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Impact of Bio solarization on the ecofriendly cultivation of Tomato (*Solanum lycopersicum* L.)

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Abstract

The present investigation on "Impact of bio solarization on the ecofriendly cultivation of tomato" was taken up in a farmer's field. **Tomato,** (*Solanum lycopersicum* L.) belongs to the family Solanaceae, cultivated extensively for its edible fruits. It is labeled as a vegetable for nutritional purposes rich in vitamin C and the phytochemical lycopene. The fruits are commonly eaten raw as salads, served as a cooked vegetable, used as an ingredient of various dishes, and pickled. Additionally, a large percentage of the world's tomato crop is used for processing; products include canned tomatoes, tomato juice, ketchup, puree, and dehydrated pulp. The experiment was conducted to study the effect of solarization in bio amended soil for the eco friendly weed management in tomato involving solarization with various amendments *viz*., tomato processing waste, grape processing waste, cruciferous crop waste, tomato plant debris and *Allium* sp. waste. This experiment was laid out in a factorial randomized block design with 10 treatments combinations replicated thrice. The treatments include a combination of solarization for four weeks with five different amendments *viz*., tomato processing waste, grape processing waste, cruciferous crop waste, tomato plant debris and *Allium* spp. waste along with amendments without solarization. The results of the experiment revealed that solarization treatment with cruciferous plant waste followed by *Allium* spp. waste were found to be effective in increasing the soil temperature on all days of observation. Similarly, the lowest weed population, were registered in the treatment receiving cruciferous plant waste followed by *Allium* spp. waste.

Key words : Bio solarization, Tomato, weed management.

Tomato, (*Solanum lycopersicum L.*) belongs to the family Solanaceae, cultivated extensively for its edible fruits. It is labeled as a vegetable for nutritional purposes rich in vitamin C and the phytochemical lycopene. The fruits are commonly eaten raw in salads, served as a cooked vegetable, used as an ingredient of various dishes, and pickled. Additionally, a large percentage of the world's tomato crop is used for processing; products include canned tomatoes, tomato juice, ketchup, puree, and dehydrated pulp. Solar heating of soil involves covering moist soil with transparent polyethylene sheet during hot months for sufficient time to raise the soil temperature to the levels lethal for soil borne pests such as weeds, insects, disease pathogen, nematodes, etc. Artificial soil heating or soil solarization is the only non-chemical soil disinfestation method which has been tested on a large scale under farming conditions. Combining organic amendments with soil solarization is a developmental approach for the control of soil borne plant diseases[7]. Higher soil temperatures may be obtained with dark-colored nature of organic amended soils since they absorb more solar radiation than light-colored soils[13]. Although the major benefit of solarization is reduction of soil borne pathogens by soil-heating effects, there are many other possible additional beneficial effects that can result in an increased growth response (IGR) of plants. Such additional effects include control of weeds and pests and release of plant nutrients[12].

Based on the above said requisites an investigation was conducted to study the impact of bio solarization with agricultural green wastes for the weed control process in tomato.

The experiment was conducted to study the effect of solarization in bio amended soil for the eco friendly weed management in tomato involving solarization with various amendments *viz*., tomato processing waste, grape processing waste, cruciferous crop waste, tomato plant debris and *Allium* sp. waste. The experiment was laid out in a factorial randomized block design with 10 treatments combinations replicated thrice. The treatments include a combination of solarization for four weeks with five different amendments *viz*., tomato processing waste, grape processing waste, cruciferous crop waste, tomato plant debris and *Allium* sp. waste along with wastes without solarization. The soil was moistened first then the wastes were spread in the respective treatments. After spreading the agricultural green wastes in the field, 0.05 mm thickness of transparent polythene sheet was spread and it was kept in the land for a month. Then the sheets were removed and transplanting of tomato seedlings was done.

The observations on soil temperature revealed that there was an increase in soil temperature on all days of observation due to solarization and the types of wastes used. Solarization with cruciferous waste recorded the maximum temperature of 39.8 ^{o}C which was on par with the treatment combination of solarization with *Allium* sp. which recorded 40.4 ^{o}C and followed by solarization with tomato processing waste and grape processing waste during the first week of bio solarization. The minimum temperature was observed in tomato plant debris for the entire four weeks. Soil moisture content was found to be maximum in cruciferous waste and *Allium* sp. waste when compared with other treatment combinations.

The moist soil covered with polyethylene sheet recorded higher temperature mainly due to prevention of evaporation; the solar energy which could have otherwise been

Table-1. Effect of bio solarization on soil temperature (°C) after fourth week of Solarization

Tr. combi-nation	W1 (Tomato processing waste)	W2 (Grape processing waste)	W3 (Cruciferous crop waste)	W4 (Tomato plant debris)	W5 (*Allium sp* waste)	MEAN
S0	38.9	39.1	40.1	40.5	41.2	39.9
S1	39.1	39.1	39.8	41.4	40.4	40.1
Interaction mean	38.9	39.1	40.1	40.9	40.8	39.9

Level of significance			
	W	S	WS
SEd	0.907	0.574	1.283
CD(P=0.05)	1.907	1.206	2.697

Table-2. Effect of bio solarization on Soil moisture after fourth week of Solarization

Tr. combi-nation	W1 (Tomato processing waste)	W2 (Grape processing waste)	W3 (Cruciferous crop waste)	W4 (Tomato plant debris)	W5 (Allium *sp* waste)	MEAN
S0	38.3	35.8	38.3	42.3	48.3	40.6
S1	38.6	40.3	49.2	40.4	46.4	43.0
Interaction mean	38.5	38.1	43.7	41.3	47.3	41.8

Level of significance			
	W	S	WS
SEd	0.956	0.605	1.353
CD(P=0.05)	2.010	1.271	2.842

