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EFFECT OF SOIL SOLARIZATION ON MANGO DECLINE PATHOGEN, LASIODIPLODIA THEOBROMAE

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Abstract

Polyethylene mulching significantly enhanced the soil temperatures in mulched soils. Soil temperatures were negatively correlated with soil depths therefore affect of mulching was more profound in upper soil layer. Soil mulching with polyethylene sheet for 2 weeks in hot summer was highly effective in reducing soil population densities of *Lasiodipodia theobromae.* Significantly less recovery of the fungus was recorded from straw pieces that were mulched at the depth of 5 cm for 2 weeks. Similarly, the polyethylene mulching for 15 days at the depth of 5 cm proved highly effective in reducing the conidial viability of *L. theobromae.* Reduction in *L. theobromae* inoculum was positively correlated with the duration of mulching and negatively correlated with soil depth.

Introduction

Since the late nineties, most of the mango orchards in mango-growing areas in Sindh province of Pakistan were found to suffer from a decline disease that kills the plants. Since then, mango decline or dieback disease has become one of the most severe problems in mango orchards. In most cases, the disease has been characterized by exudation of gum, wilting, dieback, vascular browning and death of the whole tree (Panhwar *et al*., 2007; Khanzada *et* al., 2004a, b; Mahmood *et al.*, 2002). Results of our previous studies have shown that *Lasiodipodia theobromae* is the causative agent of this disease in Sindh (Khanzada *et al*., 2004a, b).

Perennial crops like mango are the most common hosts of devastating plant pathogens and pose serious disease management challenges. Perennial plants require long-term measures instead of protecting for a few weeks or months as in case of annual crop plants. Since perennials are long-lived and there are no seasonal breaks, they are more subjected to inoculum build up and epidemic disease development. Consequently, it results in establishment of high level of inoculum density and pressure in perennial crops. It resulted in persistent pathogen infection due to the presence of large quantity of secondary inoculum within the given monoculture crop in a particular ecological area with more or less constant climatic conditions. In present case, the casual fungus *L. theobromae* is also a common soil-borne saprophyte and wound parasite, distributed throughout the tropics and subtropics (Domsch *et al.,* 1980). This fungus has a wide host range. It attacks more than 280 species of plants in different parts of the world (Domsch *et al.,* 1980; Sutton, 1980). In Pakistan, the fungus has been reported on more than 50 plant species (Ahmed *et al.,* 1997).

Soil solarization has proved as an effective and environmentally safe alternate to chemicals that is applicable to various agricultural situations for the control of various soil-borne pests, including phytopathogens and weeds (DeVay *et al*., 1990; Stapleton *et al*., 1987). Experiments were carried out to study the effect of soil solarization by polyethylene mulching on *L. theobromae.*

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Materials and Methods

Production of inoculum: Wheat straw was cut into 2-3cm long pieces and soaked in water for 2 hrs. The straw was pressed between hands to remove excess moisture, transferred into 250ml conical flasks and sterilized for 20min at 15psi. A 5mm diam., inoculum disc from an actively growing culture of *L. theobromae* on potato sucrose agar (PSA) was transferred into each flask. The flask was incubated at room temperature for one month for production and maturation of fruiting bodies. The straw was then stored in a refrigerator for future use.

Polyethylene mulching: Soil samples artificially infested with 5 g of pathogen inoculum multiplied on straw per 200 g soil were distributed in 15x15cm nylon net (100 mesh), tied with nylon strings into small bags and buried in soil at 5 cm and 10 cm depths. Moisture of the soil was brought to field capacity and transparent polyethylene sheets were spread over the soil. Margins of the sheets were buried in soil to prevent loss of moisture. A comparable set of non-mulched plots was kept as control. Plastic pipes (12 mm diam.) were inserted into soil to 5 and 10 cm depth in both the mulched and non mulched soil to place the thermometer. Soil temperature was recorded from 10 a.m. to 4 p.m. at 2 hours intervals. Soil samples were collected after 7 and 15 days intervals. After recovering samples at 7 days interval, the soil was again irrigated to field capacity before covering with polyethylene sheets. There were three replicates for each treatment. The experiment was carried out in completely randomized block design in May 2004 and repeated in My 2005. The data were pooled together and subjected to ANOVA followed by DMRT.

