EFFECT OF SOIL SOLARIZATION ON WEED CONTROL, GROWTH AND YIELD OF GROUNDNUT- TOMATO SEQUENCE IN CONJUNCTION WITH CULTURAL AND CHEMICAL METHODS OF WEED CONTROL

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CERTIFICATE

This is to certify that the Thesis entitled "**EFFECT OF SOIL SOLARIZATION ON WEED CONTROL, GROWTH AND YIELD OF GROUNDNUT - TOMATO SEQUENCE IN CONJUNCTION WITH CULTURAL AND CHEMICAL METHODS OF WEED CONTROL**" submitted by **Ms. LALITHA, B.S.** for the award of the degree of **DOCTOR OF PHILOSOPHY** in **AGRONOMY** to the University of Agricultural Sciences, Bangalore, is a record of research work done by her during the period of her study in this University under my guidance and supervision and the thesis has not previously formed the basis of the award of any degree, diploma, associateship, fellowship or other similar titles.

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CONTENTS

LIST OF TABLES

LIST OF TABLES
(continued)

LIST OF TABLES

(continued)

LIST OF FIGURES

LIST OF PLATES

INTRODUCTION

I. INTRODUCTION

Stepping up food production in tropical and sub tropical areas of the world involves more intensive cropping resulting in the problem of weed growth, insect pests and diseases. Weeds, by their manifold effect on the growing crop plants and interference with land were ranked as prime enemies in crop production. Of the total annual loss of agricultural produce from various pests in India, weeds alone account for 45 per cent of the loss (Bhan and Singh, 1993).

The cultural and mechanical methods of weed control followed by farmers are although efficient in reducing weed infestation but tedious, time consuming and expensive. Chemical weed control is a well established method in the developed countries of the world and to some extent in the developing countries like India. In addition to time and efficient weed control, intensive herbicide use has raised some other questions like polluting the ecosystem, damage to non target organisms and development of tolerance in weeds to herbicides. Moreover significant consumer demand now exists for food produced without chemicals.

Among the various management practices for moisture conservation, use of mulches is assuming greater importance. Mulches not only act as covering layer on soil to conserve moisture but also suppress , weed growth and regulate soil temperature. Mulching materials are changing rapidly with industrial development, though soil, stone, manure, straw, leaves, stubbles and peat are still used as mulches extensively. Of late, the synthetic materials such as transparent polyethylene sheets are gaining more popularity for their effectiveness in controlling weeds inspite of being uneconomical. Thus, the research for a new control method is a continuous one. Recently, a new non-hazardous method for soil disinfection and solar heating of the soil was introduced by Katan *et al.* (1976). Soil solarization is a method of hydrothermal disinfection accomplished by covering moist soil with transparent polyethylene film (TPE), by capturing solar radiation during hot summer months. In addition to reducing number of fungi, bacteria, nematodes and weed seeds, soil solarization often results in increased plant growth response, even when no major plant pathogens or plant pests can be isolated from soil or plant roots (Chen and Katan, 1980, Stapleton and Devay, 1984).

The possible mechanisms of weed control by soil solarization are breaking dormancy, solar scorching of emerged weeds, direct killing of weed seeds by heat and indirect microbial killing of seeds weakened by sublethal heating. Several successful examples of soil solarization for weed control have been proved beyond doubt of its utility as well as its environmental benign nature. One strong positive attribute of soil solarization being its ability to deplete reserve of dormant weed seeds in soil which otherwise provide a source of seeds for persistent weed problems that often require repeated control measures.

There are many locations in India experiencing extreme summer. Moreover, many farmers of the Deccan Plateau and other regions of India have exploited the solar heating of soil by ploughing the soil and leaving it fallow in the hot summer (April-June). This can be further exploited for efficient weed control by mulching with TPEs.

Efforts are going on in different parts of India to assess the effectiveness of solarization. However, there are limited efforts on various aspects of soil solarization in Eastern Dry Zone of Karnataka State.

By keeping these views, an investigation was carried out on soil solarization for weed control in groundnut during *kharif* followed by tomato in *rabi* as an economic blend of commercial and food crop with the following objectives:

1. To evaluate soil solarization effects on weed control and the yield of groundnut and tomato grown in sequence

1

2. To study the soil temperature and soil moisture dynamics in response to soil solarization

3. To determine effects of soil solarization on microbial population, organic matter and mineral nutrition balances and

4. To workout the economics of soil solarization.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

The relevant literature on various aspects of soil solarization and its influence on soil and crops are presented under different headings in this chapter.

2.1 EFFECT OF SOIL SOLARIZATION ON SOIL TEMPERATURE

The lethal level of soil temperature under transparent polyethylene (TPE) sheet is said to be responsible for soil disinfection. In this direction, Katan (1980) recorded 8-12°C of higher soil temperature in solarized plots than corresponding non solarized plots. Similar results have been reported by Chen *et al.* (1983), who have observed increase in temperature of top soil layer and decrease in soil heat loss due to solarization by using TPE.

Further, Cartia (1987) recorded a maximum soil temperature of 51°C due to solarization. Many other workers have reported the rise in soil temperature in the top 5 to 10 cm soil depth (Dwivedi and Dubey, 1987; Kaewruang *et al.*, 1989; Kumar *et al.*, 1993; Meti and Hosmani, 1994; Habbeburrahaman and Hosmani, 1996; Vijaya Bhaskar, 1996; Sudha, 1997; Mudalagiriyappa, 1998; Basavaraj, 1998).

2.1.1 **Extent of increase in soil temperature** : The extent of increase in soil temperature upon solarization varied with soil depth and location. Typical temperature rise of 7°C at Giza, Egypt (Osman and Sohab, 1983), 10-18°C in Israel (Rubin and Benjamin,1983), 10-12°C at Davis, USA (Stapleton *et al.*, 1985), 12°C in Taiwan (Tu *et al.*, 1987), 10°C at Colorado, Spain (Melero *et al.*, 1989), 9-12°C at CAZRI, Jodhpur, India (Lodha and Vaidhya, 1990) and 6-13°C Colima, Mexico (Stapleton, 1991), have been reported due to soil solarization with transparent polyethylene sheet (TPE) over non-solarized plots in the hot summer months.

The duration required to reach the maximum temperature at different depths was found to vary. Kaewruang *et al.* (1989) reported that temperature reached maximum in upper 10 cm within four to five days but it took five to six days to attain the peak at lower depths (20-45 cm). The maximum soil temperatures achieved at different depths and locations under TPE are presented in **Table 2.1**.

2.1.2 **Effect of type of polyethylene on temperature increase** : Experiments at various places in Jordan, Israel and USA, have proved a higher efficiency of transparent polyethylene (TPE) over black polyethylene and thin TPE over thick TPE in increasing soil temperature.

Table 2.1 The extent of increase in soil temperature (maximum temperature, °C) at various locations in the world (at different soil depths) due to soil solarization.

Sl. No.	Location	Soil depth (cm)	Maximum soil temperature (°C)	References
1	**India**			
	Varanasi	1	54.0	Dwivedi and Dubey (1987)
	Uttar Pradesh	30	44.0	Dwivedi and Dubey (1987)
	Uttar Pradesh	10	46.6	Dwivedi and Dubey (1987)
	Uttar Pradesh	15	38.3	Dwivedi and Dubey (1987)
	Jodhpur, Rajasthan	5	58.0	Lodha *et al.* (1991)
	Jachn, Himachal Pradesh	8	49.5	Raj and Gupta (1996)
	Jachn, Himachal Pradesh	15	41.3	Raj and Gupta (1996)
	Jachn, Himachal Pradesh	30	36.2	Raj and Gupta (1996)
	Dharwad, Karnataka	5	53.0	Meti and Hosmani (1994), Habeeburrahaman and Hosmani (1996)
	Bangalore,	5	45.9	Vijaya Baskar (1996)
	Karnataka	10	41.8	
		5	48.5	Sudha (1997)
		5	52.0	Mudalagiriyappa (1998)
		10	45.1	
		5	52.8	Basavaraj (1998)
		10	49.6	
	New Delhi	5	53.0	Arora (1998)
2	**USA**			
	Stoneville	1	69.0	Egley (1983)
	Lousiana	1	56.0	Standlefer *et al.* (1984)
	Texas	2	58.0	Hartiz *et al.* (1985)
		5	53.0	
		10	46.0	
		20	38.0	
		30	36.0	

Table 2.1 contd..)

Sl. No.	Location	Soil depth (cm)	Maximum soil tempe-rature (°C)	References
	Aberdeen	15	41.0	Davis and Sorenson (1986)
	California	-	69.0	Stapleton *et al.* (1997)
3	**Italy**			
	Naples	5	57.0	Aloi and Noviello (1982)
	Naples	10	45.0	
	Naples	5	48.0	Garibaldi (1987)
	Torino	6	48.0	Tamietti and Garibaldi (1989)
4	**Israel**			
	Bet-Dagon	5	53.0	Katan *et al.* (1983)
		10	45.0	Meron *et al.* (1989)
		30	38.5	Meron *et al.* (1989)
		10	46.0	Sztejnberg *et al.*(1987)
		30	38.0	
		50	37.0	
5	**Germany**			
	Southern Germany	5	44.0	Braun *et al.* (1987)
	Gettingen	5	52.0	Tokgonul *et al.* (1997)
		10	46.0	
		15	43.0	
		30	39.0	
6	**Japan**			
	Nara Agri. Experi-ment Station	10	41.5	Fukul *et al.* (1981)
		5	47.0	Kodama and Fukul (1982)
		10	39.9	
7	**Pakistan**	0-10	39.2	Ahmad *et al.* (1996)
		10-20	34.3	
		20-30	30.6	

Table 2.1 contd..)

Sl. No.	Location	Soil depth (cm)	Maximum soil tempe-rature (°C)	References
8	**Hawaii**	5	44.0	Regone and Wilson (1988)
		15	35.0	
		30	33.0	
9	**Spain Valencia**	10	60.0	Del Bustu *et al.* (1989)
10	**Lebanon Beirut**	5	53.0	Sobh and Abou Jawadah (1997)
		15	48.0	
		25	48.0	

Higher efficiency of TPE over black polyethylene sheet in increasing soil temperature was reported by various workers in India and abroad (Chopra and Choudhary, 1980 in New Delhi; Horowitz *et al.*, 1983; Rubin and Benjamin, 1983 in Israel; Jing *et al.*, 1986 at Shanghai, China; Salman and Gorski, 1985 at Columbus, USA; Sivakumar and Marimuthu, 1987; Vijaya Bhaskar, 1996; Sudha, 1997; Mudalagiriyappa, 1998 in India). In this regard Devay (1991) opined that compared to TPE films, black polyethylene containing carbon black absorb more solar radiation and reduces transmission resulting in reduced heating of soil.

2.1.3 **Effect of thickness of transparent polyethylene on soil temperature** : Mulching wet soil with thin TPE (0.04-0.05 mm) increased soil temperature by 10 to 18°C over control whereas, thick TPE recorded low temperature rise (Rubin and Benjamin, 1983). In Israel, higher soil temperature of 53°C was recorded with thin TPE (0.04 mm) by Katan *et al.* (1983) and similar trends were observed by Horowitz *et al.* (1983) while studying comparative efficiency of 0.03 mm and 0.1 mm thick TPE. Further many workers elsewhere have proved the efficiency of thin TPE (<0.05 mm) in increasing soil temperature over their thick counterparts (Chen and Katan, 1980; Osman and Sohab, 1983; Melero *et al.*, 1989; Lodha, 1989; Harti, 1991; Habeeburrahaman, 1992; Meti, 1993; Biradar, 1996; Raj and Gupta, 1996; Mugnozza *et al.*, 1997;

Mudalagiriyappa, 1998; Basavaraj, 1998). Devay (1991) opined that, low density polyethylene sheets are widely used for solar heat because of their flexibility, tensile strength and resistance to puncture and tearing. However, faster deterioration of thinner TPE had been established much earlier by Brighton (1972) and this opinion was confirmed by Mugnozza *et al.* (1997) and Basavaraj (1998).

2.2 EFFECT OF SOIL SOLARIZATION ON SOIL MOISTURE

Basavaraj (1998) and Arora (1998) reported that, all the solarized treatments retained higher soil moisture compared to control at 0-15 and 15-30 cm depth of soil. But there was no significant difference between thickness and duration of polyethylene sheet mulch.

2.3 SOLARIZATION AND WEED CONTROL

One of the visible effects of soil solarization is reported to be the control of wide spectrum of weeds. Grinstein *et al.* (1979) were the pioneers to notice control of many weed species including *Digitaria sanguinalis* and *Cynodon dactylon* followed by Katan *et al.* (1980) who reported decreased weed population due to soil solarization in onion fields. However, Egley (1990) opined that it is unlikely that soil solarization or other natural methods of raising soil temperature will eliminate weed seeds reserve from the field but high soil temperature may reduce weed seed population by killing heat susceptible weed seeds and by breaking dormancy of hard seeds followed by thermal killing of seedlings.

Yaduraju (1993) listed 50 weed species as partially or completely controlled followed by Katan and Devay (1995), who named 33 species of winter annual, 50 species of summer annual and 14 species of perennial weeds as moderately susceptible to soil solarization. They opined that weed seeds and propogules are controlled in various ways by solarization including heat, contact burning of the germinating seedling, reducing germination at lower depths and control due to higher temperature at surface area and possibly the imbalance of gaseous components in the soil.

2.3.1 **Influence of soil solarization on weeds** : The benefits of soil solarization are best obtained during hot summer months. The TPE sheets be kept in place for a desirable period as long as practical. Though annual weeds can be controlled by short periods, longer periods are said to be imminent for perennials.

Horowitz *et al.* (1983) reported that two to four weeks of solarization was sufficient to control annual weeds and was effective for next one year. However, four to five weeks of solarization was required to control most summer and winter annual weeds and to retain the effect for atleast next five months in Israel (Rubin and Benjamin, 1983). Further, they listed perennial weeds such as *Cyperus rotundus*, *Sorghum halepense* and *Cynodon dactylon* as partially controlled, and it is recommended longer period of solarization (upto 10 weeks) for effective control of these weeds.

A study conducted at Lakewood, USA revealed that soil solarization for 55 days could reduce the germination of many weed seeds and reduced weed cover by 97 per cent (Hilderland, 1985). Solarization for 36 days reduced seed load of soil by 90 per cent and emergence by 46 per cent in Germany (Braun *et al.*, 1987). They further observed that solarization for 30 or more days decreased weed population by 58 per cent although control of cyperus was inconsistent. In this context Emani (1991) recommended solarization for one month with thin TPE and two months with thick TPE for cowpea at Dharwad.

In another study conducted in USA, effective control of *Digitaria* and *Echinochloa* was observed by Elmore *et al.* (1993) with solarization for 40-45 days. Kumar *et al.* (1993) recommended 32 days of solarization in cowpea for effective weed control at Delhi. On a similar way solarization in bidi tobacco, Meti (1993) reported decrease in Orobanche number and dry weight due to solarization for 40 days particularly with thin (0.05 mm) TPE at Dharwad.

Good control of grassy weeds was obtained by solarization for six weeks prior to onion planting in Hawaii and the effect was persistent upto three months (Regone and Wilson, 1988). However, solarization for nine to 10 weeks was required to achieve reduction of dicot weeds by 90 per cent and monocot weeds by 94 per cent at Torio, Italy (Tamietti and Garibaldi, 1989).

Sauerborn *et al.* (1989) reported best control of weeds with solarization for 30 to 50 days in the hot season. Orobanche dry weight was decreased by 90 per cent in both bean and lentil fields in Northern Syria. Subsequent reduction in weed number due to solarization for eight weeks was noticed by Silveria *et al.* (1990) in Portugal and 72.3 per cent reduction in dry weight of Orabanche was observed by Linke *et al.* (1991). Further, Abu Irmaileh (1991) observed Orobanche free tomato plots solarized for 45 days with TPE.

Solarization with TPE (0.05 mm) reduced the emergence of *Ageratum conyzoides*, *Euphorbia hirta* and *Amaranthus spinosus* from 54 to 84 per cent (Habeeburrahaman, 1992). At New Delhi, solarization with TPE for 32 days decreased the emergence of the dominant weed seeds such as *Dactyloctenium aegypticum*, *Arachne racemosa*, *Trianthema monogyna* by over 90 per cent. Emergence of *Cyperus rotundus* from tubers was increased by the mulching treatments. Mulching for 16 days also decreased weed emergence but to a lesser extent than the 32 days treatment (Kumar *et al*., 1993). Maintaining TPE sheet followed by one hand weeding could control *Cyperus rotundus* by 98 per cent in ber nursery (Yadav *et al*., 1996; Vijaya Bhaskar, 1996). Economou *et al*. (1997) reported that solarization for a period of one month killed completely the weed seeds (*Avena sterlis*, *Bromus diandrus* and *Sinapis arvensis)* upto 10 cm soil depth at Athens, Greece. At Beirut, Lebanon, significant reduction in weed numbers and dry weight was observed due to soil solarization for 10 to 40 days duration (Haidar and Iskandari, 1997).

2.3.2 **Influence of soil solarization on burried weed seeds** : The source of persistent weed problem in agricultural soils are weed seeds and especially dormant weed seeds, dormant burried weed propagules (seed or vegetative part) have responded variably to solarization.

Horowitz *et al*. (1983) observed reduced germination of weed seeds in the top layer and the effect was found to decrease with the soil depth due to solarization. Seeds of eight weed species (*Xanthium strumarium*, *Portulaca oleracea*, *Sorghum halepense*, *Ipomea locunosa*, *Sida spinosa*, *Amaranthus retroflexus*, *Anoda cristata*, *Abutilon theophrasti*) were tolerant to 60°C temperature or less for upto seven days but most seeds were killed at 70°C after seven days (Egley, 1990). However, there was differential response in moist soil. A few seeds (1-12%) of most of the weeds survived upto three days at

70°C. Some (4-30%) seeds of weeds survived upto seven days at 60°C. He also observed promoted germination of certain species presumably because high temperature broke dormancy of some hard seeds.

Kumar *et al.* (1993) opined that the main solarization effect was restricted to the top (0-5 cm) layer of soil. In another study, Rubin and Benjamin (1983) although observed almost complete prevention of emergence of few weed species (*Sinapsis arvensis, Amaranthus retroflexus* and *Phalaris paradoxa*), rhizomes of cynodon, *Sorghum halepense*, seeds of *Solanum* and *Abutilon* were less susceptible for solarization. In a similar study at Stoneville, USA, it was revealed that solarization for one, two, three and four weeks reduced weed seed emergence by 64, 70, 98 and 98 per cent respectively. (Egley, 1983). Apart from eliminating *Sida spinosa* seeds by 94 per cent from the soil, number of viable weed seeds in soil were also reduced.

The depth upto which the weed seeds are killed upon soil solarization was also found to vary with weed species. In this regard Standlefer *et al.* (1984) reported that soil solarization with TPE for 40 days killed seeds of *Commelina cummunis* upto 11 cm and that of *Cyperus* spp. and *Echinocloa crusgalli* upto three to four cm depth. Only solarization for three weeks reduced germination of *Eleusine indica* and *Amaranthus* spp. upto 5 cm and that of compositae weed species upto 20 cm depth. Seed population of *Poa annua* was considerably reduced even upto 20 cm soil depth by two weeks of solarization (Silveria *et al.*, 1988).

In a notable study at National Research Centre for Weed Science, Jabalpur, India, Pandey and Singh (1996) suggested potential of reducing weed incidence by accelerated ageing of seeds in soil seed bank as an environmental friendly method of weed management under tropical conditions. They used solarization with TPE as one of the methods for this purpose and achieved 63.8 per cent weed control.

Lindsey and Shahid (1996) demonstrated using a simple field experiment that soil warming is sufficient to alter the emergence of *Betula penula* seedlings. On the similar lines Fidanza *et al.* (1996) opined that crab grass emergence was dependent on the total growing degree days (GDD) accumulation. Solarization for 30 days killed the weed seeds completely in both 5 cm and 10 cm depths of weed seed burial (Economou *et al.*, 1997). They proposed modelling based on degree hours (DH) to explain the germination behaviour of weed seeds in response to soil temperature.

2.4 INFLUENCE OF SOIL SOLARIZATION ON SOIL NUTRIENTS

Higher levels of soluble mineral nutrients due to plastic mulching has already been indicated by Baker and Cook (1974) and Jones *et al.* (1977). Chen and Katan (1980) while studying on soil solarization in Israel found increased concentration of soluble organic matter and mineral nutrients such as NO_3-N, NH_4-N, K^+, Ca^{2+}, Mg^{2+} and Cl^- in saturated extracts of the upper layers of eight different soils. Although concentration of NO_3-N and NH_4-N increased up to six times, concentration of P, Ca and Mg was increased only in some soils and availability of K, Fe, Mn, Zn, Cu and Cl were not affected (Stapleton *et al.*, 1985). However, no significant differences in the levels of extractable nitrate and sulphate were observed at Canterburry, Newzealand (Haynes, 1987) and levels of total N, NO_3-N, NH_4-N and total C, C/N ratio and pH at Dschang, Cameroon (Daelemans, 1989). Kaewruang *et al.* (1989) reported from Western Australia that solarized soils had significantly higher levels of NO_3-N at 0-10 cm and 10 - 30 cm depth and NH_4-N at 10 cm over control. But there was no difference with K^+, Fe^{2+} and organic C. However, NO_3-N content was increased by solarization upto 30 cm depth but NH_4-N was unaffected at any depth at ICRISAT, Hyderabad, India (Chauhan *et al.*, 1988).

Arora (1998) reported from New Delhi, India that solarization treatment with polyethylene sheet significantly increased NO_3-N and NH_4^+-N as compared to non-solarized plots. While TPE covered plots showed significant increase in available P and marginally increased K and EC. Organic carbon content and pH did not vary due to different treatments.

All the solarized treatments resulted in significantly higher level of available phosphorus, available potassium and slight rise in the level of extractable zinc, copper, iron and manganese where as soil solarized treatments significantly reduced the organic carbon (Basavaraj, 1998).

2.5 EFFECT OF SOLARIZATION ON SOIL MICROBIAL POPULATION

Solarization had no effect on the association between *Rhizobium* and groundnut roots (Grinstein *et al.*, 1979). Similarly in Cameroon, soil solarization reduced fungal population in the 0 to 2 cm layer (Daelemans, 1980). Population of *Rhizobium* spp. sufficient to effect heavy nodulation of bean roots, survived by solarization in Israel (Katan, 1981). Bacterial counts were generally unaffected by soil solarization but number in bare soil were usually lower for all bacterial types (Hankin *et al.*, 1982).

Due to solarization, changes are reported to occur in the population of soil microorganisms. At Sicily, Italy, the total fungal population of soil was decreased by 50 to 53 per cent by solarization (Cartia, 1987).

At Varanasi, India though there was a reduction in total fungi at 0 to 10 cm in solarized soils, it was found to increase when the solarized plots were under shade (Dwivedi and Dubey, 1987). At ICRISAT, Hyderabad, India, also solarization did not affect rhizobial population or nodulation of either pigeonpea or chickpea (Chauhan *et al.*, 1988). In Israel, solarization for two months drastically reduced the number of potentially deleterious fungi (Gamliel *et al.*, 1989). Solarization significantly reduced the population of fungi at 0 to 10 cm by 2.2 folds and increased it at 10 to 30 cm by 1.3 folds, in Western Australia (Kaewrung *et al.*, 1989). Solarization decreased number of fungi by 50 to 100 folds (Meron *et al.*, 1989).

The bacteria, pseudomonas was increased by 50 to 100 folds in the rhizosphere of tomato and cotton in Israel (Meron *et al.*, 1989). In Western Australia, solarization for five weeks increased the population of bacteria at soil depth of 0 to 10 cm (3.2 folds) and also increased the population of actinomycetes (1.2 folds) at both depths. At Colima, Mexico, along with fungi the bacterial population was reduced by 62 to 100 per cent (Stapleton, 1991). Raj and Kapoor (1993) reported that soil solarization eliminated **fusarium oxysporium** from the soil at 6 cm depth after 15 days, elimination at 12 cm depth occured after 45 days and 60 days, no disease symptoms were recorded on the plants in solarized plants.

2.6 INFLUENCE OF SOIL SOLARIZATION ON CROP PERFORMANCE AND YIELD THROUGH WEED CONTROL

Improvement in crop growth and yield performance due to weed control is an undisputedly established fact. Good weed control by solarization has been reported by many researchers. Increase in yield of groundnut was reported by Grinstein *et al.* (1979) due to solarization resulted in reduction of weeds. Drastic reduction in parasitization of carrot plants by broom rape increased carrot yields (Jacobson *et al.*, 1980). Katan *et al.* (1980) observed improved plant stand and growth of onion by solarization due to decreased incidence of weeds and certain soil borne fungal pathogens. Further improvement in seed cotton yield (2.46-4.17 t/ha) due to reduction in weeds and *Fusarium* on account of solarization was reported by Katan *et al.* (1983).

Altering the plant root environment and resulting increased growth of crop was attributed to several modes of action including thermal inactivation of weed seeds and weakening of propagules by the process of soil solarization (Stapleton and Devay, 1986). In line with these findings, yield of *Phaseolus vulgaris* was significantly increased due to combined effect of reduction in damping off, root-rot and weeds by solarization at Giza, Egypt (Fahim *et al.*, 1987). Similarly increase in seed yield (0.4 to 1.1 t/ha) and total dry matter accumulation (1.4 to 3.5 t ha^{-1}) even in wilt resistant genotype of pigeon pea and yield increase of 23 per cent in chickpea was reported by Chauhan *et al.* (1988). Further, increased onion yields due to solarization and even disease incidence was very low in solarized plots (Satour *et al.*, 1989). In many instances increased crop yields have been reported even when no soil pathogens or other pests have been detected (Chen and Katan, 1980; Rubin and Benjamin, 1983; Stapleton and Garza-Lopez, 1988; Sauerborn *et al.*, 1989; Abu-Irmaileh, 1991; Linke *et al.*, 1991).

Gamliel and Katan (1991) noticed rapid colonization of beneficial fluorescent pseudomonas in rhizosphere of solarized soil which could increase the dry weight of various plants. Habeeburrahaman (1992) recorded yields of sorghum and groundnut crops in solarized plots comparable to weed free plots and were superior to farmers practice at Dharwad. Kumar *et al.* (1993) reported improvement in plant height, leaf area and dry weight coupled with increased yields of sorghum by 78 per cent. Katan and Devay (1995) cited the improvement in the yield of many crops throughout the world in several places. Biradar (1996) observed improved growth and yield parameters of groundnut due to solarization as compared to weedy check. He reported on par yield between soil solarization of wet soil for 60 days with thin TPE (0.05 mm) and weed free check in groundnut. However, yield losses (1.2-61.8%) were imminent from soil solarization as compared to weed free check. Soil solarization causes chemical, physical and biological changes in the soil that improve plant growth and development and often results in substantial yield increases (Abu-Gharbieh, 1997).

2.7 EFFECT OF CULTURAL METHODS ON WEED CONTROL

Prabhakar Shetty (1973) reported maximum weed weight (9330 kg ha) in unweeded control treatment and pod yield was maximum in weed free check (1432 kg/ha) and it was on par with hand weeding and hoeing. It was found that weed free environment maintained upto 45 days after sowing with three hand weedings at an interval of 15 days, resulted in higher yield components and higher pod yield. Buchanan and Hauser (1980) reported that a single cultivation for four weeks after emergence increased the yield substantially compared with unweeded control. Cultivation had no effect when groundnut crop was kept weed free for four to eight weeks. Hand weeding and hoeing beyond 45 days after sowing caused a reduction in yield as a result of disturbing the soil around the plants. Cumulative effect of cultural practices facilitating peg penetration and pod development with less weed competition and consequently high pod yield has been reported by Rajah *et al.* (1984).

The groundnut pod yield and haulm yields were significantly higher with two hand weedings at 15 and 30 days after sowing which is closely followed by hand weeding at 15 days and hoeing at 30 days after sowing compared to the unweeded check (Rathi *et al.*, 1986).

Kondap *et al.* (1989) reported that hand weeding at 15 and 35 days afte sowing resulted in highest pod yield and the per cent increase in yield over weedy check was 302 per cent.

Malavia and Patel (1989) studied that hand weeding twice at 20 and 40 days after sowing with three intercultural operations at 20, 40 and 60 days after sowing recorded the highest pod yield (12.9 q/ha) compared to herbicidal treatments (3.5 to 4.40 q/ha) and unweeded check (2.3 q/ha).

The highest number of nodules per plant (93.8) and nodule weight per plant (13.9 g) at 90 days was obtained with two hand weedings and three intercultures compared to the herbicidal and unweeded check. Hand weeding twice at 15 and 30 days after sowing followed by intercultivation at 15, 30 and 45 days after sowing recorded the highest pod yield of 28.90 q per ha and it was followed by 28.19 q per ha with preplant application of fluchloralin at one kg a.i. per ha with three intercultivations. Increase in yield was 208 and 207 per cent, respectively over unweeded control (Murthy *et al.*, 1992).

Mahalle (1992) noticed that hand weeding twice (30 and 40 days after sowing) recorded 16.42 q/ha of groundnut pod yield and was on par with weed free check (17.17 q/ha).

Sivannarayana and Bhanumurthy (1992) observed that manual weeding twice at 20 and 40 days after sowing, reduced the total weed density and dry weight compared to weedy control in groundnut. In general, greatest control of weeds including *Cyperus rotundus* and greatest yields were achieved. Narasimha Reddy *et al.* (1993) noticed that hand weeding at 25 and 40 days after sowing produced highest groundnut yields.

2.8 EFFECT OF CHEMICAL METHODS ON WEED CONTROL

Singh *et al.* (1980) observed that pre emergence application of alachlor at 2.5 to 3 kg a.i. per ha controlled the weeds successfully and increased the pod yield.

Kulandaivelu and Morachan (1981) reported that pre sowing application of alachlor at 1.5 kg a.i. per ha or nitrofen at 2 kg a.i. per ha to bunch type cultivar POL-2 was effective against weeds and resulted in pod yield similar to those obtained with two hand weedings. Uncontrolled weed resulted in 33.77 per cent reduction in pod yield compared with the alachlor at 1.5 kg a.i. per ha.

In screening trial of herbicides for tomato crop, it was found that alachlor at 1.5 kg a.i. per ha and metribuzin at 0.35 kg a.i. per ha applied before planting gave highest weed control efficiency and produced higher fruit yield as compared to other herbicidal treatments. They also found that the dry matter of fruit and total soluble solids were not affected by herbicide treatments (Nair *et al.*, 1982).

Choudhary and Lagoke (1985) reported that uncontrolled weed growth resulted in 33.77 per cent reduction in groundnut pod yield as compared alachlor at 1.5 kg a.i. per ha. Alachlor at 1.5 kg a.i. per ha or 2 kg nitrofen pre emergence was similar to one hand weeding and one hoeing in weed control efficiency. Herbicides increased dry matter accumulation and number of pods per plant compared with cultural treatment (Kulandaivelu and Sankaran, 1986).

Kavani *et al.* (1985) noticed that application of fluchloralin, alachlor, nitrofen and metribuzin, each at two rates, gave effective control of weeds in tomato and significantly higher fruit yields than the unweeded control. Metribuzin at 0.7 to 1.05 kg a.i. per ha gave the lowest weed dry weight at harvest and also it gave the highest net returns which was 13.1 and 69.0 per cent higher than weed free condition and unweeded control, respectively.

Alachlor is a selective herbicide and groundnut was highly tolerant to pre emergence treatments and the herbicide was particularly active against most grasses and wide range of broad leaved weeds (Joshi, 1987). Lunsford *et al.* (1987) observed that 60 per cent control of grasses (*Digitaria ciliaris* and *Dactyloctenium aegyptium*) in groundnut due to application of pre emergence reduced the weed population and dry matter content of weeds. The maximum number of pods per plant and yield of pods (3514 kg/ha) were obtained with alachlor.

Doub *et al.* (1988) also reported good control of *Digitaria sanguinalis* in groundnut due to alachlor treatment. Krishinevsky *et al.* (1988) also reported that the recommended dose of alachlor in peanut did not show any adverse effect on nodulation.

Prusty *et al.* (1990) reported that application of metachlor at 0.75 kg a.i. per ha recorded highest weed control efficiency (81.2%), highest number of branches (5.4) and pods (7.6) per plant, lowest weed index (19.00) and highest groundnut pod yield (1014 kg/ha) compared to other herbicides tried. The farmers practice of two manual weedings and hoeing at 15 and 25 days after germination recorded the maximum pod yield (1252 kg/ha).

MATERIAL AND METHODS

III. MATERIAL AND METHODS

The details of the material used and the methods adopted in conducting the experiments are described in this chapter :

3.1 EXPERIMENTAL SITE

The field experiment was conducted during 1997-98 and 1998-99 at Agronomy Field Unit, Main Research Station, University of Agricultural Sciences, Hebbal, Bangalore, situated in the Eastern Dry Zone of Karnataka State at 12°58' N latitude, 77°35'E longitude with an altitude of 930 meters above the mean sea level.

