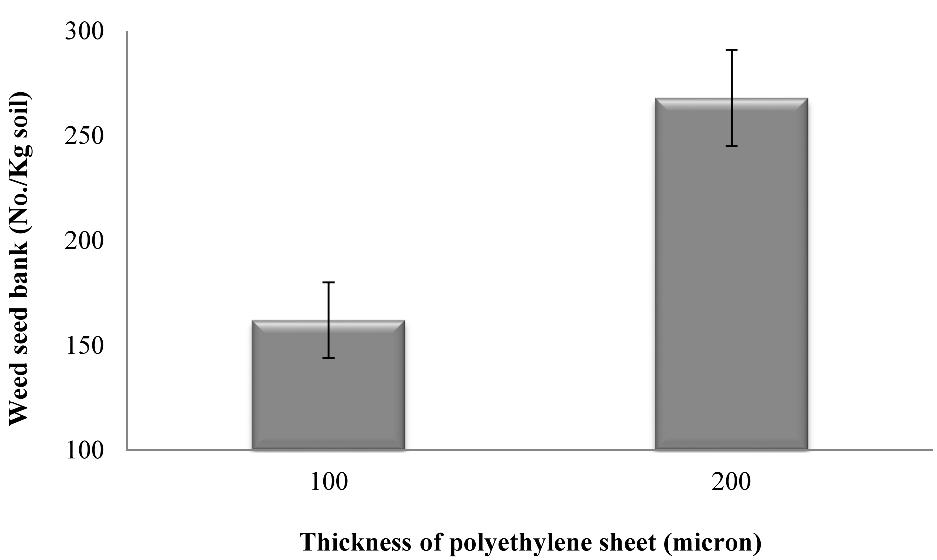

Figure 2- Comparison means results of plastic cover thickness on weeds seed bank

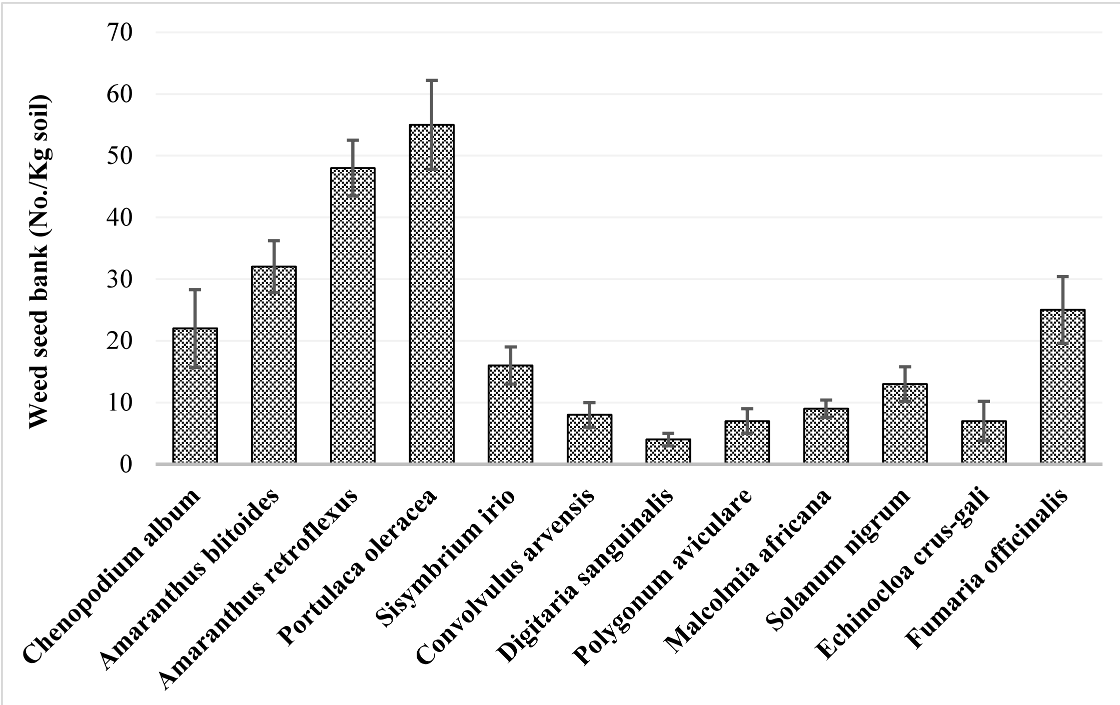

Figure 3- The size of different weeds seed bank among present species

The size of different weeds seed bank is depicted in figure 3. The high seed density of purslane, redroot pigweed and fumitory respectively obtained about 98.1, 54.40 and 31.2% per kilogram soil. Since these weeds have the high ability of seed production, they should have the more massive seed bank community in the soil. In this convergence another study reported a sole redroot pigweed occasionally might produce more than a million seeds [23]. The germination percentage of *Portulaca oleracea*, *Echinocloa crus-gali*, *Solanum nigrum* and *Descurainia Sophia* decreased with solarization; but the response of species differed among solarization treatment. So that *Discurainia sophia* and *Echinocloa crus-guli* obtained the highest percentage reduction in their germination and *Solanum nigrum* categorized in the next group in this term [24, 25]. The lowest reduction in this case devoted to *Portulaca oleracea*, which had more resistance to solarization compared to other species. They also added different responses of various species to solarization treatments are concerned to genetic diversity, seed age, seed depth in the soil, the soil organic matter concentration, soil humidity, soil temperature, solarization period, microbe existence and their antagonism and stimulating activity and ultimately their interactions [24, 25]. The effective weeds control had a direct correlation with solarization period length and the type of weeds seed. Some hard coat weeds like *Anoda cristata* and *Jpomoea* spp need more period to be affected by solarization [4]. Species, which showed consistence and resistance to agriculture operation, comprised 70-90% of total seed bank population and known as the main polluting factor in farms [26].