Effect of mulching on pathogen viability: At 7 and 15-days intervals the polyethylene sheets were removed and three bags of each treatment containing pathogen inoculum were recovered from 5 and 10 cm depths. Viability of the inoculum was assessed on PSA amended with penicillin (@ 100,000 units L^{-1}) and streptomycin (@ 0.2g L^{-1}). The straw pieces were surface sterilized with 1% Sodium hypochlorite solution for 2-3 minutes and 5 pieces were plated in each Petri plate. The plates were incubated at room temperature for 5-7 days and data on recovery percentage were recorded.

Results and Discussion

Effect of mulching on temperature: Mulching showed a significant increase in soil temperature as compared to non-mulched soil. The soil temperatures greatly varied in non-mulched and mulched treatments during the daytime. Maximum temperature was recorded at 2 o'clock. At both 5 and 10 cm depths, polyethylene mulching produced significantly higher temperatures than non-mulched soils at the same depth. At 5 cm depth, mulching brought an increment of 16ºC in soil temperature as it increased to 52ºC as compared to 36ºC in non-mulched soils at 2 o'clock. At 10 cm depth maximum temperature of 44°C was also recorded at 2 o'clock in mulched soil, whereas, in non-mulched soil temperature was 38ºC (Fig. 1). In mulched soil, increase in soil temperatures were negatively correlated with soil depths, as higher soil temperatures was recorded at 5 cm depth (48-52ºC) whereas lower soil temperatures were recorded at 10 cm depth (41-44ºC) (Fig. 1).