3.2 SOILS OF THE EXPERIMENTAL SITE AND ITS PREVIOUS HISTORY

The soils of the experimental site was red sandy loam. Composite soil samples from 0 to 15 cm soil depth were collected from the experimental site before solarization and analysed for textural classification and chemical properties. The data are presented in Table 3.1. The coarse sand, fine sand, silt and clay contents of the soil were 53.10, 27.15, 18.25 and 11.50 per cent, respectively. The bulk density of the soil was 1.48 g cc^{-1} and the particle density was 2.64 g cc^{-1}. The soil was slightly acidic in reaction (pH 6.53) with

Table 3.1 Physical and chemical properties of the soil of experimental site (0-15 cm depth).

Sl. No.	Particulars		Methods followed
I.	**Physical properties**		
A.	**(Mechanical analysis on per cent of oven dry weight basis)**		
1.	Coarse sand	53.10	International Pipette Method (Piper, 1966)
2.	Fine sand	27.15	
3.	Silt	8.25	
4.	Clay	11.50	
5.	Textural class	Sandy loam	
B.	**Moisture constants**		
1	Field capacity (%)	11.03	Field method (Piper, 1966)
2.	Permanent wilting point (%)	7.83	
3.	Available water (cm)	0.78	
4.	Bulk density (g/cc)	1.63	Core sampler method Piper (1966)
II.	**Chemical properties**		
1	Soil pH	6.53	Buckman's Zerometric pH meter (Piper, 1966)
2.	EC (dsm^{-1})	0.21	Conductometry (Jackson, 1973)
3.	Organic carbon (%)	0.37	Walkley and Black Wet Oxidation method (Piper, 1966)
4.	CEC (me/100 g)	8.40	Neutral Normal NH_4OAC (Jackson, 1973)
5.	Available nitrogen (kg ha^{-1})	161.25	Alkaline permangnate method (Subbaiah and Asija, 1956)

Table 3.1 Contd...)

Sl. No.	Particulars		Methods followed
6.	Available P_2O_5 (kg ha^{-1})	33.25	Brays method(Jackson, 1973)
7.	Available K_2O (kg ha^{-1})	249.45	Flame Photometry (Jackson, 1973)
8.	Available S (ppm)	10.01	Turbidimetry (Jackson, 1973)
9.	Exchangeable Ca (me/100 g)	0.50	EDTA method (Jackson, 1973)
8	Exchangeable Mg (me/100 g)	0.21	EDTA method (Jackson, 1973)
9	Exchangeable Na (me/100 g)	0.14	Flame photometry (Jackson, 1973)

Plate 1 General view of the experimental site

an electric conductivity of 0.21 dsm^{-1}. The soil was medium in available nitrogen (161.25 kg/ha), available phosphorus (33.35 kg P_2O_5/ha) and available potassium (249.45 kg K_2O/ha). The soil was low in organic carbon content (0.36%) with a CEC of 8.4 me/100 g, available sulphur (10.01 ppm) exchangeable calcium (0.50 me/100 g), exchangeable magnesium (0.21 me/100 g) and exchangeable sodium (0.14 me/100 g). During the previous years (1997-98 and 1998-99) the field had sunhemp green manuring crop.

3.3 CLIMATIC CONDITIONS

The normal (1986 to 1996) as well as the weather conditions for the period under study (1997-98 and 1998-99) and deviations from the normal with respect of maximum and minimum temperature, rainfall, mean relative humidity, open pan evaporation and bright sunshine hours are presented in Table 3.2 and indicated in Fig. 1 and 2.

3.3.1 Normal climatic conditions

The mean monthly maximum and minimum temperature ranged from 27.41 to 34.10°C and 13.6 to 20.5°C, respectively. The mean maximum temperature was highest during the month of April and decreased gradually upto

Table 3.2 Normal (1986-1996) and actual (1997-98 and 1998-99) mean monthly weather data at MRS, Hebbal, Bangalore.

Month	Total rainfall (mm)					Mean maximum temperature (°C)					Mean maximum temperature (°C)				
	Normal	Actual		Deviation		Normal	Actual		Deviation		Normal	Actual		Deviation	
	1986-96	1997	1998	1997	1998	1986-96	1997	1998	1997	1998	1986-96	1997	1998	1997	1998
January	5.83	-	-	-5.83	-5.83	27.41	27.80	28.90	0.39	1.49	13.60	14.10	16.90	0.50	3.30
February	3.69	-	-	-3.69	-3.69	30.60	29.80	31.10	1.30	0.50	15.30	15.70	17.50	0.40	2.20
March	8.84	20.50	1.00	17.70	-7.84	32.80	32.70	33.70	0.10	0.90	18.00	17.60	20.10	-0.40	2.00
April	82.80	37.00	40.80	14.20	-14.20	34.10	32.70	35.20	1.40	1.10	20.50	20.10	22.50	-0.40	2.00
May	60.10	53.00	41.70	-7.10	-18.90	32.10	34.10	33.90	2.00	1.80	20.50	21.30	22.60	0.80	2.10
June	71.60	23.10	7.40	-48.50	-64.20	31.92	29.90	32.10	-2.02	-0.18	19.00	20.50	21.60	1.50	2.60
July	96.47	81.40	134.70	-15.07	38.23	29.20	29.00	28.50	-0.20	0.20	18.60	20.00	21.60	1.40	2.00
August	128.19	92.00	319.90	-36.19	191.50	28.70	29.30	28.20	0.60	-0.50	18.50	20.10	20.40	1.60	1.90
September	197.94	321.20	156.70	23.26	41.24	28.60	28.90	27.90	-0.30	-0.70	18.70	19.40	20.00	0.70	1.30
October	120.80	264.40	170.70	25.60	50.90	28.30	2710	28.00	-1.20	-0.30	18.10	19.60	19.10	1.50	1.00
Nobember	48.93	44.40	40.00	-4.53	-8.93	28.90	27.00	27.10	-1.40	-1.30	16.40	18.50	17.70	2.10	1.30
December	15.50	14.90	16.90	-0.60	-24.50	26.90	26.50	26.30	-0.40	-0.60	14.40	16.50	16.10	2.10	1.70

Table 3.2 Contd...)

Month	Relative humidity (%)					Bright sunshine hours					Evaporation (mm)				
	Normal	Actual		Deviation		Normal	Actual		Deviation		Normal	Actual		Deviation	
	1986-96	1997	1998	1997	1998	1986-96	1997	1998	1997	1998	1986-96	1997	1998	1997	1998
January	62.00	65.00	68.50	3.00	6.50	4.37	4.30	4.10	-0.07	-0.27	8.68	8.60	9.50	-0.08	0.82
February	56.00	59.00	62.50	3.00	6.50	5.68	5.90	5.10	0.22	-0.58	9.90	10.40	10.10	0.49	0.19
March	49.00	57.50	55.50	8.50	6.50	7.28	7.10	6.90	-0.18	-0.58	8.56	9.60	9.90	1.04	1.34
April	54.00	58.50	57.00	4.50	3.00	7.38	6.40	7.60	-0.98	0.22	8.78	9.60	9.80	0.82	1.02
May	58.00	60.50	65.00	2.50	7.00	7.26	7.00	6.60	-0.26	-0.66	8.53	7.00	9.10	-1.53	0.57
June	67.00	62.00	70.00	5.00	3.00	5.48	6.20	6.40	0.72	0.09	6.37	7.20	7.80	0.82	1.43
July	72.00	74.50	78.00	2.50	6.00	4.88	4.90	4.30	0.02	-0.58	6.06	4.10	4.60	-1.96	-1.46
August	73.00	75.00	81.00	2.00	7.00	4.25	4.90	3.40	0.65	-0.85	4.96	5.90	4.50	0.94	-1.40
September	73.00	75.00	81.00	2.00	7.00	4.54	4.10	3.30	0.44	1.24	6.38	6.70	4.30	0.32	-2.40
October	70.00	80.50	78.50	10.50	8.50	3.79	2.80	3.10	-0.99	0.69	6.58	6.10	5.40	-0.48	-0.70
Nobember	70.00	75.00	76.00	5.50	6.00	3.40	3.00	2.90	0.40	-0.50	5.23	7.80	6.10	2.57	0.60
December	67.00	72.00	72.50	5.00	5.50	3.32	3.20	3.10	0.12	-0.22	7.17	9.60	9.00	2.43	1.83

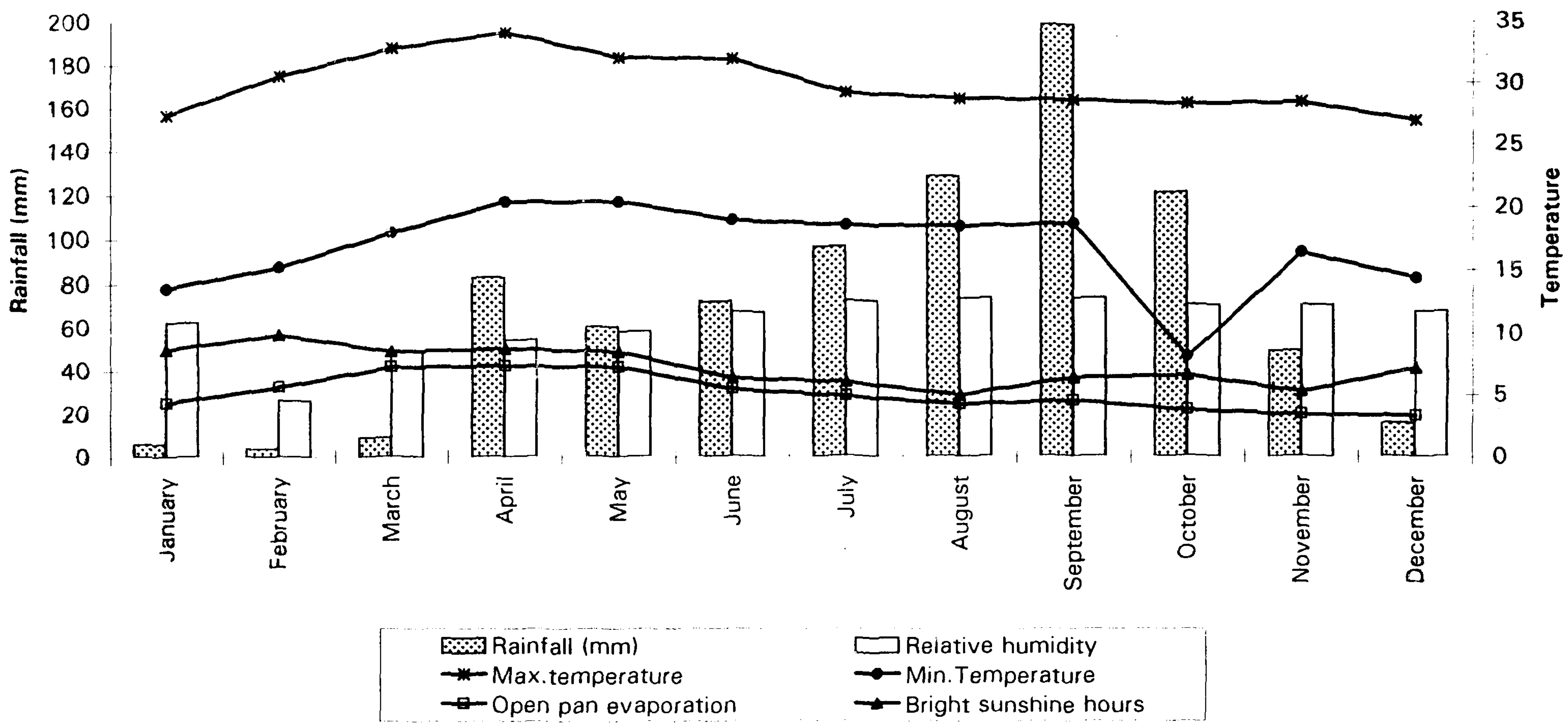


Fig.1. Meteorological data for the period 1986-1996 at MRS, Hebbal, Bangalore

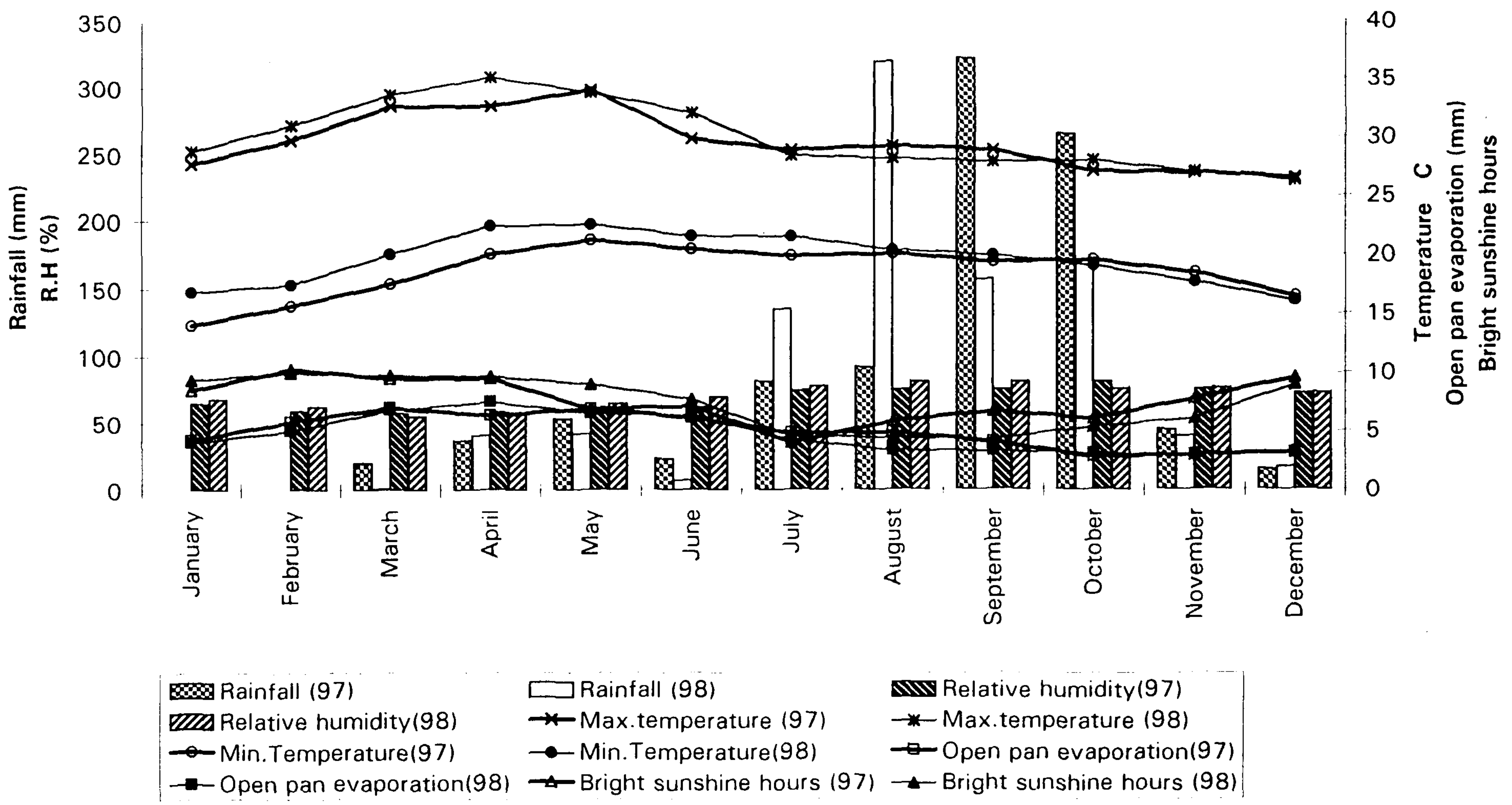


Fig.2. Meteorological data for the years 1997-98 and 1998-99 at MRS, Hebbal, Bangalore

December, while the mean minimum temperature was lowest in the month of January. It gradually increased upto June and later declined upto January.

The normal annual rainfall of the station was 780.69 mm. The major portion of it was received in the month of May and between July to October months with two peaks observed during May (60.10 mm) and September (197.94 mm). The average open pan evaporation ranged from 3.32 mm to 7.38 mm per day. Evaporation increased gradually from January to April and then decreased.

The mean relative humidity ranged from 49 per cent in March to 79 per cent in August. It increased gradually from March to August and decreased later upto February. The duration of bright sunshine hours was more than eight hours per day during the months of January to May. It was less than five hours during August to December.

3.3.2 **Weather conditions during the period of experimentation**

The mean maximum temperature was slightly below the normal in the months of June and July and September to December (1997-1998). In the remaining months it was slightly above the normal. The deviation of the mean maximum temperature was more (-1.3°C) in the month of November 1998-99 and it was marginal in the other months. The mean minimum temperature deviation ranged from 1.0 to 3.3°C (1998-99). The months of March and April (1997-98) were cooler than the normal minimum temperature.

The total rainfall received during 1997-98 (941.6 mm) and 1998-99 (930.8 mm) were more than the normal rainfall. The mean relative humidity was more than the normal in all the months during both the years of experimentation. The deviation of mean relative humidity was more in October (10.5%) during 1997-98 and in October (8.5%) during 1998-99.

The open pan evaporation ranged from 2.8 to 7.10 and 2.90 to 7.6 mm per day, respectively during 1997-98 and 1998-99. The rate of evaporation increased suddenly from February and reached maximum in March (1997-98) and April (1998-99) months. Sunshine hours observed during the experimental period was lower than normal in January, May, July and October (1997-98) and July, August, September and October during 1998-99.

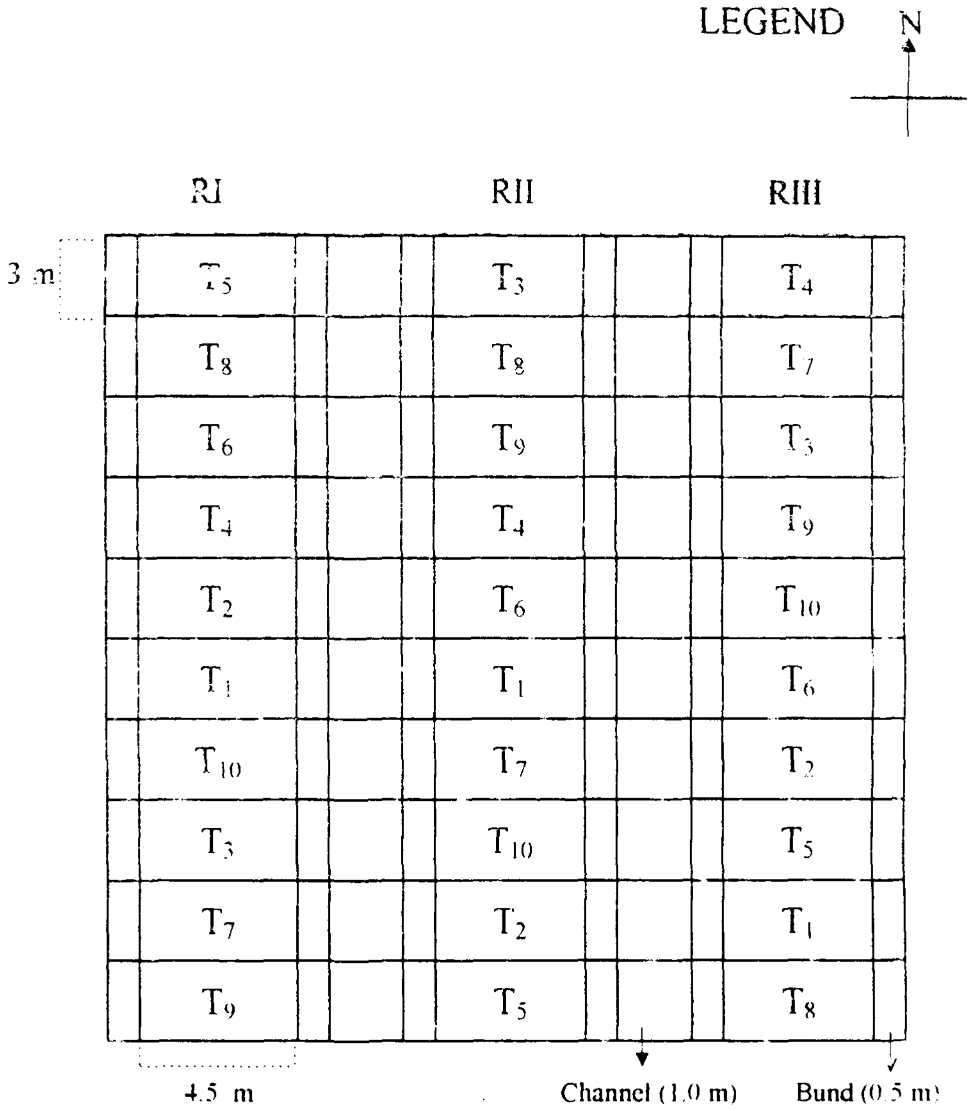
3.4 CULTURAL OPERATIONS

3.4.1 **Preparatory tillage** : Preparation of land by discing, passing cultivator and levelling was completed and plots were laid out as per the plan by creating small field bunds around each plot. The plots were irrigated before spreading polyethylene sheets. The transparent polyethylene sheets of required size were

Table 3.3 Details of the field experiments (1997-98 and 1998-99) including field operations.

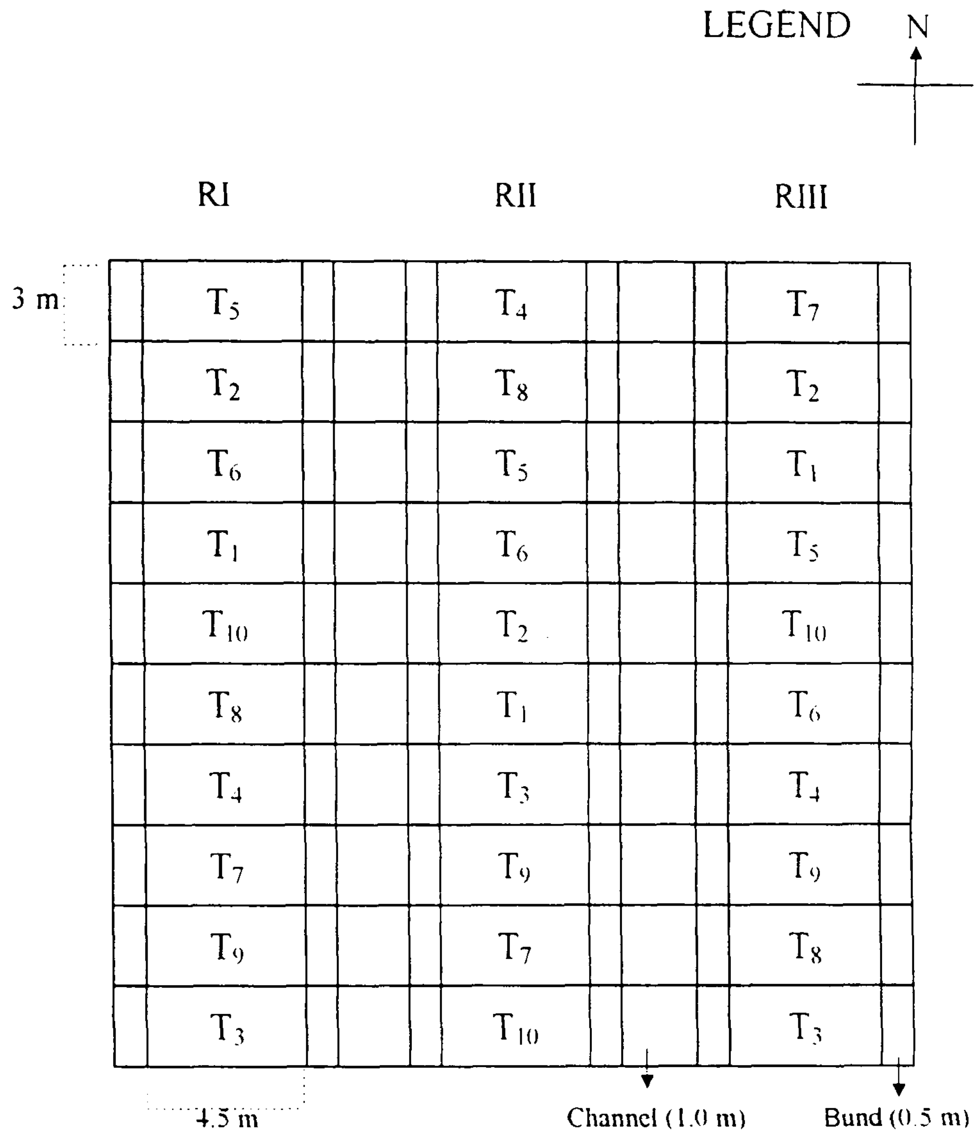
Particulars	I Year (1997-98)	II Year (1998-99)
(a) Title	Effect of soil solarization on weed control, crop growth and yield of groundnut-tomato in sequence in conjunction with cultural and chemical methods of weed control	
(b) Design	Randomized Complete Block Design	
(c) Replications	Three	
(d) Treatments	T_1 : TPE 0.05 mm 15 days T_2 : TPE 0.05 mm 30 days T_3 : TPE 0.05 mm 45 days T_4 : TPE 0.10 mm 15 days T_5 : TPE 0.10 mm 30 days T_6 : TPE 0.10 mm 45 days T_7 : Alachlor 1.5 kg a.i. ha^{-1} T_8 : One hand weeding at 20 DAS T_9 : Two hand weedings at 20 and 40 DAS T_{10}: Control	
(e) Plan of layout	Fig. 2a	Fig. 2b
(f) Plot size	**Gross plot** : 4.5 m x 3.0 m **Net plot** Groundnut : 4.05 m x 2.70 m Tomato : 3.98 m x 2.10 m	
(g) Date of TPE spreading	15-04-1997	01-04-1998

LEGEND



T_1 : TPE 0.05 mm 15 days
T_2 : TPE 0.05 mm 30 days
T_3 : TPE 0.05 mm 45 days
T_4 : TPE 0.1 mm 15 days
T_5 : TPE 0.1 mm 30 days
T_6 : TPE 0.1 mm 45 days
T_7 : Alachlor 1.5 kg a.i./ha
T_8 : One hand weeding at 20 DAS
T_9 : Two hand weedings at 20 and 40 DAS
T_{10} : Control

Fig.2a : Plan of layout of field experiment (I year 1997-98)



T_1 : TPE 0.05 mm 15 days
T_2 : TPE 0.05 mm 30 days
T_3 : TPE 0.05 mm 45 days
T_4 : TPE 0.1 mm 15 days
T_5 : TPE 0.1 mm 30 days
T_6 : TPE 0.1 mm 45 days
T_7 : Alachlor 1.5 kg a.i./ha
T_8 : One hand weeding at 20 DAS
T_9 : Two hand weedings at 20 and 40 DAS
T_{10} : Control

Fig.2b : Plan of layout of field experiment (II year 1998-99)

Table 3.3 Contd...)

Particulars	I Year (1997-98)	II Year (1998-99)
(h) Date of TPE removal	Polyethylene sheets were spread and removed after the required period of soil solarization as per treatments before groundnut crop and its effect was also studied in the suceeding crop of tomato.	
(i) Sowing/planting dates	Groundnut : 16-07-1997 Tomato : 23-10-1997	12-06-1998 26-10-1998
(j) Date of harvesting	Groundnut : 18-11-1997 Tomato : 25-02-1998	15-10-1998 24-02-1999
(k) Irrigation	Weekly irrigation schedule was given for the crops	
(k) Variety	Groundnut TMV-2, Tomato - Pusa Ruby	
(l) Seedling/Seed rate	100 kg ha^{-1}	375 g ha^{-1}
(m) Spacing	30 cm x 10 cm	75 cm x 60 cm
(n) Fertilizers (kg ha^{-1}) ($N : P_2O_5 : K_2O$)	25 : 75 : 37.5	45 : 100 : 60
(o) FYM (t ha^{-1})	10 t ha^{-1}	
(p) Gypsum	500 kg ha^{-1}	

spread on the respective plots depending on the treatments (Table 3.3) and were sealed at all the sides to make it air tight with moist soil (Plate 2 and 3).

3.4.2 **Application of manure and fertilizers** : In both the years (1997-98 and 1998-99) recommended dose of N, P_2O_5 and K_2O for groundnut and tomato and FYM for only first crop (groundnut) were applied. FYM was incorporated before spreading polyethylene sheets, whereas chemical fertilizers were applied as per the package of practice recommendation (Table 3.3) through urea, single super phosphate and murate of potash to supply N, P and K respectively.

3.4.3 **Seeds and sowing/planting** : Groundnut seeds were sown in line at a spacing of 30 cm x 10 cm after opening shallow furrows manually. Thereafter plots were irrigated immediately. After groundnut was harvested manual digging was done to remove crop and weed stubbles. Tomato seedlings of 30 days age were transplanted in the field by opening shallow lines of required spacing without disturbing the soil much. The plots were irrigated before and after transplanting to ease the transplanting and to lessen the transplanting shock.

3.4.3.1 **Tomato cultivation in nursery** : Three raised nursery beds were prepared and well decomposed compost (25 kg/bed) along with recommended dose of NPK (0.5 kg of mixed fertilizer having 15 : 15 : 15 ratio of N : P_2O_5 : K_2O) was mixed well in the soil. Seeds were sown in line at 10 cm spacing.

Plate 2 Levelling of the experimental plot before spreading polyethylene sheets

Plate 3 Sealing the spreaded polyethylene sheet to make it airtight

Then the seeds were covered with fine FYM. Shade was provided till the germination using coconut fronds and the beds were watered regularly and water supply was gradually reduced during the last 10 days before transplanting to harden the seedlings. The beds were sprayed with carbendazim at the rate of 0.5 g/litre to avoid damping off of tomato seedlings. To boost up the seedlings growth 0.1 per cent urea spray was given three weeks after sowing. The 30 days old seedlings were used for transplanting. The nursery practices remained same for both the years (1997-98 and 1998-99).

3.4.4 **Plant protection measures** : The groundnut crop was sprayed with monocrotophos (2 ml/litre) at four and eight weeks after sowing to control pests. The tomato crop was sprayed with cypermethrin (2 ml/litre) at flowering stage to avoid *Heliothis* problem and Dithane M-45 (3 g/litre) fungicide was sprayed at 60 days after transplanting to control leaf spot.

3.4.5 **Weeding** : In both the years (1997-98 and 1998-99) hand weeding was done as per the treatments. In the solarized plots (T_1 to T_6) and in control (T_{10}) no weeding was done. Weeding was done once (T_8) at 20 days after sowing and twice (T_9) at 20 DAS and 40 DAS sowing. Pre emergence application of alachlor at 1.5 kg a.i. ha^{-1} applied soon after sowing of groundnut seeds (T_7).

3.4.6 **Harvesting** : Harvesting and threshing of groundnut was done as per the package of practices and in tomato, fruits were harvested twice a week.

3.5 DETAILS OF COLLECTION OF EXPERIMENTAL DATA

The daily observations recorded and procedures followed are given in **Table 3.4**.

3.6 CHEMICAL ANALYSIS OF SOIL AFTER SOLARIZATION

The solarized soil was analysed for oxidizable carbon, available N, available phosphorus, available potassium, available sulphur, exchangeable magnesium, exchangeable calcium and exchangeable sodium. The soil samples were collected from 0 to 15 cm immediately after solarization from solarized and control plots, dried under sun, powdered and used for the estimation of oxidizable carbon, available N, available P_2O_5, available K_2O and available S as outlined by Jackson (1973). Similarly exchangeable calcium and exchangeable magnesium and sodium were analysed by EDTA method following the procedure outlined by Jackson (1973).

3.7 MICROBIAL POPULATION

From each treatment, 10 g of soil was taken from 0-15 cm soil depth and the suspensions were made and cultured by using different media following the

Table 3.4 Details of collection of experimental data.

Sl. No.	Parameters	Procedures
1	**Soil**	
	(a) Soil temperature	Soil temperature was recorded using piercing type of mercury thermometer (Plate 4) at 5.0 and 10 cm soil depth in both covered and non covered plots at five days interval (5, 10, 15, 20, 25, 30, 35, 40 and 45 DAPS) between 2.00 to 3.00 P.M. The hole made in TPE film while recording soil temperature was pasted with transparent gum tape.
	(b) Soil moisture	Soil moisture content was determined at 0-15 cm and 15-30 cm soil depth gravimetrically at 5 days interval (5, 10, 15, 20, 25, 30, 35, 40 and 45 DAPS) while recording soil temperature.
2	**Weeds**	
	(a) Weed count/m^2	Periodical recording of weed number at 30 days interval from 1.0 m^2 area was done in both groundnut and tomato
	(b) Weed dry weight (g/0.25 m^2)	Weed dry weight was recorded periodically at 30 days interval in 0.25 m^2 destructive sampling area (oven dried at 60 ± 5°C). Sundried weed dry weight was recorded in the net plot area after the harvest of both groundnut and tomato crops and expressed in kg/ha
3	**Crops**	
	(a) Plant height	Height from base of the plant to the tip of main shoot in groundnut and tomato at 30 days interval and average was workedout
	(b) Branches	Branch number (both primary and secondary branches no/plant) on five labelled plants was counted periodically at 30 days interval and average was worked out

Plate 4 Measuring soil temperature using piercing type of thermometer

Table 3.4 Contd...)

