Seminar paper:

Pre-Planting Weed Control Using Soil Solarization

Keynote Speaker
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Abstract

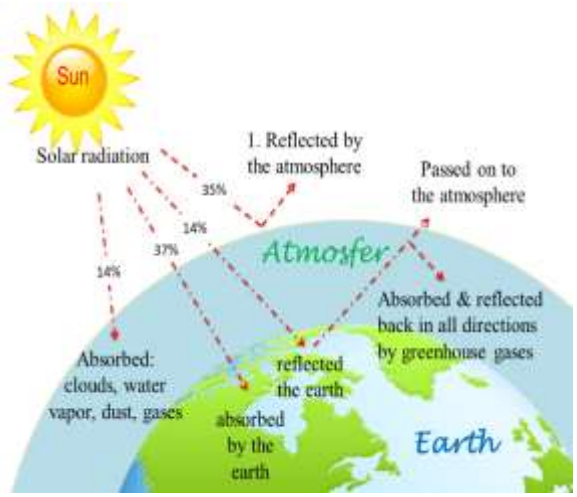
Weed control currently relies more on the use of herbicides. Many types of herbicide products have been produced to meet the needs of agriculture, especially in vegetable cultivation. The excessive use of herbicides is very harmful to humans and damages the environment in both the short and long term. However, these negative impacts can be overcome by using soil solarization technology. This technology can be applied by exploiting the potential of solar radiation. Pre-planting soil solarization is a hydrothermal process that utilizes solar energy to heat soil moisture with the help of transparent plastic sheets. Weed propagules in the topsoil will experience death due to high soil temperatures. The purpose of this study was to determine the role of soil solarization on the mortality of weed propagules on the soil surface. The results of the review show that soil solarization can be used as a more environmentally friendly substitute for weed control. The color of the transparent plastic sheet can produce a higher soil temperature than red and black plastic. High soil temperatures can kill weed propagules in the soil. There are several types of weeds that are tolerant of high soil temperatures. It is hoped that in the future the use of herbicides in vegetable cultivation can be reduced and replaced by pre-planting soil solarization.

Keywords: soil solarization, weed propagule, soil temperature, solar radiation

Introduction

Weed control currently relies more on the use of herbicides. Many types of herbicide products have been produced to kill weeds in paddy fields, moor, or gardens, especially in vegetable cultivation. The excessive use of herbicides is very harmful to humans and damages the environment in both the short and long term. However, these negative impacts can be overcome by using soil solarization technology. This technology can be applied by exploiting the potential of solar radiation which is very abundant in this world.

1. Solar Radiation



Gambar 1. Pancaran radiasi matahari pada permukaan tanah dan atmosfer bumi

The following is the radiation from the sun to the earth (Figure 1). The sun is a source of energy for living things on earth. The sun supplies energy to the earth in the form of radiation. About 35% of solar radiation does not reach the earth's surface. Most of the short-wave radiation (alpha, beta, and ultraviolet rays) is absorbed by the top three layers. Another radiation is scattered and reflected into space by gas molecules, clouds and particles.

The remaining 65% of solar radiation enters the troposphere: In the troposphere, about 14% of solar radiation is absorbed by water vapor, dust, and certain gases. Only 51% reaches the surface of the earth. Furthermore, about 37% is direct radiation received (absorbed) by the earth, and 14% is received by the earth and reflected into the atmosphere as diffuse radiation which has undergone scattering in the troposphere by gas molecules and dust particles.

The solar energy that reaches the surface of the earth has been widely used by humans, including to control pre-emergence weeds. Solar energy radiates to the earth in the form of energy packages called photons. Each color in the spectrum has a different energy, frequency, and wavelength. The spectrum of sunlight with a shorter wavelength will have greater photon energy.

The intensity of light hitting the ground is converted into heat energy (long waves) to increase the soil temperature. Heat energy is partly reflected in the

atmosphere and partly absorbed by the ground. The heat that occurs will be transferred from the soil surface to a deeper soil depth.

2. Heat Transfer

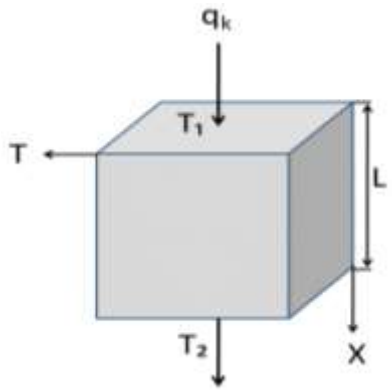


Figure 2. One-dimensional conduction in the soil layer

Heat transfer in the soil can be seen in the following (Figure 2). Heat transfer in the soil occurs by conduction. Heat transfer occurs because the soil molecules at higher temperatures vibrate more passionately, so they can transfer energy to the more sluggish molecules that are nearby by the microscopic work of heat.