Table-3. Effect of bio solarization on weed population (m^2)

Tr. combi-nation	W1 (Tomato processing waste)	W2 (Grape processing waste)	W3 (Cruciferous crop waste)	W4 (Tomato plant debris)	W5 (Allium *sp* waste)	MEAN
S0	108.7	109.7	106.3	112.4	107.4	108.9
S1	51.60	52.30	47.80	54.80	49.80	51.26
Interaction mean	80.15	81.00	77.05	83.60	78.60	80.08

Level of significance			
	W	S	WS
SEd	0.859	1.358	1.922
CD(P=0.05)	1.719	2.717	3.843

Table-4. Effect of bio solarization on number of fruits per plant

Tr. combi-nation	W1 (Tomato processing waste)	W2 (Grape processing waste)	W3 (Cruciferous crop waste)	W4 (Tomato plant debris)	W5 (Allium *sp* waste)	MEAN
S0	31.71	31.14	32.88	30.58	32.28	31.72
S1	35.22	34.63	36.35	34.04	35.77	35.21
Interaction mean	33.46	32.88	34.61	32.31	34.03	33.46

Level of significance			
	W	S	WS
SEd	0.292	0.462	0.653
CD(P=0.05)	0.584	0.924	1.306

Table-5. Effect of bio solarization on fruit yield per hectare (t ha^{-1})

Tr. combi-nation	W1 (Tomato processing waste)	W2 (Grape processing waste)	W3 (Cruciferous crop waste)	W4 (Tomato plant debris)	W5 (Allium *sp* waste)	MEAN
S0	87.09	83.81	92.42	80.66	89.06	86.60
S1	105.60	102.58	112.85	99.34	109.63	105.99
Interaction mean	96.34	93.18	102.63	90.03	99.34	96.31

Level of significance			
	W	S	WS
SEd	0.844	1.334	1.886
CD(P=0.05)	1.687	2.668	3.773

used in evaporation of water from the soil was stored as sensible heat in the irrigated mulch soil. The formation of small water droplets initially attains water film later on the underside of the polyethylene sheet increased the transmittance of polyethylene sheet to incoming short wave solar radiation but prevented the escape of outgoing long wave radiation from the soil[6]. The sudden rise in soil temperature under the polyethylene sheet is due to prevention of back radiation of solar long waves through transparent polyethylene films thus trapping and preventing the heat loss. The probable reason for the increase in the temperature may be because of the dark colour of the soil (influenced by the application of wastes) that might have absorbed more solar energy and raised the soil temperature as reported by Clay Robison and Dirt[3]. This is also in accordance with the findings of Kaskavalci[9]. Increase in soil moisture and thermal conductivity in compost amended soil and on exothermic microbial activity are reported to be other possible reasons for the increase in soil temperature over non solarized soil[4].

Data on the weed population (Table 3) showed the existence of significant treatment differences. Among the treatments, bio solarization with cruciferous waste recorded the desirable lowest value (47.80 m^{-2}) followed by bio solarization with *Allium* waste. One of the objectives in using solarization is to provide adequate weed control in most of the freshly consumed vegetables in which no safe herbicide is available[11]. Solarization with amendments produced two different complementary effects like foliar scorching of emerged plants under plastic cover and decreased weed emergence after removing the plastic sheets. This residual effect on weeds is considered as the principal benefit of the treatment. In this investigation, solarization with cruciferous waste and *Allium* sp. waste suppressed the weed population at higher level. The excess heat generated during the period of solarization with cruciferous waste and *Allium* sp. waste might have contributed for suppressing germination of weed seeds as well as vegetative structures present in the upper layer of the soil. Studies by Herdricks and Taylorson[5] further revealed that heating weed seeds from 30 to 35°C modified the membrane permeability, which resulted in leakage of endogenous amino acid and simultaneous reduction in germination rate. In the present study also, the highest level of soil temperature attained over control in all days of observation resulted in efficient suppression of weed growth though not in complete elimination as reported earlier by Abu-Irmaileh[1].

Specific environmental conditions such as light, temperature, carbon-di-oxide, oxygen and other volatile compounds in the soil controls the process of weed seed germination[10]. Hence seeds located at a soil depth where the prevailing conditions due to solarization are not favourable for germination may remain dormant, but viable until the conditions change. However, when the temperature increases, seeds may die or otherwise increase in temperature in the deep layers probably may not be high enough to be lethal, but significant to break the dormancy and force the germination. Changes in carbon-di-oxide oxygen levels in soil under polyethylene mulch may also play an important role in partial or complete breaking of seed dormancy thus enhancing germination. Thus, during their emergence, the seedlings were killed by the temperature of hot upper layer.

Solarization with cruciferous waste recorded the maximum number of fruits per plant (36.35) which was followed by treatment combination of bio solarization with *Allium* sp. waste which recorded (35.77) and followed by solarization with tomato processing waste (35.22) (Table-4). Similarly, the estimated yield of tomato was recorded the highest with cruciferous waste (112.85 t ha^{-1}) followed by *Allium* sp. (109.63 t ha^{-1}) and tomato processing waste (105.60 t ha^{-1}) (Table-5). Brassicaceae and *Allium* sp. produces numerous sulfur-containing chemical products, including volatile compounds arising via cleavage of certain S-alk(en)yl cysteine sulphoxides[8] which can act upon a variety of soil borne pests including fungi, bacteria and nematodes. It is found that the *Allium sp.* wastes were inhibitory to many soil and root organisms and it might be the reason for higher yield of the fruits when compared to other treatments[2].

To conclude, at the agricultural level, activity of these residues could be exploited as a component of integrated weed management using appropriate crop sequencing, and may extend utility of soil heating treatments (e.g. bio solarization) for weed control.

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