Soil Solarization: A Nonpesticidal Method for Controlling Weeds, Diseases and Nematodes

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ABSTRACT

Soil solarization is an organic approach for managing soil-borne pests using high temperature produced by absorbing radiant energy from the sun. The method involves soil heating by covering it with a clear plastic film (2-4 mil, Note: 1 mil = 0.025mm) for 4 to 6 weeks during summer months of the year when the soil receives the highest amount of direct sunlight. It is an effective tool for managing the population of soil-borne pathogens, weed flora, eggs and larvae of harmful insects. Being non-chemical in nature, it can be a useful eco-friendly option for pest management in organic food production. Increased plant growth and yield of annual and perennial field crops, vegetables and fruit crops usually occur by adopting this technique

INTRODUCTION

Soil-borne pests can be controlled in vegetable and fruit crops by pre-plant application of pesticides, including the fumigants methyl bromide, chloropicrin, and metam sodium. The use of these materials, however, is often undesirable due to their toxicity to animals and people, and their high cost involvement. Furthermore, restrictions on the use of soil-applied pesticides seem imminent as existing environmental legislation is implemented. As a result, there has been an increased emphasis on reduced-pesticide or non pesticidal control methods. Soil solarization is a nonpesticidal method of controlling soil-borne pests by placing plastic sheets (2-4 mil) on moist soil during periods of high ambient temperature. The plastic sheets allow the sun's radiant energy to be trapped in the soil, heating the upper levels. Solarization during the hot summer months can increase soil temperature to levels that kill many disease-causing organisms (pathogens), nematodes, and weed seed and seedlings. It leaves no toxic residues and can be easily used on a small or large scale.

How to solarize soil?

1. Soil Preparation

Solarization is most effective when the plastic sheeting (tarp) is laid as close as possible to a smooth soil surface. Preparation of the soil begins by disking, or turning the soil by hand to break up clods and then smoothing the soil surface. Remove any large rocks, weeds, or any other objects or debris that will raise or puncture the plastic.

2. Irrigate the Soil

The success of soil solarization depends on moisture for maximum heat transfer; maximization of heat in soil increases with increasing soil moisture. Wet soil conducts heat better than dry soil and makes soil organisms more vulnerable to being killed by heat and antagonistic microorganisms. Wet the soil to at least 12 inches deep. In larger areas it is easiest to do this prior to laying the plastic, but in smaller areas it can also be done after the plastic is applied by placing a garden or soaker hose, or drip tape under the plastic tarp. Otherwise, place the covers over the site as soon as possible after the water has been applied to reduce evaporation. Unless the soil gets dry during the course of soil solarization, do not irrigate again as this will lower the soil temperature and lengthen the time required for successful solarization.

3. **Laying the Plastic**

Plastic sheets may be laid by hand or machine. Plastic is laid either in complete coverage where the entire field or area to be planted is treated, or strip coverage where only beds or selected portions of the field are treated. Complete coverage is recommended if the soil is heavily infested with pathogens, nematodes, or perennial weeds, since there is less chance of reinfestation by soil being moved to the plants through cultivation or furrow-applied irrigation water. The interaction between temperature and soil moisture brings about cycling of water in soil during soil solarization.

4. **Treatment duration**

Solarization is both time and temperature dependent. The longer the soil is heated, the better and deeper the control of all soil pests and weeds will be. Thus, long, hot sunny days work best to kill soil-borne pathogens and weed seed. The plastic sheets should be left in place for 4 to 6 weeks to allow the soil to heat to the greatest depth possible. To control the most resistant species, leave the plastic in place for 6 weeks.

5. **Removal of the plastic and planting**

After solarization is complete, the plastic may be removed before planting. Or, the plastic may be left on the soil as mulch for the following crop by transplanting plants through the plastic. A disadvantage of leaving the plastic on the soil is that it may degrade and be difficult to clean up in the spring.

Beneficial effects of soil solarization

Effect on weeds

Soil solarization at (37°C) for 2-4 weeks almost completely prevents the emergence of many annual weeds, especially at the top layer because temperature increases more slowly at deeper depths. Soil solarization effectively controls Orobanche spp. and many other weeds, but not Cuscuta species, bindweed, or purple nutsedge due to theirdeeply buried underground vegetative structures such as roots and rhizomes. Efficacy of soil solarization for weed control in the field is increased by providing irrigation at least 2-3 week prior to solarization, letting the weeds grow, and incorporating them in soil before establishing the solarization treatment.

Effect on soil borne pathogens

Efficacy of soil solarization for control of soil-borne pathogens and pests is a function of time and temperature relationships 2-4 weeks of exposure at 37°C may be required to kill 90% of populations for most of mesophylic fungi - an organism that grows best in moderate temperatures. During soil solarization, temperatures commonly reach up to 35-60°C depending on soil type, season, location, soil depth and other factors. These high temperatures induce changes in soil volatile compounds that are toxic to organisms already weakened by high temperature. Soil solarization is effective against fungal pathogens such as Verticillium spp.

(wilt), *Fusarium spp*. (several diseases), *Phytophthora spp*. (Phytophthora root rot) and bacterial pathogens such as *Streptomyces scabies* (potato scab) and *Agrobacterium tumefaciens* (crown gall). It also reduces the populations of different plant parasitic nematodes in soil, especially *Meloidogyne spp.* (root-knot) and *Pratylenchus spp.* (root lesion) nematodes which are the most important ones for crop growers.

Effect on plant nutrients

The increased availability of plant nutrients and the relative increase in rhizosphere populations of favorable bacteria, such as *Bacillus spp.* (which contribute to the marked increase in the growth, development and yield of plants grown in solarized soil) are other major components of soil solarization benefits. It speeds up the breakdown of organic material in the soil resulting in the release of soluble nutrients such as nitrogen (NO_3, NH_4^+), (Ca^{2+}), magnesium (Mg^{2+}), potassium (K^+) and fulvic acid making them more available to plants. Improvements in soil tilth through soil aggregation are also observed.

CONCLUSION

Soil solarization is trouble-free, safe, cost- efficient and ecofriendly technology toward sustainable development of farming community of India. It appears to be adaptable to a wide range of agricultural applications, alone and in combination with agricultural chemicals and biological control agents. As population and temperature is increasing parallel at global level and this high temperature can be utilized by using the concept of soil solarization to feed the people high quality produce by mitigating the harmful effect of climate change as well as harmful pesticides.

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