Pak. j. sci. ind. res., vol. 32, no. 6, June 1989

EFFECT OF SOIL SOLARIZATION ON THE REDUCTION IN VIABILITY OF SCLEROTIA OF *MACROPHOMINA PHASEOLINA* AT DIFFERENT FIELD LOCATIONS

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(Received on February 22, 1989; revised on June 13, 1989)

The effect of soil solarization on the viability of sclerotia of *Macrophomina phaseolina* was tested at 3 different field locations viz., Karachi, Sakrand and Lahore during the hot summer month of June, 1984. A 7-day mulching of soil artificially infested with *M. phaseolina* reduced sclerotial viability by 98-100 % and considerably reduced Macrophomina infection on sunflower used as a test plant. Loss in viability was related to the rise in soil temperature. The maximum temperature attained in wet soil after mulching was 54° compared with 42° in non mulched treatments. An increase in organic matter, pH, potassium, phosphorus and a decrease in nitrogen occurred in solarized as compared with non-solarized soil.

Key words: Soil solarization, Polyethylene mulching, *M. phaseolina.*

INTRODUCTION

Macrophomina phaseolina (Tassi) Goid, the fungus causing seedling blight, root rot, stem rot, pod rot and charcoal rot of more than 500 plant species [16] is widely distributed in tropical and sub tropical countries of the world. The fungus survives in soil or on infected host tissues in the form of small black sclerotia measuring 60-100 x 56-80 μm [6,7] which are liberated in soil upon tissue decomposition [5,10]. Considerable reduction in numbers of sclerotia was obtained at high soil moisture of 75-100 % MHC [13] but complete eradication of inoculum was not obtained. A polyethylene mulching technique, as developed by Katan *et al.* [9], has recently been used in Pakistan to reduce the viability of sclerotia of *Sclerotium oryzae* [18] and *Macrophomina phaseolina* [14]. This technique was tested at different field locations with different soil textures. Preliminary results have been published [20].

MATERIALS AND METHODS

Field experiments were carried out at 3 different field locations with different soil textures *viz.*, Karachi (sandy loam), Sakrand (sandy loam) and Lahore (clay loam) during the hot summer season of 1984. Two month old sclerotia of *M. phaseolina* isolated from a root rot specimen of cotton and subsequently grown on corn-meal sand medium at 30° were passed through a 150 μm sieve and mixed with soil. Nylon bags containing 500 g soil, artificially infested with 37-42 sclerotia 1 g soil were buried in the field at 0-5 cm and 15-20 cm depths and covered with transparent plastic sheets. The soil was brought to field capacity before mulching. The mulching treatment was carried out in plots measuring 5 x 3 m. Non-mulched plots were kept as control. There were three replicates of each treatment and the plots were randomized. Soil temperature was measured by inserting thermometers at 5 and 20 cm depths. Readings were recorded every 2 hr from 800 to 1600 hrs at the Karachi university experimental plots.

After one week the polyethylene sheets were removed and nylon bags containing sclerotia recovered. The population of sclerotia in artificially infested soil both in mulched and non-mulched treatments was determined at 0-time and after 1-week of the mulching treatment using a wet sieving and dilution technique [12]. Soil passed through 100 mesh sieve and sclerotia collected on 300 mesh screen was suspended in 0.5 % $Ca(OCl)_2$ and 1 ml aliquot evenly spread onto the surface of 3-day old Potato Dextrose Agar, pH 5.4, supplemented with penicillin and streptomycin each @ 100 ppm/liter, demosan 300 mg/liter and rose bengal 100 mg/liter. The plates were incubated at 30° and number of *M. phaseolina* colonies counted after 5-day. Soil samples were also transferred into 12 cm diam., plastic pots, 200 g in each, and 10 seeds of sunflower planted in each. There were three replicates of each treatment and the pots were randomized on a green house bench (30 ± 5°. *Macrophomina* infection was recorded on 20 day old sunflower seedlings.

Air dried soil was sieved (4 mm) before chemical analysis. The pH of the soil was determined electrometrically in a mixture of soil and distilled water (1 part soil : 5 part water, w/v). Available phosphorus was extracted with $NaHCO_3$ and measured by the molybdenum blue me-

thod [19]. The organic matter content was determined by loss on ignition. Potassium was measured by atomic absorption spectophotometry. Total nitrogen was calculated by Kjeldahl's method.

RESULTS AND DISCUSSION

A 7 day mulching of soil artificially infested with sclerotia of *M. phaseolina* reduced the population in soil upto 5 cm depth by 98–100 % at all the field locations and gave 100 % reduction in *Macrophomina* infection on sunflower used as a test plant (Fig. 1). It is interesting to note

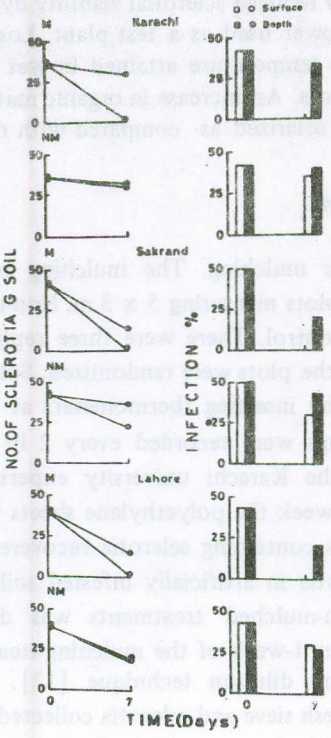

Fig. 1. The effect of soil solarization on sclerotial populations of *Macrophomina phaseolina* and on infection of sunflower at different field locations.