Sl. No.	Parameters	Procedures
	(c) Leaves	Leaves on five labelled plants were counted periodically at 30 days interval and average was worked out
	(d) Leaf area	Leaf area (dm^2/plant) was worked out periodically at 30 days interval by using disc method in groundnut and tomato on dry weight basis (Vivekanandan *et al.*, 1972)
	(e) Leaf area index	$LAI = \frac{\text{Leaf area } (dm^2)}{\text{Land area } (dm^2)}$ (Sestak *et al.*, 1971)
	(f) Dry matter accumulation (g/plant)	Leaves, stem and reproductive parts were separated and dried at 65-70°C in oven and weights were recorded separately and totalled at 30 days interval
	(g) Nodule number and dry weight/ plant	Nodules were counted and oven dried to a constant weight and their weight were recorded at 60 and 90 DAS
	(h) Pod weight	Mean weight of the pods from five plants was taken as pod weight (g/plant) at harvest
	(i) Number of pods/plant	Recorded on five plants of groundnut at harvest
	(j) 100 kernel weight (g)	Recorded on randomly picked 100 seeds (g) from net plot yield in groundnut at harvest

Table 3.4 Contd...)

Sl. No.	Parameters	Procedures
	(k) kernel yield	$$\text{Kernel yield (q/ha)} = \frac{\text{Pod yield (q/ha) x Shelling per cent}}{100}$$ Kernel yield/ha was calculated by multiplying the pod yield per ha with shelling per cent
	(l) Shelling percentage	Worked out by dividing kernel yield by pod yield and expressed in percentage at harvest
	(m) Pod yield	The pods from the net plot area separated, dried and their dry weight was recorded. It was expressed as quintals per ha at harvest
	(n) Haulm yield	The yield of above ground dry matter per net plot was recorded after drying and weight was recorded and expressed as quintals per ha at harvest
	(o) Number of mature pods/plant	The number of mature pods including single kernel and more than one kernel were counted in five plants and the mean number was worked out at harvest.
	(p) Days taken for 50% flowering in tomato	The number of plants flowered every day after commencement of flowering and noting the date on which 50 per cent of the plants flowered in each plot. The days taken from the date of transplanting to this date was expressed as days taken for 50 per cent at flowering.
	(q) Number of marketable fruits/plant in tomato	The total number of marketable tomato fruits from all the pickings was recorded from the tagged plants and then mean number of marketable tomato fruits per plant was worked out at each harvest

Table 3.4 Contd...)

Sl. No.	Parameters	Procedures
(r)	Weight of marketable tomatoes	The weight of marketable tomatoes from all the pickings was recorded from the tagged plants and totalled. The mean weight of marketable tomatoes per plant was calculated at each harvest.
(s)	Specific gravity of tomato (w/v)	The specific gravity of the fruit was computed by dividing the value of the fresh weight of tomato by that of its volume. Volume of the tomato was determined by water displacement method using a measuring cylinder. The readings for specific gravity for tomato from the tagged plants were recorded and the mean value was worked out at each harvest
(t)	Weed control efficiency (WCE)	$\text{WCE} = \dfrac{\text{Weed dry weight in control plot} - \text{Weed dry weight in treated plot}}{\text{Weed dry weight in control plot}} \times 100$

DAPS = Days after polyethylene spreading dilution plate technique as suggested by Allen (1953). The number of colonies were counted and multiplied by the dilution factor for the concerned group of micro organisms and expressed as the number of fungi, bacteria and actinomycetes per gram of oven dry soil.

3.8 CORRELATION STUDIES

Simple correlation test was used to findout the relationship between growth,yield and yield components of groundnut crop.

3.9 SATELLITE EXPERIMENT

3.9.1 **Germination studies in polyethylene covers** : The soil samples were collected treatment wise during 1998-99 field experiment. Further, the soil samples were collected in three depths (0-5 cm, 5-10 cm and 10-15 cm) and were taken in polyethylene covers conferring each depth and each plot to a polyethylene cover. They were incubated at air temperature maintaining optimum moisture conditions. Germinated weed seeds were counted periodically at five days interval upto 45 days.

3.10 ECONOMICS

While working out the economics, information on market rates of different inputs including labour charges were considered. Net profits were estimated for each treatments considering the cost of cultivation and gross profits for each treatment.

3.11 STATISTICAL ANALYSIS AND INTERPRETATION OF THE DATA

The data were statistically analysed and analysis of variance tables were formed following the procedure outlined by Gomez and Gomez (1984) and Sundarraj *et al.* (1972). The results have been discussed at five per cent probability level. The weed data (population and dry weight) have been transformed ($\sqrt{x + 0.5}$) prior to analysis and the transformed values have been used for presenting the results.

EXPERIMENTAL RESULTS

IV. EXPERIMENTAL RESULTS

The results of the experiment conducted during 1997-98 and 1998-99, on the effect of soil solarization for weed control in groundnut-tomato crop sequence in conjunction with cultural and chemical methods of weed control are presented in this chapter.

4.1 INFLUENCE OF SOIL SOLARIZATION ON PHYSICAL AND CHEMICAL PROPERTIES OF SOIL

4.1.1 **Soil temperature** : Soil temperature differed significantly at 5 cm and 10 cm soil depths due to soil solarization with Transparent polyethylene sheet (TPE) in both the years 1997-98 and 1998-99.

In pooled data (**Table 4.1**) the maximum soil temperature attained at 20 days after polyethylene spreading (DAPS) due to TPE 0.05 mm for 45 days was 53.1 and 50.7°C at 5 and 10 cm soil depths respectively and the temperature were higher over control (40 and 36°C at 5 and 10 cm soil depth respectively).

During 1997-98, among all the treatments, all soil solarization treatments resulted in higher mean soil temperature (48.25°C at 5 cm and 44.85°C at 10 cm soil depth) as compared to non solarization treatment (38.84°C at 5 cm and 34.6°C at 10 cm soil depth). Among the solarization treatments, TPE 0.05 mm for 45 days recorded significantly higher soil temperature at all readings at both 5 cm (52.2°C) and 10 cm (49°C) over TPE 0.05 mm for 15 days at 30 days solar tarping (**Appendix 1 and 2**). Among the TPE, 0.1 mm for 45 days caused

Table 4.1. Soil temperature (°C) at 5 and 10 cm soil depth as influenced by solarization treatments (pooled)*.

Treatment	5 DAPS		10 DAPS		15 DAPS		20 DAPS		25 DAPS		30 DAPS		35 DAPS		40 DAPS		45 DAPS	
	5 cm	10 cm	5 cm	10 cm	5 cm	10 cm	5 cm	10 cm	5 cm	10 cm	5 cm	10 cm	5 cm	10 cm	5 cm	10 cm	5 cm	10 cm
TPE 0.05 mm 15 days	48.9	47.4	47.8	44.7	51.5	47.5												
TPE 0.05 mm 30 days	49.2	47.2	49.1	45.9	52.0	49.3	51.8	49.0	50.4	46.9	50.8	47.4						
TPE 0.05 mm 45 days	49.8	47.5	49.7	46.3	52.5	49.9	53.1	50.7	42.2	49.4	52.7	49.9	51.5	48.1	50.4	48.3	50.1	47.9
TPE 0.1 mm 15 days	46.9	44.1	48.2	41.9	49.0	45.5												
TPE 0.1 mm 30 days	48.6	45.6	46.6	43.9	49.4	47.1	49.4	46.1	49.1	45.4	49.1	46.2						
TPE 0.1 mm 45 days	48.3	45.9	47.4	44.6	50.7	47.8	51.5	48.9	50.6	47.9	50.3	47.7	49.4	47.1	48.6	45.8	47.9	45.7
Control	39.8	36.5	35.8	32.8	41.6	38.0	40.0	36.0	40.3	35.0	39.0	34.5	37.6	34.5	37.0	34.8	37.5	34.1
S Em±	0.27	0.44	0.51	0.61	0.51	0.63	0.39	0.58	0.49	0.51	0.77	0.43	0.61	0.24	0.38	0.80	0.67	0.71
CD at 5%	0.81	1.32	1.53	1.79	1.53	1.89	1.17	1.72	1.49	1.53	2.31	1.29	1.82	0.72	1.14	2.39	2.01	2.12

DAPS = Days after polyethylene spread;
TPE = Transparent polyethylene;
* = Pooled data of two years.

higher soil temperature at all readings both at 5 cm (50.1°C) and 10 cm (45.9°C) soil depth as compared to TPE 0.1 mm thickness for 15 and 30 days after polyethylene tarping. However, in general TPE 0.05 mm recorded higher soil mean temperature (49.45°C at 5 cm and 46.56°C at 10 cm soil depth) over TPE 0.1 mm (47.2°C at 5 cm and 43.81°C at 10 cm soil depth) at all the stages of observations.

During 1998-99, soil solarization with TPE 0.05 mm resulted in higher temperature at 5th (52.8 and 50.9°C), 10th (53.3 and 51.5°C), 15th (54.2 and 52.0°C), 20th (54.0 and 52.3°C), 25th (53.0 and 51.3°C) and 30th (53.3 and 51.7°C) days and soil solarization with TPE 0.1 mm for 45 days recorded higher soil temperature at 5th (51.6 and 50.3°C), 10th (51.8 and 50.2°C), 15th (52.5 and 50.3°C), 20th (52.9 and 50.5°C), 25th (51.5 and 49.9°C) and 30th (50.5 and 49.5°C) days after spreading TPE at 5 cm and 10 cm soil depths, respectively. However, soil solarization with TPE 0.05 mm for 45 days recorded higher soil temperature (54.2 and 52.0°C at 5 cm and 10 cm soil depths, respectively) as compared to TPE 0.1 mm for 45 days (52.5 at 5 cm and 50.3°C at 10 cm soil depths, respectively). In general TPE 0.05 mm resulted in higher soil temperature over TPE 0.10 mm in all the durations during both the years (**Appendix 1 and 2**).

4.1.2 **Soil moisture** : Soil moisture differed due to soil solarization (both at 0-15 cm and 15-30 cm soil depth) over non solarized control **(Table 4.2)**. All the solarization treatments retained higher soil moisture of 11.69 and 12.39 per cent at 0-15 cm and 15-30 cm soil depths, respectively over control. Soil moisture

Table 4.2. Soil moisture (%) as influenced by soil solarization treatments.

Treatment	5 DAPS		10 DAPS		15 DAPS		20 DAPS		25 DAPS		30 DAPS		35 DAPS		40 DAPS		45 DAPS	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
TPE 0.05 mm 15 days	13.18	13.21	12.98	12.90	12.55	12.58												
TPE 0.05 mm 30 days	13.2	13.21	12.86	12.89	12.54	12.56	12.31	12.33	11.99	12.01	11.72	11.75						
TPE 0.05 mm 45 days	13.19	13.22	12.87	12.89	12.55	12.57	12.32	12.34	12.08	12.32	11.73	11.76	11.40	11.45	11.18	11.23	10.96	10.99
TPE 0.1 mm 15 days	13.21	13.23	12.93	12.95	12.64	12.65												
TPE 0.1 mm 30 days	13.22	13.24	12.94	12.96	12.65	12.67	12.43	12.45	12.13	12.15	11.89	11.91						
TPE 0.1 mm 45 days	13.21	13.23	12.93	12.95	12.64	12.66	12.42	12.44	12.11	12.14	11.88	11.90	11.59	11.62	11.38	11.41	11.14	11.18
Control	4.75	7.69	6.69	9.27	4.51	7.58	7.54	9.61	6.81	9.24	6.72	8.94	4.79	6.26	6.79	7.21	4.86	6.21

DAPS = Days after polyethylene spread;
TPE = Transparent polyethylene;

recorded in control was 5.94 per cent and 8 per cent at 0-15 cm and 15-30 cm soil depths, respectively. In general deeper soil depth retained higher soil moisture compared to shallow soil depth. Variation due to soil solarization in different depths was only 5.65 per cent but it was 27.75 per cent in control in 0-15 cm and 15-30 cm soil depths.

4.1.3 **Soil nutrients**

4.1.3.1 **Organic carbon** : The level of organic carbon was significantly influenced by soil solarization (**Table 4.3**). All the solarized treatments had significantly lower organic carbon (0.34-0.46%) as compared to control (0.52%). Thickness of TPE and duration of soil solarization had significant influence on organic carbon content. TPE (0.05 mm) for 45 days soil solarization recorded (0.34%) significantly lower mean organic carbon as compared to TPE 0.10 mm for 45 days (0.39%). Thinner TPE 0.05 mm recorded lower organic carbon (0.38%) as compared to 0.1 mm (0.42%) at all durations of polyethylene tarping. Among the different durations of solar tarping, soil solarization for 45 days resulted in lower organic carbon (0.34%) as compared to 15 days and 30 days (0.42 and 0.39%) of solar tarping, respectively.

4.1.3.2 **Available nitrogen** : Available nitrogen level in the soil differed significantly due to soil solarization over non solarization. All the solarization treatments recorded significantly higher mean level of available nitrogen in the soil (190.66 kg ha-1) compared to control (156.88 kg ha-1).

Table 4.3. Plant nutrient availability as influenced by solarization treatments.

Treatment	Organic carbon (%)	Availa-ble N (kg/ha)	Availa-ble P (kg/ha)	Availa-ble K (kg/ha)	Availa-ble S (kg/ha)	Exch. Cal me/ 100 g soil	Exch. Mg me/ 100 g	Exch. Na me/ 100 g	pH	Electric conducti-vity (dSm^{-1})
TPE 0.05 mm 15 days	0.42	194.70	41.03	295.49	8.69	0.66	0.35	0.25	6.71	0.31
TPE 0.05 mm 30 days	0.39	198.81	43.89	320.33	7.34	0.68	0.38	0.28	6.89	0.33
TPE 0.05 mm 45 days	0.34	202.56	45.99	348.04	6.01	0.72	0.41	0.32	7.02	0.46
TPE 0.1 mm 15 days	0.46	182.50	39.49	293.46	9.92	0.61	0.31	0.23	6.59	0.29
TPE 0.1 mm 30 days	0.42	184.85	41.86	299.89	8.19	0.62	0.32	0.24	6.76	0.31
TPE 0.1 mm 45 days	0.39	189.95	44.32	329.63	7.69	0.66	0.38	0.30	6.84	0.35
Control	0.52	169.34	39.01	290.48	10.01	0.58	0.29	0.19	6.46	0.17
S.Em±	0.004	0.801	0.498	0.982	0.074	0.005	0.005	0.008		
CD at 5%	0.012	2.403	1.513	2.950	0.223	0.016	0.015	0.024		

TPE = Transparent polyethylene.

Thickness of TPE and duration of soil solarization influenced available nitrogen level in the soil. Soil solarization with TPE 0.05 mm for 45 days recorded (202.56 kg ha^{-1}) significantly higher available nitrogen as compared to TPE 0.10 mm for 45 days (189.95 kg ha^{-1}). Thinner TPE (0.05 mm) recorded higher mean available nitrogen (197.3 kg ha^{-1}) as compared to 0.1 mm (184 kg ha^{-1}) at all durations of polyethylene mulch. Among the different durations of solar tarping, soil solarization for 45 days resulted in higher available nitrogen (202.56 kg ha^{-1}) as compared to 15 days and 30 days (194.52 kg ha^{-1} and 198.81 kg ha^{-1}) of solar tarping with TPE 0.05 mm respectively.

4.1.3.3 **Available phosphorus** : Soil solarization had significant (41.17 kg ha^{-1}) influence on available phosphorus in the soil as compared to control (30.02 kg ha^{-1}). Among the solarized treatments TPE 0.05 mm for 45 days resulted significantly higher available phosphorus (45.99 kg ha^{-1}) over other solarized treatments. Next best treatment was TPE 0.10 mm for 45 days (44.32 kg ha^{-1}).

4.1.3.4 **Available potassium** : Soil solarization had significant influence on available potassium. All the solarized treatments recorded significantly higher mean level of available potassium in the soil (311.16 kg ha^{-1}) compared to control (222.68 kg ha^{-1}).

Thickness of TPE and duration of soil solarization influenced the available potassium in the soil. Soil solarization with TPE 0.05 mm for 45 days recorded significantly higher available potassium (348.04 kg ha^{-1}) compared to TPE 0.10 mm for 45 days (329.63 kg ha^{-1}). Among the different durations of solar tarping, soil solarization with TPE 0.05 mm for 45 days resulted in higher available potassium (348.04 kg ha^{-1}) compared to 15 and 30 days of solar tarping with TPE 0.05 mm (293.46 and 299.89 kg ha^{-1} respectively).

4.1.3.5 **Available sulphur** : The level of available sulphur was significantly influenced by soil solarization. All the solarized treatments had significantly lower mean available sulphur (7.972 ppm) as compared to non-solarized treatment (10.01 ppm).

Thickness of TPE and duration of soil solarization had significant influence on available sulphur. Thicker TPE (TPE 0.1 mm) and shorter duration (15 days) had significantly higher available sulphur (9.92 ppm). Whereas, TPE 0.05 mm for 45 days recorded significantly lower available sulphur (6.01 ppm).

4.1.3.6 **Exchangeable calcium, magnesium and sodium** : Exchangeable calcium, magnesium and sodium in the soil differed significantly due to soil solarization over non-solarization (**Table 4.3**). All the solarization treatments recorded significantly higher mean level of exchangeable Ca, Mg and Na in the soil (0.66 me/100 g, 0.35 me/100 g and 0.24 me/100 g, respectively) compared to control (0.50 me/100 g, 0.21 me/100 g and 0.14 me/100 g of calcium, magnesium and sodium, respectively).

Thickness of TPE and duration of soil solarization influenced the exchangeable Ca, Mg and Na level in the soil. Soil solarization with TPE 0.05 mm recorded significantly higher exchangeable Ca (0.72 me/100 g), exchangeable Mg (0.41 me/100 g) and exchangeable Na (0.32 me/100 g) over all other solarized and non solarized treatments. Next best effective treatment was soil solarization for 45 days with TPE 0.1 mm (0.66 me/100 g, 0.38 me/100 g and 0.30 me/100 g of Ca, Mg and Na, respectively).

4.1.3.7 **Electrical conductivity** : All the solarization treatments recorded significantly higher level of electrical conductivity (0.34 dSm^{-1}) compared to control (0.17dSm^{-1}).

Thickness of TPE and duration of soil solarization had significant influence on electrical conductivity. Soil solarization with TPE 0.05 mm for 45 days recorded significantly higher electrical conductivity (0.46 dSm^{-1}) compared to TPE 0.1 mm for 15 days (0.29 dSm^{-1}). Next best treatment was TPE 0.1 mm for 45 days (0.35 dSm^{-1}).

4.1.3.8 **Soil pH** : Soil solarization did not influence the soil pH (6.80) significantly compared to control (6.46). But soil solarization had positive effect on soil pH. Solarization with TPE 0.05 mm for 45 days brought the pH to neutrality compared to control.

4.1.3.9 **Effect of soil solarization on micro organisms** : The data on the effect of various treatments on the microbial population revealed that the fungal and bacterial population were affected by soil solarization (**Table 4.4**).

Fungi : The non solarized control recorded 10.5 x 10^4 fungi per gram of soil. The treatment TPE 0.05 mm for 45 days had significantly lesser number of fungi (7.2 x 10^4). All the solarized treatments recorded significantly less fungal population compared to control. Between the thickness of polythene sheets, TPE 0.05 mm recorded less mean population (8.43 x 10^4) compared to TPE 0.1 mm (9.26 x 10^4). As the duration of solar tarping increased the fungal population decreased.

At harvest, there was build up of fungal population in all the solarized treatments irrespective of thickness and duration of polyethylene mulch but less population compared to control.

Bacteria : There was no significant difference between soil solarization and non solarization. However, lower bacterial count was observed in TPE 0.05 mm for 45 days (15.69 x 10^6) and TPE 0.10 mm for 45 days (15.01 x 10^6), as compared to control (16.0 x 10^6). At harvest higher bacterial count was observed in all the solarized treatments compared to control.

Actinomycetes : Soil solarization did not have significant influence on Actinomycetes population. However, soil solarization for 45 days with TPE 0.05 mm recorded lower actinomycetes population (7.01 x 10^5) compared to

Table 4.4. Soil microbial population as influenced by solarization treatments.

Treatment	Population per gram of soil					
	Fungi (10^4)		Bacterial (10^6)		Actinomycetes (10^5)	
	ASS	At harvest	ASS	At harvest	ASS	At harvest
TPE 0.05 mm 15 days	9.80	11.33	15.09	20.56	6.99	7.10
TPE 0.05 mm 30 days	8.30	10.42	15.08	21.79	6.98	7.66
TPE 0.05 mm 45 days	7.20	9.00	15.69	22.94	7.01	8.00
TPE 0.1 mm 15 days	9.98	12.66	14.86	20.19	6.34	7.00
TPE 0.1 mm 30 days	9.94	11.39	14.98	21.34	6.49	7.39
TPE 0.1 mm 45 days	7.86	10.00	15.01	22.00	6.84	7.88
Control	10.50	13.98	16.00	20.08	8.00	7.50
S.Em±	0.15	0.25	0.58	0.83	0.45	0.32
CD at 5%	0.45	0.75	NS	NS	NS	NS

ASS = After soil solarization
TPE = Transparent polyethylene

control (8.00 x 10^5). At harvest more actinomycetes population was recorded in TPE 0.05 mm for 45 days.

4.2 INFLUENCE OF SOIL SOLARIZATION ON WEED CONTROL IN GROUNDNUT

4.2.1 **Weed flora observed in the experimental plot** : The important monocotyledons weeds observed were *Cynodon dactylon* (L.) Pers., *Digitaria marginata*, *Dactyloctenium aegpticum* and *Dicanthium annulatum*, while common dicotyledonous weeds noticed were *Acanthospermum hispidum* D.C., *Commelina bengalensis* L., *Amaranthus viridis*, *Lagasca mollis* Cav., *Euphorbia hirta* L., *Portulaca oleracea* L., *Parthenium hysterophorus* L., *Phyllanthus niruri* Linn., *Bidense spilosa*, *Borreria hispida* and *Polygonum plebezum* and sedges *Cyperus rotundus* were the predominant species.

4.2.1.1 **Weed population** : Weed population differed significantly due to solarization over control in pooled analysis and in both the years.

In pooled analysis, at all the stages (30, 60, 90 DAS and at harvest) of weed observations, significantly higher number of monocots, dicots, sedges and total weed population were recorded in control (4.79 to 8.74, 3.80 to 5.59, 5.14 to 7.97 and 7.89 to 13.05/m^2, respectively) and minimum due to TPE 0.05 mm for 45 days i.e., monocots (0.99 to 2.11), dicots (1.05 to 2.08), sedges (1.41 to 4.62) and total weeds (1.73 to 5.84) which was statistically on par with two hand weedings (monocots 0.76 to 2.67, dicots 0.91 to 2.76, sedges 1.50 to 5.42 and total weeds 2.03 to 6.57). Next best effective treatments were TPE 0.05

Table 4.5. Weed count/m^2 in groundnut as influenced by solarization treatments (pooled*).

Treatments	30 DAS				60 DAS				90 DAS				At harvest			
	Mono-cots	Dicots	Sedges	Total weed	Mono-cots	Dicots	Sedges	Total weed	Mono-cots	Dicots	Sedges	Total weed	Mono-cots	Dicots	Sedges	Total weed
TPE 0.05 mm 15 days	3.67 (12.96)	2.57 (6.11)	3.89 (14.63)	5.85 (33.78)	4.19 (17.19)	3.29 (10.35)	4.86 (23.12)	7.24 (51.89)	5.12 (25.71)	4.13 (16.55)	6.13 (37.08)	8.93 (79.34)	5.91 (34.49)	4.48 (19.48)	6.34 (39.69)	9.70 (93.66)
TPE 0.05 mm 30 days	2.94 (8.14)	2.02 (3.58)	3.26 (10.09)	4.72 (21.81)	3.49 (11.68)	2.68 (6.68)	4.20 (17.41)	6.01 (35.68)	4.31 (18.08)	3.05 (8.79)	5.57 (30.52)	7.50 (56.84)	4.83 (22.83)	3.66 (12.93)	5.75 (32.56)	8.30 (68.32)
TPE 0.05 mm 45 days	0.99 (0.48)	1.05 (0.53)	1.41 (1.49)	1.73 (2.50)	1.42 (1.52)	1.30 (1.20)	2.85 (7.62)	3.29 (10.34)	1.66 (2.24)	1.88 (3.01)	4.43 (19.08)	5.50 (29.79)	2.11 (3.95)	2.08 (8.81)	4.62 (20.86)	5.84 (33.59)
TPE 0.1 mm 15 days	4.08 (16.14)	2.95 (8.20)	4.03 (15.74)	6.37 (40.08)	4.65 (21.12)	3.51 (11.85)	5.50 (29.75)	7.87 (61.48)	5.64 (43.59)	4.33 (18.29)	6.25 (38.50)	10.31 (105.72)	6.51 (41.85)	4.78 (22.36)	6.66 (43.86)	10.42 (108.07)
TPE 0.1 mm 30 days	3.51 (11.82)	2.37 (5.11)	3.59 (12.38)	5.46 (29.31)	4.07 (16.06)	3.11 (9.18)	4.78 (22.38)	6.95 (47.76)	4.96 (24.10)	2.96 (8.25)	5.69 (31.81)	8.99 (80.49)	5.66 (31.48)	4.28 (17.83)	5.96 (35.02)	9.21 (84.33)
TPE 0.1 mm 45 days	2.38 (5.16)	1.83 (2.83)	2.90 (7.91)	4.05 (15.90)	3.27 (10.92)	2.51 (5.82)	3.94 (15.02)	5.69 (31.93)	3.74 (13.49)	3.00 (8.51)	4.95 (23.95)	7.38 (54.01)	4.00 (15.5)	3.57 (12.32)	5.74 (32.48)	7.79 (60.30)
Alachlor 1.5 kg a.i./ha	2.18 (4.25)	1.62 (2.13)	2.32 (4.89)	3.43 (11.27)	3.21 (9.77)	2.52 (5.87)	3.94 (15.02)	5.66 (31.64)	3.14 (9.33)	2.60 (6.26)	4.51 (19.82)	6.45 (41.11)	3.38 (10.89)	3.48 (11.59)	6.01 (35.62)	7.65 (58.10)
One hand weeding	1.40 (1.46)	1.42 (1.52)	2.14 (4.08)	2.68 (6.66)	3.07 (8.94)	2.09 (3.86)	3.74 (13.49)	4.92 (23.67)	2.84 (7.57)	2.53 (5.88)	5.13 (25.76)	6.95 (47.74)	3.19 (9.68)	3.53 (11.99)	6.09 (36.59)	7.67 (58.26)
Two hand weedings	0.76 (0.08)	0.91 (0.33)	1.36 (1.35)	1.50 (1.76)	1.15 (0.83)	1.48 (1.72)	2.29 (4.77)	2.83 (7.49)	2.55 (6.00)	1.75 (5.70)	4.39 (18.82)	5.39 (28.62)	2.67 (6.60)	2.76 (7.15)	5.42 (28.96)	6.57 (42.71)
Control	4.79 (22.44)	3.80 (13.94)	5.14 (25.92)	7.89 (61.82)	5.59 (30.14)	4.92 (23.71)	7.09 (49.69)	10.20 (104.79)	7.14 (50.55)	5.70 (31.99)	7.42 (54.56)	12.23 (149.13)	8.74 (75.86)	5.59 (30.79)	7.97 (63.03)	13.05 (169.68)
S.Em±	0.08	0.11	0.14	0.27	0.15	0.11	0.18	0.27	0.21	0.28	0.15	0.05	0.19	0.12	0.16	0.27
C.D. at 5%	0.23	0.33	0.42	0.80	0.43	0.33	0.53	0.82	0.62	0.84	0.44	0.15	0.57	0.36	0.47	0.81

DAS = Days after sowing;
TPE = Transparent polyethylene;
* = Pooled data of two years.

(Figures in parentheses indicate original value) mm for 30 days, TPE 0.1 mm for 45 days, alachlor at 1.5 kg a.i. ha^{-1} and one hand weeding (**Table 4.5**).

During the year, 1997-98 at all the stages of weed observations two hand weedings recorded significantly lower number of monocots (0.71 to 1.85), dicots (0.71 to 3.17), sedges (1.01 to 6.15) and total weeds (1.08 to 6.10). Lesser number of monocots (1.21-2.21), dicots (1.26 to 2.01), sedges (1.51 to 6.72) and total weeds (1.51 to 7.29) were registered due to TPE 0.05 mm for 45 days which was on par with alachlor at 1.5 kg a.i. ha^{-1} and one hand weeding. TPE 0.05 mm for 45 days recorded significantly lower number of monocots (1.21 to 2.21), dicots (1.26 to 2.01), sedges (1.51 to 6.72) and total weeds (1.51 to 7.29) compared to TPE 0.1 mm for 45 days (monocots 2.44 to 4.01, dicots 1.93 to 4.19, sedges 3.18 to 6.86 and total weeds 4.43 to 8.93). During 1998-99 trend was similar to that of pooled analysis (**Appendix 3 and 4**).

In general TPE 0.05 mm was superior over TPE 0.1 mm at all the durations of polyethylene sheet mulch during both the years.

4.2.2 **Weed dry weight (g/0.25 m^2)** : Pooled data on the dry weight of weeds revealed that, at all the stages of observations (**Table 4.6**), there was significantly lower weed dry weight due to TPE 0.05 mm for 45 days viz., monocots (1.14 to 1.69), dicots (0.91 to 1.5), sedges (1.05 to 1.59) and total (1.34 to 2.59) weed dry weight which was statistically on par with two hand weedings i.e., monocots (0.96 to 1.63), dicots (0.84 to 1.30), sedges (0.88 to

Table 4.6. Weed dry weight (g/0.25 m^2) in groundnut as influenced by solarization treatments (pooled*).

Treatments	30 DAS				60 DAS				90 DAS				At harvest			
	Mono-cots	Dicots	Sedges	Total weed	Mono-cots	Dicots	Sedges	Total weed	Mono-cots	Dicots	Sedges	Total weed	Mono-cots	Dicots	Sedges	Total weed
TPE 0.05 mm 15 days	3.31 (10.46)	2.74 (7.01)	1.63 (2.16)	4.49 (19.72)	3.93 (14.96)	2.89 (7.88)	1.86 (2.96)	5.13 (25.81)	4.11 (16.35)	3.07 (8.92)	2.12 (3.99)	5.30 (27.74)	4.62 (20.84)	3.31 (10.46)	2.24 (4.52)	5.91 (34.42)
TPE 0.05 mm 30 days	1.63 (2.16)	2.05 (3.70)	1.47 (1.66)	2.84 (7.55)	1.50 (1.76)	2.50 (5.75)	1.60 (2.06)	3.29 (10.34)	1.95 (3.30)	2.77 (7.17)	1.87 (2.98)	3.74 (13.48)	2.46 (5.56)	2.98 (8.35)	2.02 (3.58)	4.25 (17.59)
TPE 0.05 mm 45 days	1.14 (0.79)	0.91 (0.33)	1.05 (0.60)	1.34 (1.32)	1.33 (1.22)	1.11 (0.73)	1.18 (1.15)	1.95 (3.15)	1.52 (1.80)	1.30 (1.19)	1.52 (1.42)	2.29 (4.76)	1.69 (2.34)	1.50 (1.75)	1.59 (2.04)	2.59 (6.23)
TPE 0.1 mm 15 days	3.51 (11.78)	2.95 (8.20)	1.40 (1.47)	4.79 (22.43)	4.18 (16.94)	3.16 (9.49)	1.98 (3.40)	5.51 (29.82)	4.34 (18.29)	3.38 (10.89)	2.10 (4.32)	5.84 (33.59)	4.91 (23.55)	3.57 (12.24)	2.40 (5.26)	6.45 (41.13)
TPE 0.1 mm 30 days	1.79 (2.70)	2.27 (5.09)	1.57 (1.95)	3.21 (9.78)	2.04 (3.64)	2.52 (5.81)	1.74 (2.51)	3.54 (12.03)	4.34 (18.29)	2.71 (6.87)	1.99 (3.48)	3.88 (14.59)	2.55 (5.98)	3.13 (9.27)	2.17 (4.21)	4.49 (19.45)
TPE 0.1 mm 45 days	1.55 (1.90)	1.83 (2.83)	1.33 (1.27)	2.56 (6.03)	1.39 (1.48)	1.91 (3.15)	1.57 (1.96)	2.82 (7.43)	2.15 (4.12)	1.98 (3.40)	1.77 (2.62)	3.04 (8.76)	1.89 (3.09)	2.79 (7.28)	1.89 (3.05)	6.37 (13.01)
Alachlor 1.5 kg a.i./ha	1.60 (2.02)	1.49 (1.71)	1.31 (1.22)	2.42 (5.36)	1.72 (2.46)	1.38 (1.40)	1.47 (1.66)	2.45 (5.49)	1.79 (2.72)	1.65 (2.22)	1.63 (2.14)	2.80 (7.35)	1.93 (3.21)	1.93 (3.22)	1.78 (2.67)	3.10 (9.11)
One hand weeding	1.40 (1.46)	1.02 (0.54)	1.23 (1.01)	1.87 (3.02)	1.69 (2.36)	1.39 (1.45)	1.47 (1.66)	2.46 (5.55)	1.73 (2.84)	1.76 (2.59)	1.74 (2.51)	2.73 (6.94)	1.93 (3.22)	1.91 (3.15)	1.78 (2.67)	3.09 (9.05)
Two hand weedings	0.96 (0.42)	0.84 (0.21)	0.88 (0.26)	1.18 (0.69)	0.94 (0.33)	0.87 (0.25)	1.06 (0.62)	1.55 (1.78)	1.47 (1.65)	1.13 (1.78)	1.39 (1.43)	2.09 (3.87)	1.63 (2.16)	1.30 (1.15)	1.48 (1.68)	2.36 (5.05)
Control	4.32 (18.12)	3.68 (13.01)	2.17 (4.23)	6.14 (37.18)	5.10 (25.53)	3.86 (14.36)	2.51 (3.80)	6.79 (45.66)	5.31 (27.64)	(15.19)	2.68 (6.68)	7.12 (50.22)	5.66 (31.54)	4.20 (17.14)	2.79 (7.28)	7.53 (56.10)
S.Em±	0.08	0.03	0.06	0.13	0.13	0.08	0.05	0.16	0.05	0.11	0.05	0.11	0.07	0.08	0.07	0.10
C.D. at 5%	0.23	0.10	0.18	0.38	0.39	0.24	0.15	0.48	0.15	0.33	0.15	0.32	0.21	0.24	0.21	0.30

DAS = Days after sowing;
TPE = Transparent polyethylene;
* = Pooled data of two years.

