Scientific Papers. Series A. Agronomy, Vol. LIX, 2016
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

EFFECT OF DIFFERENT PLASTIC COVER MATERIALS AND BIOFUMIGATION TO SOIL ORGANIC MATTER DECOMPOSITION IN GREENHOUSE SOLARIZATION

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Abstract

Solarization is a hydrothermal process which brings about thermal and other physical, chemical, and biological changes the moist soil during, and even after, mulching. Organic matter, the soil is the most important component, emerges as an important parameter in the solarization applications, because it contains many changes and events. The experimental site was located at the University of Suleyman Demirel Research Center in Isparta. Greenhouse experiments were conducted during 2011-2012 in the 60 day period (July-August). The experiments were arranged as a randomized block design, with three replications per treatment, based on a plot size of 2m x 2m. Four soil treatments and control (non-sol) were applied: solarization, biofumigation, bubble solarization and bubble-water solarization. After the experiment, samples of treated soil were taken from 15 and 30 cm depths from the center of each tested plot, immediately after termination of solarization and then soil was tested organic matter. The high organic matter content is determined in Sol treatment according to data from the year 2011. According to these results, it can be said that Sol treatment was the lowest mineralization in applications. Similarly to the first year, in 2012, while amount of organic matter decreased with depth, it was determined that only an increase in BSol treatment. Based on these results, it was concluded that soil organic matter with solarization application convert available nutrition form to plants with decomposition it.

Key words: *biofumigation, decomposition, greenhouse, organic matter, soil solarisation.*

INTRODUCTION

Soil solarization refers to covering the soil with transparent plastic sheeting during the appropriate period. The plastic sheeting is the modern tool for capturing solar energy to heat the soil in the open field or a greenhouse (Katan and De Vay, 1991). Solarization is a hydrothermal process which brings about thermal and other physical, chemical, and biological changes the moist soil during, and even after, mulching (Stapleton et al., 1985).

The method is sample, safe, and effective, leaves no toxic residues, and can be easily used on a small or large scale. Soil solarization has the long-term benefits of increased nutritional status, and decreased microbial, nematode and weed population of the soil, which finally leads to better plant vigor (Sofi et al., 2014).

Soil solarization with polyethylene film mulch alone may not be consistently effective for the control of soil borne pathogens and therefore combinations with organic or inorganic soil amendments have been used to enhance the effectiveness of solarization (Ramirez-Villapudua and Munnecke, 1987; Komariah et al., 2011). Solarization may cause an increased growth response in plants not only due to reductions in soil pathogens but also due to changes in chemical or physical properties of the soil (Seman-Varner et al., 2008). Soil solarization improves soil structures and increases the availability of nitrogen and other essential plant nutrients (Elmore et al., 1997).

Although the heat generated in soil by solar radiation and the resultant death of plant pathogens and pests encompass the mayor principles of soil solarization, the increase in available plant nutrients and relative increase in populations of rhizosphere competent bacteria (Stapleton and DeVay, 1984). One of common results of soil heating is an increase in concentration of certain soluble mineral nutrients. When soil is heated, much of resident

microbiata is killed and degraded, thus liberating the mineral nutrients (Stapleton, 1990). Organic matter, the soil is the most important component emerges as an important parameter in the solarization applications, because it contains many changes and events.
The main objective of this research was to determine the effect of traditional solarization cover material with testing new different covering materials and bio-fumigation treatments to soil organic matter decomposition.