Heat transfer flows from a place with a high temperature to a place where the temperature is lower, with a constant heat-conducting medium.

Heat transfer occurs due to an increase in the motion or kinetic energy of the soil molecules so that it collides with nearby molecules whose motive force is smaller. The amount of heat transferred per unit area of time is called the heat flow density (qk) which is determined by the temperature gradient (dT/dX) and the thermal conductivity (k).

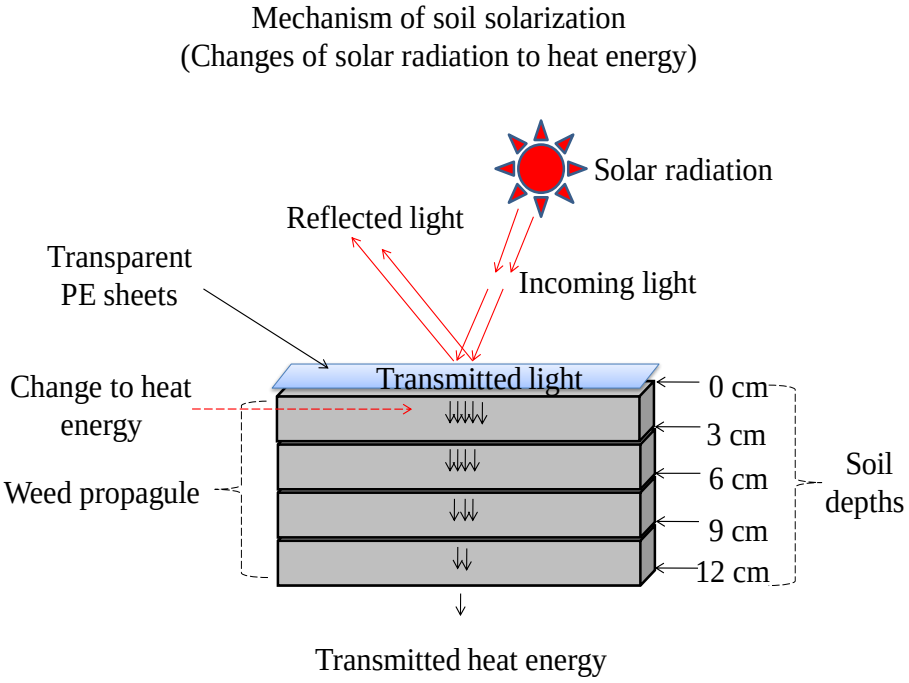
3. Transparent Plastic sheet properties

An illustration of the optical properties of transparent plastic sheets can be seen in the following figure (Figure 3). Transparent plastic sheets have optical properties so that sunlight on the plastic will be polarized into monochromatic light. The transparent color plastic sheet as a ground cover will act to trap the convection heat released by the soil so that the soil temperature under the plastic becomes high.

In the optical field, transparent plastic sheets can have the following characteristics: 1). Transparency is a physical property that allows light to pass through a material. 2).

Translucency, allows light to easily pass through and not return. The optical properties of plastic sheets when emitted by light are: forward (T), reflect (R), and absorb (A). The intensity of the incident light transmitted to the surface of the plastic sheet (Io) will be equal to the intensity of light transmitted (T), absorbed (A), and reflected (R) which is expressed in the form of the formula: Io = T + A + R.

Heat flow in the soil will move from high soil temperature to low soil temperature, namely from layer 1 to 2 (temperature T1), layer 2 to 3 (temperature T2), layer 3 to 4 (temperature T3), layer 4 to 5 (temperature T4)), layer 5 to thereafter (temperature T5).