(Figures in parentheses indicate original value)

1.48) and total weed dry weight (1.18 to 2.36). Next most effective treatments were one hand weeding, alachlor at 1.5 kg a.i. ha^{-1}, TPE 0.05 mm for 30 days and TPE 0.1 mm for 45 days which were statistically on par with each other in respect of weed dry weight.

During 1997-98, at all the stages of observation there were significant differences among the treatments. Significantly lower values of monocot weed dry weight (0.82 to 1.5 g/0.25 m^2), dicot weed dry weight (0.86-1.05 g/0.25 m^2), sedges weed dry weight (0.89 to 1.5 g/0.25 m^2) and total weed dry weight (1.09 to 2.4 g/0.25 m^2) were recorded by two hand weedings and maximum was in control (4.98 to 5.86 g/0.25 m^2, 3.82 to 4.25 g/0.25 m^2, 2.19 to 2.92 g/0.25 m^2 and 6.52 to 7.74 g/0.25 m^2, monocot, dicot, sedges and total weed dry weight, respectively). Minimum monocot (1.32 to 1.78 g/0.25 m^2), dicot (0.98 to 1.52 g/0.25 m^2), sedge (1.10 to 1.67 g/0.25 m^2) and total weed dry weight (1.71 to 2.50 g/0.25 m^2) was due to TPE 0.05 mm for 45 days and was on par with Alachlor at 1.5 kg a.i./ha and one hand weeding. During 1998-99 trend was similar in pooled analysis data. TPE 0.05 mm registered significantly lower weed dry weight compared to TPE 0.1 mm at all the durations of polyethylene sheet mulch (**Appendix 5 and 6**).

4.2.2.1 **Weed control efficiency (%)** : Pooled data on weed control efficiency (WCE) of the various treatments at 30, 60, 90 DAS and at harvest (**Table 4.7**) showed significant differences. Next to two hand weedings, TPE 0.05 mm for

Table 4.7. Weed control efficienty (WCE) in groundnut as influenced by solarization treatments (pooled*).

Treatment	Weed control efficiency (%)			
	30 DAS	60 DAS	90 DAS	At harvest
TPE 0.05 mm 15 days	47.07	47.36	44.69	38.59
TPE 0.05 mm 30 days	79.59	77.39	73.12	68.79
TPE 0.05 mm 45 days	95.41	92.15	90.51	88.37
TPE 0.1 mm 15 days	39.69	35.45	33.24	26.82
TPE 0.1 mm 30 days	73.65	73.69	71.07	71.93
TPE 0.1 mm 45 days	83.67	83.76	82.88	80.27
Alachlor 1.5 kg a.i./ha	84.93	87.95	85.30	80.36
One hand weeding	94.31	87.81	86.11	85.75
Two hand weedings	98.19	96.86	92.21	90.71
Control	0.00	0.00	0.00	0.00

DAS = Days after sowing;
TPE = Transparent polyethylene;
* = Pooled data of two years.

45 days had the maximum weed control efficiency (95.41 to 88.37). Further, most effective treatments are one hand weed (94.31 to 85.75%), alachlor at 1.5 kg a.i. ha^{-1} (84.93 to 80.36) and TPE 0.10 mm for 45 days (83.67 to 80.27).

Similar trend was observed in both years (1997-98 and 1998-99) regarding weed control efficiency (**Appendix 7**).

4.2.2.2 **Total weed dry weight at harvest (t ha^{-1})** : Pooled analysis data (**Table 4.8**) indicated that significantly lower weed dry weight was registered by two hand weedings (0.21 t ha^{-1}) which was statistically on par with TPE 0.05 mm for 45 days (0.25 t ha^{-1}). Alachlor at 1.5 kg a.i. ha^{-1} registered the weed dry weight of 0.36 t ha^{-1} which was on par with one hand weeding (0.36 t ha^{-1}). Control recorded (2.25 t ha^{-1}) significantly higher weed dry weight over all other treatments. During 1997-98, two hand weedings registered significantly lower weed dry weight (0.16 t ha^{-1}) and maximum was in control (2.38 t ha^{-1}). Further TPE 0.05 mm for 45 days recorded the weed dry weight of 0.27 t ha^{-1} which was statistically on par with one hand weeding (0.36 t ha^{-1}) and alachlor at 1.5 kg a.i. ha^{-1} (0.37 t ha^{-1}) (**Appendix 8 and Fig. 3**).

During 1998-99 weed dry weight followed the trend of pooled data.

Table 4.8. Weed dry weight (q/ha) at harvest of groundnut as influenced by solarization treatments (pooled*).

Treatments	Weed dry weight (q/ha)
TPE 0.05 mm 15 days	13.80
TPE 0.05 mm 30 days	7.00
TPE 0.05 mm 45 days	2.50
TPE 0.1 mm 15 days	16.50
TPE 0.1 mm 30 days	7.80
TPE 0.1 mm 45 days	5.20
Alachlor 1.5 kg a.i./ha	3.60
One hand weeding	3.60
Two hand weedings	2.10
Control	22.50
S.Em±	0.037
CD at 5%	0.11

TPE = Transparent polyethylene;

LEGEND

T_1 = TPE 0.05mm 15 days

T_2 = TPE 0.05mm 30 days

T_3 = TPE 0.05mm 45 days

T_4 = TPE 0.10mm 15 days

T_5 = TPE 0.10mm 30 days

T_6 = TPE 0.10mm 45 days

T_7 = Alachlor 1.5Kg a.i./ha

T_8 = One hand weeding

T_9 = Two hand weedings

T_{10} = Control

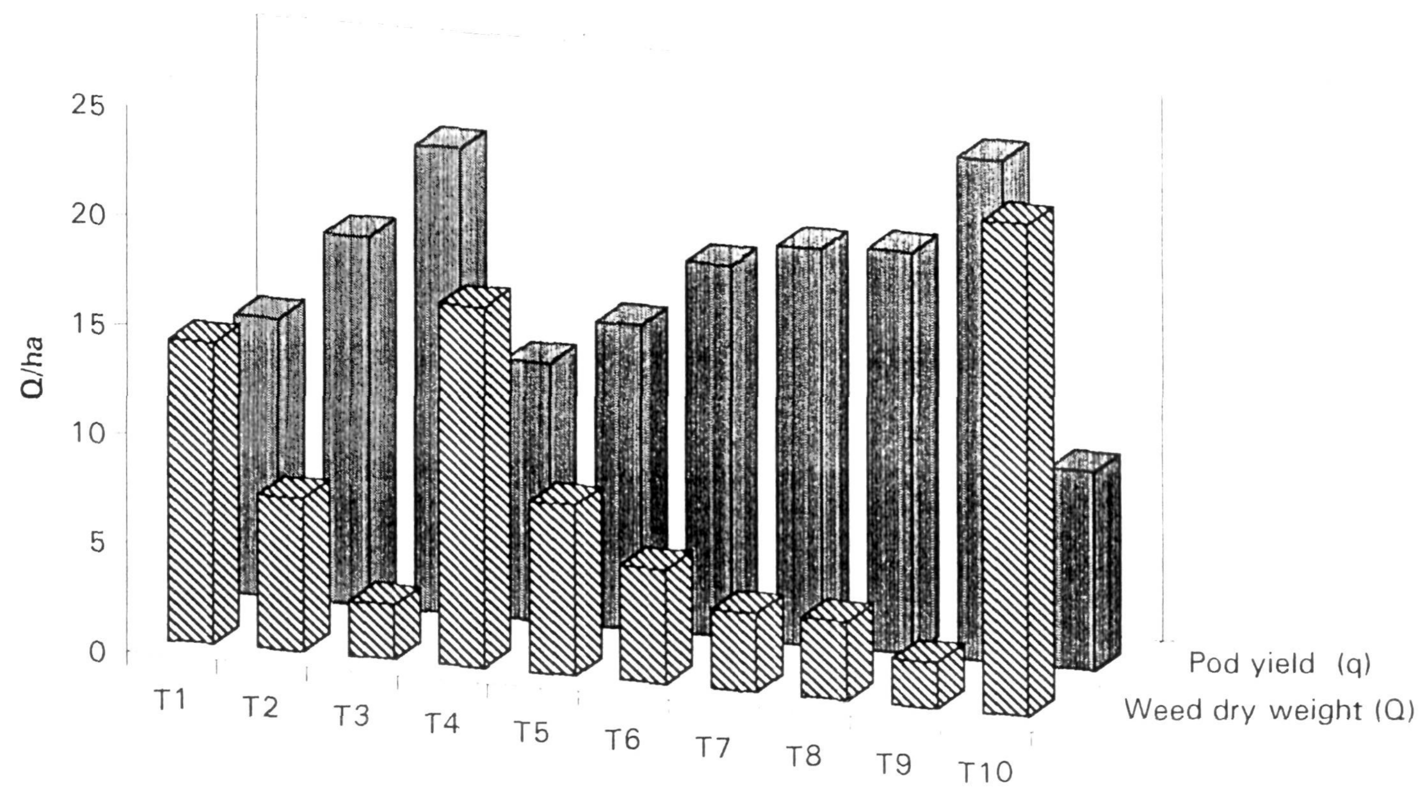


Fig.3. Ground pod yield (Q/ha) and weed dry weight (Q/ha) in groundnut at harvest due to solarization treatments

4.2.3 **Growth and growth components of groundnut**

4.2.3.1 **Plant height (cm)** : Plant height varied significantly due to soil solarization at all the stages (30, 60, 90 DAS and at harvest) of crop growth periods.

Analysis of pooled data indicated significantly taller plants (11.12 to 41.87 cm) with TPE 0.05 mm for 45 days and was statistically on par with two hand weedings (11.13 to 43.12 cm). Further plant height due to TPE 0.1 mm for 45 days (10.39 to 39.38 cm), one hand weeding (9.49 to 39.49 cm), alachlor at 1.5 kg a.i. ha^{-1} (9.44 to 38.91 cm) and TPE 0.05 mm for 30 days (9.30 to 36.96 cm) were statistically on par with each other (**Table 4.9**).

During 1997-98 among the treatments soil solarization with TPE 0.05 mm for 45 days registered the plant height of 10.85 to 41.29 cm was on par with alachlor at 1.5 kg a.i. ha^{-1} (10.01 to 39.09 cm) and one hand weeding (10.40 to 39.98 cm) at all the stages of crop growth. Significantly higher plant height (12.24 to 42.98 cm) was recorded by two hand weedings over other treatments (**Appendix 9**).

Plant height in 1998-99 trend was similar to that of pooled data. In general all the solarized treatments recorded higher plant height compared to control during both the years.

4.2.3.2 **Number of branches** : It was observed that, at all the stages, there was significant differences in the number of branches due to different treatments

Table 4.9. Plant height (cm), number of branches per plant and number of leaves per plant of groundnut as influenced by solarization treatments (pooled*).

Treatments	Plant height (cm)				Number of branches per plantt				Number of leaves per plant			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
TPE 0.05 mm 15 days	7.99	32.15	37.84	34.33	4.67	7.71	8.54	6.28	7.04	22.54	54.31	34.36
TPE 0.05 mm 30 days	9.30	34.67	39.86	36.96	5.92	9.09	9.79	7.48	7.83	25.42	56.56	37.29
TPE 0.05 mm 45 days	11.12	38.25	43.89	41.87	7.51	11.17	11.19	8.79	8.99	29.59	61.05	42.7
TPE 0.1 mm 15 days	7.17	30.66	37.01	33.68	5.28	7.39	8.45	6.11	6.71	21.73	53.59	33.39
TPE 0.1 mm 30 days	9.22	33.04	38.96	35.95	5.68	8.71	9.50	7.24	7.75	24.82	55.69	36.92
TPE 0.1 mm 45 days	10.39	36.42	41.49	39.38	6.26	9.48	9.94	7.54	8.22	26.54	57.68	38.11
Alachlor 1.5 kg a.i./ha	9.44	36.25	40.96	38.91	6.59	9.14	9.26	7.84	8.29	27.59	57.88	40.08
One hand weeding	9.49	35.05	42.07	39.49	6.61	9.32	9.52	7.96	8.37	28.48	57.17	39.19
Two hand weedings	11.13	39.54	46.46	43.12	8.05	12.12	12.01	9.49	9.48	31.63	63.21	43.94
Control	5.86	26.70	34.49	30.53	3.84	5.71	6.68	4.75	6.05	18.55	50.08	30.31
S.Em±	0.25	0.51	0.56	0.77	0.26	0.35	0.30	0.26	0.18	0.92	0.74	0.84
CD at 5%	0.74	1.52	1.67	2.30	0.77	1.02	0.89	0.77	0.54	2.73	2.21	2.49

DAS = Days after sowing;
TPE = Transparent polyethylene.
* = Pooled data.

(**Table 4.9**). In pooled data, maximum number of branches was registered due to two hand weedings (8.05 to 9.49) which was statistically on par with TPE 0.05 mm for 45 days (7.51 to 8.79). Further, one hand weeding produced more number of branches (6.61 to 7.96) and was on par with alachlor at at1.5 kg a.i. ha^{-1} (6.59 to 7.84), TPE 0.1 mm for 45 days (6.26 to 7.54) and TPE 0.05 mm for 30 days (5.92 to 7.84).

During 1997-98, two hand weedings recorded significantly higher number of branches (6.80 to 9.62) followed by TPE 0.05 mm for 45 days (5.89 to 8.35), alachlor at 1.5 kg a.i. ha^{-1} (5.64 to 8.14) and one hand weeding (5.34 to 8.32). Control produced significantly lower (2.98 to 4.62) number of branches over all other treatments. Whereas during 1998-99, number of branches produced per plant were similar to that of pooled data (**Appendix 9**).

4.2.3.3 **Number of leaves per plant** : The number of leaves per plant at all stages, differed significantly due to treatments (**Table 4.9**). In pooled analysis, two hand weedings recorded maximum number of leaves per plant (9.48 to 43.94) and it was on par with TPE 0.05 mm for 45 days (8.99 to 42.7). Further one hand weeding (8.37 to 39.19), alachlor at 1.5 kg a.i. ha^{-1} (8.29 to 40.08), TPE 0.1 mm for 45 days (8.22 to 38.11) and TPE 0.05 mm for 45 days (7.83 to 37.29) were statistically on par among themselves. The lowest number of leaves per plant (5.06 to 30.31) were observed in control.

During 1997-98, solarization with TPE 0.05 mm for 45 days registered higher number of leaves (7.77 to 39.31) which was on par with one hand weeding (7.35 to 38.54) and alachlor at 1.5 kg a.i. ha^{-1} (7.26 to 38.49). Maximum number of leaves were recorded by two hand weedings (8.64 to 42.19) and lowest was in control (4.94 to 28.61). Data during 1998-99 followed the similar trend of pooled analysis (**Appendix 10**).

4.2.3.4 **Leaf area (dm^2/plant)** : It was observed that, the solarization treatments, hand weeding and alachlor at 1.5 kg a.i./ha had significant effect on leaf area per plant as compared to control at all stages of crop growth.

In pooled data, two hand weedings registered the maximum leaf area (2.78 to 4.07 dm^2/plant) which was statistically on par with TPE 0.05 mm for 45 days (2.6 to 3.74 dm^2/plant). Further higher leaf area was due to one hand weeding (2.13 to 3.48 dm^2/plant), alachlor at 1.5 kg a.i. ha^{-1} (2.10 to 3.42 dm^2/plant), TPE 0.10 mm for 45 days (2.02 to 3.49 dm^2/plant) and TPE 0.05 mm for 30 days (1.95 to 3.74 dm^2/plant). Significantly lowest leaf area was recorded in control (1.33 to 1.69 dm^2/plant) (**Table 4.10**).

During 1997-98, among all the treatments, soil solarization with TPE 0.05 mm for 45 days recorded leaf area of 2.29 to 3.29 dm^2/plant and was statistically on par with one hand weeding (2.26 to 3.01 dm^2/plant) and alachlor at 1.5 kg a.i./ha (2.19 to 2.98 dm^2/plant). Further significantly higher leaf area (2.88 to 3.86 dm^2/plant) was recorded by two hand weedings over all other treatments and least was in control (1.12-1.54 dm^2/plant) at all stages of crop growth.

Table 4.10. Leaf area (dm^2/plant) and leaf area index in groundnut as influenced by solarization treatments (pooled*).

Treatments	Leaf area (dm^2/plant)				Leaf area index			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
TPE 0.05 mm 15 days	1.58	5.53	8.52	2.71	0.53	1.84	2.84	0.90
TPE 0.05 mm 30 days	1.95	6.31	9.98	3.33	0.62	2.21	3.33	1.16
TPE 0.05 mm 45 days	2.60	8.11	12.11	3.74	0.87	2.70	4.04	1.27
TPE 0.1 mm 15 days	1.52	5.23	8.46	2.64	0.51	1.74	2.82	0.88
TPE 0.1 mm 30 days	1.69	5.92	9.76	3.21	0.56	1.98	3.25	1.07
TPE 0.1 mm 45 days	2.02	6.75	10.47	3.49	0.64	2.25	3.52	1.16
Alachlor 1.5 kg a.i./ha	2.10	7.03	10.69	3.42	0.70	2.34	3.57	1.14
One hand weeding	2.13	7.02	10.84	3.48	0.73	2.41	3.61	1.16
Two hand weedings	2.78	8.67	12.97	4.07	0.93	2.89	4.32	1.36
Control	1.33	3.71	6.66	1.69	0.44	1.24	2.22	0.56
S.Em±	0.06	0.23	0.35	0.08	0.03	0.08	0.12	0.03
CD at 5%	0.18	0.69	1.04	0.24	0.08	0.23	0.35	0.10

Data during 1998-99 followed the similar trend of pooled analysis (**Appendix 11**).

4.2.3.5 **Leaf area index** : The leaf area index at all stages was found to vary significantly among treatments (**Table 4.10**). In pooled analysis at all stages two hand weedings recorded significantly higher LAI (0.93 to 1.36) which was statistically on par with TPE 0.05 mm for 45 days (0.87 to 1.27). Further higher LAI was due to one hand weeding (0.73 to 1.16) being on par with alachlor at 1.5 kg a.i. ha^{-1} (0.70 to 1.14), TPE 0.10 mm for 45 days (0.64 to 1.16) and TPE 0.05 mm for 30 days (0.62 to 1.16). Whereas, control recorded significantly lower LAI of 0.44 to 0.56.

During 1997-98, significantly higher LAI was recorded by two hand weedings (0.86 to 1.29) and the lowest was in control (0.37 to 0.51). Further higher leaf area index (0.76 to 1.09) was registered due to TPE 0.05 mm for 45 days being on par with one hand weeding (0.75 to 1.00) and alachlor at 1.5 kg a.i. ha^{-1} (0.73 to 0.99) (**Appendix 11**).

During 1998-99 leaf area index followed the similar trend of pooled analysis.

4.2.3.6 **Dry matter accumulation in leaves (g plant^{-1})** : Pooled data on the dry matter accumulation in leaf at different growth stages (**Table 4.11**) revealed that there was significant differences among treatments. Two hand weedings recorded significantly higher leaf dry weight (3.65 to 4.95 g $plant^{-1}$) which was statistically on par with TPE 0.05 mm for 45 days (3.36 to 4.97 g plant^{-1}) followed by alachlor at 1.5 kg a.i. ha^{-1} (2.95 to 4.21 g plant^{-1}), one hand weeding (2.94 to 4.24 g plant^{-1}), TPE 0.05 mm for 45 days (2.82 to 4.28 g plant^{-1}) and TPE 0.05 mm for 30 days (2.64 to 3.95 g plant^{-1}) and the lowest was in control (1.44 to 3.01 g plant^{-1}).

During 1997-98, soil solarization with TPE 0.05 mm for 45 days registered higher dry matter accumulation in leaves (2.84 to 4.29 g plant^{-1}) which was on par with alachlor at 1.5 kg a.i. ha^{-1} (2.69 to 3.85 g plant^{-1}) and one hand weeding (2.68 to 3.86 g plant^{-1}). Maximum dry matter accumulation in leaf was recorded by two hand weedings (3.28 to 4.56 g plant^{-1}) and the least was in control (0.64 to 2.81 g plant^{-1}). Leaf dry matter accumulation during 1998-99 followed the trend of pooled analysis (**Appendix 12**).

4.2.3.7 **Dry matter accumulation in stem (g plant^{-1})** : At all stages significant differences were observed in dry matter accumulation in stem. Analysis of pooled data indicated at all stages significantly higher dry matter accumulation in stem was due to two hand weedings (2.73 to 11.89 g plant^{-1}) and which was statistically on par with TPE 0.05 mm for 45 days (2.51 to 11.85 g plant^{-1}). Further, TPE 0.1 mm for 45 days registered higher dry matter accumulation in stem (1.95 to 9.66 g plant^{-1}) which was on par with alachlor at 1.5 kg a.i. ha^{-1} (1.44 to 9.95 g plant^{-1}), TPE 0.05 mm for 30 days (1.44 to 9.12

g plant^{-1}) and one hand weeding (1.42 to 10.06 g plant^{-1}) and the least was in control (0.59 to 6.55 g plant^{-1}) (**Table 4.11**).

During 1997-98, at all stages of observation, the maximum dry matter accumulation in stem was registered by two hand weedings (1.21 to 10.73 g plant^{-1}) and the lowest was in control (0.51 to 6.08 g plant^{-1}). Soil solarization with TPE 0.05 mm for 45 days recorded higher dry matter accumulation in stem (1.06 to 9.59 g plant^{-1}) which was on par with one hand weeding (0.91 to 10.49 g/plant) and alachlor at 1.5 kg a.i./ha (0.90 to 10.29 g plant^{-1}). During 1998-99, dry matter accumulation in stem followed the trend of pooled analysis data (**Appendix 12**).

4.2.3.8 **Dry matter accumulation in pods (g plant^{-1})** : The dry matter accumulation in pods showed significant variation due to treatments at all stages of crop growth (**Table 4.11**). Pooled analysis showed that hand weeding twice recorded significantly higher dry matter accumulation in pods at all stages (5.52 to 15.63 g plant^{-1}) and was statistically on par with TPE 0.05 mm for 45 days (4.81 to 15.07 g plant^{-1}), while one hand weeding produced higher dry matter in pods (4.44 to 14.87 g plant^{-1}) was statistically on par with alachlor at 1.5 kg a.i. ha^{-1}, TPE 0.10 mm for 45 days and TPE 0.05 mm for 30 days.

During 1997-98, higher dry matter accumulation in pods was registered by TPE 0.05 mm for 45 days (3.95 to 13.82 g plant^{-1}) being statistically on par with one hand weeding (3.72 to 13.89 g plant^{-1}) and alachlor at 1.5 kg a.i./ha

(3.69 to 13.86 g plant^{-1}). Significantly lower dry matter accumulation was observed in control (1.00 to 6.86 g plant^{-1}) and maximum was in two hand weedings (4.87 to 14.24 g plant^{-1}) over all other treatments at all stages of crop growth. The trend during 1998-99 was similar to that of pooled analysis regarding dry matter accumulation in pods (**Appendix 13**).

4.2.3.9 **Total dry matter accumulation (g plant^{-1})** : Data on total dry matter accumulation in groundnut is presented in **Table 4.11**. Pooled analysis indicated that hand weeding twice recorded significantly higher total dry matter accumulation (6.38 to 33.62 g plant^{-1}) per plant at all stages of crop growth and was statistically on par with TPE 0.05 mm for 45 days (5.62 to 32.24 g plant^{-1}). Next effective treatments were TPE 0.10 mm for 45 days (4.77 to 28.98 g plant^{-1}), TPE 0.05 mm for 30 days (4.08 to 28.06 g plant^{-1}), alachlor at 1.5 kg a.i. ha^{-1} (4.39 to 28.98 g plant^{-1}) and one hand weeding (4.35 to 29.59 g plant^{-1}), while the least was in control (2.03 to 17.88 g plant^{-1}) (**Fig. 4**).

During 1997-98, at all stages, higher total dry matter accumulation was in TPE 0.05 mm for 45 days (3.90 to 28.70 g plant^{-1}) and was statistically on par with one hand weeding (3.59 to 28.24 g plant^{-1}) and alachlor at 1.5 kg a.i. ha^{-1} (3.59 to 27.85 g plant^{-1}). Maixmum total dry matter accumulation per plant was registered by two hand weedings (4.49 to 31.84 g plant^{-1}) and lowest was in control (1.15 to 16.68 g plant^{-1}). Trend during 1998-99 regarding total

Table 4.11. Dry matter accumulation in leaves (g/plant), stem (g/plant), pod (g/plant) and total dry matter (g/plant) in groundnut as influnced by solarization treatments (pooled*).

Treatments	Dry matter of leaves (g/plant)				Dry matter of stem (g/plant)				Dry matter of pod (g/plant)			Total dry matter (g/plant)			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
TPE 0.05 mm 15 days	1.92	6.33	8.87	3.51	0.87	4.52	7.83	7.84	3.22	5.87	12.74	2.79	14.07	22.58	24.08
TPE 0.05 mm 30 days	2.64	7.33	10.31	3.95	1.44	5.68	9.59	9.12	4.05	6.72	13.66	4.08	17.36	26.56	28.06
TPE 0.05 mm 45 days	3.36	9.05	13.16	4.97	2.51	7.13	11.49	11.85	4.81	7.52	15.07	5.62	20.78	32.42	33.24
TPE 0.1 mm 15 days	1.87	6.23	8.61	3.40	0.83	4.07	6.21	7.18	2.58	5.36	12.51	2.69	11.64	20.17	24.04
TPE 0.1 mm 30 days	2.31	6.59	10.27	3.84	1.39	5.05	7.97	8.42	3.34	6.08	13.49	3.71	14.98	24.31	26.82
TPE 0.1 mm 45 days	2.82	7.93	11.24	4.28	1.95	6.11	9.73	9.66	4.06	6.79	14.27	4.77	17.83	27.33	28.98
Alachlor 1.5 kg a.i./ha	2.95	7.99	11.58	4.21	1.44	6.14	9.67	9.95	4.42	6.51	14.93	4.39	19.27	27.25	29.07
One hand weeding	2.94	8.08	11.73	4.24	1.42	6.15	9.75	10.06	4.44	6.56	14.87	4.35	19.46	28.03	29.59
Two hand weedings	3.65	9.19	14.27	4.95	2.73	7.60	13.18	11.89	5.52	7.99	15.63	6.38	21.87	35.45	33.62
Control	1.44	4.56	7.76	3.01	0.59	3.57	6.07	6.55	2.46	4.99	7.86	2.03	12.05	18.82	17.88
S.Em±	0.13	0.26	0.55	0.17	0.08	0.18	0.58	0.36	0.25	0.16	0.23	0.40	0.33	1.05	0.66
CD at 5%	0.38	0.77	1.62	0.51	0.24	0.54	1.71	1.08	0.75	0.48	0.68	1.20	0.98	3.14	1.99

DAS = Days after sowing;
TPE: Transparent polyethylene.
* Pooled data.

LEGEND

T_1 = TPE 0.05mm 15 days

T_2 = TPE 0.05mm 30 days

T_3 = TPE 0.05mm 45 days

T_4 = TPE 0.10mm 15 days

T_5 = TPE 0.10mm 30 days

T_6 = TPE 0.10mm 45 days

T_7 = Alachlor 1.5Kg a.i./ha

T_8 = One hand weeding

T_9 = Two hand weedings

T_{10} = Control

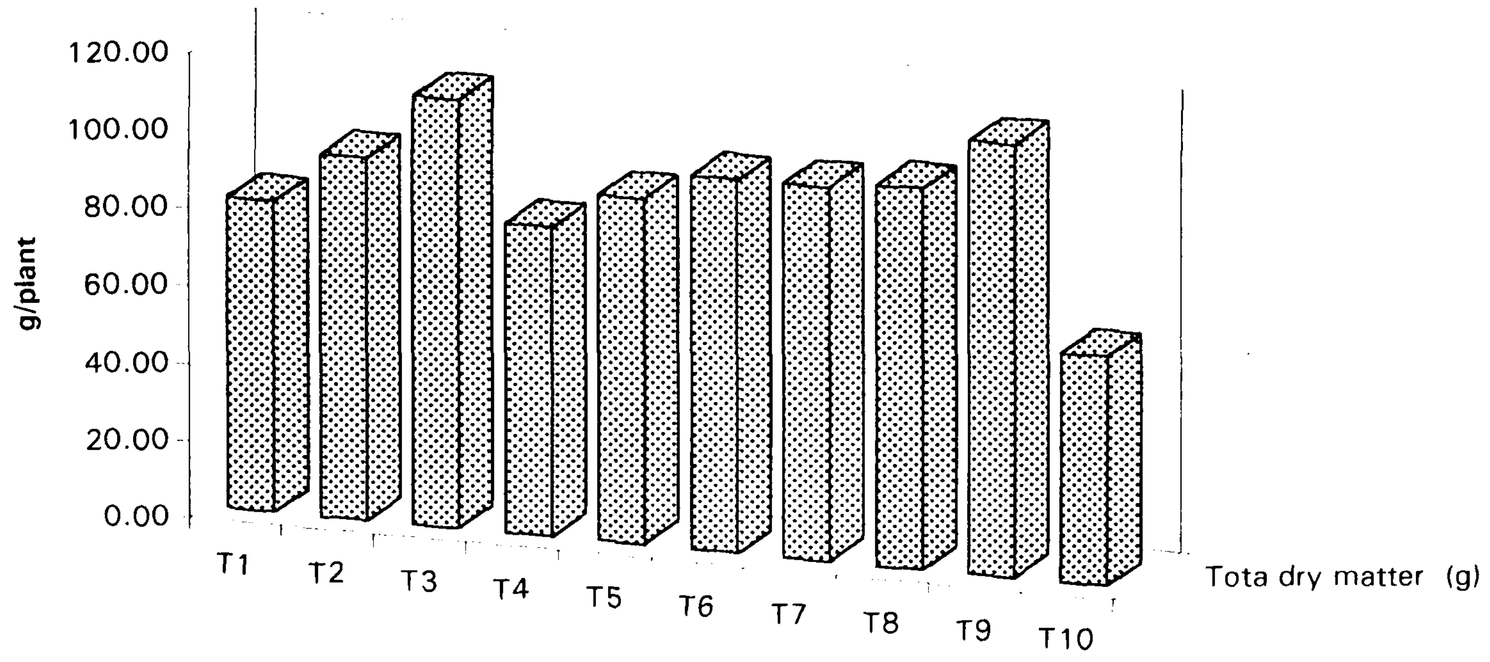


Fig.4. Total dry matter accumulation (g/plant) in groundnut at harvest due to solarization treatments

dry matter accumulation per plant was similar to that of pooled data (**Appendix 13**).

4.2.3.5.1 **Nodule number and nodule dry weight (g plant^{-1})** : Nodule number and nodule dry weight differed significantly due to treatments. In pooled data (**Table 4.12**), at 60 and 90 DAS, two hand weedings recorded more number of nodules (99.73 to 113.57 g plant^{-1}) and nodule dry weight (0.11 to 0.147 g plant^{-1}) and was on par with TPE 0.05 mm for 45 days of nodule number 98.7 to 114.49 and nodule dry weight 0.108 to 0.152 g plant^{-1}. Further there was no significant difference between treatments in respect of nodule number and nodule dry weight. But control recorded significantly lower nodule number (80.17 to 93.11 plant^{-1}) and nodule dry weight (0.050 to 0.091 g plant^{-1}) over all other treatments (**Appendix 10**).

Similar trend was observed during both the years (1997-98 and 1998-99) regarding nodule number and nodule dry weight per plant.

