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Implication of Solarization against Soil -borne fusaria in leguminous crop fields in Kalli paschim village in Lucknow, India: A Tropical Country

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ABSTRACT

Soil solarisation is a technique to trap sun's energy helps to increase the temperature of the soil .This higher temperature is unsuitable for most of the plant pathogens results decreased in their population. It's a very beneficial technique for management of pathogen microbes in tropical countries where sunlight is available for a long period in a day time. Soil solarisation also helps to increases the productivity of soil both by suppressing the pathogens as well as by increasing the metabolic rate of soil materials, which helps to enhance the fertility of the soil. This procedure is also enhancing the bulk and bustle of antagonistic microbes. The purpose of present study is to test the effect of soil solarization on population dynamics of two pathogenic soil fusaria *i.e. Fusarium oxysporum f.sp.ciceri* and *fusarium udum* causing wilt in chickpea and pigeonpea crops. All treatment comprises treated plots and untreated (control) plots at different depth i.e. 5, 10 and 15 cm on 7, 14 and 21st days of experiment. It is found that in solarized plots the population of pathogens significantly reduced in compared to control plot. Significant increase in temperature is found in solarized plots in comparison to control with increase in days of experiment.

Keywords: Soil solarisation, increase, temperature, suppressing, pathogens.

1. Introduction

Soil Solarization is basically used for suppressing a wide range of soil-borne pathogens and weeds (Katan, 1987; Katan *et al.*,1976). It can be done by covering the plots with separate plastic strips (Katan *et al,* 1976, 1980) or covering the whole plot with a continuous polythene sheet (Grienstein and Hetzroni,1991;Grienstein *et al*.,1979;Jacob-sohn *et al*.,1980). The solar radiation heated the soil and due to physical and biological process many soil-borne pests are killed. Soil-solarization, a non-chemical disease management technology introduced by katan (1981, 1998) to control weeds, nematodes and soil-borne pathogens. Control of soil-borne pathogens by soil-solarization technique enhanced plant growth and yield (Katan 1981,1998).Solar heating or solarization is a process uses sun's energy to enhanced temperature of the soil to that level at which most plant pathogens will be inhibited or reduced to obtained significant level of disease control. Soil solarization not only reduced the pathogen population but also increase the density and activity of antagonistic microbes. Several reviews have been described the process of solarization and its suppressive effect against pest, pathogens and weeds(Devay *et al*.,1991; Devay,1995; Katan,1996). Solarization suppress those population of pathogens, which are responsible for reducing the productivity of soil (Bouhot,1997).Other advantage of solarization is its long term effect. Once time solarization treatment control the disease incidence and enhancing the yield for two or sometimes three years after solarization. This effect is mainly due to both reduction of the inoculum density and developed supressiveness of the soil against pathogens (Lopez-

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Escudero and Blanco-Lopez,2001). Solarization experiment is effective in warm and sunny areas in the world. The present study has been conducted in Kalli paschim village, Distt. Sarojini Block, Lucknow, India.The objective of this work is to evaluate the effect of soil solarization on population of *Fusarium udum* and *fusarium oxysporum f.sp.ciceri* causing wilt disease in pigeonpea and chickpea at different depths on 7^{th},14^{th} and 21^{st} days of experiment.