M = Mulched NM = Non-mulched * = Sandy loam.
** = Sandy loam *** = Clay loam
□–□, == – == = Surface (0–5 cm)
■ – – ■, ■ – – ■ = Depth (15 – 20 cm)

that in non-mulched plots also upto 54 % reduction in viability of sclerotia was noticed presumbly due to the high temperature prevailing under wet soil conditions. Sclerotia at 15–20 cm depth which showed 24–64 % loss in viability after 7 days mulching treatment showed 100 % loss in viability when brought back to the surface and remulched for a further 7 days (Fig. 2). Covering the field plots with transparent polyethylene sheets was found to increase the soil temperature. The maximum daily soil temperature recorded after mulching in wet soil at 0–5 cm depth was 54° in Sakrand, 50° in Lahore and 49° in Karachi (Fig. 3). Such high temperatures usually lasted from 1400–1600 hr and were higher than the thermal death point of *M. phaseolina* [3]. The temperature in tarped soil reached levels reported as being lethal to many soilborne fungi [1] *Rhizoctonia solani* is injured by temperatures of 45° or 5 min. exposure at 50° [15], moist microsclerotia of *Verticillium dahliae* by 40 min. at 47° [11], chlamydospore of *Thielaviopsis basicola* by 115 hrs at 40° [2,8] and 1.5 hr at 50° was required to kill scleroitia of *M. phaseolina* [3]. It is possible that lethal/sublethal temperatures may reduce the infectivity of sclerotia

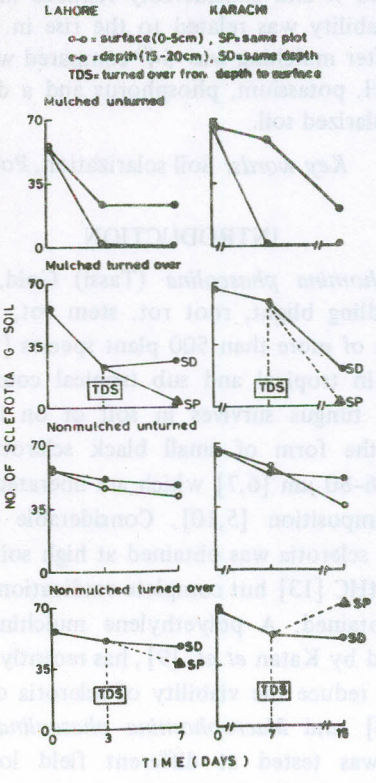

Fig. 2. The effect of turning over of soil and soil solarization on the reduction in viability of sclerotia of *Macrophomina phaseolina* at Karachi and Lahore.

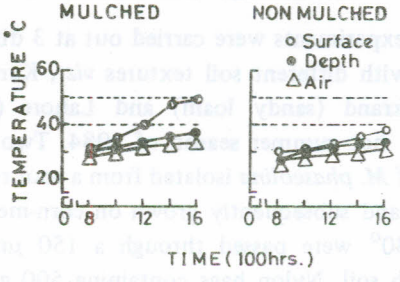

Fig. 3. The effect of soil solarization with transparent plastic sheets on soil temperature. Data are average temperature recorded for one week in June, 1984 at Karachi University experimental plots.

Table 1. Chemical analysis of soil following soil solarization at different field locations (Data are for the year 1984).

	Organic matter %		pH		Nitrogen ppm		Potassium ppm		Phosphorus ppm	
Locations	M	NM	M	NM	M	NM	M	NM	M	NM
Karachi	0.90	0.76	8.18	8.08	1450.50	1472.7	86.37	68.42	86.51	95.98
Lahore	0.46	0.44	8.94	8.75	1059.07	1105.0	15.64	15.64	20.25	18.28
Sakrand	0.57	0.43	8.39	8.27	736.8	742	24.44	26.39	16.60	15.13

M = Mulched, NM = Non-mulched.

by changing the population of the surrounding soil micro-organisms or may weaken sclerotia rendering them more vulnerable to antagonistic microorganisms. These results are in need of investigation.

Solar heating may affect the chemistry of the soil. Chen and Katan [4] in Israel found increased amounts of soluble minerals and organic materials in solarized soil. Stapleton and DeVay [17] reported that in Hickman (California) solarized soil contained lower concentrations of available P, K and nitrate nitrogen than untreated ones and at Davis (California) solarized soil contained higher levels of P, K and nitrate nitrogen as compared to those of the non-solarized plots. Soil used in the present study, showed an increase of organic matter and pH in solarized soil as compared to non-solarized soil. The proportion of of potassium and phosphorus increased in solarized soil at Karachi and Lahore respectively, whereas decrease in nitrogen content were observed at all field locations (Table 1). Differences between the results obtained in Israel, California and Pakistan may be due to difference in soil depths used, soil type, previous fertilization or cropping history.

Detrimental effects of high temperature caused by polyethylene mulching can be applied in the field to eliminate root rot disease caused by *M. phaseolina.* The inoculum which survives at 15-20 cm depth can be brought back to the surface by mechanical ploughing and then eliminated by mulching. The judicious application of this procedure could be expected to give beneficial results.

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