4.2.3.6 **Yield and yield components of groundnut**

4.2.3.6.1 **Total pods and number of filled pods per plant** : In pooled analysis significantly higher total pods (25.48 plant^{-1}) and number of filled pods (21.42 plant^{-1}) were registered by hand weeding twice which was on par with TPE 0.05 mm for 45 days (Total pods are 23.63 and number of filled pods are 20.21) and were significantly superior over all other treatments. Further one hand

Table 4.12. Nodule number and nodule dry weight (g/plant) of groundnut as influenced by solarisation treatments (pooled*).

Treatments	Nodule number		Nodule dry weight (g)	
	60 DAS	90 DAS	60 DAS	90 DAS
TPE 0.05 mm 15 days	88.20	105.65	0.088	0.116
TPE 0.05 mm 30 days	91.09	107.33	0.092	0.117
TPE 0.05 mm 45 days	98.70	114.49	0.108	0.152
TPE 0.1 mm 15 days	86.44	103.64	0.086	0.113
TPE 0.1 mm 30 days	89.91	106.86	0.094	0.115
TPE 0.1 mm 45 days	96.45	112.66	0.102	0.117
Alachlor 1.5 kg a.i./ha	88.22	102.00	0.080	0.115
One hand weeding	91.14	106.56	0.108	0.133
Two hand weedings	99.73	113.57	0.110	0.147
Control	80.17	93.11	0.050	0.091
S.Em±	1.72	3.25	0.12	0.23
CD at 5%	5.16	9.69	0.34	0.68

DAS = Days after sowing;
TPE = Transparent polyethylene.
* = Pooled data.

weeding, alachlor at 1.5 kg a.i. ha^{-1}, TPE 0.10 mm for 45 days and TPE 0.05 mm for 30 days were on par with each other. Control recorded significantly lower number of pods (16.42/plant) and number of filled pods (9.18/plant) over all other treatments (**Table 4.13**).

During 1997-98, significantly higher and maximum number of total pods (25.01/plant) and number of filled pods (20.83/plant) were registered by two hand weedings. Next best was TPE 0.05 mm for 45 days and was on par with alachlor at 1.5 kg a.i. ha^{-1} and one hand weeding and the least was in control. Trend in 1998-99 regarding total pod number and number of filled pods per plant were similar to that of pooled analysis (**Appendix 14**).

4.2.3.6.2 **Pod weight (g plant^{-1})** : It was observed that pod weight increased significantly over control in all the treatments (**Table 4.13**). In pooled analysis, more pod weight was recorded by hand weeding twice (18.94 g $plant^{-1}$) and was statistically on par with TPE 0.05 mm for 45 days (17.94 g $plant^{-1}$) and were significantly superior over other treatments. While, pod weight recorded in alachlor at 1.5 kg a.i. ha^{-1} (16.71 g $plant^{-1}$), one hand weeding (16.62 g $plant^{-1}$), TPE 0.10 mm for 45 days (16.13 g $plant^{-1}$) and TPE 0.05 mm for 30 days (15.78 g $plant^{-1}$) were on par with each other. Control recorded the lowest pod weight of 8.98 g $plant^{-1}$.

During 1997-98, maximum pod weight was observed in two hand weedings (17.90 g $plant^{-1}$) and the least was in control (8.50 g $plant^{-1}$) over all other treatments. Further higher pod weight was registered by TPE 0.05 mm for 45 days (16.24 g plant^{-1}) and was statistically on par with one hand weeding (16.32 g plant^{-1}) and alachlor at 1.5 kg a.i. ha^{-1} (16.02 g plant^{-1}) over control and other treatments. During 1998-99, pod weight per plant followed the pattern of pooled analysis data (**Appendix 14**).

4.2.3.6.3 **Pod yield (q ha^{-1})** : The pod yield of groundnut significantly increased over control in all treatments (**Table 4.13**). In pooled data maximum pod yield was obtained with two hand weedings (22.93 q ha^{-1}) and was statistically on par with TPE 0.05 mm for 45 days (21.31 q ha^{-1}). Further one hand weeding recorded pod yield of 18.37 q ha^{-1} and it was on par with alachlor at 1.5 kg a.i. ha^{-1} (18.16 q ha^{-1}), TPE 0.1 mm for 45 days (17.02 q ha^{-1}) and TPE 0.05 mm for 30 days (16.89 q ha^{-1}) and the lowest pod yield was recorded in control (9.1 q ha^{-1}) (**Fig. 3**).

During 1997-98, maximum pod yield was observed in two hand weedings (23.34 q ha^{-1}) over all other treatments. Further higher pod yield was registered by TPE 0.05 mm for 45 days (19.61 q ha^{-1}) and was statistically on par with one hand weeding (18.74 q ha^{-1}) and alachlor at 1.5 kg a.i. ha^{-1} (18.12 q ha^{-1}) whereas least pod yield was obtained in control (8.98 q ha^{-1}) over all other treatments. During 1998-99, pod yield obtained was similar to that of pooled analysis (**Appendix 14**).

4.2.3.6.4 **Haulm yield (q ha^{-1})** : Analysis of pooled data indicated that, maximum haulm yield was recorded in two hand weedings (23.21 q ha^{-1}) and was statistically on par with TPE 0.05 mm for 45 days (20.59 q ha^{-1}). While one hand weeding recorded the haulm yield of 19.84 q ha^{-1} which was on par with alachlor at 1.5 kg a.i. ha^{-1} (19.52 q ha^{-1}), TPE 0.10 mm for 45 days (18.37 q ha^{-1}) and TPE 0.05 mm for 30 days (18.15 q ha^{-1}) and the lowest was in control (14.15 q ha^{-1}) (**Table 4.13**).

During 1997-98, haulm yield of 20.66 q ha^{-1} was recorded by two hand weedings and the least was in control (12.02 q ha^{-1}) and these were statistically significant over other treatments. Further, one hand weeding gave the haulm yield of 17.98 q ha^{-1} and was on par with TPE 0.05 mm for 45 days and alachlor at 1.5 kg a.i. ha^{-1} (17.05 q ha^{-1}). Haulm obtained during 1998-99 followed the trend of pooled analysis (**Appendix 14**).

4.2.3.6.5 **Shelling percentage** : In pooled data maximum shelling percentage was registered by two hand weedings (72.03%) and was statistically on par with TPE 0.05 mm for 45 days (71.99%) and next most effective treatments regarding shelling percentage were one hand weeding (70.01%), alachlor at 1.5 kg a.i. ha^{-1} (70.62%) and TPE 0.10 mm for 45 days. Least shelling percentage was recorded by control (60.88%) (**Table 4.13 and Appendix 14**). Similar trend was also observed during 1997-98 and 1998-99 regarding shelling percentage.

Table 4.13. Number of pods per plant, pod weight (g/plant), pod and haulm yield (q/ha), shelling percentage, 100 kernel weight (g) and kernel yield (q/ha) of groundnut as influenced by solarization treatments (pooled*).

Treatments	Total number of pods	No. of filled pods	Pod weight (g/pl.)	Pod yield (q/ha)	Haulm yield (q/ha)	Shelling percent-age	100 kernel Wt. (g)	Kernel yield (q/ha)
TPE 0.05 mm 15 days	18.70	11.84	12.90	12.79	15.15	66.54	32.95	8.50
TPE 0.05 mm 30 days	21.24	15.77	15.78	16.89	18.15	68.74	34.81	11.62
TPE 0.05 mm 45 days	23.63	20.21	17.94	21.31	21.09	71.99	45.68	15.46
TPE 0.1 mm 15 days	17.57	11.60	11.71	11.73	14.05	65.35	30.04	7.62
TPE 0.1 mm 30 days	19.25	15.26	14.01	13.93	15.33	67.27	34.16	9.39
TPE 0.1 mm 45 days	22.34	17.57	16.13	17.02	18.37	69.21	37.25	11.64
Alachlor 1.5 kg a.i./ha	22.49	18.57	16.77	18.18	19.52	70.32	38.13	13.08
One hand weeding	22.44	18.82	16.62	18.37	19.84	70.70	37.43	13.94
Two hand weedings	25.48	21.42	18.94	22.93	23.21	72.03	45.96	16.51
Control	16.42	9.18	8.98	9.09	14.15	60.88	24.98	5.56
S.Em±	0.64	0.54	0.39	0.51	0.62	0.42	1.14	0.37
CD at 5%	1.89	1.63	1.15	1.52	1.84	1.28	3.42	1.11

TPE = Transparent polyethylene.
* = Pooled data of two years.

4.2.3.6.6 **100 kernel weight (g)** : In pooled data, higher 100 kernel weight was recorded by two hand weedings (45.96 g) and was statistically on par with TPE 0.05 mm for 45 days (45.68 g). Further, alachlor at 1.5 kg a.i. ha^{-1} recorded the 100 kernel weight of 38.13 g which was on par with one hand weeding (37.25 g), TPE 0.10 mm for 45 days (37.43 g) and TPE 0.05 mm for 30 days (34.81 g). The lowest 100 kernel weight of 24.98 g was obtained in control (**Table 4.13 and Appendix 14**). Similar trend was observed regarding 100 kernel weight during both years 1997-98 and 1998-99.

4.2.3.6.7 **Kernel yield (q ha^{-1})** : Kernel yield of groundnut was influenced significantly by various treatments (**Table 4.13 and Appendix 14**). In pooled analysis the maximum value was recorded due to two hand weedings (16.51 q ha^{-1}) which was statistically on par with TPE 0.05 mm for 45 days (15.46 q ha^{-1}) but significantly superior over all other treatments. Next best treatments are one hand weeding (13.94 q ha^{-1}) and alachlor at 1.5 kg a.i. ha^{-1} (13.08 q ha^{-1}). Control recorded significantly lower kernel yield (5.56 q ha^{-1}) over all other treatments. During 1997-98 and 1998-99 kernel yield trend was similar to that of pooled analysis.

4.3 INFLUENCE OF SOIL SOLARIZATION ON WEED CONTROL IN SUCCEEDING TOMATO CROP AFTER GROUNDNUT

4.3.1 **Weed population (per m^2)** : Data on number of monocots, dicot, sedges and total weeds revealed that, at all the stages of observation there was significant reduction in weed count due to soil solarization.

Table 4.14. Weed count/m^2 in tomato as influenced by solarization treatments (pooled*).

Treatments	30 DAT				60 DAT				At harvest			
	Mono-cots	Dicots	Sed-ges	Total weed	Mono-cots	Dicots	Sed-ges	Total weed	Mono-cots	Dicots	Sed-ges	Total weed
TPE 0.05 mm 15 days	3.34 (10.63)	3.21 (9.81)	4.53 (19.99)	5.65 (31.43)	4.38 (18.66)	3.85 (14.34)	5.07 (25.19)	7.66 (58.18)	5.21 (26.69)	3.97 (15.24)	5.27 (27.24)	8.35 (69.17)
TPE 0.05 mm 30 days	2.59 (6.18)	1.94 (3.24)	2.68 (6.66)	4.08 (16.08)	3.01 (8.56)	2.42 (5.33)	3.34 (10.65)	5.05 (24.99)	3.79 (13.86)	2.69 (6.71)	3.53 (11.96)	5.75 (32.62)
TPE 0.05 mm 45 days	1.18 (0.89)	1.37 (1.38)	2.37 (5.09)	2.80 (7.36)	2.41 (5.31)	1.42 (2.53)	2.80 (6.90)	3.65 (12.79)	3.38 (10.89)	1.99 (3.46)	3.01 (8.56)	4.85 (22.98)
TPE 0.1 mm 15 days	3.58 (12.32)	3.27 (10.21)	4.53 (20.04)	6.58 (42.86)	4.48 (19.57)	3.87 (14.51)	5.21 (26.67)	7.83 (60.76)	5.29 (27.43)	4.04 (15.83)	5.34 (28.00)	8.19 (66.57)
TPE 0.1 mm 30 days	2.95 (8.20)	2.44 (5.45)	3.03 (8.68)	4.78 (22.32)	3.38 (10.92)	2.76 (7.12)	3.93 (14.94)	5.79 (32.99)	4.21 (17.81)	3.21 (9.80)	4.22 (17.27)	6.69 (44.31)
TPE 0.1 mm 45 days	2.55 (6.00)	1.99 (3.46)	2.80 (7.34)	4.17 (16.86)	2.94 (8.11)	2.36 (5.05)	3.33 (10.59)	4.90 (23.52)	3.82 (14.09)	2.83 (7.51)	3.85 (14.32)	6.04 (35.93)
Alachlor 1.5 kg a.i./ha	2.52 (5.85)	1.94 (3.26)	2.78 (7.20)	4.08 (16.21)	2.91 (7.96)	2.11 (3.93)	3.31 (10.46)	4.78 (22.39)	3.82 (14.09)	2.85 (7.62)	3.66 (12.89)	5.93 (34.71)
One hand weeding	2.51 (5.80)	1.95 (3.30)	2.18 (7.12)	4.12 (16.45)	2.93 (8.08)	2.10 (3.91)	3.33 (10.56)	4.80 (22.58)	3.77 (13.72)	2.76 (7.12)	3.61 (12.53)	5.82 (33.41)
Two hand weedings	1.37 (1.38)	1.38 (1.40)	2.36 (5.07)	2.89 (7.86)	2.42 (5.33)	1.60 (2.06)	2.55 (6.00)	3.45 (11.41)	3.27 (10.16)	2.16 (4.12)	3.15 (9.42)	4.92 (23.74)
Control	3.58 (12.35)	3.38 (10.92)	4.77 (22.24)	6.79 (45.67)	4.64 (21.03)	3.97 (14.26)	5.27 (27.27)	8.01 (63.67)	5.38 (28.44)	4.16 (16.81)	5.55 (29.20)	8.66 (74.61)
S.Em±	0.07	0.13	0.08	0.42	0.05	0.80	0.11	0.38	0.05	0.06	0.13	0.29
CD at 5%	0.21	0.39	0.24	1.24	0.15	0.24	0.33	1.12	0.15	0.18	0.39	0.86

DAT = Days after transplanting; TPE = Transparent polyethylene; * = Pooled data of two years.

In pooled analysis, at all the stages (30, 60 DAT and at harvest) of weed (**Table 4.14 and Appendix 15 and 16**), observations, significantly lower number of monocots (1.18 to 3.38), dicots (1.37 to 1.99), sedges (2.37 to 3.01) and total weeds were recorded due to TPE 0.05 mm for 45 days (2.80 to 4.85) which was statistically on par with two hand weedings (1.37 to 3.27, 1.38 to 2.16, 2.36 to 3.15 and 2.89 to 4.92 of monocots, dicots, sedges and total weeds, respectively) and significantly higher weed population were recorded by control i.e., monocots (3.58 to 5.38), dicots (3.38 to 4.16), sedges (4.77 to 5.55) and total weeds (6.79 to 8.66). Further next effective treatments are alachlor at 1.5 kg a.i. ha^{-1}, one hand weeding, TPE 0.05 mm for 30 days and TPE 0.1 mm for 45 days. Similar trend was observed regarding weed population in both the years (1997-98 and 1998-99) as in case of pooled analysis.

In general TPE 0.05 mm was superior over TPE 0.1 mm at all the durations of polyethylene sheet mulching during both the years and longer duration of polyethylene sheet mulching (45 days) was better over shorter durations (15 days or 30 days).

4.3.2 **Dry weight of weeds (g/0.25 m^2)** : Weed dry weight differed significantly due to treatments in both years. All the treatments recorded significantly lower weed dry weight as compared to control.

Pooled data (**Table 4.15**) on the dry weight of weeds revealed that, at all the stages of observations there was significantly lower weed dry weight due to soil solarization with TPE 0.05 mm for 45 days (monocots 1.25 to 1.86 g/0.25

Table 4.15. Weed dry weight (g/0.25 m^2) in tomato as influenced by solarization treatments (pooled*).

Treatments	30 DAT				60 DAT				At harvest			
	Mono-cots	Dicots	Sed-ges	Total weed	Mono-cots	Dicots	Sed-ges	Total weed	Mono-cots	Dicots	Sed-ges	Total weed
TPE 0.05 mm 15 days	1.91	1.72	2.53	3.37	2.44	1.91	2.71	4.08	3.09	2.33	2.94	4.84
	(3.15)	(2.47)	(5.88)	(10.89)	(5.49)	(3.16)	(6.87)	(16.17)	(9.06)	(4.94)	(8.12)	(22.92)
TPE 0.05 mm 30 days	1.49	1.37	1.52	2.29	1.86	1.39	1.45	2.81	1.56	1.51	1.55	3.29
	(1.71)	(1.38)	(1.81)	(4.73)	(2.95)	(1.43)	(1.59)	(7.38)	(2.22)	(1.78)	(1.90)	(9.79)
TPE 0.05 mm 45 days	1.25	1.16	1.28	1.85	1.56	1.19	1.33	2.32	1.86	1.35	1.39	2.91
	(1.06)	(0.85)	(1.13)	(2.92)	(1.96)	(0.93)	(1.27)	(4.90)	(2.98)	(1.24)	(1.43)	(7.94)
TPE 0.1 mm 15 days	1.92	1.79	2.60	3.46	2.49	1.92	2.25	4.17	3.22	2.39	2.95	4.87
	(3.18)	(2.69)	(6.26)	(11.44)	(5.70)	(3.19)	(4.59)	(16.87)	(9.45)	(4.24)	(8.12)	(23.26)
TPE 0.1 mm 30 days	1.67	1.53	1.57	2.62	1.85	1.56	1.59	3.08	1.90	1.76	1.70	3.40
	(2.28)	(2.70)	(1.96)	(6.34)	(2.56)	(1.93)	(2.01)	(9.01)	(3.11)	(2.59)	(2.39)	(11.08)
TPE 0.1 mm 45 days	1.46	1.36	1.44	2.21	1.89	1.39	1.48	2.72	1.78	1.47	1.52	3.13
	(1.62)	(1.38)	(1.62)	(4.40)	(2.74)	(1.43)	(1.71)	(6.90)	(2.67)	(1.69)	(1.81)	(9.31)
Alachlor 1.5 kg a.i./ha	1.46	1.41	1.38	2.24	1.88	1.37	1.43	2.84	1.82	1.43	1.55	3.12
	(1.63)	(1.49)	(1.43)	(4.52)	(3.03)	(1.38)	(1.56)	(7.57)	(2.81)	(1.54)	(1.89)	(9.26)
One hand weeding	1.46	1.41	1.41	2.23	1.84	1.36	1.48	2.85	1.84	1.44	1.55	3.14
	(1.63)	(1.46)	(1.47)	(4.48)	(2.88)	(1.35)	(1.69)	(7.59)	(2.88)	(1.57)	(1.89)	(9.34)
Two hand weedings	1.24	1.18	1.26	1.87	1.64	1.22	1.35	2.36	1.55	1.31	1.38	2.96
	(1.04)	(0.89)	(1.08)	(3.01)	(2.88)	(0.99)	(1.32)	(5.07)	(2.62)	(1.22)	(1.40)	(8.27)
Control	2.03	1.81	2.64	3.47	2.54	1.92	2.80	4.34	3.14	2.64	2.95	4.97
	(3.62)	(2.78)	(6.49)	(12.27)	(5.95)	(3.20)	(7.34)	(18.29)	(9.43)	(4.02)	(8.20)	(24.20)
S.Em±	0.09	0.08	0.04	0.10	0.08	0.04	0.04	0.11	0.07	0.23	0.05	0.04
CD at 5%	0.27	0.24	0.12	0.30	0.23	0.12	0.13	0.33	0.21	0.69	0.14	0.12

DAT = Days after transplanting; TPE = Transparent polyethylene; * = Pooled data of two years.

m^2, dicots 1.16 to 1.35 g/0.25 m^2, sedges 1.28 to 1.3 g/0.25 m^2 and total weed dry weight 1.85 to 2.91 g/0.25 m^2) which was statistically on par with two hand weedings (1.24 to 1.55 g/0.25 m^2, 1.81 to 2.64 g/0.25 m^2, 2.64 to 2.95 g/0.25 m^2 and 3.47 to 4.97 g/0.25 m^2 of monocots, dicots, sedges and total weed dry weight, respectively) and maximum was in control of monocots (2.03 to 3.14 g/0.25 m^2), dictos (1.81 to 2.64 g/0.25 m^2), sedge (2.64 to 2.95 g/0.25 m^2) and total weed dry weight (3.47 to 4.97 g/0.25 m^2). Further most effective treatments were one hand weeding, alachlor at 1.5 kg a.i./ha, TPE 0.1 mm for 45 days and TPE 0.05 mm for 30 days which were statistically on par with each other in respect of weed dry weight. During 1997-98 and 1998-99, weed dry weight followed the similar trend of pooled analysis (**Appendix 16 and 17**).

4.3.3 **Weed control efficiency (%)** : Pooled data on weed control efficiency (WCE) of the various treatments at 30, 60 DAT and at harvest (**Table 4.16**) showed that TPE 0.05 mm for 45 days had maximum weed control efficiency (77.95 to 67.24%) and followed by two hand weedings which had the weed control efficiency of 77.29 to 66.90 per cent. Further TPE 0.1 mm for 45 days had the weed control efficiency of 66.77 to 61.31 per cent, alachlor at 1.5 kg a.i. ha^{-1} (66.21 to 61.68%) and one hand weeding (66.16 to 61.36%). Similar trend was observed in both years (1997-98 and 1998-99) regarding weed control efficiency (**Appendix 18**).

4.3.4 **Dry weight of weeds at harvest (t ha^{-1})** : Pooled data on the weed dry weight revealed that, significantly lower weed dry weight was registered by two

Table 4.16. Weed control efficiency (WCE) in tomato as influenced by solarization treatments (pooled*).

Treatments	Weed control efficiency (%)		
	30 DAT	60 DAT	At harvest
TPE 0.05 mm 15 days	17.73	16.51	55.50
TPE 0.05 mm 30 days	64.33	61.74	59.32
TPE 0.05 mm 45 days	77.95	74.72	67.24
TPE 0.1 mm 15 days	13.57	12.15	40.25
TPE 0.1 mm 30 days	52.06	48.46	53.73
TPE 0.1 mm 45 days	66.77	64.38	61.31
Alachlor 1.5 kg a.i./ha	66.21	60.91	61.68
One hand weeding	66.16	60.77	61.36
Two hand weedings	77.29	73.83	66.90
Control	0.00	0.00	0.00

DAT = Days after transplanting;
TPE = Transparent polyethylene.
* = Pooled data of two years.

Table 4.17. Weed dry weight (q/ha) at harvest of tomato as influenced by solarization treatments (pooled*).

Treatments	Weed dry weight (q/ha)
TPE 0.05 mm 15 days	9.20
TPE 0.05 mm 30 days	3.90
TPE 0.05 mm 45 days	3.20
TPE 0.1 mm 15 days	9.20
TPE 0.1 mm 30 days	4.50
TPE 0.1 mm 45 days	3.70
Alachlor 1.5 kg a.i./ha	3.60
One hand weeding	3.50
Two hand weedings	3.20
Control	9.70
S.Em±	0.01
CD at 5%	0.03

TPE = Transparent polyethylene
* = Pooled data for two years.

LEGEND

T_1 = TPE 0.05mm 15 days

T_2 = TPE 0.05mm 30 days

T_3 = TPE 0.05mm 45 days

T_4 = TPE 0.10mm 15 days

T_5 = TPE 0.10mm 30 days

T_6 = TPE 0.10mm 45 days

T_7 = Alachlor 1.5Kg a.i./ha

T_8 = One hand weeding

T_9 = Two hand weedings

T_{10} = Control

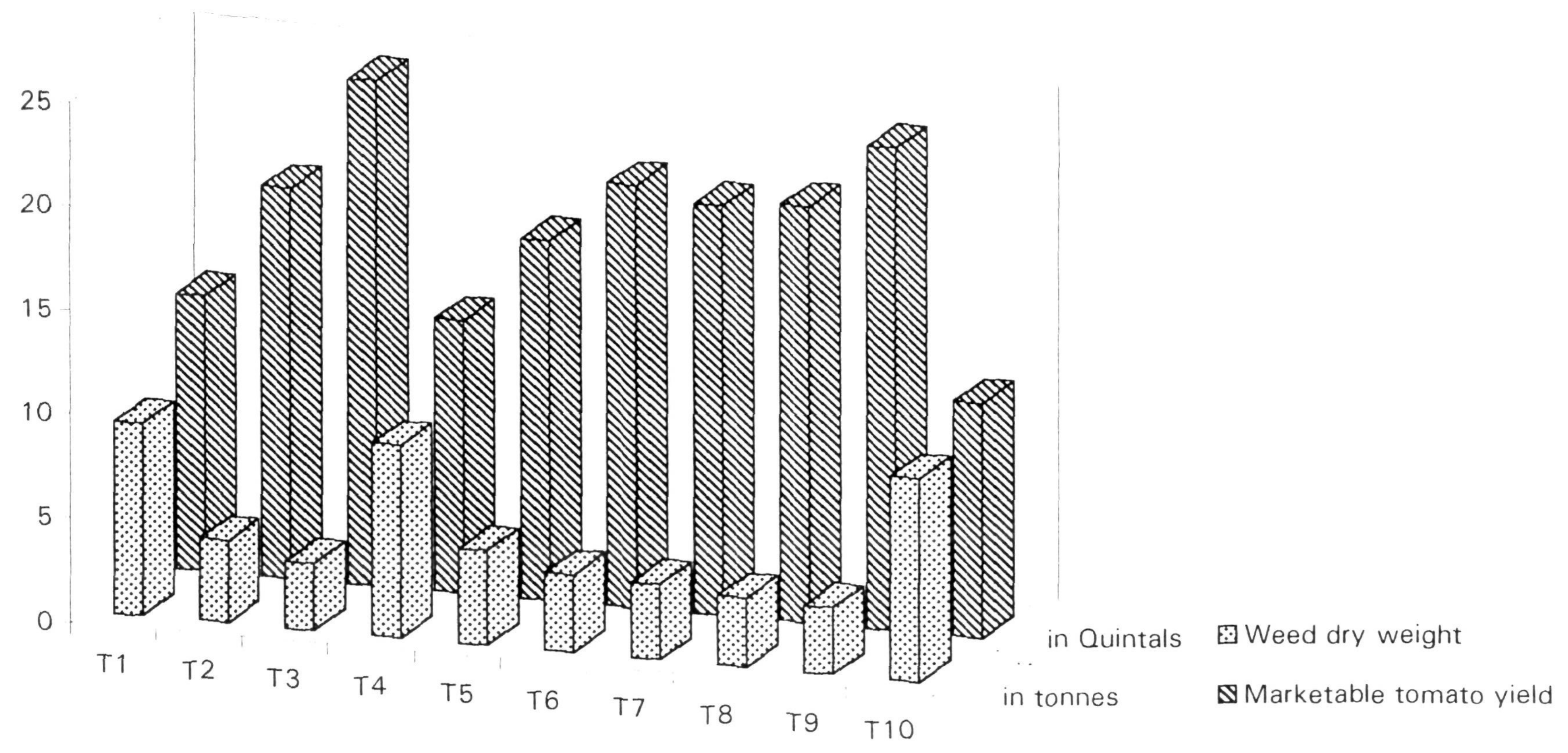


Fig.5. Marketable tomato yield (t/ha) and weed dry weight (Q/ha) at harvest due to solarization treatments

hand weedings (0.32 t ha^{-1}) and was statistically on par with TPE 0.05 mm for 45 days (0.32 t ha^{-1}). Further alachlor at 1.5 kg a.i. ha^{-1} recorded lower weed dry weight (0.36 t ha^{-1}) which was on par with one hand weeding (0.33 t ha^{-1}), TPE 0.1 mm for 45 days (0.37 t ha^{-1}) and TPE 0.05 mm for 30 days (0.39 t ha^{-1}). Highest weed dry weight was recorded in control (0.97 t ha^{-1}) being on par with TPE 0.05 mm and TPE 0.10 mm for 15 days (**Table 4.17**). During both 1997-98 and 1998-99, weed dry weight followed the similar trend of pooled data (**Appendix 19 and Fig. 5**).

4.3.3 Tomato crop growth and development

4.3.3.1 **Plant height (cm)** : Plant height differed significantly due to treatments at all the stages (30, 60 DAT and at harvest) of crop growth as compared to control. Analysis of pooled data indicated significantly taller plants in soil solarization with TPE 0.05 mm for 45 days (37.47 cm to 76.31 cm) which was statistically on par with two hand weedings (36.44 to 75.95) over all other treatment. Further one hand weeding recorded plant height of 33.57 to 74.49 cm and was on par with alachlor at 1.5 kg a.i. ha^{-1} (32.53 to 74.55), TPE 0.05 mm for 30 days (32.10 to 73.59) and TPE 0.1 mm for 45 days (32.05 to 74.1). There was no significant difference between short duration (15 days) soil solarization over control (**Table 4.18**).

Similar trend was observed during both the years (1997-98 and 1998-99) regarding plant height. Thinner polyethylene sheet with longer duration was superior over thicker with shorter duration in general (**Appendix 20**).

4.3.3.2 **Number of branches** : It was noticed that at all the stages there were significant differences in the number of branches due to different treatments.

In pooled (**Table 4.18**) data, maximum number of branches was recorded by two hand weedings (7.59 to 8.11) and was statistically on par with TPE 0.05 mm for 45 days (7.53 to 8.11). Least number of branches was recorded by control being statistically on par with shorter duration (15 days) solarization with TPE 0.05 mm and TPE 0.1 mm. Next best treatments are one hand weeding, alachlor at 1.5 kg a.i. ha^{-1}, TPE 0.10 mm for 45 days and TPE 0.05 mm for 30 days. During both the years of 1997-98 and 1998-99 number of branches per plant followed the trends of pooled data (**Appendix 20**).

4.3.3.3 **Number of leaves per plant** : Number of leaves showed significant differences at all the stages. In pooled data significantly higher number of leaves was registered by two hand weedings (13.02 to 35.19) and was statistically on par with TPE 0.05 mm for 45 days (12.94 to 34.37) (**Table 4.18**). The lowest number of leaves per plant was in control (7.42 to 27.74) and was statistically on par with soil solarization for a short period of 15 days with TPE 0.05 mm and TPE 0.10 mm (8.16 to 28.58 and 8.06 to 28.51, respectively). Further alachlor at 1.5 kg a.i. ha^{-1} had 11.27 to 33.06 number of leaves per plant and was statistically on par with one hand weeding. During 1997-98 and 1998-99 number of leaves produced per plant were similar to that of pooled data (**Appendix 21**).

Table 4.18. Plant height (cm), number of branches per palnt and number of leaves per plant of tomato as influenced by solarization treatments (pooled*).

Treatments	Plant height (cm)			Number of branches/plant			Number of leaves per plant		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
TPE 0.05 mm 15 days	26.51	61.33	67.69	6.00	6.24	6.39	8.16	28.29	28.58
TPE 0.05 mm 30 days	32.10	69.20	73.59	6.60	7.05	7.25	10.55	34.10	32.29
TPE 0.05 mm 45 days	37.47	72.67	76.31	7.53	8.41	8.11	12.94	37.09	34.37
TPE 0.1 mm 15 days	26.39	61.11	67.06	5.38	6.22	6.23	8.06	27.59	28.51
TPE 0.1 mm 30 days	29.37	67.95	72.29	6.03	6.69	6.97	9.60	33.73	31.17
TPE 0.1 mm 45 days	32.05	70.45	74.11	6.66	7.16	7.41	10.80	35.18	32.77
Alachlor 1.5 kg a.i./ha	32.53	70.10	74.55	6.76	7.32	7.63	11.48	35.96	33.06
One hand weeding	33.57	70.51	74.49	6.69	7.31	7.47	11.16	35.85	32.93
Two hand weedings	36.44	72.81	75.95	7.59	8.18	8.11	13.02	37.96	35.19
Control	23.84	30.38	66.81	5.65	5.78	6.08	7.42	26.94	27.74
S.Em±	1.17	0.46	0.38	0.21	0.16	0.11	0.33	0.35	0.36
CD at 5%	3.49	1.36	1.28	0.63	0.47	0.33	0.99	1.03	1.28

DAT = Days after transplanting; TPE = Transparent polyethylene; * = Pooled data of two years.

4.3.3.4 **Leaf area (dm^2/plant)** : Data for pooled analysis (**Table 4.19**) at all the stages showed significantly higher leaf area per plant due to solarization with TPE 0.05 mm for 45 days (3.91 to 8.14 dm^2/plant) which was on par with two hand weedings (3.93 to 7.85 dm^2/plant). While alachlor at 1.5 kg a.i. ha^{-1} produced the leaf area of 3.31 to 7.21 dm^2/plant which was statistically on par with one hand weeding, TPE 0.1 mm for 45 days and TPE 0.05 mm for 30 days. Significantly lower leaf area per plant was recorded by control (2.00 to 5.41 dm^2/plant) and was statistically on par with short duration (15 days) soil solarization with TPE 0.05 mm and TPE 0.1 mm. Leaf area per plant recorded in 1997-98 and 1998-99 were similar to that of pooled analysis (**Appendix 21**).