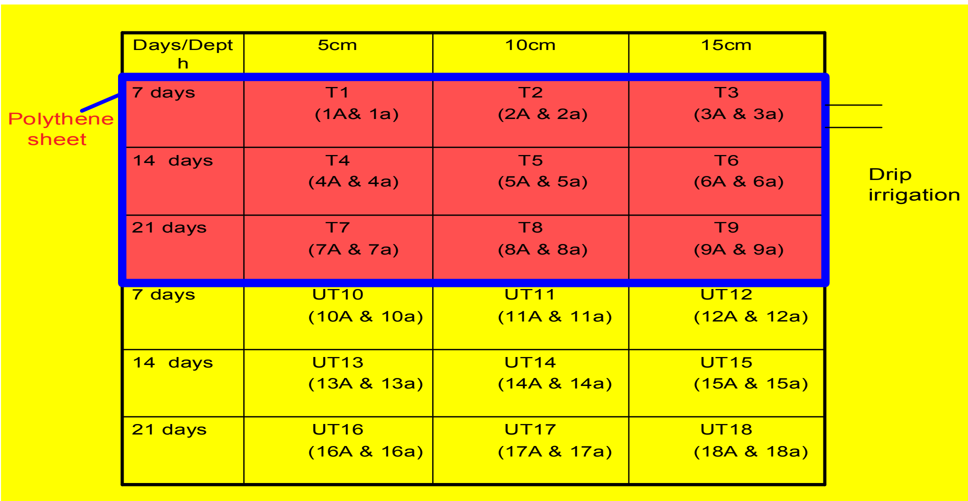
2. Material and Method

2.1 Preparation of inoculum

250 gm of oat seeds were taken, soaked in water for overnight, and washed three to four times with distilled water and then drained the distilled water from it. The seeds were taken in two conical flasks(500ml) and were autoclaved at $15lb/in^2$ twice for one hour. 10-15 blocks of 5mm diameter of a week old colony of both the pathogens were inoculated to the flask. The flasks were incubated at 25±2˚C for 15 days. After a week flasks were shaken thoroughly for luxuriant growth of the pathogens. After incubation period was over, the oat grains were taken out of the flask, dried on brown sheet at room temperature. The dried grains were powdered in an electrical grinder and stored in sterilized conical flasks and kept in a refrigerator at 4˚C for further studies.

2.2 Soil solarization experiment

0.2% w/w of oat inoculum (already prepared as describe in 2(a)) of pathogen was thoroughly mixed with 50 gm autoclaved soil kept in sterilized polythene bags. Each experiment was done in triplicates. The experiment was done during the hot summer month (June, 2009). The plot size 2mX2m was prepared. All treatment comprises solarized and unsolarized (control) plot. From prior to set the experiment the plots were uniformly irrigated, weeds were taken out of the plots. The polythene bags containing 0.2%w/w of inoculum of *Fusarium udum* and *Fusarium oxysporum f.sp.ciceri* separately were put in soil at different depth i.e. 5, 10 and 15 cm. Non-solarized plots were also prepared for comparison. Each experiment was done in triplicates (Rao and Krishnappa, 1995).



A= *Fusarium oxysporum f.sp.ciceri*
a = *Fusarium udum*

The solarized plot were covered with polythene in such a way that there was no air gap. The moisture of the soil was maintained by drip irrigation method (Cauhan *et al.*, 1988).
The polythene bags were removed from the soil after completion of 7th, 14th and 21st days of solarization. Polythene bags from non-solarized plots also removed at the same time. The population of *Fusarium udum* and *Fusarium oxysporum f.sp.ciceri* were calculated on colony count basis. Results are expressed as colony forming units per gram (cfu/gm) of dry soil. Data were analyzed statically.

The solarized plot were covered with polythene sheet. The moisture of the soil were maintained by adding pipe at one side(Cauhan *et al.*,1988).The polythene bags were removed from the soil after completion of 7,14 and 21 days of solarization. Polythene bags from non-solarized plots also removed at the same time. The density of propagules of *fusarium udum* and *fusarium oxysporum f.sp.ciceri* infested by colony count methods. Result was expressed as colony forming units per gram of dry soil.

4. Result and Discussion

In soil solarization experiment was performed for 21 days at different depth i.e. 5, 10 and 15cm depth.Atmospheric temperature has been recorded at 7th , 14th and 21st day of experiment as shown in Fig.1.

From temperature study it has been shown that in unsolarized plot, the increase in temperature at 5 cm depth has been recorded 38°C, 40°C and 41°C on 7th , 14th and 21st day of experiment while In case of solarized plot, at 5cm depth temperature has been recorded 40°C on 7th day, 43°C on 14th day and 44°C on 21st day of experiment (Fig.2).

