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Okur N., Tüzel Y., Cengel M.

in

Choukr-Allah R. (ed.).
Protected cultivation in the Mediterranean region

Paris : CIHEAM / IAV Hassan II
Cahiers Options Méditerranéennes; n. 31

1999
pages 407-411

EFFECTS OF SOIL SOLARIZATION ON THE MICROBIAL POPULATION AND ACTIVITY IN THE GREENHOUSE

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Abstract: This research was conducted to determine the effects of soil solarization on microbial biomass, dehydrogenase activity and anaerobe bacteria number. The soil that had been cultivated in summer was saturated with water and covered with a 40 micron thick transparent PE sheet for 6 weeks. Soil samples were taken from four different depths (0-1, 1-5, 5-10 and 10-15 cm) just before and after solarization. The effect of solarization on microbial biomass was not statistically significant and the activity decreased through the soil profile. There were significant differences with respect to the dehydrogenase activity and anaerobe bacteria number. Solarization decreased the enzyme activity and anaerobe bacteria number by 55% and 76%, respectively. The soil depth was examined with respect to the mentioned criteria. The highest values were obtained from the 3rd depth (5-10 cm) and the lowest from 0-1 cm.

INTRODUCTION

Among the soil disinfection methods, soil solarization is accepted to be the most recent and easy one. It causes some physical, chemical and biological changes that favor plant health and growth (Nemli, 1990).

Soil solarization is applied by covering the watersaturated soil with a transparent PE sheet for 4 or 6 weeks in order to heat the soil by using solar energy (Katan, 1981). It provides the control of pathogenic fungi, some bacteria, nematodes, insects, mites and weeds by killing or reducing their efficiency and longevity (Gauer and Perry, 1991) and thus enhances the yield (Hartz and Bogle, 1989; Eltez and Tüzel, 1994). Other soil microorganisms are also influenced from solarization in different ways. Ristaino et al. (1991), the dept of have determined that heat-resistant fungi increased at the depth of 10 cm, whereas, fluorescent pseudomonad population decreased. Solarization also causes a drastical reduction in total fungus population in rhizospher and plant roots (Gamliel and Katan, 1991).

MATERIAL AND METHODS

This investigation was conducted in the experimental greenhouse and laboratories of Ege University Departments of Horticulture and Soil Science in 1991.

Soil solarization was carried out in a glasshouse, which had four equal compartments (42 m²) lying in south-north direction. The soil that was cultivated in summer was saturated with water and then covered with a 40 micron thick transparent sheet for 6 weeks from July 31 to September 11, 1995. Soil samples were taken from four different depths (0-1, 1-5,5 -10 and 10-15 cm) just before (July 30) and after (Sept. 12) solarization kept at 4°C and then passed through a 2 cm mesh sieve for microbiological analysis. Soil samples were subsampled after being air dried for physical and chemical analysis.

Soil structure (Bauyoucos, 1955), total soluble salt (Soil Survey Staff, 1951), calcium carbonate (Çaðlar, 1949), pH (Jackson, 1958) and organic matter (Rauterberg and Kremkus, 1951; Slack, 1965) were determined. The results are given table 1.

Table 1. Some physical and chemical properties of the soil samples.

	Soil Samples			
Analysis	1	2	3	Average
Sand (%)	59.68	58.60	55.00	57.76
Silt (%)	16.32	17.72	16.00	16.68
Clay (%)	24.00	23.68	29.00	25.56
pH (at 25°C)	6.84	6.90	6.95	6.90
$CaCO_3$ (%)	4.13	3.85	3.32	3.77
Salt (%)	0.11	0.12	0.11	0.11
Org. mat. (%)	5.40	5.10	5.30	5.27
Texture	Sandy loam			

In order to determine the general microbial activity in the soil, microbial biomass and dehydrogenase activity were measured according to Anderson and Domsch (1978) and Thalmann (1968), respectively. Anaerobic bacteria (*Clostridium*) were also counted on brewer-agar (Merck, 1968).

The experimental design was "randomized parcels" with 3 replicates and results are evaluated by Genstat 5.1 programme.