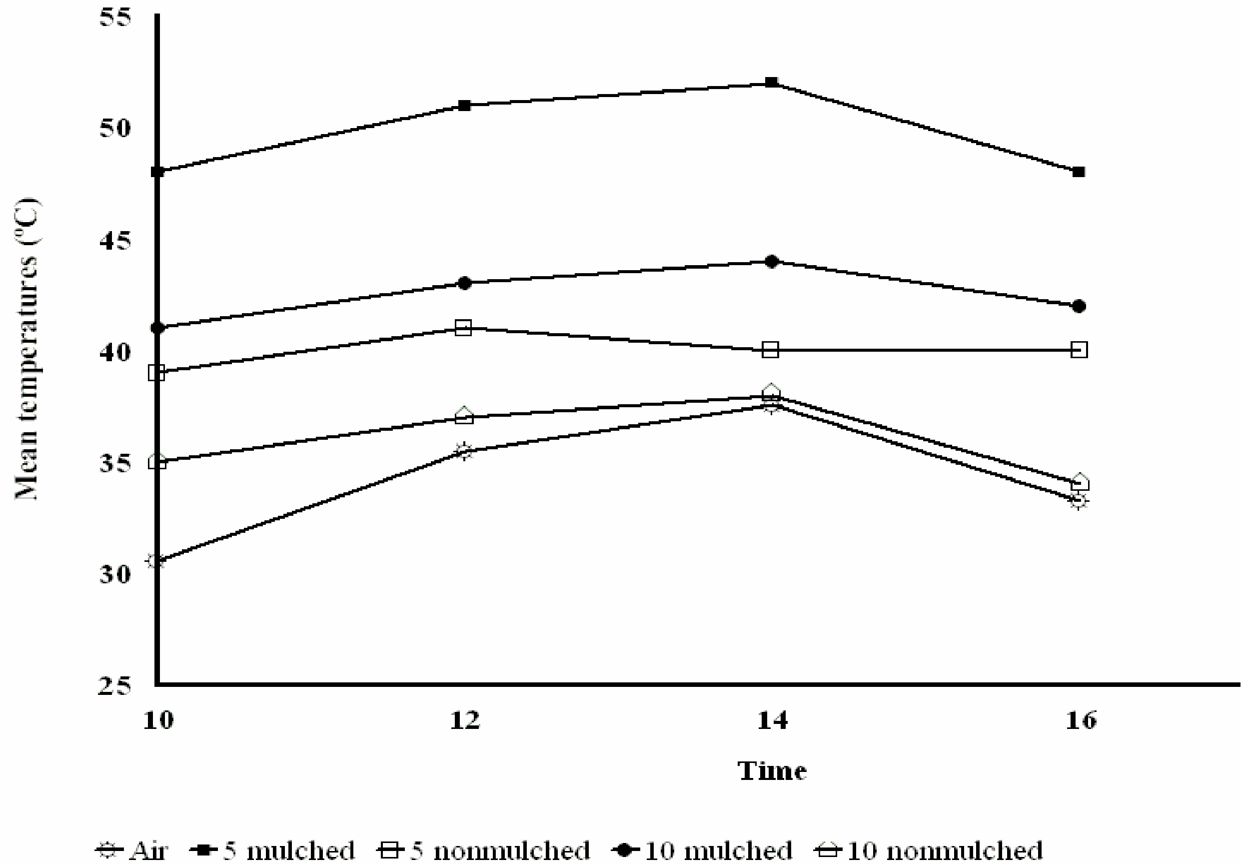

Fig. 1. Average daily day temperatures at different depths in mulched and non-mulched soils. [LSD ($p<0.05$) = 1.5721]

Effect of Polyethylene mulching on pathogen: Soil mulching with polyethylene sheet for 2 weeks in hot summer was highly effective in reducing soil population densities of *L. theobromae*. Significantly less recovery of the fungus was recorded from straw pieces that were mulched at the depth of 5 cm for 2 weeks (Fig. 2). Reduction in pathogen inoculum was positively correlated with the time for which pathogen remained in soil but was negatively correlated with soil depth (Fig. 2). The mulching for 7 days at the depth of 5 cm resulted in 70% reduction in pathogen inoculum as compared to 59% in non-mulched soil at the same depth. Similarly, mulching for 7 days at the depth of 10 cm reduced the fungal colonization by 47% as compared to 23% reduction in non-mulched (Fig. 2). At all soil depths, more reductions were observed when mulching time increased from 7 to 15 days. After 15 days of mulching the fungus was recovered from 8 and 23% pieces buried at 5 cm depth in mulched and non-mulched soils, respectively, and 18 and 49% from 10 cm depth mulched and non-mulched soils, respectively (Fig. 2).

Effect of Polyethylene mulching on conidial viability: Polyethylene mulching for 15 days at the depth of 5 cm proved highly effective in reducing the conidial viability of *L. theobromae* (Fig. 3). After 7 days, conidial viability in mulched soil was 52 and 66% at 5 and 10 cm depths and reduced to 20 and 48%, respectively, after 15 days. In non-mulched soil, conidial viability after 7 days was 86 and 85% at 5 and 10 cm depths and 72 and 78% respectively at 5 and 10 cm depths after 15 days (Fig. 3).