Table 1: Atmospheric temperature (˚C) recorded on sampling day/date

Day/Date	7th day/08/06/2009	14th day/15/06/2009	21st day/22/06/2009
Temperature(˚C)	39	42.5	43.3

At 10 cm depth, unsolarized plot the temperature is found 36°C on 7th day, 38°C on 14th day and 39°C on 21st day of experiment while temperature of treated plot has been recorded 37°C on 7th day, 40°C on 14th and 42°C on 21st day of experiment (Fig.3).

At 15 cm depth, the record in temperature has been found 33°C, 35°Cand 36°C on 7th, 14th and 21st day of experiment at unsolarized plot condition while at treated plot, temperature has been recorded 35°C on 7th day, 39°C on 14th day and 41°C on 21st day of experiment(Fig.4).Temperature of solarized plot has been found higher in comparison to unsolarized plot. It also shows that temperature has been increased with increasing day of experiment. It also found that temperature is found higher at 5 cm depth followed by 10 and 15 cm depth in both experimental condition.

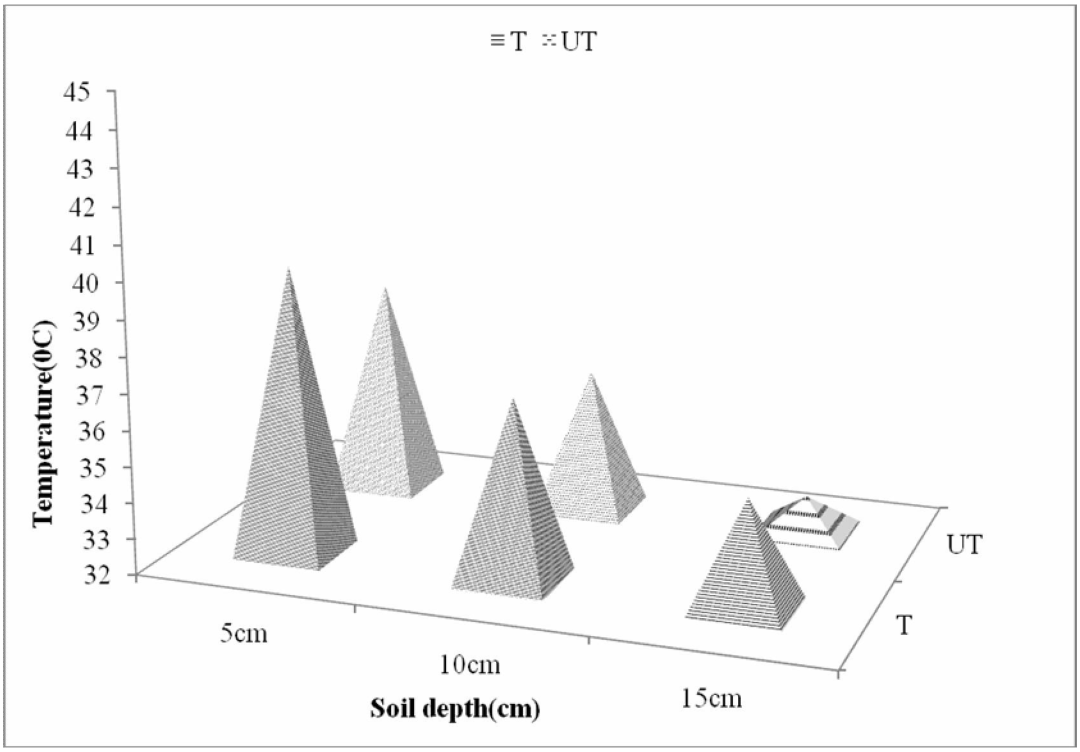


Figure 1: Temperature of treated and untreated soil sample at different depth on 7th day of soil solarization experiment