4.3.3.5 **Leaf area index** : In pooled data, significantly higher leaf area index was registered by soil solarization with TPE 0.05 mm for 45 days (0.86 to 1.81) and was statistically on par with two hand weedings (0.87 to 1.75). Next best effective treatments regarding leaf area index were alachlor at 1.5 kg a.i. ha^{-1} (0.74 to 1.62), one hand weeding (0.71 to 1.66), TPE 0.05 mm for 30 days (0.68 to 1.53) and TPE 0.1 mm for 45 days (0.71 to 1.53). Least leaf area index was observed in control (0.45 to 1.19) (**Table 4.19**).

During 1997-98 and 1998-99 the leaf area index followed by pattern of pooled analysis data (**Appendix 22**).

Table 4.19. Leaf area (dm^2/plant), leaf area index and days taken for 50 per cent flowering in tomato as influenced by solarization treatments (pooled*).

Treatments	Leaf area (dm^2/plant)			Leaf area index			Days taken for 50% flowering
	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest	
TPE 0.05 mm 15 days	2.40	4.97	5.87	0.53	1.11	1.31	30.04
TPE 0.05 mm 30 days	3.08	6.11	6.87	0.68	1.36	1.53	32.08
TPE 0.05 mm 45 days	3.91	6.82	8.14	0.86	1.52	1.81	35.02
TPE 0.1 mm 15 days	2.22	4.83	5.74	0.49	1.08	1.27	29.6
TPE 0.1 mm 30 days	2.75	5.61	6.41	0.61	1.24	1.42	31.18
TPE 0.1 mm 45 days	3.18	6.09	6.89	0.71	1.35	1.53	33.27
Alachlor 1.5 kg a.i./ha	3.31	6.21	7.21	0.74	1.37	1.62	33.60
One hand weeding	3.19	6.22	7.34	0.71	1.38	1.66	33.61
Two hand weedings	3.93	6.86	7.85	0.87	1.53	1.75	35.29
Control	2.00	4.68	5.41	0.45	1.03	1.19	27.52
S.Em±	0.12	0.11	0.16	0.03	0.04	0.05	0.20
CD at 5%	0.37	0.33	0.48	0.08	0.12	0.14	0.60

DAT = Days after transplanting; TPE = Transparent polyethylene; * = Pooled data of two years.

4.3.3.6 **Dry matter accumulation in leaves (g plant^{-1})** : Data on the dry matter accumulation in leaf at different stages (**Table 4.20**) revealed that the two hand weedings recorded significantly higher leaf dry matter accumulation (22.31 to 25.26 g plant^{-1}) and was statistically on par with TPE 0.05 mm for 45 days (22.45 to 25.00 g plant^{-1}). The lowest leaf dry weight was recorded in control (12.21 to 16.15 g plant^{-1}) and was on par with TPE 0.05 mm and TPE 0.1 mm for 15 days soil solarization (**Appendix 23**).

4.3.3.7 **Dry matter accumulation in stem (g plant^{-1})** : Analysis of pooled data indicated that at all stages (**Table 4.20**) significantly higher dry matter accumulation in stem was recorded when two hand weedings were done (20.09 to 30.96 g plant^{-1}) and it was statistically on par with TPE 0.05 mm for 45 days (20.01 to 31.60 g plant^{-1}). Further alachlor at 1.5 kg a.i. ha^{-1} produced higher stem dry matter (16.96 to 25.99 g plant^{-1}) and it was statistically on par with one hand weeding (17.11 to 25.60 g plant^{-1}), TPE 0.1 mm for 45 days (16.38 to 25.43 g plant^{-1}) and TPE 0.05 mm for 30 days (16.29 to 25.25 g plant^{-1}). Significantly lower dry matter accumulation in stem was recorded in control (9.89 to 20.41 g plant^{-1}).

During 1997-98 and 1998-99 dry matter accumulation in stem followed the pattern of pooled analysis data (**Appendix 23**).

4.3.3.8 **Dry matter accumulation in fruit (g plant^{-1})** : Pooled analysis showed that TPE 0.05 mm for 45 days recorded significantly higher dry matter accumulation in tomato (55.05 to 76.68 g plant^{-1}) and was statistically on par with two hand weedings (55.19 to 78.03 g plant^{-1}). Alachlor at 1.5 kg a.i. ha^{-1} produced more dry matter (52.22 to 74.60 g plant^{-1}) being statistically on par with one hand weeding, TPE 0.05 mm for 30 days and TPE 0.1 mm for 45 days. The lowest dry matter accumulation in tomato was recorded in control (38.67 to 60.05 g plant^{-1}) which was statistically on par with TPE 0.05 mm and TPE 0.1 mm for 15 days (**Table 4.20**).

Similar trend was observed in 1997-98 and 1998-99 regarding dry matter accumulation in fruit (**Appendix 24**).

4.3.3.9 **Total dry matter accumulation (g plant^{-1})** : Data on total dry matter accumulation in tomato showed that it was significantly increased over control by all treatments, except soil solarization for 15 days with TPE 0.05 mm and TPE 0.1 mm which were on par with control at all stages of crop growth.

Pooled analysis indicated that two hand weedings recorded significantly higher total dry matter accumulation (42.49 to 134.24 g plant^{-1}) at all stages of crop growth and was statistically on par with TPE 0.05 mm for 45 days (42.40 to 133.85 g plant^{-1}) (**Table 4.20 and Fig. 6**). Further, alachlor at 1.5 kg a.i. ha^{-1} produced more total dry matter accumulation (35.71 to 122.08 g plant^{-1}) which was on par with one hand weeding (36.03 to 126.62 g plant^{-1}), TPE 0.05 mm for 30 days (33.61 to 118.53 g plant^{-1}) and TPE 0.1 mm for 45 days (34.56 to 120.90 g plant^{-1}). The lowest total dry matter was observed in control

Table 4.20. Dry matter of leaves (g/plant), dry matter of stem (g/plant), dry matter of fruit (g/plant) and total dry matter (g/plant) in tomato as influenced by solarization treatments (pooled*).

Treatments	Dry matter of leaves (g/plant)			Dry matter of stem (g/plant)			Dry matter of fruit (g/plant)		Total dry matter (g/plant)		
	30 DAT	60 DAT	At harvest	30 DAT	60 DAT	At harvest	60 DAT	At harvest	30 DAT	60 DAT	At harvest
TPE 0.05 mm 15 days	13.39	17.37	17.76	11.89	20.27	21.79	40.48	60.10	25.19	78.19	100.66
TPE 0.05 mm 30 days	17.31	22.83	21.27	16.29	25.82	25.25	46.80	72.01	33.61	95.45	118.53
TPE 0.05 mm 45 days	22.45	28.47	25.00	20.01	30.34	31.60	55.05	76.68	42.40	113.75	133.85
TPE 0.1 mm 15 days	12.03	16.86	17.21	11.62	20.36	20.39	39.36	60.58	23.65	76.58	98.18
TPE 0.1 mm 30 days	15.75	22.44	19.39	14.25	23.56	22.90	45.91	71.66	29.99	93.17	113.72
TPE 0.1 mm 45 days	18.19	24.71	21.57	16.38	25.95	25.43	49.91	73.90	34.56	99.86	120.90
Alachlor 1.5 kg a.i./ha	18.76	25.49	21.49	16.96	26.32	25.99	52.22	74.60	35.71	103.76	122.08
One hand weeding	18.72	24.51	21.38	17.11	25.01	25.60	51.80	74.58	36.03	101.41	121.62
Two hand weedings	22.31	28.79	25.26	20.09	30.01	30.96	55.19	78.03	42.49	113.04	134.24
Control	12.21	15.45	16.15	9.89	9.11	20.41	38.67	60.05	21.96	73.39	96.61
S.Em±	0.74	0.78	0.55	0.55	0.56	0.56	0.61	0.55	1.44	2.22	1.67
CD at 5%	2.19	2.31	1.64	1.64	1.67	1.66	1.82	1.63	4.29	6.62	5.01

DAT = Days after transplanting; TPE = Transparent polyethylene; * = Pooled data of two years.

LEGEND

T_1 = TPE 0.05mm 15 days

T_2 = TPE 0.05mm 30 days

T_3 = TPE 0.05mm 45 days

T_4 = TPE 0.10mm 15 days

T_5 = TPE 0.10mm 30 days

T_6 = TPE 0.10mm 45 days

T_7 = Alachlor 1.5Kg a.i./ha

T_8 = One hand weeding

T_9 = Two hand weedings

T_{10} = Control

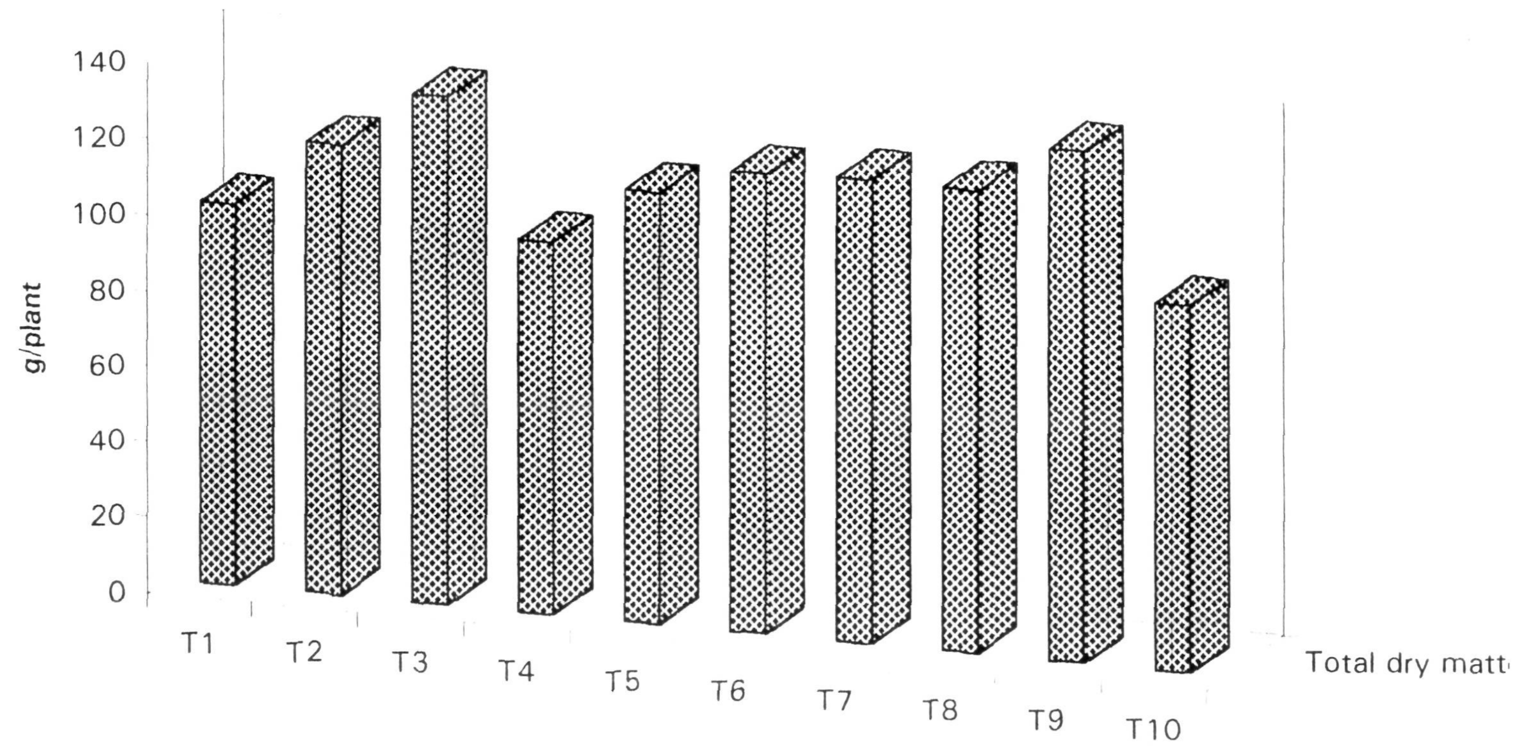


Fig.6. Total dry matter accumulation (g/plant) in tomato at harvest due to solarization treatments

(21.96 to 96.61 g plant^{-1}) and was on par with solarization for 15 days with TPE 0.05 mm and TPE 0.1 mm. Similar trend was observed during 1997-98 and 1998-99 regarding total dry matter accumulation (**Appendix 24**).

4.3.3.10 **Days taken for 50 per cent flowering** : There were no significant differences among the treatments regarding days for 50 per cent flowering but there was significant difference between control versus treatments, except solarization for 15 days with TPE 0.05 mm and TPE 0.10 mm. However, more days for 50 per cent flowering was obtained in two hand weedings (35.29%) followed by TPE 0.05 mm for 45 days (35.02). Less number of days taken was by control (27.52) which was on par with TPE 0.05 mm and TPE 0.10 mm for 15 days in pooled analysis (**Table 4.19**). During 1997-98 and 1998-99, days taken for 50 per cent flowering followed the pattern of pooled analysis (**Appendix 22**).

4.4. YIELD AND YIELD COMPONENTS OF TOMATO

4.4.1 **Total number of fruits and number of marketable fruits (plant^{-1})** : In pooled analysis significantly more number of fruits (44.90 plant^{-1}) and number of marketable fruits (43.74 plant^{-1}) were recorded by two hand weedings (**Table 4.21**) and was statistically on par with TPE 0.05 mm for 45 days (total number of fruits 44.81 and number of marketable tomato 43.26). Next best treatments were alachlor at 1.5 kg a.i. ha^{-1}, one hand weeding, TPE 0.1 mm for 45 days and TPE 0.05 mm for 30 days. Least was in control being on par with solarization or 15 days with TPE 0.05 mm for 45 days and TPE 0.1 mm.

Similar results obtained regarding total number of tomato and marketable tomato per plant during both years (1997-98 and 1998-99) as in pooled data (**Appendix 25**).

4.4.2 **Total and marketable fruit weight (kg plant^{-1})** : It was observed that fruit weight varied significantly due to various treatments over control (**Table 4.21**). In pooled data, significantly more total fruit weight (1.88 kg plant^{-1}) and marketable tomato weight (1.69 kg plant^{-1}) was registered by TPE 0.05 mm for 45 days which was statistically on par with two hand weeding of total tomato weight (1.88 kg plant^{-1}) and marketable tomato weight (1.65 kg plant^{-1}). Further alachlor at 1.5 kg a.i. ha^{-1} produced the total tomato weight of 1.61 kg plant^{-1} and marketable tomato weight (1.36 kg plant^{-1}) which were statistically on par with one hand weeding, TPE 0.1 mm for 45 days and TPE 0.05 mm for 30 days. The trend of total and marketable fruit weight obtained in 1997-98 and 1998-99 were similar to that of pooled data (**Appendix 25**).

4.4.3 **Total and marketable fruit yield (t ha^{-1})** : The maximum total tomato yield (25.95 t ha^{-1}) and marketable fruit yield (24.27 t ha^{-1}) was registered (**Table 4.21 and Fig. 5**) in soil solarization with TPE 0.05 mm for 45 days and was statistically on par with two hand weedings (total fruit yield 24.83 and marketable fruit yield 23.17). While, least fruit yield was in control and was statistically on par with TPE 0.05 mm and TPE 0.1 mm for 15 days. One hand weeding produced total (22.1 t ha^{-1}) and marketable fruit yield of 19.25

Table 4.21. Total number of tomato per plant, number of marketable fruits per plant, total fruit weight (kg/plant), marketable fruit weight (kg/plant), total tomato yield (t/ha), marketable tomato yield (t/ha) and specific gravity (w/v) of tomato as influenced by solarization treatments (pooled*).

Treatments	Total No. of tomato/ plant	No. of market-able tomato per plant	Total tomato weight (kg/plant)	Marketa-ble tomato weight (kg/plant)	Total tomato yield (t/ha)	Marketa-ble tomato yield (t/ha)	Specific gravity (w/v)
TPE 0.05 mm 15 days	31.95	28.32	1.15	0.95	16.87	13.21	0.88
TPE 0.05 mm 30 days	40.32	39.81	1.52	1.31	20.80	18.74	1.09
TPE 0.05 mm 45 days	44.81	43.26	1.88	1.69	25.95	24.27	1.27
TPE 0.1 mm 15 days	32.17	27.79	1.12	0.94	16.71	13.09	0.86
TPE 0.1 mm 30 days	38.41	37.67	1.29	1.14	20.13	17.26	0.99
TPE 0.1 mm 45 days	41.58	40.48	1.54	1.31	21.79	20.27	1.07
Alachlor 1.5 kg a.i./ha	41.88	41.33	1.61	1.36	21.98	19.63	1.09
One hand weeding	41.62	40.75	1.59	1.35	22.10	19.95	1.11
Two hand weedings	44.90	43.74	1.88	1.65	24.83	23.17	1.22
Control	30.27	28.75	0.99	0.78	15.47	11.22	0.80
S.Em±	0.96	0.36	0.06	0.05	0.48	0.72	0.05
CD at 5%	2.83	1.68	0.17	0.15	1.41	2.16	0.14

DAT = Days after transplanting; TPE = Transparent polyethylene; * = Pooled data of two years.

t ha^{-1} being statistically on par with alachlor at 1.5 kg a.i. ha^{-1}, TPE 0.10 mm for 45 days and TPE 0.05 mm for 30 days. During 1997-98 and 1998-99 the trend of total and marketable tomato yield was similar to that of pooled analysis (**Appendix 25**).

4.4.4 **Specific gravity (w/v)** : In pooled data, significantly higher specific gravity was recorded when soil solarization with TPE 0.05 mm for 45 days (1.27) and was statistically on par with two hand weedings (1.22) and these two were significantly superior over other treatments. Next effective treatments were one hand weeding, alachlor at 1.5 kg a.i. ha^{-1}, TPE 0.10 mm for 45 days and TPE 0.05 mm for 30 days. Least specific gravity was recorded by control (0.80) being on par with TPE 0.05 mm and TPE 0.10 mm for 15 days (**Table 4.21**). The trend of specific gravity obtained during 1997-98 and 1998-99 followed the pooled analysis data (**Appendix 25**).

4.5 RELATIONSHIP BETWEEN GROWTH, YIELD AND YIELD COMPONENTS OF GROUNDNUT

The correlation between yield and plant height, number of branches, leaf area index, total dry matter accumulation, number of filled pods per plant, pod weight per plant, shelling percentage and 100 kernel weight as estimated by 'r' values are presented in **Table 22**. Groundnut pod yield had significant positive correlation with plant height (r = 0.56), number of branches (r = 0.59), leaf area index (r = 0.97), total dry matter accumulation (r = 0.98), number of filled pods

Table 4.22. Correlation coefficientt (r) values for groundnut pod yield with growth and yield components.

Parameters	Correlation co-efficient (r)
Plant height	0.56**
Number of branches per plant	0.59**
Leaf area index	0.97**
Total dry matter accumulation (g/plant)	0.98**
Number of filled pods per plant	0.97**
Pod weight (g/plant)	0.96**
Shelling percentage	0.95**
100 kernel weight	0.97**

** Significant at 1%

per plant (r = 0.9704), pod weight per plant (r = 0.96), shelling percentage (r = 0.94) and 100 kernel weight (r = 0.97).

4.6 **ECONOMICS OF SOLARIZATION TREATMENTS**

In groundnut - tomato sequence, two hand weedings (**Table 23 and 23a**). recorded the maximum gross income (Rs. 1,48,035 ha^{-1}) and net income (Rs. 1,34,830 ha^{-1}) during 1997-98, but in 1998-99 TPE 0.05 mm for 45 days recorded higher gross income (Rs. 1,61,553 ha^{-1}) and net income (Rs. 1,41,330 ha^{-1}).

4.7 **EFFECT OF SOIL SOLARIZATION ON GERMINATION OF WEED SEEDS**

The germination of different weed seeds differed significantly among the different treatments. Significantly fewer weed seeds germinated when the soil solarization was done with TPE 0.05 mm for 45 days at all the depths compared to other treatments and the highest was in control. Among the different depths, 5 cm soil depth recorded significantly lower weed seed germination compared to 10 cm and 15 cm soil depth (**Table 24**).

Among the interactions, the germination of all the weed species was lower by the combination of TPE 0.05 mm for 45 days with 5 cm soil depth.

Table 4.23 Economics of weed control treatments in groundnut - tomato crop sequence during 1997-98.

Treatments	Gross income (Rs./ha)		Total gross income (Rs/ha)	Total costs (Rs/ha)		Grand total costs (Rs/ha)	Net income (Rs/ha)
	Ground-nut	Tomato		Ground-nut*	Tomato		
TPE 0.05 mm 15 days	16,930	61,850	78,780	12,093	7418	19,511	59,268
TPE 0.05 mm 30 days	17,688	86,050	1,03,738	12,093	7418	19,511	84,227
TPE 0.05 mm 45 days	26,654	11,280	1,39,454	12,093	7418	19,511	1,19,942
TPE 0.1 mm 15 days	14,067	60,950	75,017	15,427	7418	22,845	52,172
TPE 0.1 mm 30 days	16,485	75,000	91,485	15,427	7418	22,845	68,640
TPE 0.1 mm 45 days	21,278	86,400	1,07,678	15,427	7418	22,845	84,833
Alachlor 1.5 kg a.i./ha	27,213	90,950	1,18,163	5,917	7418	13,335	1,04,828
One hand weeding	26,715	98,600	1,25,315	5,607	7418	13,025	1,12,290
Two hand weedings	33,585	1,14,450	1,48,035	5,787	7418	13,205	1,34,830
Control	10,994	30,270	41,265	5,427	7418	12,845	15,574

* Includes TPE cost
TPE 0.05 mm = Rs. 3.00/2.0 m^2
TPE 0.10 mm Rs. 5.00/2.0 m^2

Groundnut Pods = Rs. 1400/q
Groundnut Haulm = Rs. 60/q
Tomato Rs. 500/q
Alachlor Rs. 240/lit

Table 4.23a Economics of weed control treatments in groundnut - tomato crop sequence during 1998-99.

Treatments	Gross income (Rs./ha)		Total gross income (Rs/ha)	Total costs (Rs/ha)		Grand total costs (Rs/ha)	Net income (Rs/ha)
	Ground-nut	Tomato		Ground-nut*	Tomato		
TPE 0.05 mm 15 days	20,351	70,250	90,601	12,593	7629	20,222	70,378
TPE 0.05 mm 30 days	28,899	1,01,300	1,30,199	12,593	7629	20,222	1,09,976
TPE 0.05 mm 45 days	36,653	1,24,900	1,61,553	12,593	7629	20,222	1,41,330
TPE 0.1 mm 15 days	18,785	70,071	88,856	15,297	7629	23,556	65,300
TPE 0.1 mm 30 days	21,494	97,600	1,19,094	15,927	7629	23,556	95,538
TPE 0.1 mm 45 days	26,471	1,06,300	1,32,771	15,927	7629	23,556	1,09,215
Alachlor 1.5 kg a.i./ha	26,914	1,01,350	1,28,264	6,417	7629	14,046	1,14,218
One hand weeding	26,515	1,00,950	1,27,465	6,107	7629	13,736	1,13,729
Two hand weedings	33,073	1,17,250	1,50,323	6,287	7629	13,916	1,36,407
Control	14,542	37,020	51,562	5,927	7629	13,556	38,006

* Includes TPE cost
TPE 0.05 mm = Rs. 3.00/2.0 m^2
TPE 0.10 mm = Rs. 5.00/2.0 m^2

Groundnut Pods = Rs. 1400/q
Groundnut Haulm = Rs. 60/q
Tomato = Rs. 500/q
Alachlor = Rs. 240/lit

Table 4.24. Effect of solarization treatments on germination of weed seeds at different depths.

Treatments	*Dactyloctenium aegypticum*				*Ergostic tunnela*				*Cyperus rotundus*				Other weeds			
	5 cm	10 cm	15 cm	Mean	5 cm	10 cm	15 cm	Mean	5 cm	10 cm	15 cm	Mean	5 cm	10 cm	15 cm	Mean
TPE 0.05 mm 15 days	3.83	3.98	5.83	4.55	1.66	3.00	4.34	3.00	0.66	3.00	3.25	2.30	2.66	3.66	3.54	3.29
TPE 0.05 mm 30 days	2.00	2.65	4.00	2.88	1.33	2.33	2.33	1.99	0.33	1.66	1.68	1.22	1.00	1.33	1.66	1.33
TPE 0.05 mm 45 days	0.98	1.69	2.68	1.78	1.00	1.33	1.86	1.39	0.00	1.00	1.00	0.66	0.00	0.66	1.33	0.66
TPE 0.1 mm 15 days	4.33	4.86	6.33	5.17	2.00	3.66	4.33	3.33	0.66	3.00	3.33	2.33	2.00	3.98	3.89	3.29
TPE 0.1 mm 30 days	2.33	3.66	5.00	3.66	1.66	2.66	3.33	2.55	0.33	2.33	2.31	1.66	1.33	2.00	2.33	1.88
TPE 0.1 mm 45 days	1.33	2.95	3.66	2.48	1.33	2.00	2.33	1.88	0.00	1.33	1.36	0.89	0.66	1.33	2.66	1.55
Control	4.33	4.94	6.66	5.32	2.60	4.00	4.66	3.75	0.99	3.33	3.88	2.73	2.66	4.00	4.00	
Mean	2.66	3.46	4.77		1.65	2.70	3.31		0.42	2.24	2.40		1.47	2.42	2.77	

	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%	S.Em±	CD at 5%
Solarization	0.23	0.68	0.16	0.48	0.07	0.22	0.18	0.53
Depth	0.25	0.75	0.34	1.01	0.04	0.14	0.20	0.60
Interaction	0.11	0.33	0.11	0.33	0.11	0.33	0.31	0.92

DISCUSSION

V. DISCUSSION

The most striking physical change upon soil solarization is increase in soil temperature to high levels and thereby reducing the weed problem by killing weed seeds or their propagules by various mechanisms. Soil solarization is gaining grounds as means of soil disinfection due to its eco-friendly nature. In this context, the results of the field experiments and laboratory studies conducted during 1997-98 and 1998-99 to know the influence of soil solarization on soil nutrients, soil micro organisms, weed control, performance of crops (groundnut-tomato) in sequence and weed seeds germinated from solarized soil following soil solarization are discussed in this chapter.

5.1 WEATHER AND CROP GROWTH

The crop experienced favourable weather conditions during its growth period (**Table 3.2**). The mean maximum temperature was below the normal in the months of June and July and September to December 1997. The months of March and April (1998) were cooler than the normal minimum temperature. The mean minimum temperature during 1999 was more than normal minimum temperature in all the months. The total rainfall received during 1997 and 1998 were more than the normal. During 1997 more rainfall was received during solarization period (March to May). Comparatively less rainfall was received during 1998. The mean relative humidity was more than the normal in all the months during both the years. Bright sunshine hours during 1997 and 1998 exceeded the normal. Comparatively more bright sunshine hours were recorded during 1998 compared to 1997. The mean evoparation was less than the normal from July to October during both the years.

5.2 EFFECT OF SOIL SOLARIZATION ON PHYSICAL AND CHEMICAL PROPERTIES OF SOIL

5.2.1 **Soil temperature** ; Significantly higher soil temperature was recorded due to soil solarization with thinner TPE (0.05 mm) compared to thicker TPE (0.1 mm). A maximal soil temperature of 53.1 and 50.7°C were recorded by 5 and 10 cm soil depths with TPE 0.05 mm for 45 days of solarization. The bare soil recorded the maximum soil temperature of 41.6 and 38.0°C at 5 and 10 cm soil depths, respectively at all the stages of observations.

The higher soil temperature in the surface layer over deeper layers has been reported by Sauerborn *et al.* (1989), Raj and Gupta (1996), Ahmed *et al.* (1996), Mudalagiriyappa (1998) and Basavaraj (1998). Significantly higher soil temperatures under the TPEs could be attributed to the ability of transparent sheets to transmit the short wave solar radiation into the polyethylene film and generating heat waves, thus raising soil temperature eventually. Higher soil temperature under TPEs has been reported by many workers (Katan, 1981; Usmani and Ghaffar, 1981; Raj and Kapoor, 1993).

Between the thickness, TPE 0.05 mm recorded significantly higher mean soil temperatures of 51.50 and 48.0°C at 5 and 10 cm soil depths. It was 49.30 and 45.90 for 0.10 mm thickness. The higher soil temperatures under this TPE (0.05 mm) could be attributed to favourable properties such as higher transmission, lower reflection and absorption of solar radiation. Many workers have reported that higher efficiency of thin TPE over thick TPE in increasing soil temperature (Chen and Katan, 1980; Melero *et al.*, 1989; Harti, 1991; Habeeburrahaman, 1992; Mungnozza *et al.*, 1997); Mudalagiriyappa, 1998; Basavaraj, 1998).

During 1998-99 slightly higher soil temperature was recorded than 1997-98. This was mainly due to more number of days with higher air temperature maxima during the solarization period in 1998-99. Moreover, the soil solarization treatment commenced later in 1997-98 than in 1998-99. This gave more scope for build up of soil temperature during 1998-99 and total rainfall received during 1998-99 was lower compared to 1997-98, during soil solarization period.

5.2.2 **Soil moisture** : All the solarization treatments retained higher soil moisture (upto 13% and 14% at 0-15 cm and 15-30 cm soil depths) over non-solarization control (upto 8.4 to 10.2% at 0-15 cm and 15-30 cm soil depths). As proposed by Yaduraju (1993) pre solarization irrigation is one of the pre-requisites for achieving higher soil temperatures under TPEs and retention of heat for longer time. So in this context higher soil moisture under TPEs would have probably contributed towards achieving higher soil temperature irrespective of thickness and duration of solarization. Non solarization control on the other hand with dry soil almost throughout the period, did not have a favourable factor such as higher soil moisture to attain higher soil temperature. Thus the non solarized control recorded lower soil temperature as compared to soil under TPEs at any given atmospheric temperature. Here the TPE acted as a physical barrier for preventing the loss of soil moisture in the form of evaporation. In general, moisture percentage was more at 15-30 cm than at 0-15 cm soil depth in all the plots. Similar findings were made by Gutelal *et al.* (1982), Restuccia *et al.* (1994), Ravinder Kumar and Srivastava (1997); Arora (1998) and Basavaraj (1998).

5.2.3 **Plant nutrients** : The influence of soil solarization on nutrient content of soil is believed to be due to soil temperature. In the present study, the organic carbon and available sulphur content of soil upon solarization reduced appreciably to 0.34% and 6.01 ppm, respectively as compared to non solarization control (0.53% and 10.01 ppm of organic carbon and S respectively). However the level of available nitrogen, available phosphorus (P_2O_5), available potassium (K_2O), exchangeable Ca, exchangeable Mg and exchangeable Na content of soil was enhanced by soil solarization. An increase of 33.22 kg N ha^{-1}, 6.98 kg P_2O_5 ha^{-1}, 57.56 kg K_2O ha^{-1}, 0.14 me 100 g^{-1} of exchangeable calcium, 0.12 me 100 g^{-1} of exchangeable magnesium and 0.13 me 100 g^{-1} of exchangeable sodium was observed over non solarized control.

Maximum soil pH was recorded in TPE 0.05 mm for 45 days (7.02) and the least in control (6.46). The results are in conformity with the findings of Arora (1998). The reason may be due to the air tight conditions which could have led to decrease in gaseous exchange, especially oxygen and inturn might have given way for proton consuming reactions leading to increase in pH cum reduction in acidity. Electrical conductivity was maximum in TPE 0.05 mm for 45 days (0.46 dsm^{-1}) compared to other treatments. The results are in consonance with the findings of Arora (1998). This might be due to increase in the salt concentration like calcium, magnesium and sodium (**Table 4.3**).

The influence of either thickness of TPEs and duration of solarization could be mainly due to differential soil temperatures achieved in different thickness (0.05 mm and 0.10 mm) and durations (15, 30 and 45 days). Soil solarization with TPE 0.05 mm and for the duration of 45 days showed lower organic carbon and available sulphur and increased the levels of available nitrogen, available phosphorus, available potassium, exchangeable calcium, exchangeable magnesium and exchangeable sodium. The decrease in organic carbon, sulphur and increased levels of other nutrients could be mainly attributed to the effect of higher soil temperature under TPEs resulted in faster degradation of organic matter and increase solubility of nutrients. Mobilisation of nutrients from the organic matter took place by micro organisms due to congenial environment provided by plastic mulching during the first week of solarization also the microbes after death might have added to the nutrient pool. Under plastic film soil moisture and soluble nutrients might have moved upwards by capillary movement and increase in pH might have made the nutrients available (Haynes, 1987).

5.2.4 **Effect of soil solarization on microbial population** : The microbial population of soil was significantly influenced by various treatments. Soil solarization with TPE 0.05 mm for 45 days resulted in significant reduction

(68.57%) in fungal population. Cartia (1987) also reported that decrease in fungal population by 53 per cent due to solarization. Similarly TPE 0.05 mm for 45 days recorded more number of bacterial population at harvest of groundnut. Stapleton (1991) also reported that the increase in bacterial population in tomato by 3.2 folds. Actinomycetes population was also more with TPE 0.05 mm for 45 days at harvest of groundnut. Similar observations were recorded by Stapleton and Debay (1986).

5.3 **EFFECT ON WEEDS**

The effect of soil solarization on weed count, weed dry weight and weed control efficiency in groundnut and tomato are discussed here.