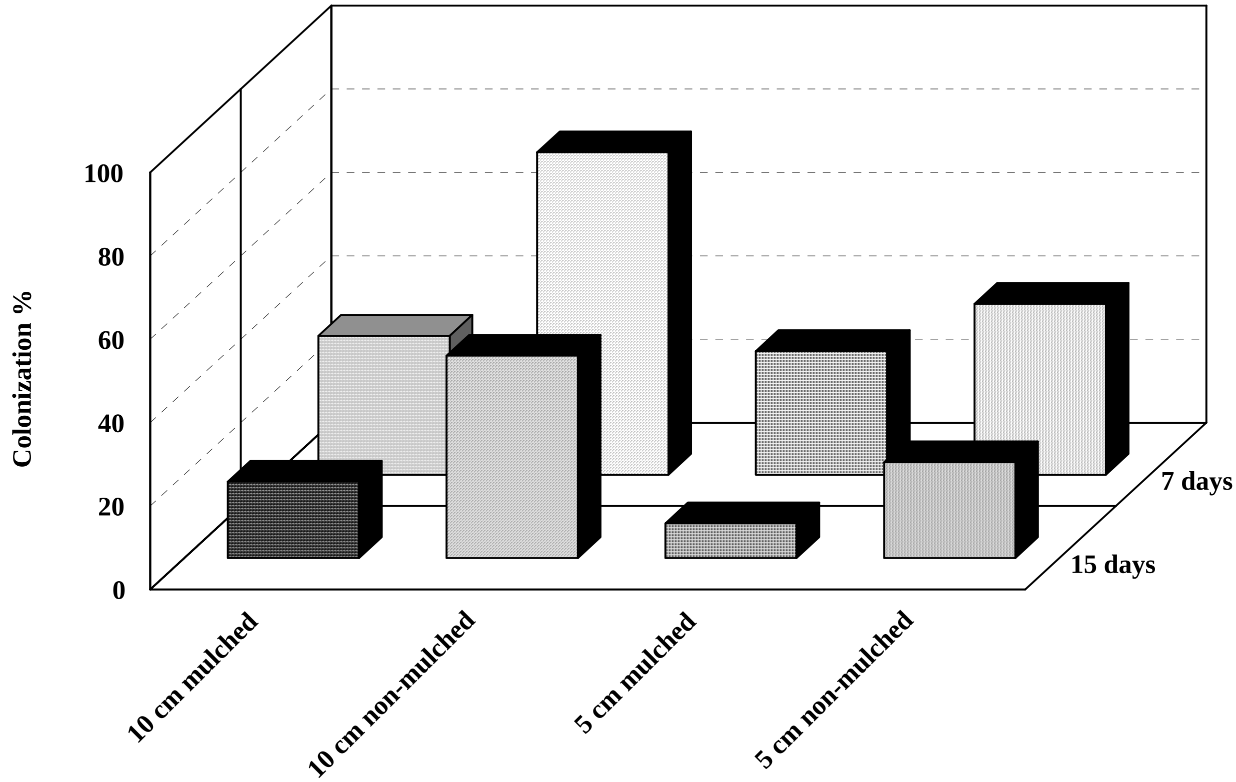

Fig. 2. Effect of plastic mulching on *L. theobromae* inoculum.
[LSD (p<0.05) = 1.5698]