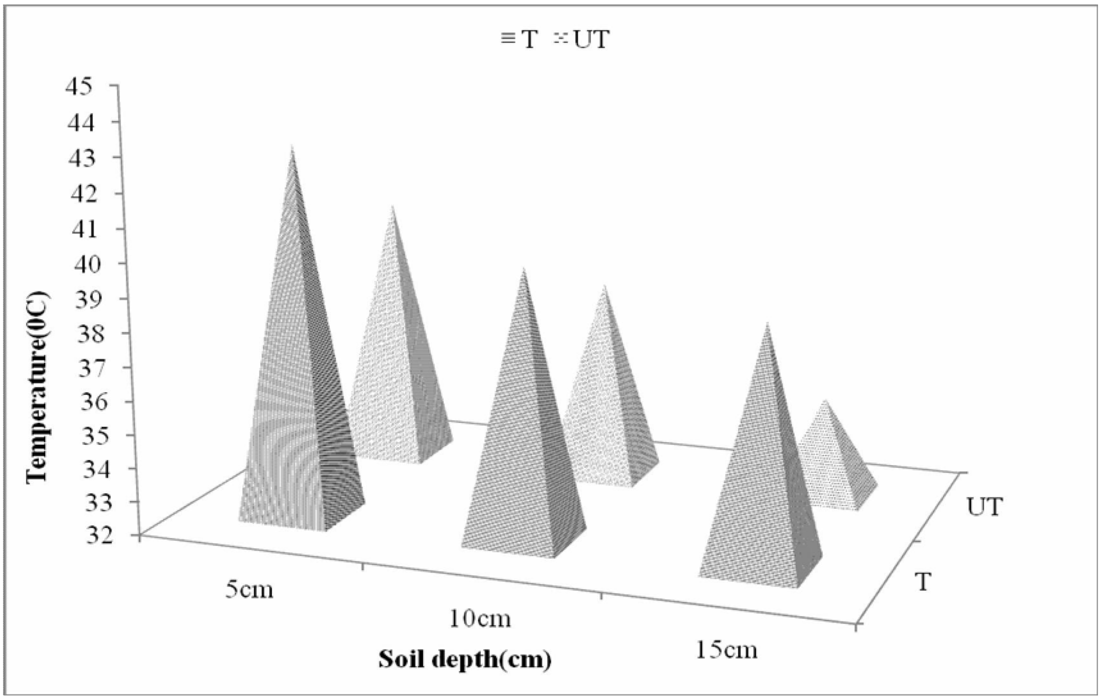


Figure 2: Temprature of treated and untreated soil sample at different depth on 14th day of soil solarization experiment