Analysis variance result showed the solarization period length had no significant effect on soil acidity and its moisture content, but it was significant on soil organic matter at the level of 5%. Also the plastic cover thickness had no significant effect on either of measured parameters. Furthermore the interaction of these two treatments was not significant on three before mentioned parameters (Table 4). The soil acidity rate increased slightly by adding solarization period time, but statistically there were no difference between treatments (Table 5). These achievements were in convergence of another research [5]. Not only polyethylene plastic covers utilization prevent leaching the nutrient elements, but also cut the soil acidity by maintaining ions like Fe and aluminum in the soil texture; the event which occurred through the leaching [27]. Results of compression mean (Table 5) showed by adding the weeks of soil solarization, the rate and proportion of soil organic matter decreased. But the total organic carbon content of the soil was not affected by solarization and there were no significant difference between treatments. The light polyethylene sheets approximately transmitted the sun waives and by increasing the soil temperature influence the available organic matter rate. This issue in the warm regions, where the decomposition rate is high can be perceived as a main fatal reason. In convergence of this point another study declared by increasing temperature along the solarization period, actions of decomposing the soil organic matter will accelerate [7]. It is reported the total organic matter of the soil had no significant difference among solarized and non-solarized soil treatments [28]. In this case the study of different solarization levels effect on soil moisture content showed by increasing the solarization period length, the soil moisture rate is not decreased because of preventing the moisture evaporation from the soil surface; however no significant difference was observed between these treatments (Table 5). Any operations, which cover parts of the soil surface, can be effective in evaporative water dissipation [27]. It is indicated the soil, which was treated under the plastic cover had the rather humidity rate compared to lands without plastic layers [29]. To concern with this case, it is declared that the plastic cover use on the soil surface made evaporation control in such situation [30]. The analysis variance result of plastic cover thickness on soil acidity, organic matter and soil moisture content had no significant effect (Table 4). In concern of plastic cover thickness on traits, it is cleared that among different thicknesses statistically there were no significant difference (Table 6).

Table 4- Analysis variance of different solarization levels and plastic cover thickness on acidity, organic matter and soil moisture content

S.O.V	d.f.	pH	OC (%)	Om (%)
Replication	2	32.13	94.12	**46.28**
Solarizaton	6	$51.34^{n.s}$	127.17^{*}	$\mathbf{42.73^{n.s}}$
Thickness	1	$126.85^{n.s}$	$92.45^{n.s}$	$\mathbf{68.28^{n.s}}$
Thickness×Solarizaton	6	$64.29^{n.s}$	$45.21^{n.s}$	$\mathbf{51.27^{n.s}}$
Error	26	27.38	13.75	**21.47**
C.V (%)	-	11.74	10.58	**8.18**

n.s.,*,** no significant and significant at 5 and 1% levels

Table 5- Comparison mean results of different solarization levels on the acidity, organic matter and soil moisture content

	Solarization duration (Weeks)						
Treatments	0	1	2	3	4	5	6
pH	7 ab	7.11ab	7.08ab	7.24 a	7.21 a	7.28 a	**7.25 a**
OC (%)	1.47 a	1.51 a	1.43 a	1.42 a	1.48 a	1.43 a	**1.46 a**
Om (%)	12.71ab	12.72ab	13.11ab	13.51 a	13.92 a	14.25 a	**15.13 a**

Means within a column followed by the same letters are not significantly difference at the α=0.05 (Duncan's multiple-range test).
OC: Organic carbon; Om: percentage of moisture content

Table 6- Comparison mean result of plastic cover thickness on acidity, organic matter and soil moisture content

	Thickness (µm)	
Treatments	100	**200**
pH	7.0 a	**7.2 a**
OC (%)	1.44 a	**1.42 a**
Om (%)	13.0 a	**13.8 a**

Means within a column followed by the same letters are not significantly difference at the α=0.05 (Duncan's multiple-range test).
OC: Organic carbon; Om: percentage of moisture content

CONCLUSION

Results of this study showed that the solarization with 100 micron plastic significantly reduced the population and biomass of weeds that showed the effect of solarization on germination and emergence of weeds. According to the results of this experiment can make use of thin plastic as a method of weed control in fallow period or before planting be recommended. Also, to prevent weed growth and significant effect in elimination of weeds keeping polyethylene plastic sheet at least 4 weeks is recommended. Solarization with thin plastic significantly reduced the weeds seed bank. Although solarization with thin plastic cannot eliminate all weeds of seeds but with population decline of seeds that are sensitive to heat due to solarization and the attenuation of other weeds, will reduce weeds pressure in subsequent periods and so in the long programs recommended for period of weeds management.

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