Gambar 3. Sifat Optik Lembaran Plastik Transparan

4. Soil Solarization Flowchart

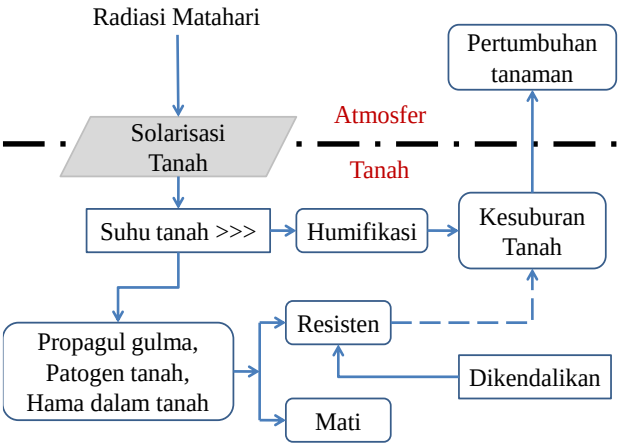


Figure 4. Soil Solarization Flowchart

Short rays after penetrating the transparent plastic will be converted into long waves in the form of heat. The heat is not able to penetrate the surface of the plastic so it is trapped under the transparent plastic. This heat can increase the soil temperature high more 54°C so that it can kill the weed propagules in the top-soil layer.

5. Bed Covered with transparent Plastic

Figure 5. Weed seeds and weeds die from high soil temperatures

High temperature affects weed propagule protein. Proteins often change their properties after experiencing high-temperature treatment, although they have not yet caused the breakdown of peptide bonds which is called protein denaturation.

The temperature at which the denaturation of most proteins occurs ranges from 55-75 °C. Soil temperature has a major influence on physiological and biochemical processes. High soil temperatures can reduce the dormancy period of some weed propagules or induce them to become secondary dormant. Longer solarization times can kill weed propagules. High soil temperature past the maximum germination

temperature results in enzyme breakdown. Above 45 °C soil temperature, the enzyme will be denatured.

The days number of soil temperature > 50 °C in 0-3 cm and 3-6 cm of soil depth

Colored PE films	Soil solarization	0-3 cm	3-6 cm
Non-solarization	30	0.0	0.0
Black	10	0.0	0.0
	20	1.0	0.0
	30	1.7	0.7
Red	10	3.7	1.7
	20	8.7	2.3
	30	10.0	3.0
Transparent	10	5.0	1.3
	20	9.3	4.0
	30	10.3	4.0

The use of transparent plastic as a heat trap in soil solarization can result in soil temperature frequencies more than 50°C more than red and black plastics. During 30 days, soil solarization at a depth of 0-3 cm can produce soil temperatures more than 50°C of 10 times and at a depth of 3-6 cm of 4 times. Weed propagules at both soil depths will experience disturbances due to high soil temperatures.

Percentage of weed propagules resistant (%) in size of 50 x 50 cm square plots

Colored PE films	Duration of soil solarization (days)			Average
	10	20	30	
Black	75.2	62.3	51.9	63.1 a
Red	52.9	35.7	26.8	38.5 b
Transparent	45.0	31.6	22.2	33.1 c
Average	57.7 p	43.2 q	33.8 r	(-)
Treatment				44.9 y
Non-solarization				100.0 x

Remarks: Number in the same column followed by the same characters are not significantly different based on DMRT at 5% significant levels. (-) = no significant interaction

Based on the research results, soil solarization for 30 days using transparent plastic can reduce the germination of weed seeds by 77.8% and is higher than the use of red and black plastics.

Conclusions

Based on the research results, it can be concluded that: pre-planting weed control using soil solarization can be used as an alternative to environmentally friendly weed control. Soil solarization with a transparent plastic sheet can produce soil temperatures of more than 50ºC at a soil depth of 0-3 cm. High soil temperatures can kill weed propagules. This pre-planting weed control can be applied to plant cultivation, especially horticulture.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Chairman
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2 MBOT CPD HOURS

Salibu Rice Cultivation Technology in Indonesia

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Abstract

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SPEAKER'S PROFILE

Dr. Paiman is an Assistant Professor of Agriculture at the Faculty of Agriculture, *Universitas PGRI Yogyakarta* (UPY). He was the Rector of Universitas PGRI Yogyakarta (2017-2021) and the head of Perkumpulan Ahli dan Dosen Republik Indonesia (ADRI) Special Territory of Yogyakarta (2017-2021). His research interests lie in weed and rice science.

He graduated from Universitas Gadjah Mada, Indonesia for undergraduate & doctoral studies in Agriculture science. Dr. Paiman has presented more than twenty research papers at local, national, and international levels since the year 2011, and also the reviewer article for a national and international journal. He was had more than twelve articles indexed by Scopus.