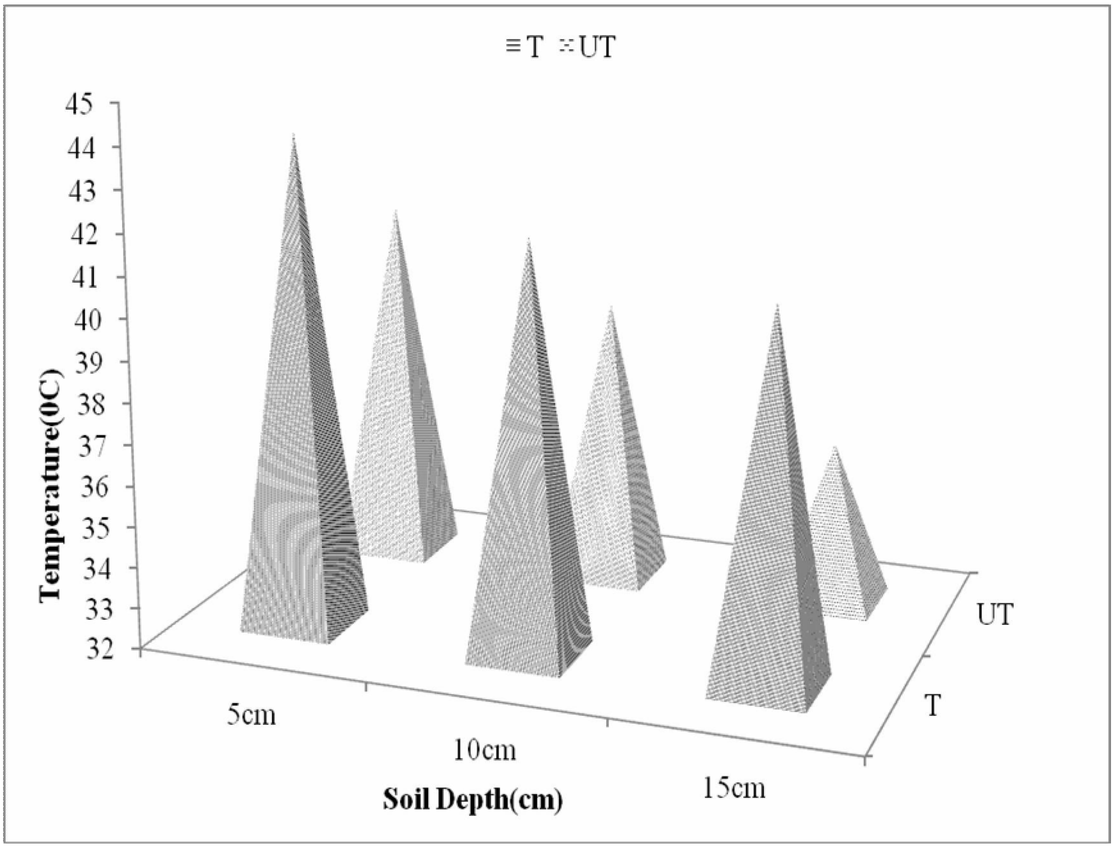


Figure 3: Temprature of treated and untreated soil sample at different depth on 21st day of soil solarization experiment

At 5 cm depth the population of *Fusarium udum* has been significantly reduced by 72.09 % on 21st day of experiment followed by 56.60 % and 40.68 % on 14th and 7th day (at p<0.01) (y = 15.708x + 25.043, R^2 = 0.9999) respectively (Table 2, Fig.4) wherease in case of *Fusarium oxysporum f. sp. ciceri* the same trend is found with 70.27%, 62.22% and 48.39% reduction in population on 21st , 14th and 7th day of experiment(at p<0.01))(y = 10.94x + 38.414, R^2 = 0.9772) (Table 2, Fig.5).

At 10 cm depth the population of *Fusarium udum* has been significantly reduced by 59.65 % on 21st day of experiment followed by 50.79 % and 34.72 % on 14th and 7th day (at p<0.01) (y = 12.463x + 23.461, R^2 = 0.9728) respectively (Table 3, Fig.4) wherease in case of *Fusarium oxysporum f. sp. ciceri* the same trend is found with 69.09 %, 54.55 % and 39.08% reduction in population on 21st , 14th and 7th day of experiment(at p<0.01) (y = 15.005x + 24.228, R^2 = 0.9997) (Table 3, Fig.5).

At 15 cm depth the population of *Fusarium udum* has been significantly reduced by 53.15 % on 21st day of experiment followed by 40 % and 29.27 % on 14th and 7th day (at p<0.01) (y = 11.928x + 16.941, R^2 = 0.9967). respectively (Table 4, Fig.4) wherease in case of *Fusarium oxysporum f. sp. ciceri* the same trend is found with 56.76 %, 43.18 % and 32.65 % reduction in population on 21st , 14th and 7th day of experiment(at p<0.01) (y = 12.053x + 20.089, R^2 = 0.9947) (Table 4, Fig.5) .