MATERIALS AND METHODS

The experimental site was located at the University of Suleyman Demirel Research Center in Isparta. Greenhouse experiments were conducted during 2011-2012 in the 60 day period (July-August). The soil at the study site was range alluvial profile, mild and moderate alkaline character. Measured soil texture was 46 % clay, 35 % silt and 19 % sand.
The experiments were arranged as a randomized block design, with three replications per treatment, based on a plot size of 2m x 2m. Four soil treatments and control (non-sol) were applied: solarization (Sol), biofumigation (BioSol), bubble solarization (BSol) and bubble-water solarization (BWSol). In the research, two different cover materials were used. For the soil used for solarization and biofumigation treatments were covered with a 0.04mm transparent polyethylene film. For bubble solarization and bubble-water solarization treatments were covered with 30 mm in diameter, 12.5 mm in height bubble transparent polyethylene film.
In the biofumigation (BioSol) treatment, wet poultry manure of 1.5 kg m^{-2} was added to each parcel in order to increase temperature even further by virtue of bio-fumigation Barbour et al. (2002).
In the third application (BSol), double-layered bubble cover material with air between layers, recommended by Bainbridge (2010), was implemented. The air between the two layers of polyethylene on this material was expected to ensure temperature isolation between the soil and air, therefore, to attain higher temperatures compared to control group. The fourth application (BWSol) includes the bubble water solarization study that is tried for the first time for solarization process and that constitutes the main element of hereby research. In this test, the cover material consists of cover material obtained by filling water into the bubble wrap in BSol application.
After the experiment, samples of treated soil were taken from 15 and 30 cm depths from the center of each tested plot, immediately after termination of solarization and then soil was tested organic matter according to Schlichting and Blume (1966).
All data were subjected to one way analysis of variance with the MSTAT-C software (Version 1.2; Crop and Soil Department Michigan State University). Classification was applied to Duncan test described by Bek (1983). Variance analysis was prepared using a randomized complete block experimental design model.

RESULTS AND DISCUSSIONS

The results for the organic matter content defined in the study are given in Table 1. The high organic matter content is determined in Sol treatment according to data from the year 2011. According to these results, it can be said that Sol treatment was the lowest mineralization in applications. It was determined that the amount of organic matter decreased with depth. The difference between the mean of the values were not statistically significant (P<0.05).

Table 1. Change of organic matter content at the treatments (%)

	Years	Depth	Sol	BSol	BWSol	BioSol	Non-Sol
Organic Matter[1] (%)	2011	0-15 cm	1.92a	1.85ab	1.87ab	1.77ab	1.86ab
		15-30 cm	1.36b	1.57ab	1.41ab	1.49ab	2.11a
	2012	0-15 cm	1.60b	1.88ab	1.65b	1.69b	1.77ab
		15-30 cm	1.55b	2.28a	1.50b	1.65b	1.59b

[1]Different small letters indicate significant differences for P<0.05 in the column for each year

The second year, the highest amount of organic matter is determined in the 15-30 cm soil depth BSol treatment. Similarly to the first year, in 2012, while amount of organic matter decreased with depth, it was determined that only an increase in BSol treatment. Every each year in terms of the overall average, the difference was not statistically significant between treatments (P<0.05).
Soil solarization, which is a moderate heating treatment, did not result in significant changes in total soil organic matter (Katan, 1991).

Ozeres-Hampton et al (2004) and Seman-Varner et al. (2008) showed that organic matter decomposition was not affected by solarization. Organic matter values determined in study by the depth and mean per year is given in Figure 1 and Figure 2.