RESULTS AND DISCUSSION

Microbial biomass

The effect of solarization on microbial biomass was not statistically significant (Table 2).

Table 2. Microbial biomass (mg biomass-C/100 g dry soil)

	Depth of soil (cm)				
Treatment	0-1	1-5	5-10	10-15	Ave.
Before solarization	115.4	95.2	106.0	92.2	102.2
After solarization	145.7	89.4	90.6	81.8	101.9
$LSD_{0.05}$	130.6a	92.3b	98.3b	87.0b	

Microbial biomass is the characteristic of microorganisms which participate in the biochemical cycles and are the alive part of the soil organic matter (Çengel, 1990; Srivastava, 1992). It is not effected negatively by solarization.

Microbial biomass includes bacteria, fungi, actinomycetes and algae (Çengel, 1990). Tezcan et al. (1988) have claimed that thermophillic fungi and actinomycetes are more resistant to solarization than the other fungi and actinomycetes, therefore their population increases in solarized soil.

Although sensitive organisms have died, the increases in resistant ones contribute to the microbial biomass and the same level is provided in solarized soils. However, high organic matter level of the soil may decrease the 2negative effect of solarization, because, there is a close relationship between organic matter and biomass and activity of soil microflora (Kaiser et al., 1992).

When the solarization effect is not taken into consideration, microbial biomass is shown to be significantly different at examined soil depths. The highest value was obtained from the first depth (0-1 cm) and the activity decreased through the soil profile similar to the reductions of biomass-c parallel to the depth are shown by previous researches (Campbell and Biederbeck, 1976; Mc Gill et al., 1986; Gestel et al., 1992).

Dehydrogenase activity

Solarization is found to exert significant effects on dehydrogenase activity (Table 3). The enzyme activity decreased by 55 % in solarized soils. The reductions were in the order of 69 % at 0-1 cm, 55 % at 1-5 and 5-10 cm and 44 % at 10-15 cm depths.

Table 3. Dehydrogenase activity (µg TPF/g dry soil)

	Depth of soil (cm)				
Treatment	0-1	1-5	5-10	10-15	Ave
Before solarization	498	613	772	600	620a
After solarization	153	274	348	338	278b
$LSD_{0.05}$	326c	443b	560c	469b	

Optimum temperature and pH values are particularly important in the activation of reactions by enzymes, the biological catalyzers. Since enzymes are proteins in nature, they loss their activity at the temperatures their proteins are denaturated. However, Akbaba (1994) and Özçelik (1996) claim that enzymes are inactive above 50°C. During the solarization, increasing soil temperatures, particularly at the top level and the resulting hydro thermal effect (Tezcan et al., 1988) causes a reduction in the dehydrogenase activity.

The depth of soil was also effective on enzyme activity significantly. The highest and the lowest enzyme activities were obtained at 5-10 cm and 0-1 cm, respectively. Lower enzym activity at the top soil layer is probably due to the lower humidity levels in soil humidity.

Anaerobe bacteria number

Anaerobe bacteria number varied significantly depending upon the solarization (Table 4) and decreased by 76 % after the solarization. The reduction at investigated soil depths were 74 %, 73 %, 80 % and 70 % respectively.

Table 4. Anaerobe bacteria number (number/g dry soil).

	Depth of soil (cm)				
Treatment	0-1	1-5	5-10	10-15	Ave.
Before solarization	6038	20085	30802	13274	17549a
After solarization	1568	5395	6036	4034	4258b
$LSD_{0.05}$	3803c	12740ab	18419a	8654bc	

It was expected to have an increment in the number of anaerobe bacteria because of the limited ventilation during solarization, however, significant reductions that appeared show that high temperatures are effective on these organisms negatively.

Gamliel and Katan (1991) determined that bacteria and fungi population decreased significantly after solarization. The reductions resulted from the mesophilic characteristics of these microorganisms.

The effects of soil depth were examined with respect to anaerobe bacteria, and the highest values were obtained from the 3 rd (5-10 cm) and the lowest from 0-1 cm depth. Owing to the fact that, higher soil layers possess more oxygen, anaerobe bacteria number was found less because of the lethal and/or promoting effect of the oxygen.

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