5.3.1 **Weed count** : The total number of weeds, number of monocots, dicots and sedges per meter square counted at 30, 60, 90 DAS and at harvest of groundnut and tomato showed significant differences due to treatments. The highest weed count was recorded in the control at all the stages. Significant reduction in weed count due to soil solarization was noticed at all the stages of crop growth due to TPE 0.05 mm for 45 days and two hand weedings. Further, alachlor at 1.5 kg a.i. ha^{-1}, TPE 0.1 mm for 45 days, TPE 0.05 mm for 30 days and one hand weeding were on par with each other.

In groundnut, the treatment TPE 0.05 mm for 45 days given 95.41, 93.58, 80.00 and 76.57 per cent reduction in total weed count; 97.86, 95.56, 95.05 and 94.78 per cent reduction in monocot weeds 96.21, 94.94, 90.59 and

87.63 per cent reduction in dicot weeds and 94.25, 84.66, 65.03 and 51.05 per cent reduction in sedges over control at 30, 60, 90 DAS and at harvest, respectively (Plate 5 and Plate 6).

The corresponding magnitude of reduction of weeds in tomato crop due to TPE 0.05 mm for 45 days was 83.98, 77.65 and 51.63 per cent with respect to total weed count; 92.79, 74.75 and 59.66 with respect to monocots; 85.62, 82.32 and 79.42 per cent in the case of dicots and 77.12, 74.69 and 70.68 per cent in sedges at 30, 60 DAT and at harvest. TPE 0.05 mm for 45 days was on par with two hand weedings.

From the above results on weed count it is evident that, solarization for 45 days is highly effective in reducing weed number. This could be due to the effect of high temperature achieved by soil solarization. Similar reduction in weed count due to soil solarization has also been reported earlier by Katan *et al.* (1983), Kumar *et al.* (1993) and Stapleton *et al.* (1985).

The extent of reduction in weed count at all the stages was in the order of TPE 0.05 mm and TPE 0.10 mm. Rise in temperature maxima was also in the same order. The rise in temperature to higher levels by TPE 0.05 mm might have caused the death or damage to the weed seeds present in the soil to a greater extent. Thus reducing their emergence to the minimum. Standifer *et al.* (1984), Stapleton and Garza-Lopez (1988) and Patel *et al.* (1990) also observed the superiority of thin TPE over thick TPE with respect to reduction in weed count.

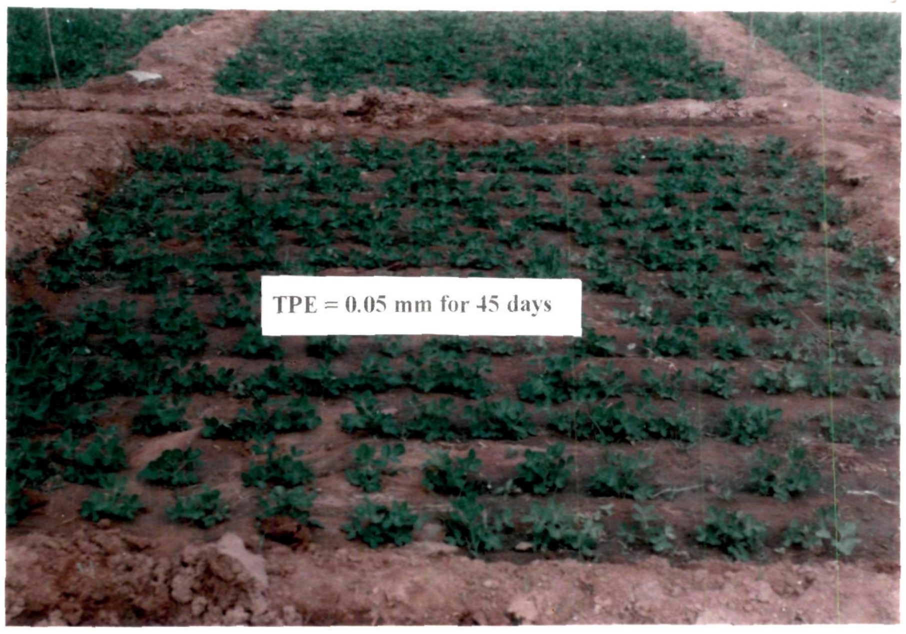


Plate 5 Groundnut plot at 20 DAS with TEP 0.05 mm for 45 days soil solarization

Plate 6 Unweeded control plot of groundnut at 20 DAS

In general, longer duration of solarization (45 days) with TPE affected maximum reduction in weed count upto the harvest of both groundnut and tomato. This is due to the availability of more number of days with soil temperature maxima exceeding lethal levels of 45°C. These observations are supported by that of Hilderland (1985), Braun *et al.* (1987) and Silveria *et al.* (1990). In the tomato crop maximum reduction in weed count was due to less infestation in the previous season wherein soil solarization helped to maintain lower weeds through thermal killing of weed seeds/propagules in the soil.

While comparing the reduction in dicot and monocot weed count, it was observed that the extent of reduction was more in dicot weeds. Lower efficiency of solarization in controlling perennials with underground propagules was also observed by Braun *et al.* (1987), Regone and Wilson (1988) and Stapleton and Garza-Lopez (1988).

Between the two years studied comparatively better reduction in weed count was observed in 1998-99 in spite of heavy rains during crop growth period. This is mainly attributed to the more number of days with higher temperature maxima during solarization period and there was less gap between soil solarization and sowing of groundnut.

5.3.2 **Weed dry weight (g/0.25 m^2)** : Data on weed dry weight at different growth stages of groundnut and tomato revealed that there were significant differences due to various treatments. As in case of weed count the maximum weed dry weight was recorded by control and minimum by two hand weedings and solarization for 45 days with TPE 0.05 mm. The performance of solarization treatments in reducing dry weight of weeds was almost similar to that of weed count. TPE 0.05 mm for 45 days appeared to be the best in reducing weed dry weight. This is mainly because of the reduced emergence of weeds which inturn occurred as a result of repeated daily heating for a period of 45 days. Similarly Habeeburrahaman (1992) observed 80 per cent reduction in weed dry weight due to TPE 0.05 mm for 40 days even after 125 DAS (125 days after solarization) and Abu-iramaileh (1991) also observed 95 per cent reduction in weed dry weight in tomato at 30 DAS and even at harvest (five months after sowing). The per cent reduction was to the tune of 40 per cent.

In groundnut, TPE 0.05 mm for 45 days resulted in 96.45, 93.13, 90.52 and 88.90 per cent reduction in total weed dry weight; 95.56, 94.44, 93.49 and 92.58 per cent reduction in monocot weight; 97.46, 94.92, 92.46 and 89.79 per cent reduction in dicot and 85.82, 80.17, 78.74 and 71.98 per cent reduction in sedges weight at 30, 60, 90 DAS and at harvest, respectively. The corresponding per cent reduction over control in tomato were 76.20, 73.21 and 67.19 per cent with respect to total weed dry weight; 70.72, 67.07 and 66.88 per cent with respect to monocot weed dry weight and 69.42, 68.75 and 66.66 per cent with respect to dicot weed dry weight and 61.14, 59.64 and 43.30 per cent with respect to sedge weed dry weight. Similar results with weed control for longer periods were obtained by solarization in groundnut (Daelemans, 1989), in carrot (Jacobson *et al*., 1980) and in sunflower (Vijaya Bhaskar, 1996). In groundnut, because of the reduction in weed dry weight there was considerable increase in weed control efficiency (WCE) of solarization treatment for 45 days owing to the season long weed free conditions. In comparison to two hand weedings the WCE achieved by TPE 0.05 mm for 45 days was remarkably higher especially at 90 DAS and at harvest. WCE, at harvest, due to TPE 0.05 mm for 45 days was 88.37 in groundnut and 67.25 per cent in tomato. The corresponding values due to two hand weedings were 88.32 and 66.90 for groundnut and tomato respectively. Similar trends were observed by Habeeburrahaman (1992) in jowar and groundnut and Mudalagiriyappa (1998) in groundnut and potato.

5.3.3 **Growth and growth components of groundnut and tomato** : The weed control treatments recorded significantly higher plant height compared to control at all the stages of crop growth in groundnut (**Table 4.9**) and tomato (**Table 4.18**). Significantly lesser plant height was recorded in control plots. This may be due to the competition between weeds and the crop for growth resources. Reduction of plant height in control in groundnut was also noticed by Murthy *et al.* (1992). In both the crops, the treatment TPE 0.05 mm for 45 days recorded plant height on par with two hand weedings and were significantly superior over other treatments which might be on account of weed restricted environment upto harvest. Similarly, increase in plant height of groundnut due to TPE was observed by Biradar (1996). In comparison to control, TPE 0.05 mm for 30 days, TPE 0.10 mm for 45 days, resulted in taller plants. One hand weeding and alachlor at 1.5 kg a.i. ha^{-1} can only prevent or delay the emergence of weeds thus giving chance for them to come up at a certain period after the weed control operations, whereas, solarization for longer durations could affect the weed seed bank itself in the soil by causing thermal killing of weed seeds/propagules.

The number of branches in groundnut and tomato (**Table 4.9**) differed significantly due to weed control treatments at all the stages. The maximum number of branches in both the crops was recorded by two hand weeding which was on par with TPE 0.05 mm for 45 days and significantly higher over all other treatments. The per cent increase in number of branches over control was 4.21 to 4.74 by two hand weedings and 3.60 to 4.04 by TPE 0.05 mm for 45 days. Provision of extended weed free period due to effective weed treatments resulted in higher number of branches. The findings are in close agreement with Kulandaivelu and Sankaran (1986).

The number of leaves in groundnut and tomato differed significantly due to various treatments. The maximum number of leaves in both the crops was recorded by two hand weedings, but was on par with TPE 0.05 mm for 45 days consequent to the luxuriant vegetative growth. Due to non competition in two hand weeding plots and high temperature in TPE 0.05 mm affected weed seed germination and induced weed suppression in solarized plots. There was a higher leaf retention even at harvest. Significantly higher number of leaves due to solarization treatments over control throughout the crop growth period. Similar findings were reported by Harti (1991) and Emani (1991).

Regarding leaf area per plant, higher leaf area at all the stages recorded by two hand weedings which was on par with TPE 005 mm for 45 days in groundnut and tomato. The minimum leaf area was recorded by non solarized control. Similar reduction in leaf area in control plot was observed by Mudalagiriyappa (1998). The trend in leaf area per plant of both groundnut and tomato is tallying with the increase in leaf number as a result of effective weed control. The per cent increase in leaf area over control at 60 DAS, due to two hand weedings and TPE 0.05 mm for 45 days, respectively, was 4.96 and 4.40 in groundnut and 2.18 and 2.14 in tomato. The increase in leaf area under TPE 0.05 mm for 45 days was mainly attributed to higher leaf retention even upto harvest in this treatment.

Leaf area index (LAI) also varied significantly due to treatments at all the stages of both groundnut (**Table 4.10**) and tomato (**Table 4.19**). Maximum LAI at all stages was in two hand weedings and TPE 0.05 mm for 45 days which can be attributed to the higher leaf number and leaf area recorded by the treatments. In groundnut, the LAI at 90 DAS due to two hand weedings, TPE 0.05 mm for 45 days and control were 4.47, 4.04 and 2.22, respectively. Fryer and Makepeace (1977) opined that higher LAI in weed control treatments might be due to higher leaf number and leaf area. Increase in LAI due to weed control treatments was reported in groundnut by Murthy *et al.* (1992).

The total dry matter accumulation (TDM) of groundnut and tomato differed significantly due to various treatments. In both the crops the maximum TDM was recorded by two hand weedings being on par with TPE 0.05 mm for 45 days and minimum by control at all the stages. Other solarization treatments with longer duration and one hand weeding and alachlor at 1.5 kg a.i. ha^{-1} also helped in significantly increasing TDM over control. An additive effect of higher leaf dry matter, stem dry matter and pod dry matter was observed in groundnut by two hand weedings and TPE 0.05 mm for 45 days, likewise higher leaf dry matter, stem dry matter and fruit dry matter contributed to higher TDM in tomato. The less weed infestation in plots with two hand weedings and TPE 0.05 mm for 45 days at all the stages of groundnut and tomato have drastically reduced the competition for growth factors, thus helping the crops to putforth more number of leaves, expose more leaf area for harvesting solar energy and thus accumulating more dry matter. Similarly, Naidu *et al.* (1985) observed significantly higher TDM in weed free or controlled plots. On the contrary control and other solarization treatments (TPE 0.05 mm and TPE 0.10 mm for 15 days) recorded lower TDM on account of severe competition. Similar observations were made by Patel *et al.* (1990).

On perusal of all the growth components discussed, it is evident that there is remarkable increase in the performance of groundnut and tomato due to solarization for longer duration especially with TPE 0.05 mm for 45 days which was on par with two hand weedings. These findings are in agreement with Habeeburrahaman (1992). TPE has several modes of action including thermal inactivation of weed seeds, weakening of propagules and altering the plant root environment which results in better crop response in terms of increased growth (Stapleton and Devay, 1986). Similarly Elmore (1993) observed improvement in crop vigour by soil solarization in Bracoli.

5.3.4 **Effect on yield and yield components**

5.3.4.1 **Groundnut** : The maximum pod yield of groundnut (21.31 q ha^{-1}) was recorded when soil solarization was taken with TPE 0.05 mm for 45 days which was on par with two hand weedings (22.93 q ha^{-1}) and significantly superior to all other treatments (**Table 4.13**). Non solarized control recorded the lowest pod yield (9.09). The yields recorded by other effective treatments namely, alachlor at 1.5 kg a.i. ha^{-1} (18.18), one hand weeding (18.37), TPE 0.10 mm for 45 days (17.02) and TPE 0.05 mm for 30 days (16.89) were on par with each other but significantly superior over TPE 0.05 mm and TPE 0.1 mm for 15 days and control. TPE 0.05 mm and TPE 0.10 mm for 15 days recorded higher pod yield compared to control.

The better growth of groundnut in terms of plant height, number of leaves, leaf area and dry matter accumulation indicates better availability of growth resources in the plots with longer duration of solarization. The resource availability inturn might have been increased, on account of reduction in weed growth by higher temperature achieved in these treatments. Minimum pod yield recorded by control was due to unchecked weed growth. Yield reduction in groundnut under uncontrolled weed situations was observed earlier by Girijesh (1988) and Murthy *et al.* (1992). Significantly higher pod yield recorded by two hand weedings and TPE 0.05 mm for 45 days is attributed to the higher values for the yield components such as number of pods per plant, weight of pods per plant and 100 kernel weight recorded by those treatments, which inturn was on account of higher leaf area and total dry matter.

The maximum pod weight per plant was recorded by two hand weedings (18.94) which was on par with TPE 0.05 mm for 45 days (17.94). As the weight of pod per plant was the main contribution for pod yield, the treatments having higher pod weight per plant also recorded higher pod yield in this study. The results are in conformity with (Habeeburahaman, 1992) and Bhan and Singh (1993). Higher pod weight per plant can be correlated with higher pod number per plant. The maximum pod number per plant was also recorded by TPE 0.05 mm for 45 days (23.63) which was on par with two hand weedings (25.48) and significantly higher over TPE 0.05 mm for 30 days (21.24), TPE 0.10 mm for 45 days (22.34), alachlor at 1.5 kg a.i. ha^{-1} (22.49) and one hand weeding (22.44). Increased pod number per plant due to effective weed control was also reported by Biradar (1996).

Higher pod yield in two hand weedings and TPE 0.05 mm for 45 days could also be due to significantly higher 100 kernel weight recorded by these treatments. Further, higher dry matter accumulation in pods observed in these treatments might have helped in proper filling of pods and thus increasing the 100-kernel weight. Reduction in 100 kernel weight due to severe weed competition in unweeded check plots and other ineffective treatments has been observed earlier by Naik *et al*. (1977).

Significant variation due to various treatments with respect to shelling percentage was observed in groundnut (**Table 4.13**). Better development of kernels due to higher dry matter accumulation in a situation of lesser weed competition as evidenced by higher kernel weight might have contributed to the higher shelling percentage recorded by TPE 0.05 mm for 45 days (71.99%). Mudalagiriyappa (1998) observed higher shelling percentage due to TPE 0.05 mm for 45 days.

The maximum haulm yield in two hand weedings (23.21 q ha^{-1}) and TPE 0.05 mm for 45 days (21.09) could be attributed to vigorous crop growth as seen in the form of taller plants, more number of branches, more number of leaves and higher dry matter accumulation in haulm. Biradar (1996) and Mudalagiriyappa (1998) also got significantly higher haulm yield of groundnut by effective weed control treatments.

5.3.4.2 **Tomato** : Maximum marketable fruit yield (24.27 t ha^{-1}) was recorded by TPE 0.05 mm for 45 days which was on par with two hand weedings (23.17 t ha^{-1}) and were significantly superior over all other treatments. Non solarized control recorded the lowest tomato yield (11.22 t ha^{-1}). There was only marginal increase in fruit yield due to TPE 0.05 mm and TPE 0.10 mm for 15 days over control.

As in case of groundnut, here also the better growth of tomato in terms of plant height, number of branches, number of leaves, leaf area and dry matter accumulation are indicators of better availability of growth resources in the plots with longer duration of solarization which ultimately helped in better translocation of metabolites to the fruits. The resource availability inturn might have been increased on account of reduction in weed growth by higher temperatures achieved in those treatments is an end result of their favourable effect on yield components such as fruit number, fruit weight per plant and specific gravity of fruits. The number of fruits per plant was maximum in case of TPE 0.05 mm for 45 days (44.81 per plant) which was on par with two hand weedings (44.90/plant).

The maximum fruit weight per plant was recorded by TPE 0.05 mm for 45 days (1.69 kg plant^{-1}) and significantly higher over other treatments. As the weight of fruit per plant was the main contributor for fruit yield, the treatments having higher fruit weight per plant also recorded higher fruit yield per hectare in this study.

Better development of fruits due to higher dry matter accumulation in a situation of lesser weed competition as evidenced by higher specific gravity might have been contributed by higher fruit weight per plant which in turn recorded higher marketable fruit yield by TPE 0.05 mm for 45 days (24.27 t/ha). In potato, Mudalagiriyappa (1998) observed increase in yield and yield components due to solarization treatments.

TPE 0.05 mm for 30 days, TPE 0.10 mm for 45 days, one hand weeding and alachlor at 1.5 kg a.i. ha^{-1} recorded fruit yield significantly superior over TPE 0.05 mm and TPE 0.10 mm for 15 days and control.

Based on the growth and yield of groundnut and tomato, it is evident that solarization with TPE for longer durations, especially with TPE 0.05 mm resulted in great improvement in growth (Plate 7 and 8). As a result, remarkable increase was noticed in the various yield components, ultimately

Plate 7 Performance of succeeding tomato crop at 50 DAT with TPE 0.05 mm for 45 days soil solarization (Good crop growth)

Plate 8 Performance of succeeding tomato crop from unweeded control (poor crop growth)

leading to higher yields. The increase in yield of the crops as a result of weed control through soil solarization is in line with that obtained in groundnut (Grinstein *et al.*, 1979; Habeeburrahaman, 1992; Mudalagiriyappa, 1998), in onion (Katan *et al.*, 1980; Satour *et al.*, 1989), in carrots (Jacobson *et al.*, 1980), in cotton (Katan *et al.*, 1983) in sesame (Stapleton and Garza-Lopez, 1988) and in beans and tomato (Abu-Irmaileh, 1991).

The reduction in weed growth due to solarization treatments and the associated improvement in growth and increase in yield was better during 1998-99 as compared to 1997-98. This is mainly because of the prevalence of higher temperatures or increased frequency of higher temperatures during 1998-99, less interference of rain during solarization period (1998-99) and the gap between soil solarization and sowing of groundnut seeds were less in 1998-99 compared to 1997-98. This might also helped the crop to putforth maximum growth before weed seeds present in the soil could germinate fully.

5.3.4.3 **Correlation studies**

The association of groundnut pod yield with growth and yield components is presented in the simple correlation co-efficients (**Table 22**). A strong and positive correlation was observed between pod yield and plant height, number of branches per plant, LAI, total dry matter accumulation per plant, number of pods per plant, pod weight per plant, shelling percentage and 100 kernel weight. It is reasonable to assume that the photosynthesizing area helped for more dry matter accumulation. Increased plant height also accomodated more number of branches which eventually lead to higher LAI. All these resulted in increased number of filled pods per plant, pod weight per plant, shelling percentage and 100 kernel weight. Finally, all these resulted in increased pod yield in groundnut.

5.3.4.4 ECONOMICS OF SOLARIZATION TREATMENTS

During 1997-98, in groundnut - tomato sequence, TPE 0.05 mm for 45 days resulted in higher net income (Rs. 1,19,942) next to two hand weedings. The net income of two hand weedings was more due to the less cost incurred compared to solarization treatments during 1997-98. During 1998-99 TPE 0.05 mm for 45 days recorded higher net income (Rs. 1,41,330 ha^{-1}) compared to two hand weedings (Rs. 1,36,407). The higher net income in TPE 0.05 mm for 45 days was mainly due to maximum yield of tomato than two hand weedings.

5.4 EFFECT OF SOIL SOLARIZATION ON GERMINATION OF SEEDS/ UNDERGROUND PROPAGULES OF WEED SPECIES FROM DIFFERENT DEPTHS

The germination of weed seeds showed significant differences due to solarization (S), depth (D) and their interaction (S & D).

The reduction in the germination of different weed species showed that among the levels of solarization, TPE 0.05 mm for 45 days resulted in significant reduction in the germination of all the species except *Cyperus rotundus*. Survival of *Cyperus* due to solarization has been observed earlier by Ragone and Wilson (1988). Similarly Egley (1983) reported that, the appreciable kill of all the weeds except *Cyperus*. He also observed that the major effect of solarization was upon these seeds that were in the process of germination. The intense temperature probably killed many weed seeds prior to emergence thereby solarization for longer duration becomes effective.

In comparison of the interactions, it was observed that the effect of longer duration (45 days) of solarization with TPE 0.05 mm was more pronounced at 5 cm depth due to the higher temperature recorded at this depth. Egley (1983) who observed that solarization was comparatively more effective upon seeds near the surface. Similarly, Yaduraj (1993) reported that weed seeds were unaffected at deeper depths. At 5 cm depth appreciable reduction was observed in TPE 0.05 mm for 45 days in case of all weed species. Standifer *et al.* (1984) opined similar variation in sensitivity of weed species to heat.

At 10 cm depth, the differences in germination of various species due to levels of solarization were not significant due to the fact that the germination in the non solarized treatment itself was very low. The effect can be described due to the fact that propagules of most weed species could not germinate effectively from depths below 7 to 10 cm except that of deep rooted perennials like *Cyperus rotundus* (Brecke and Duke, 1980; Chancellor, 1964; Habeeburrahaman, 1992; Mudalagiriyappa, 1998).

Higher germination similar to that observed at 5 cm depth was recorded at 10 cm also by *Cyperus rotundus*. Similar results were corroborated by Rubin and Benjamin (1983) and Sistachs and Leon (1985). And also, the temperature maxima at 10 cm crossed 45°C only rarely and hence did not have harmful effect on propagules of lower depths. Deeply burried seeds escaped solarization effect (Horowitz *et al*., 1983; Standifer *et al*., 1984).

Based on the above results, it can be concluded that, solarization for 45 days with TPE 0.05 mm thickness controlled weed propagules lying in the surface layer by lethal temperatures. Similar observations were made by Habeeburrahaman (1992), Biradar (1996) and Mudalagiriyappa (1998).

5.5 **THE RESULTS OF PRACTICAL UTILITY**

Based on the results discussed hitherto, it can be concluded that:

1. Soil solarization with TPE 0.05 mm for 45 days immediately followed by planting is effective in controlling weeds and thereby increasing the yield of groundnut and succeeding tomato crop.

2. Soil solarization increases the level of available plant nutrients in the soil.

5.6 **FUTURE LINE OF WORK**

The results of the present investigation points out that further elaborate research is needed in the following aspects to obtain insight into the soil solarization technology.

1. The lethal level of soil temperature needed to kill different weed seeds in the soil.

2. The accurate depth upto which particular weed seeds loose viability upon soil solarization.

3. As there is possibility of solarized plots being contributed with weed seeds by irrigation water, efforts can be made to know the extent of such contribution.

4. The research must be continued to look out for alternative low cost and efficient material in place of TPEs for elevating soil temperature and to achieve better weed control.

5. Integration of soil solarization with other methods of weed control is worth investiagting.

6. Enzymatic studies and oxygen diffusion rate need to be done to know the exact reasons for change in the soil nutrient status after solarization.

SUMMARY

IV. SUMMARY

Field experiments were conducted during 1997-98 and 1998-99 to investigate the effect of soil solarization on weed control, growth and yield of groundnut-tomato grown in sequence on sandy loam soils of Main Research Station, University of Agricultural Sciences, Hebbal, Bangalore, under irrigated conditions. The investigation involved two thicknesses of TPE (TPE 0.05 mm and TPE 0.10 mm), three durations of soil solarization (15, 30 and 45 days), cultural (one hand weeding and two hand weeding) and chemical method (alachlor at 1.5 kg a.i. ha^{-1}) with standard unweeded check as control in Randomised Complete Block Design with three replications. The satellite experiment was also carried out to study the weed seed emergence from solarized soil. The salient features of the investigation are summarised hereunder.

Significantly higher soil temperature (53.1°C at 5 cm soil depth) was recorded under the transparent polyethylene film (TPE) of 0.05 mm for 45 days. Soil temperature achieved in bare soil was only 43°C.The atmospheric temperature was found to have direct influence on soil temperature under the TPEs. Soil temperature elevation was found to decrease with increase in thickness of TPE. In addition, all the solarization treatments retained higher soil moisture over non solarized plots. The soil organic carbon content and available sulphur was reduced appreciably upon soil solarization (0.34 to 0.46% and 6.01 to 9.92

ppm, respectively) as compared to control of 0.52 per cent organic carbon and 10.01 ppm of available sulphur. But the mean available nitrogen (190.66 kg ha^{-1}), available phosphorus (41.17 kg ha^{-1}), available potassium (222.68 kg ha^{-1}), exchangeable calcium (0.66 me/100 g), exchangeable magnesium (0.35 me/100 g) and exchangeable sodium (0.24 me/100 g) contents were enhanced by soil solarization. Soil solarization with TPE 0.05 mm for 45 days caused significant reduction in fungal population (8.43×10^4) and positive effect on bacterial population. The population of actinomycetes remained unaffected.

It was seen in groundnut as well as in tomato that, there was significant reduction in weed count and dry weight even upto the harvest of groundnut and tomato due to solarization with transparent polyethylene. Transparent polyethylene of 0.05 mm thickness was significantly superior in reducing number and dry weight of weeds, as compared to that of 0.1 mm thickness. Among the different durations tried, 45 days was found to be effective for maximum reduction in weeds. The performance of shorter duration (15 days) of solarization with transparent polyethylene was on par with non solarized control. The best solarization treatment causing maximum extent of weed reduction was TPE 0.05 mm for 45 days was similar to that of two hand weedings. Comparing the dicot and monocot weeds, the extent of reduction due to effective solarization treatments was more in the case of dicots.

As a result of the effective weed control achieved through soil solarization, appreciable increase in yield of groundnut and tomato was also noticed. The treatment TPE 0.05 mm for 45 days resulted in significantly higher pod yield of 21.31 q ha^{-1} in groundnut and marketable yield of tomato fruits (24.27 t ha^{-1}), which were on par with two hand weedings (22.93 q ha^{-1} and 23.17 t ha^{-1} of groundnut and tomato fruits, respectively). The yield obtained due to TPE 0.05 mm for 45 days was significantly superior over one hand weeding. Other treatments such as 30 days solarization with TPE 0.05 mm, 45 days solarization with TPE 0.1 mm and alachlor at 1.5 kg a.i. ha^{-1} resulted in yields on par with the one hand weeding. The increase in yield due to TPE 0.05 mm and TPE 0.10 mm for 15 days was only marginal. Haulm yield and kernel yield of groundnut also performed in a similar way. TPE 0.05 mm for 45 days recorded the highest net income (Rs. 1,41,330 ha^{-1}).

Higher values for yield components of groundnut such as number of pods per plant, number of filled pods per plant, pod weight per plant, 100 kernel weight and shelling percentage as recorded by TPE 0.05 mm for 45 days, was on par with two hand weedings with respect to growth parameters of groundnut viz., plant height, leaf number, leaf area, LAI and dry matter accumulation.

Significantly higher and the maximum values for yield components of tomato such as number of fruits per plant, fruit weight per plant and specific gravity was recorded by TPE 0.05 mm for 45 days and was statistically on par with two hand weedings. Likewise, significantly superior performance was shown by TPE 0.05 mm for 45 days and two hand weedings with respect to growth components like dry matter accumulation, leaf area, LAI, number of leaves, plant height at all the stages of observation.

With respect to germination of weed seeds from solarized soil, the germination of weed seeds could be reduced significantly by solarization with TPE 0.05 mm for 45 days. The effect was more pronounced at 5 cm soil depth compared to that of 10 cm soil depth.

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VII. REFERENCES

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* Original not seen.

APPENDICES

Appendix 1. Soil temperature (°C) at 5 cm soil depth as influenced by solarization treatments.

Treatments	5 DAPS		10 DAPS		15 DAPS		20 DAPS		25 DAPS		30 DAPS		35 DAPS		40 DAPS		45 DAPS	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	46.2	51.6	45.3	50.3	50.5	52.5												
TPE 0.05 mm 30 days	46.9	52.5	45.5	52.8	50.8	53.3	51.8	51.8	50.2	50.7	50.8	50.8						
TPE 0.05 mm 45 days	46.9	52.8	46.1	53.3	50.9	54.2	52.2	54.0	51.5	53.0	52.2	53.3	51.1	51.9	50.0	48.5	50.0	50.1
TPE 0.1 mm 15 days	44.2	49.5	49.9	48.5	47.9	50.2												
TPE 0.1 mm 30 days	44.4	49.0	41.9	51.3	48.0	50.5	49.1	49.8	48.6	49.5	49.3	48.9						
TPE 0.1 mm 45 days	44.9	51.6	43.1	51.8	48.9	52.5	50.1	52.9	49.7	51.5	50.1	50.5	49.3	49.5	48.6	45.1	47.9	48.0
Control	38.8	42.0	35.6	36.0	39.3	44.0	42.0	38.0	40.5	40.0	39.0	39.0	40.3	35.0	37.0	35.5	37.9	37.0
S.Em±	0.39	0.55	0.61	0.47	0.58	0.46	0.55	0.62	0.55	0.46	0.67	0.78	0.54	0.66	0.62	0.45	0.60	0.62
CD at 5%	1.17	1.65	1.83	1.41	1.72	1.38	1.65	1.86	1.65	1.36	2.10	2.34	1.62	1.98	1.85	1.34	1.80	1.85

DAPS = Days after polyethylene spread;
TPE = Transparent polyethylene.

Appendix 2. Soil solarization (°C) at 10 cm soil depth as influenced by solarization treatments.

Treatments	5 DAPS		10 DAPS		15 DAPS		20 DAPS		25 DAPS		30 DAPS		35 DAPS		40 DAPS		45 DAPS	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	44.2	50.3	41.2	48.66	46.9	48.0												
TPE 0.05 mm 30 days	43.9	50.1	41.2	50.5	47.2	51.3	48.5	49.5	45.9	48.0	47.3	47.5						
TPE 0.05 mm 45 days	43.8	50.9	41.1	51.5	47.7	52.0	49.0	52.3	47.5	51.3	48.2	51.7	51.1	51.9	48.2	48.5	47.8	47.8
TPE 0.1 mm 15 days	42.2	45.9	48.2	45.8	45.0	46.0												
TPE 0.1 mm 30 days	41.7	49.5	38.2	49.7	45.2	49.0	46.6	46.7	44.9	45.8	45.6	46.8						
TPE 0.1 mm 45 days	41.6	50.3	39.1	50.2	45.3	50.3	47.2	50.5	45.8	49.9	45.9	49.5	49.3	49.5	45.1	46.5	45.1	46.3
Control	34.6	39.0	31.5	34.0	35.0	41.0	37.0	35.0	35.0	35.0	35.0	34.0	40.3	35.0	35.5	34.0	33.3	35.0
S.Em±	0.44	0.16	0.61	0.36	0.72	0.43	0.56	0.61	0.24	0.47	0.62	0.49	0.54	0.66	0.77	0.65	0.89	0.37
CD at 5%	1.32	0.47	1.79	1.08	2.13	1.29	1.66	1.83	1.71	1.41	1.86	1.47	1.62	1.98	2.31	1.94	2.68	1.11

DAPS = Days after polyethylene spread;
TPE = Transparent polyethylene.

Appendix 3. Weed count/m^2 in groundnut as influenced by solarization treatments (30 DAS and 60 DAS).