Table 2: Population of *Fusarium udum* and *Fusarium oxysporum f. sp. ciceri* in solarized(treated)and unsolarized (Control) soil (on cfu basis) at 5 cm depth on 7th , 14th and 21st day of experiment

S.No.	Soil Sample	Days	Colony Count (cfu/gm of dry soil)	
			Fusarium udum	***Fusarium oxysporum f. sp. ciceri***
1	T	7	17.5±0.71 **(40.68)**	16±1.41 **(48.39)**
2	UT		29.5±3.54**(0)**	31±1.41 **(0)**
3	T	14	11.5±0.71 **(56.60)**	8.5±2.12 **(62.22)**
4	UT		26.5±42.12 **(0)**	22.5±3.54 **(0)**
5	T	21	6±1.41 **(72.09)**	5.5±0.71 **(70.27)**
6	UT		21.5±3.54 **(0)**	18.5±2.12 **(0)**

T = Treated (Solarized soil), UT = Untreated (Unsolarized soil)
± = S.E. of mean of triplicate
Values in parenthesis represent percent reduction over untreated soil

Table 3: Population of *Fusarium udum* and *Fusarium oxysporum f. sp. ciceri* in solarized(treated) and unsolarized (Control) soil (on cfu basis) at 10 cm depth on 7th , 14th and 21st day of experiment

S.No.	Soil Sample	Days	Colony Count (cfu/gm of dry soil)	
			Fusarium udum	***Fusarium oxysporum f. sp. ciceri***
1	T	7	23.5±4.95 **(34.72)**	26.5±0.71 **(39.08)**
2	UT		36±2.83 **(0)**	43.5±4.95 **(0)**
3	T	14	15.5±2.12 **(50.79)**	12.5±0.71 **(54.55)**
4	UT		31.5±3.54 **(0)**	33±4.24 **(0)**
5	T	21	11.5±0.71 **(59.65)**	8.5±2.21 **(69.09)**
6	UT		28.5±2.12 **(0)**	27.5±2.12 **(0)**

T = Treated (Solarized soil), UT = Untreated (Unsolarized soil)
± = S.E. of mean of triplicate
Values in parenthesis represent percent reduction over untreated soil

Table 4: Population of *Fusarium udum* and *Fusarium oxysporum f. sp. ciceri* in solarized(treated) and unsolarized (Control) soil (on cfu basis) at 15 cm depth on 7th , 14th and 21st day of experiment

S.No.	Soil Sample	Days	Colony Count (cfu/gm of dry soil)	
			Fusarium udum	***Fusarium oxysporum f. sp. ciceri***
1	T	7	14.5±2.12 **(29.27)**	16.5±0.71 **(32.65)**
2	UT		20.5±6.36 **(0)**	24.5±4.95 **(0)**
3	T	14	10.5±0.71 **(40)**	12.5±2.12 **(43.18)**
4	UT		17.5±2.12 **(0)**	22±2.83 **(0)**
5	T	21	7.5±0.71 **(53.15)**	8±1.41 **(56.76)**
6	UT		16±1.41 **(0)**	18.5±3.54 **(0)**

T = Treated (Solarized soil), UT = Untreated (Unsolarized soil)
± = S.E. of mean of triplicate
Values in parenthesis represent percent reduction over untreated soil