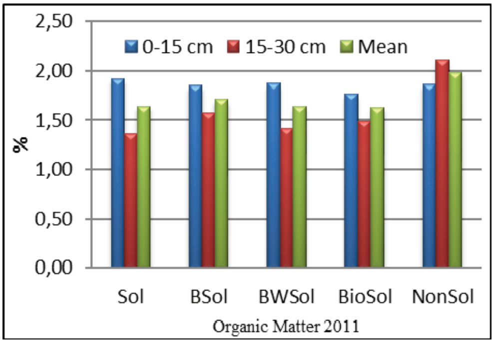

Figure 1. Organic matter values in 2011

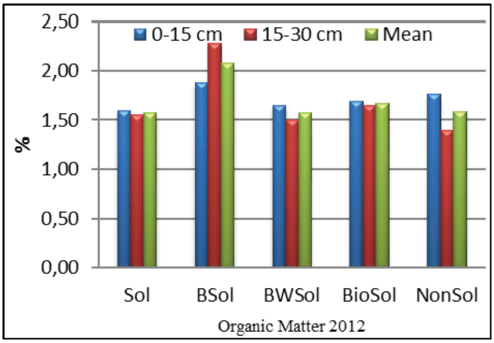

Figure 2. Organic matter values in 2012

Solarization prepares favorable environment for plants, changing the soil physical and chemical structure. In particular, plays an important role decomposition of organic matter in transforming such as plant nutrient elements N, Ca^{+}, Mg^{+}, K^{+} available plant nutrition form for the plants (Elmore et al., 1997).

CONCLUSIONS

Analyzed results obtained in this study, compared to control parcel, organic matter content in treatments decreased in both depth only except BSol treatment in 2012. Based on these results, it was concluded that soil organic matter with solarization application convert available nutrition form to plants with decomposition it.

ACKNOWLEDGEMENTS

This research work was carried out with the support of Suleyman Demirel University, Scientific Research Projects under project no: 2795-D-11

REFERENCES

Bainbridge D.A., 2010. Soil solarization for restorationists. Restoration and Management Notes, 8(2): 96-97.

Barbour E.K., Husseini S.A., Farran M.T., Itani D.A., Houalla R.H., Hamadeh S.K., 2002. Soil Solarization: A sustainable agriculture approach to reduce microorganisms in chicken manure-treated soil. J. of Sustainable Agriculture, 19(4): 95-104.

Bek Y., 1983. Research and Experimental Methods. Cukurova University. Agriculture Faculty Lecture, 92, Adana.

Elmore C.L., Stapleton J.J., Bell C.E., Devay J.E., 1997. Soil solarization-a nonpesticidal method for controlling diseases, nematodes, and weeds. University Of California, Division of Agriculture and Naturel Resources Puplication, 213771-16.

Katan J., DeVay J.E., 1991. Soil solarization. Boca Raton, 267, Florida.

Komariah K., Ito K., Onishi T., Senge M., 2011. Soil properties affected by combinations of soil solarization and organic amendment. Paddy Water Environ, 9, 357-366.

Ozores-Hampton M., McSorley R., Stansly P.A., Roe N.E., Challemi D.O., 2004. Long term large scale soil solarization as a low-input production system for Florida vegetables. Acta Horticulturae, 638,177-188.

Ramirez-Villapudua J., Munnecke D.M., 1987. Control of cabbage yellows (Fusarium oxysporum f. sp. conglutinans) by solar heating of field soils amended with dry cabbage residues. Plant Diseas, 71, 217-221.

Schlichting E., Blume E., 1966. Bodenkundliches Prakticum. Paul Parey Verlag, Hamburg, Berlin.

Seman-Varner R., McSorley R., Gallaher R.N. 2008. Soil nutrient and plant responses to solarization in an agroecosystem utilizing an organic nutrient source. Renewable Agriculture and Food Syst., 23, 149-154.

Sofi T.A., Tewari A.K., Razdan V.K., Koul V.K., 2014. Long term effect of soil solarization on soil properties and cauliflower vigor, Phytoparasitica, 42, 1-11.

Stapleton J.J., DeVay J.E., 1984. Thermal components of soil solarization as related to changes in soil and root microflora and increased plant growth response. Phytopathol, 74, 255-259.

Stapleton J.J., Quick J., DeVay J.E., 1985. Soil solarization: effect on soil properties, crop fertilization and plant growth. Soil Biology and Biochemistry, 17, 369-375.

Stapleton J.J., 1990. Thermal inactivation of crop pests and pathogens and other soil changes caused by solarization. Proceedings of the First International Conference on Soil Solarization, Feb 19-25, Amman, (Jordan), 108-117.