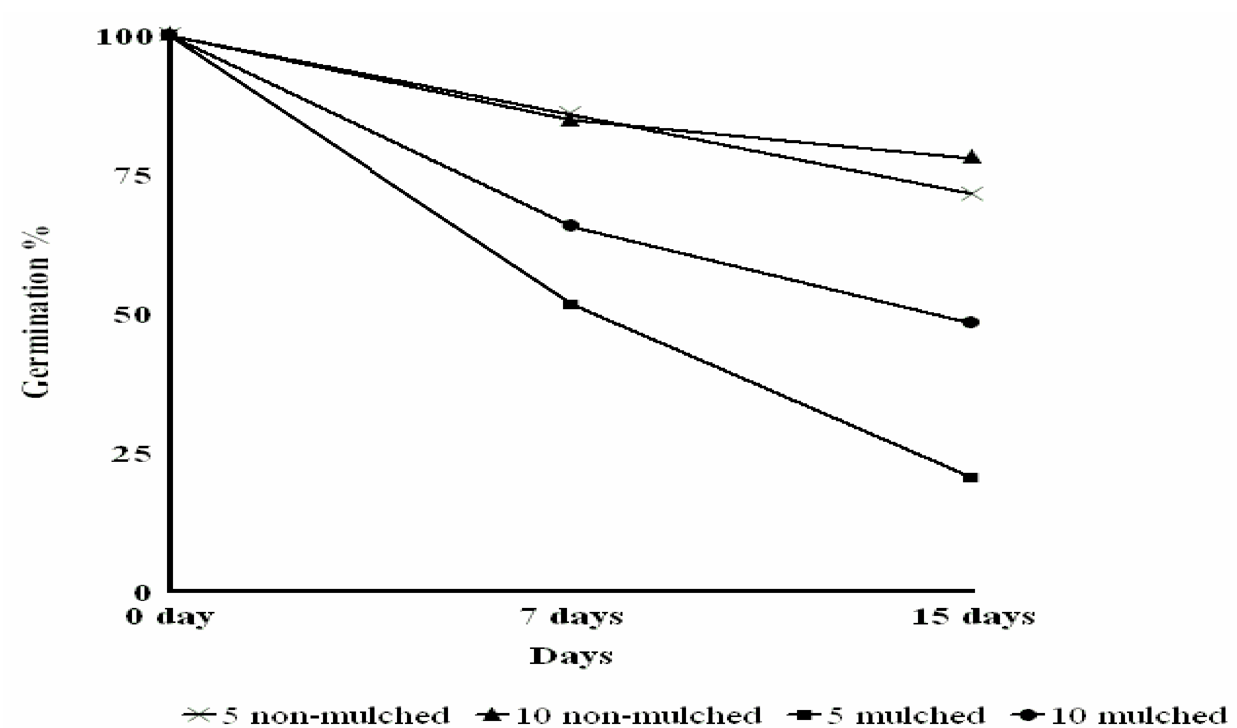

Fig. 3. Effect of plastic mulching on viability of *L. theobromae* conidia.
[LSD (p<0.05) = 1.0094]

Soil solarization has proved to be an effective method to control soil inhabiting pathogens. *L. theobromae* is a soil borne plant pathogen that causes disease in wide range of plant species throughout the world. During the present studies, polyethylene mulching significantly enhanced the soil temperatures in mulched soils. Soil temperatures was negatively correlated with soil depths therefore effect of mulching was more profound in upper soil layer since higher temperatures in mulched soils were recorded at 5 cm depth as compared to 10 cm depth. Singh *et al.*, (1990) also recorded maximum temperature of 53ºC in a mulched plot at 1 cm depth. Similar results have also been recorded by Shahzad & Ghaffar (1991), Usmani & Ghaffar (1982) and Sheikh & Ghaffar (1984) who evaluated the effect of mulching on *Rhizoctonia solani*, *Sclerotium oryzae* and *Macrophomina phaseolina*, respectively.

During the present investigation reduction in *L. theobromae* inoculum was positively correlated with the duration of mulching and negatively correlated with soil depth. Maximum pathogen mortality occurred at 5cm depth after 15 days mulching. There are many reports where soil inhabiting plant pathogens such as *Sclerotium rolfsii* (Elad *et al.*, 1980; Stevens *et al.*, 2003), *Fusarium solani* and *Pythium aphanidermatum* (Triki *et al.*, 2001), *Rhizoctonia solani*, *Thielaviopsis basicola* and *Pythium* spp., (Pullman *et al.*, 1981), *Verticillium dahliae* (Katan *et al.*, 1976; Pullman *et al.*, 1981), *Sclerotium cepivorum* and *Sclerotinia minor* (Porter & Merriman, 1983), *Fusarium oxysporum* f.sp. *lycopersici* (Katan *et al.*, 1976), *Phytophthora cinnamomi* (Pinkas *et al.*, 1984), *Macrophomina phaseolina* (Sheikh & Ghaffar, 1984) and *S. oryzae* (Usmani & Ghaffar, 1982) can be effectively controlled by soil mulching.

In the light of present investigation, it would be suggested that soil solarization by polyethylene mulching should be practiced in mango orchards in order to minimized the primary inoculums of soil-borne casual pathogen (*L. theobromae*) especially in the nursery beds and pits in orchards before transplanting.

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