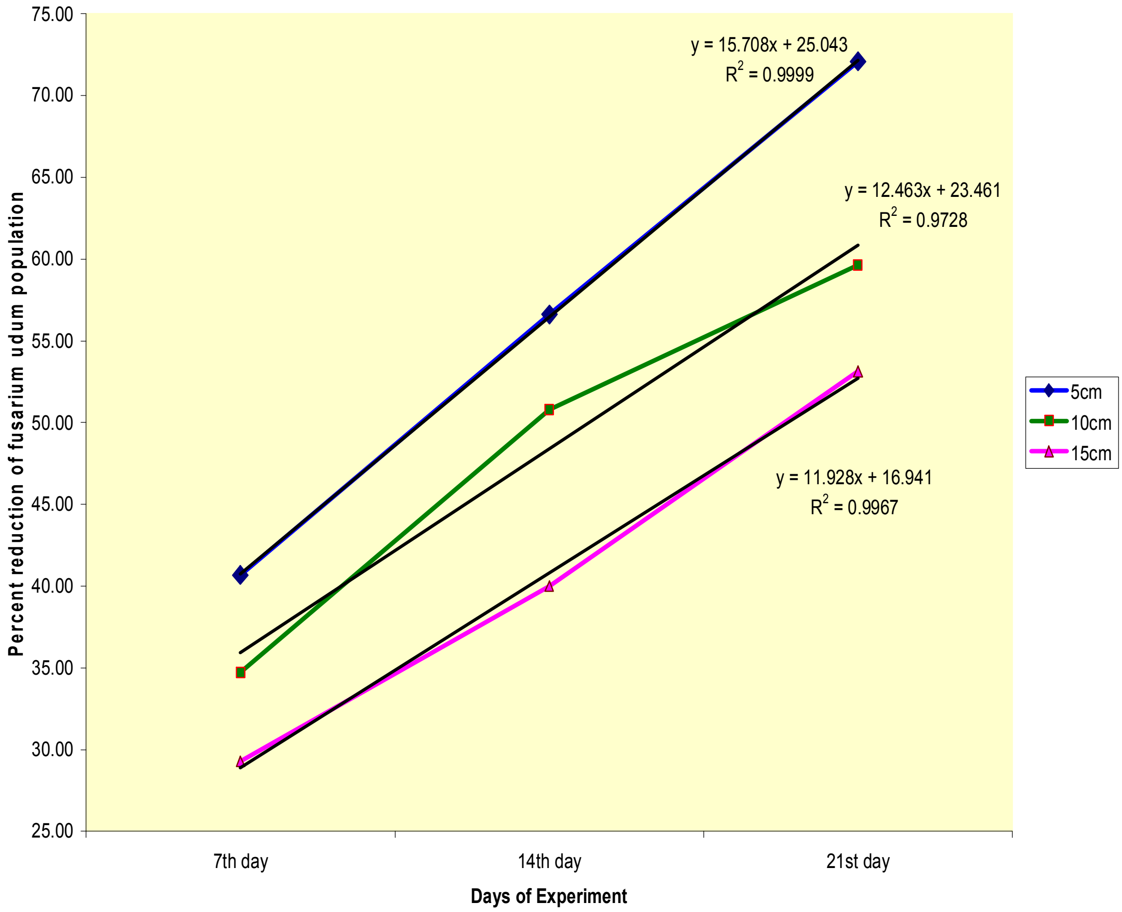


Figure 4: Percent reduction in population of *fusarium udum* in treated soil compared to untreated soil at diffent depth on different days of soil solarization experiment

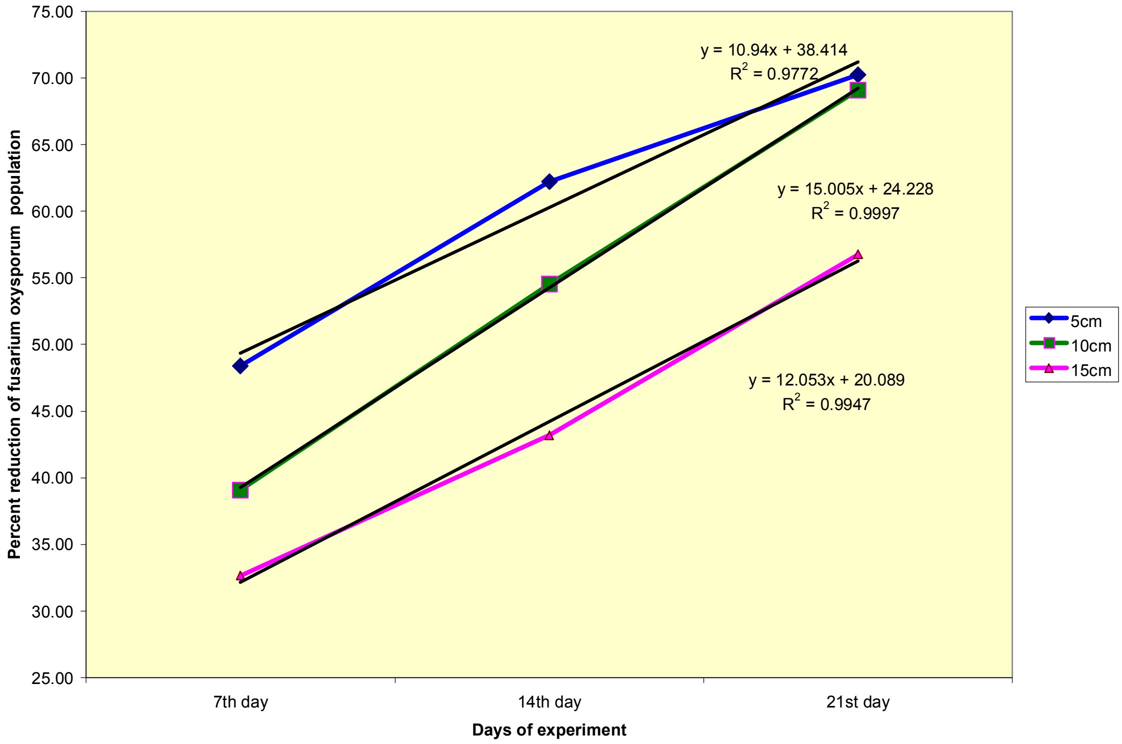


Figure 5: Percent reduction in population of *fusarium oxysporum f.sp. ciceri* in treated soil compared to untreated soil at diffent depth on different days of of soil solarization experiment

In Soil-solarization experiment, at all the depth with increasing day of experiment, the populations of both the pathogens were reduced in both treated and untreated soil.The maximum reduction was found in treated soil due to higher temperature compared to untreated soil at 5 cm depth followed by 10 and 15 cm depth. Soil pH was remains the same at all treatments while the nutrient contents (Orgaic carbon, nitrogen and potassium) was higher in treated soil in comparison to untreated ones. Average temperature under polythene sheet could be increased more than 45°C, which is the lethal range of many microorganisms(Pullman *et al.*,1981). The increase in soil temperature by 7.7°C by solarization has been considered as the major driving force for various biological changes in the soil(Katan,1981). Chauhan *et al.*(1988) also reported the increase in soil temperature using soil solarization. Rao and Krishnappa (1995) conducted field experiment to study the effect of soil solarization for the control of *Meloidogyne incognita* and *Fusarium oxysporum f. sp.ciceri* by covering the soil by transparent polythene sheet for 6 week during hot summer months. Result showed that increase in soil temperature caused significant reduction of population of *Meloidogyne incognita* and *Fusarium oxysporum f. sp.ciceri* to 58.1% and 80.8% respectively. The availability of soil nutrients were increased by soil solarization while the physical and chemical characteristic of soil remains unchanged.

5. Conclusion

From the above experiment it concluded that population of both *Fusarium udum* and *Fusarium oxysporum f.sp.ciceri* significantly reduced at 5cm depth followed by 10 and 15 cm depth in both treated and untreated soil with increase in temperature and length of days.

Result also showed that with increase in time of experiments the number of colonies reduced at higher level in treated soil in comparison to untreated ones in both *Fusarium udum* and *Fusarium oxysporum f.sp.ciceri.*

Increasing the temperature of the soil causes rapid degradation of complex organic matter into simple organic substances which enhancing the nutritional status of soil in solarized plot in comparison to unsolarized ones. All the findings are significant at $p<0.01$ level and Quantitative Structure Activity Relationship indicating regression (r^2) values is in the range of 0.97 to 0.99, indicating good regression data fit..

5.1 Future findings

Due to global warming and constant increase in the erosion of the natural ecosystem emphasize the importance of soil-solarization as an important tool in agricultural production system. Further research mainly emphasize on application of soil-solarization along with other biological agents and large scale application of this technology.

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