Treatments	30 DAS								60 DAS							
	Monocots		Dicots		Sedges		Total weed		Monocots		Dicots		Sedges		Total weed	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	3.82 (14.01)	3.53 (11.96)	2.60 (6.26)	2.54 (5.95)	4.14 (16.63)	3.64 (12.74)	6.12 (36.90)	5.58 (30.65)	4.56 (20.29)	3.82 (14.09)	3.58 (12.32)	2.98 (8.38)	4.36 (28.22)	4.36 (18.51)	7.83 (60.33)	6.58 (42.95)
TPE 0.05 mm 30 days	3.10 (9.11)	2.79 (7.28)	2.00 (3.50)	2.04 (3.66)	3.87 (12.97)	2.84 (7.57)	5.11 (25.58)	4.36 (18.58)	3.80 (13.94)	3.19 (9.68)	2.98 (8.38)	2.34 (4.97)	4.42 (19.04)	3.98 (15.34)	6.47 (41.36)	5.52 (29.99)
TPE 0.05 mm 45 days	1.21 (0.96)	0.77 (0.10)	1.26 (1.09)	0.77 (0.10)	1.51 (2.02)	1.38 (1.40)	2.14 (4.07)	1.45 (1.60)	1.79 (2.70)	1.06 (0.63)	1.40 (1.46)	1.20 (0.94)	3.54 (12.03)	2.16 (4.17)	2.86 (7.70)	2.49 (5.74)
TPE 0.1 mm 15 days	4.18 (16.97)	3.79 (13.86)	3.01 (8.56)	2.89 (7.58)	4.17 (16.88)	3.89 (14.63)	6.55 (42.41)	6.07 (36.34)	4.81 (22.64)	4.49 (19.66)	3.82 (14.09)	3.18 (9.61)	5.94 (34.78)	5.06 (25.11)	8.49 (71.51)	7.20 (51.45)
TPE 0.1 mm 30 days	3.62 (12.60)	3.38 (10.92)	2.47 (5.60)	2.26 (4.61)	3.96 (15.18)	3.22 (9.87)	5.80 (33.38)	5.09 (25.40)	4.25 (17.56)	3.89 (14.63)	3.49 (11.68)	2.68 (6.68)	5.14 (25.92)	4.42 (9.04)	7.46 (55.16)	6.39 (40.35)
TPE 0.1 mm 45 days	2.44 (5.45)	2.32 (4.88)	1.93 (3.22)	1.72 (2.46)	3.18 (9.61)	2.62 (6.36)	4.43 (18.28)	3.77 (13.70)	3.52 (11.89)	3.01 (8.56)	2.81 (7.39)	2.18 (4.25)	4.32 (18.16)	3.56 (12.17)	6.16 (37.44)	5.19 (26.41)
Alachlor 1.5 kg a.i./ha	1.31 (1.22)	3.05 (15.90)	1.36 (1.34)	1.85 (2.92)	1.96 (3.46)	2.61 (6.31)	3.51 (11.79)	5.06 (25.13)	3.41 (11.13)	3.00 (8.50)	1.75 (2.56)	2.19 (4.29)	4.14 (16.64)	3.34 (10.66)	5.55 (30.33)	5.78 (32.94)
One hand weeding	0.86 (0.25)	1.94 (2.88)	0.96 (0.42)	1.88 (3.03)	1.96 (3.46)	2.37 (5.12)	2.39 (5.23)	2.96 (8.27)	2.90 (7.91)	3.24 (9.97)	1.70 (2.39)	2.18 (4.25)	4.13 (16.56)	3.35 (10.72)	5.23 (26.86)	4.58 (20.47)
Two hand weedings	0.71 (0.00)	0.81 (0.15)	0.71 (0.00)	0.98 (0.46)	1.01 (0.52)	1.69 (2.36)	1.08 (0.67)	1.86 (2.97)	1.01 (0.52)	1.27 (1.13)	1.01 (0.52)	1.85 (2.92)	2.58 (6.16)	2.01 (3.54)	2.79 (7.29)	2.15 (7.07)
Control	4.87 (22.92)	4.78 (22.35)	3.82 (14.09)	3.78 (13.78)	5.40 (28.66)	4.88 (23.31)	8.13 (65.07)	7.74 (59.44)	5.87 (33.95)	5.89 (34.19)	4.97 (24.20)	4.86 (23.12)	7.67 (58.64)	6.48 (41.49)	10.83 (116.79)	9.96 (98.80)
S.Em±	0.13	0.11	0.18	0.13	0.13	0.14	0.29	0.15	0.28	0.18	0.31	0.17	0.23	0.06	0.03	0.09
C.D. at 5%	0.39	0.33	0.54	0.39	0.38	0.42	0.87	0.44	0.84	0.54	0.93	0.51	0.68	0.18	0.06	0.27

DAS = Days after sowing;
TPE = Transparent polyethylene

Appendix 4. Weed count/m^2 in groundnut as influenced by solarization treatments (90 DAS and At harvest).

Treatments	90 DAS								At harvest							
	Monocots		Dicots		Sedges		Total weed		Monocots		Dicots		Sedges		Total weed	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	5.98 (35.26)	4.25 (17.56)	4.69 (21.49)	3.48 (21.49)	7.28 (52.49)	4.98 (24.30)	10.48 (109.24)	9.06 (81.66)	5.99 (35.38)	5.84 (33.60)	4.89 (23.41)	3.93 (14.94)	7.56 (56.65)	5.11 (26.11)	10.76 (115.44)	8.69 (74.65)
TPE 0.05 mm 30 days	4.86 (23.12)	3.76 (13.64)	3.52 (11.89)	2.49 (5.70)	6.72 (44.66)	4.41 (18.95)	8.95 (79.67)	8.03 (64.00)	4.84 (22.92)	4.82 (22.73)	4.24 (17.47)	2.98 (8.38)	6.79 (45.60)	4.70 (21.59)	9.30 (85.99)	7.31 (52.70)
TPE 0.05 mm 45 days	1.86 (2.96)	1.45 (1.60)	1.86 (2.96)	1.89 (3.07)	5.00 (24.50)	3.85 (14.32)	5.56 (30.42)	5.44 (29.17)	2.21 (4.38)	2.01 (3.54)	2.01 (3.54)	2.14 (4.08)	6.72 (44.66)	4.48 (19.57)	7.29 (52.58)	5.26 (27.11)
TPE 0.1 mm 15 days	6.58 (42.79)	4.70 (21.54)	4.76 (22.16)	3.86 (14.41)	7.48 (55.45)	5.01 (24.60)	10.99 (120.04)	9.59 (9.140)	6.97 (48.08)	6.01 (35.62)	5.37 (28.34)	4.11 (16.39)	7.98 (63.18)	5.34 (28.02)	11.84 (139.60)	8.97 (80.03)
TPE 0.1 mm 30 days	6.02 (35.74)	3.89 (14.63)	3.96 (15.18)	3.29 (10.32)	6.78 (45.47)	4.59 (20.57)	9.53 (90.39)	8.42 (70.42)	6.21 (38.06)	5.04 (24.90)	4.86 (23.12)	3.61 (2.53)	6.99 (48.36)	4.92 (23.71)	10.49 (109.54)	7.85 (61.14)
TPE 0.1 mm 45 days	3.98 (15.34)	3.49 (11.68)	3.34 (10.66)	2.62 (6.36)	5.70 (31.99)	4.19 (17.06)	7.56 (57.99)	7.11 (50.03)	4.01 (15.58)	3.99 (15.42)	4.19 (17.06)	2.84 (7.57)	6.86 (46.56)	4.62 (20.84)	8.93 (79.20)	6.66 (43.83)
Alachlor 1.5 kg a.i./ha	2.36 (4.61)	4.01 (15.58)	2.22 (4.43)	2.98 (8.38)	5.69 (31.88)	4.22 (17.31)	6.44 (41.03)	7.50 (55.84)	2.54 (5.95)	4.21 (17.22)	3.98 (15.34)	2.89 (7.85)	7.24 (51.92)	4.78 (22.35)	8.54 (72.50	6.92 (47.42)
One hand weeding	2.25 (4.56)	3.42 (11.26)	2.21 (4.38)	2.84 (7.57)	6.01 (35.62)	4.24 (17.48)	6.72 (44.56)	7.41 (54.45)	2.52 (5.85)	3.86 (14.39)	3.99 (15.42)	3.01 (8.56)	7.19 (51.21)	4.98 (24.30)	8.54 (72.50)	6.91 (47.25)
Two hand weedings	1.04 (0.52)	2.71 (6.84)	1.49 (1.72)	2.01 (3.54)	4.78 (22.35)	4.01 (15.48)	5.01 (14.59)	5.76 (32.73)	1.85 (2.93)	3.48 (14.39)	3.17 (9.55)	2.29 (4.74)	6.15 (37.32)	5.91 (20.60)	7.09 (45.80)	6.10 (37.25)
Control	7.15 (50.62)	7.14 (50.48)	5.72 (32.22)	5.68 (31.76)	8.16 (66.09)	6.68 (44.12)	12.22 (148.93)	12.24 (149.33)	8.49 (71.58)	8.98 (80.14)	5.98 (35.26)	5.18 (26.33)	8.76 (76.24)	7.18 (51.05)	13.55 (183.08)	12.57 (57.52)
S.Em±	0.18	0.13	0.13	0.10	0.18	0.08	0.33	0.21	0.12	0.13	0.16	0.14	0.14	0.08	0.05	0.27
C.D. at 5%	0.54	0.39	0.39	0.30	0.59	0.22	0.98	0.63	0.36	0.38	0.48	0.42	0.42	0.24	0.15	0.81

DAS = Days after sowing;
TPE = Transparent polyethylene

Appendix 5. Weed dry weight (g/0.25 m^2) in groundnut as influenced by solarization treatments (30 DAS and 60 DAS).

Treatments	30 DAS								60 DAS							
	Monocots		Dicots		Sedges		Total weed		Monocots		Dicots		Sedges		Total weed	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	3.61 (14.01)	3.01 (11.96)	2.84 (6.26)	2.64 (5.95)	1.74 (16.63)	1.51 (12.74)	4.80 (36.90)	4.16 (30.65)	3.86 (14.39)	2.54 (12.03)	2.98 (12.32)	2.81 (8.38)	1.89 (3.07)	1.83 (2.85)	5.13 (25.84)	4.77 (22.27)
TPE 0.05 mm 30 days	1.74 (2.52)	1.52 (1.81)	2.06 (3.74)	2.04 (3.66)	1.56 (1.93)	1.38 (1.40)	2.95 (8.22)	2.71 (6.87)	1.79 (2.70)	1.68 (2.32)	2.58 (6.16)	2.42 (5.26)	1.68 (2.32)	1.52 (1.81)	3.41 (11.18)	3.16 (9.49)
TPE 0.05 mm 45 days	1.32 (1.24)	0.95 (0.40)	0.98 (0.46)	0.84 (0.21)	1.10 (0.71)	1.00 (0.50)	1.71 (2.41)	1.27 (1.11)	1.40 (1.60)	1.31 (1.22)	1.13 (0.78)	1.09 (0.69)	1.30 (1.19)	1.07 (1.12)	2.02 (3.60)	1.87 (3.03)
TPE 0.1 mm 15 days	3.82 (14.09)	3.19 (9.68)	3.01 (8.56)	2.89 (7.85)	1.80 (2.74)	1.56 (1.93)	5.09 (25.39)	4.47 (19.46)	4.62 (20.84)	3.68 (13.04)	3.24 (9.99)	3.08 (8.99)	2.01 (3.54)	1.94 (3.26)	5.90 (34.24)	5.07 (25.29)
TPE 0.1 mm 30 days	1.86 (2.96)	1.72 (2.46)	2.47 (5.60)	2.26 (4.61)	1.68 (2.32)	1.45 (1.60)	3.37 (10.88)	3.03 (8.67)	2.09 (3.66)	1.98 (3.42)	2.68 (6.69)	2.35 (5.03)	1.82 (2.81)	1.65 (2.22)	3.60 (13.16)	3.37 (10.91)
TPE 0.1 mm 45 days	1.56 (1.95)	1.54 (1.89)	1.93 (3.22)	1.72 (2.46)	1.35 (1.32)	1.31 (1.22)	2.64 (6.49)	2.46 (5.57)	1.76 (2.59)	1.59 (2.03)	1.98 (3.42)	1.84 (2.89)	1.62 (2.12)	1.52 (1.81)	2.93 (8.13)	2.68 (6.73)
Alachlor 1.5 kg a.i./ha	1.52 (1.81)	1.68 (2.32)	1.42 (1.52)	1.55 (2.92)	1.30 (1.19)	1.32 (1.24)	2.18 (4.24)	2.41 (6.48)	1.74 (2.53)	1.70 (2.39)	1.42 (1.52)	1.34 (1.29)	1.42 (1.52)	1.52 (1.81)	2.46 (5.57)	2.43 (5.41)
One hand weeding	0.96 (0.42)	1.84 (2.88)	0.87 (0.26)	1.19 (0.89)	1.21 (0.96)	1.24 (1.04)	1.70 (2.39)	1.53 (1.85)	1.69 (2.36)	1.69 (2.36)	1.45 (1.60)	1.32 (1.45)	1.43 (1.54)	1.51 (1.78)	2.44 (5.50)	2.46 (5.59)
Two hand weedings	0.82 (0.17)	1.09 (0.68)	0.86 (0.24)	0.82 (0.17)	0.89 (0.29)	0.86 (0.23)	1.09 (0.71)	1.09 (0.69)	0.89 (0.21	0.98 (0.46)	0.89 (0.29)	0.84 (0.21)	1.04 (0.58)	1.08 (0.46)	1.80 (1.76)	1.21 (1.13)
Control	4.98 (23.67)	4.18 (16.97)	3.82 (14.09)	3.53 (11.96)	2.19 (4.29)	2.16 (4.17)	6.52 (6.52)	5.72 (32.33)	5.24 (26.96)	4.96 (24.10)	3.99 (15.42)	3.72 (13.34)	2.54 (5.95)	2.48 (5.65)	6.98 (48.30)	6.60 (43.01)
S.Em±	0.07	0.06	0.18	0.11	0.07	0.04	0.18	0.08	0.10	0.04	0.12	0.09	0.05	0.04	0.07	0.19
C.D. at 5%	0.21	0.16	0.54	0.32	0.21	0.12	0.54	0.24	0.30	0.12	0.36	0.26	0.15	0.12	0.21	0.56

DAS = Days after sowing;
TPE = Transparent polyethylene

Appendix 6. Weed dry weight (g/0.25 m^2) in groundnut as influenced by solarization treatments (90 DAS and At harvest).

Treatments	90 DAS								At harvest							
	Monocots		Dicots		Sedges		Total weed		Monocots		Dicots		Sedges		Total weed	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	4.32 (18.16)	3.89 (14.63)	3.15 (28.22)	2.99 (18.51)	2.26 (4.61)	1.98 (3.42)	5.43 (28.99)	5.19 (26.49)	4.52 (19.93)	5.41 (18.95)	3.36 (60.33)	3.26 (42.95)	2.31 (4.83)	2.17 (4.21)	6.06 (35.55)	5.81 (33.29)
TPE 0.05 mm 30 days	1.98 (3.42)	1.92 (3.19)	2.89 (7.85)	2.67 (6.63)	2.01 (3.54)	1.72 (2.45)	3.90 (14.79)	3.57 (12.27)	2.73 (6.98)	2.19 (4.29)	3.01 (8.56)	2.94 (8.14)	2.19 (4.29)	1.85 (2.92)	4.50 (19.83)	3.98 (15.35)
TPE 0.05 mm 45 days	1.58 (1.99)	1.42 (1.52)	1.34 (1.29)	1.26 (1.09)	1.59 (2.03)	1.45 (1.60)	2.40 (5.31)	2.17 (4.21)	1.78 (1.70)	1.59 (2.03)	1.52 (1.82)	1.48 (1.69)	1.67 (2.29)	1.52 (1.81)	2.70 (6.81)	2.50 (6.24)
TPE 0.1 mm 15 days	4.48 (19.58)	4.19 (17.06)	3.52 (11.96)	3.22 (9.87)	2.38 (5.16)	2.01 (3.14)	6.09 (36.70)	5.56 (30.47)	5.13 (25.82)	4.68 (21.40)	3.65 (12.82)	3.49 (11.68)	2.48 (5.65)	2.32 (4.88)	6.69 (44.29)	6.20 (37.96)
TPE 0.1 mm 30 days	2.21 (4.38)	2.09 (3.86)	2.84 (7.57)	2.59 (6.21)	2.21 (4.38)	1.78 (2.67)	4.10 (16.43)	3.60 (12.47)	2.93 (8.13)	2.16 (4.17)	3.19 (9.68)	3.06 (8.86)	2.30 (4.79)	2.04 (3.66)	4.81 (22.60)	4.14 (16.69)
TPE 0.1 mm 45 days	1.83 (2.85)	1.76 (2.59)	2.01 (3.54)	1.94 (3.26)	1.89 (3.07)	1.64 (2.19)	3.15 (9.47)	2.92 (8.04)	1.93 (3.23)	1.86 (2.96)	2.64 (6.47)	2.78 (7.23)	1.94 (3.27)	1.83 (2.85)	3.66 (12.97)	3.68 (13.05)
Alachlor 1.5 kg a.i./ha	1.67 (2.28)	1.78 (2.67)	1.70 (2.39)	1.94 (3.26)	1.62 (2.12)	1.64 (2.19)	2.79 (7.31)	2.80 (7.29)	1.98 (3.42)	1.87 (2.99)	1.97 (3.40)	1.89 (3.07)	1.72 (2.46)	1.84 (2.88)	3.12 (9.28)	3.07 (8.94)
One hand weeding	1.66 (2.28)	1.79 (2.70)	1.69 (2.36)	1.83 (1.29)	1.63 (2.16)	1.84 (2.88)	2.70 (6.80)	2.75 (7.07)	1.97 (3.39)	1.89 (3.07)	1.96 (3.34)	1.86 (2.96)	1.73 (2.49)	1.83 (2.85)	3.11 (9.22)	3.06 (8.88)
Two hand weedings	1.48 (1.69)	1.45 (1.60)	0.96 (0.42)	1.29 (1.16)	1.36 (1.35)	1.42 (1.52)	1.98 (3.46)	2.18 (4.28)	1.50 (1.75)	1.76 (2.59)	1.05 (0.06)	1.52 (1.81)	1.50 (1.75)	1.50 (1.75)	2.14 (4.10)	2.57 (6.15)
Control	5.49 (29.64)	5.12 (25.71)	4.09 (16.23)	3.98 (15.34)	2.84 (7.57)	2.52 (5.85)	7.34 (53.54)	6.88 (46.90)	5.86 (33.83)	5.46 (29.31)	4.25 (17.56)	4.15 (16.72)	2.92 (8.03)	2.65 (6.52)	7.74 (59.52)	7.27 (52.76)
S.Em±	0.03	0.11	0.12	0.07	0.05	0.04	0.14	0.19	0.09	0.09	0.15	0.14	0.06	0.05	0.18	0.18
C.D. at 5%	0.09	0.33	0.36	0.21	0.15	0.12	0.41	0.56	0.27	0.26	0.45	0.42	0.18	0.15	0.53	0.53

DAS = Days after sowing;
TPE = Transparent polyethylene

Appendix 7. Weed control efficiency (WCE) in groundnut as influenced by solarization treatments.

Treatment	Weed control efficiency (%)							
	30 DAS		60 DAS		90 DAS		At harvest	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	46.18	47.95	46.50	48.22	45.85	43.52	40.27	36.90
TPE 0.05 mm 30 days	80.45	78.73	76.85	77.94	72.39	73.84	66.68	70.90
TPE 0.05 mm 45 days	94.26	96.56	92.54	92.96	90.01	91.02	88.56	88.17
TPE 0.1 mm 15 days	39.62	39.75	28.90	41.99	31.45	35.03	25.58	28.05
TPE 0.1 mm 30 days	74.12	73.16	72.75	74.63	69.31	72.83	75.48	68.37
TPE 0.1 mm 45 days	84.57	82.76	83.17	84.34	82.31	82.85	85.28	75.26
Alachlor 1.5 kg a.i./ha	89.92	79.94	99.47	97.42	96.35	94.24	87.65	83.06
One hand weeding	94.32	94.27	88.61	87.00	87.29	84.92	88.34	83.17
Two hand weedings	98.33	97.86	96.36	97.37	93.59	90.87	93.10	88.32
Control	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TPE = Transparent polyethylene
DAS = Days after sowing

Appendix 8. Weed dry weight (t/ha) at harvest of groundnut as influenced by solarization treatments.

Treatments	Weed dry weight (t/ha)	
	1997-98	1998-99
TPE 0.05 mm 15 days	1.42	1.33
TPE 0.05 mm 30 days	0.79	0.61
TPE 0.05 mm 45 days	0.27	0.24
TPE 0.1 mm 15 days	1.77	1.52
TPE 0.1 mm 30 days	0.90	0.67
TPE 0.1 mm 45 days	0.52	0.52
Alachlor 1.5 kg a.i./ha	0.37	0.37
One hand weeding	0.36	0.37
Two hand weedingss	0.16	0.25
Control	2.38	2.11
S.Em±	0.03	0.04
C.D. at 5%	0.09	0.12

TPE = Transparent polyethylene.

Appendix 9. Plant height (cm) and number of branches per plant in groundnut as influenced by solarization treatments.

Treatments	Plant height (cm)								Number of branches per plant							
	30 DAS		60 DAS		90 DAS		At harvest		30 DAS		60 DAS		90 DAS		At harvest	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	7.73	8.26	24.61	39.68	33.37	42.63	33.51	35.14	3.85	5.49	6.77	8.64	6.96	10.12	5.94	6.63
TPE 0.05 mm 30 days	8.93	9.87	27.01	42.34	36.96	44.02	36.91	37.01	4.91	7.03	7.46	10.72	8.00	11.59	7.14	7.82
TPE 0.05 mm 45 days	10.85	11.38	30.86	45.63	42.01	46.27	41.29	42.46	5.89	9.13	9.68	12.66	9.21	13.17	8.35	9.24
TPE 0.1 mm 15 days	7.01	7.32	23.98	37.34	32.19	42.23	32.68	34.69	3.64	6.93	6.27	8.52	6.84	10.06	5.69	6.52
TPE 0.1 mm 30 days	8.48	9.96	26.24	39.86	35.18	43.08	35.19	36.69	4.29	7.06	7.39	10.02	7.98	10.99	7.01	7.46
TPE 0.1 mm 45 days	9.55	11.22	28.98	43.86	38.17	44.82	38.56	40.19	5.01	7.51	8.21	10.74	8.17	11.71	7.24	7.84
Alachlor 1.5 kg a.i. ha	10.01	9.98	29.86	42.64	40.09	44.83	39.09	38.72	5.64	7.55	8.19	10.09	8.19	10.49	8.14	7.54
One hand weeding	10.40	9.97	29.01	41.09	41.24	42.89	39.98	39.00	5.11	7.88	8.61	10.00	8.29	10.86	8.12	7.61
Two hand weedings	12.24	11.01	13.07	46.01	45.19	47.73	42.98	43.26	6.80	9.29	10.94	13.29	10.32	13.69	9.62	9.36
Control	6.03	5.69	19.96	34.24	29.56	39.43	28.04	33.01	2.98	4.69	3.96	7.46	4.86	8.50	4.62	4.87
S.Em±	0.35	0.47	0.77	0.67	1.01	0.46	0.91	0.62	0.25	0.52	0.23	0.63	0.35	0.49	0.37	0.38
C.D. at 5%	1.03	1.39	2.31	2.01	3.03	1.38	2.71	1.86	0.74	1.56	0.69	1.89	1.03	1.47	1.11	1.13

DAS = Days after sowing;
TPE = Transparent polyethylene

Appendix 10. Number of leaves, nodule number and nodule dry weight (g/plant), in groundnut as influenced by solarization treatments.

Treatments	Number of leaves per plant								Nodule number per plant				Nodule dry weight (g plant)			
	30 DAS		60 DAS		90 DAS		At harvest		60 DAS		90 DAS		60 DAS		90 DAS	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	6.01	8.07	18.64	26.43	52.19	56.43	32.26	36.46	86.48	88.92	102.58	108.73	0.087	0.089	0.115	0.116
TPE 0.05 mm 30 days	6.82	8.84	22.34	28.50	53.99	59.13	36.17	38.42	91.94	90.24	103.37	111.29	0.093	0.091	0.115	0.118
TPE 0.05 mm 45 days	7.77	10.22	26.21	32.96	56.86	65.23	39.31	43.09	98.06	99.34	109.77	119.21	0.107	0.109	0.120	0.132
TPE 0.1 mm 15 days	5.94	7.49	18.52	24.94	52.00	55.19	31.96	35.19	85.87	87.01	102.54	104.73	0.084	0.087	0.112	0.113
TPE 0.1 mm 30 days	6.69	8.90	21.96	27.66	52.46	58.92	35.68	38.16	89.48	90.34	103.82	109.88	0.092	0.095	0.114	0.115
TPE 0.1 mm 45 days	6.97	9.47	22.56	30.51	55.12	60.12	36.01	40.20	95.56	97.34	107.60	117.71	0.101	0.103	0.116	0.118
Alachlor 1.5 kg a.i. ha	7.26	9.33	25.49	29.68	55.98	59.78	38.49	39.61	87.48	88.96	101.44	102.56	0.076	0.084	0.114	0.115
One hand weeding	7.35	9.40	26.78	30.19	56.14	58.19	38.54	39.84	90.44	91.84	106.55	106.56	0.108	0.109	0.130	0.135
Two hand weedings	8.64	10.31	29.72	33.53	59.61	66.78	42.19	44.69	99.44	100.01	109.61	116.73	0.109	0.112	0.145	0.149
Control	4.94	5.17	15.14	21.96	48.94	51.23	28.61	32.01	80.07	80.27	88.91	97.30	0.053	0.069	0.841	0.962
S.Em±	0.27	0.25	1.18	0.82	0.58	0.50	0.91	0.62	2.39	2.26	0.77	1.95	0.109	0.078	0.258	0.232
C.D. at 5%	0.79	0.75	3.54	2.46	1.73	1.50	2.72	1.85	7.13	6.78	2.31	5.85	0.330	0.230	0.774	0.696

DAS : Days after sowing;
TPE: Transparent polyethylene

Appendix 11. Leaf area (dm^2/plant) and leaf area index in groundnut as influenced by solarization treatments.

Treatments	Leaf area (dm^2 plant)								Leaf area index							
	30 DAS		60 DAS		90 DAS		At harvest		30 DAS		60 DAS		90 DAS		At harvest	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	1.43	1.73	4.75	6.30	8.42	8.61	2.33	3.09	0.48	0.58	1.58	2.10	2.81	2.87	0.77	1.03
TPE 0.05 mm 30 days	1.70	2.20	5.45	7.16	9.42	10.54	2.82	3.84	0.57	0.66	1.92	2.49	3.14	3.51	1.00	1.32
TPE 0.05 mm 45 days	2.29	2.91	7.23	8.99	11.88	13.63	3.29	4.19	0.76	0.97	2.41	2.99	3.86	4.54	1.09	1.39
TPE 0.1 mm 15 days	1.34	1.69	4.21	6.24	8.39	8.52	2.29	2.98	0.45	0.56	1.40	2.08	2.79	2.84	0.76	0.99
TPE 0.1 mm 30 days	1.41	1.96	4.85	6.99	9.32	10.19	2.78	3.64	0.47	0.65	1.62	2.33	3.10	3.39	0.93	1.21
TPE 0.1 mm 45 days	1.80	2.24	5.98	7.52	10.19	10.75	3.00	3.98	0.62	0.66	1.99	2.51	3.39	3.65	1.00	1.32
Alachlor 1.5 kg a.i. ha	2.19	2.01	6.57	7.48	11.24	10.14	2.98	3.86	0.73	0.67	2.19	2.49	3.75	3.38	0.99	1.29
One hand weeding	2.26	2.00	6.81	7.62	11.32	10.35	3.01	3.95	0.75	0.71	2.27	2.54	3.77	3.45	1.00	1.32
Two hand weedings	2.88	2.98	7.98	9.36	12.52	13.42	3.86	4.27	0.86	0.99	2.66	3.12	4.17	4.47	1.29	1.42
Control	1.12	1.54	3.40	4.01	5.83	7.49	1.54	1.83	0.37	0.51	0.13	1.34	1.94	2.49	0.51	0.61
S.Em±	0.10	0.07	0.24	0.34	0.30	0.63	0.15	0.07	0.01	0.07	0.08	0.12	0.09	0.11	0.06	0.02
C.D. at 5%	0.30	0.22	0.70	1.02	0.88	1.86	0.45	0.21	0.03	0.21	0.23	0.35	0.27	0.33	0.18	0.06

DAS = Days after sowing;
TPE = Transparent polyethylene

Appendix 12. Dry matter of leaves (g/plant) and dry matter of stem (g/plant) in groundnut as influenced by solarization treatments.

Treatments	Dry matter of leaves (g/plant)								Dry matter of stem (g/plant)							
	30 DAS		60 DAS		90 DAS		At harvest		30 DAS		60 DAS		90 DAS		At harvest	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	1.24	2.60	4.80	6.85	8.57	9.17	3.27	3.74	0.66	1.08	3.12	5.91	7.55	8.12	7.21	8.46
TPE 0.05 mm 30 days	1.78	3.49	5.20	9.45	9.97	10.64	3.68	4.21	0.81	2.07	4.17	7.18	8.96	10.22	8.38	9.85
TPE 0.05 mm 45 days	2.84	3.88	6.86	11.24	12.42	13.89	4.29	5.65	1.06	3.95	5.96	8.26	10.52	12.46	9.59	14.01
TPE 0.1 mm 15 days	1.22	2.51	4.76	7.69	8.21	9.01	3.07	3.73	0.60	1.06	3.08	5.06	6.26	6.15	6.22	8.13
TPE 0.1 mm 30 days	1.76	2.86	5.18	8.01	9.61	10.92	3.48	4.19	0.75	2.05	3.98	6.12	7.69	8.25	7.34	9.49
TPE 0.1 mm 45 days	2.40	3.23	6.47	9.38	11.05	12.42	3.86	4.69	0.89	3.01	5.01	7.20	9.10	10.35	8.46	10.85
Alachlor 1.5 kg a.i./ha	2.69	3.21	6.82	9.16	11.07	12.08	3.85	4.54	0.90	1.98	5.12	7.16	9.01	10.32	9.61	10.29
One hand weeding	2.68	3.19	6.91	9.24	11.34	12.12	3.86	4.61	0.91	1.92	5.10	7.19	9.16	10.33	9.62	10.49
Two hand weedings	3.28	4.01	7.25	11.12	13.82	14.72	4.56	5.34	1.21	4.25	6.21	8.99	12.94	13.42	10.73	13.04
Control	0.64	2.23	3.42	5.62	7.01	8.51	2.81	3.21	0.51	0.68	2.28	4.85	6.12	6.02	6.08	7.01
S.Em±	0.15	0.12	0.13	0.49	0.47	0.49	0.14	0.16	0.05	0.31	0.28	0.36	0.48	0.69	0.38	0.46
C.D at 5%	0.44	0.37	0.39	1.44	1.41	1.46	0.41	0.46	0.15	0.93	0.84	1.07	1.42	2.04	1.12	1.37

DAS = Days after sowing;
TPE = Transparent polyethylene

Appendix 13. Dry matter of pods (g/plant) and total dry matter (g/plant) in groundnut as influenced by solarization treatments.

Treatments	Drymatter of pods (g/plant)						Total dry matter (g/plant)							
	60 DAS		90 DAS		At harvest		30 DAS		60 DAS		90 DAS		At harvest	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	2.02	4.42	4.77	6.98	11.98	13.50	1.90	3.68	9.94	18.18	20.89	24.27	22.46	25.71
TPE 0.05 mm 30 days	3.01	5.00	5.61	7.82	12.83	15.49	2.59	5.56	12.38	22.33	24.54	28.58	26.36	29.76
TPE 0.05 mm 45 days	3.95	5.68	6.59	8.95	13.82	6.32	3.90	7.33	16.78	25.18	29.53	35.30	28.70	35.98
TPE 0.1 mm 15 days	1.15	4.01	4.07	6.64	11.52	13.50	1.82	3.57	6.51	16.76	18.54	21.80	22.72	25.36
TPE 0.1 mm 30 days	2.07	4.61	4.91	7.24	12.69	14.29	2.51	4.91	11.23	18.74	22.21	26.41	25.66	27.97
TPE 0.1 mm 45 days	3.00	5.12	5.35	7.29	13.01	15.53	3.29	6.24	14.48	21.17	25.50	30.16	27.72	30.24
Alachlor 1.5 kg a.i./ha	3.69	5.14	5.25	7.76	13.86	15.99	3.59	5.19	17.08	21.46	24.33	30.16	27.85	30.29
One hand weeding	3.72	5.15	5.32	7.79	13.89	15.84	3.59	5.11	17.33	21.58	25.82	30.24	28.24	30.94
Two hand weedings	4.87	6.18	6.98	9.01	14.24	17.01	4.49	8.26	20.44	23.29	33.74	37.15	31.84	35.39
Control	1.00	3.92	3.04	6.04	6.86	8.85	1.15	2.91	9.64	14.46	17.07	20.57	16.68	19.07
S.Em±	0.31	0.17	0.28	0.19	0.14	0.27	0.30	0.36	0.89	0.83	1.37	0.65	0.23	0.47
C.D. at 5%	0.92	0.50	0.84	0.57	0.41	0.81	0.90	1.08	2.67	2.49	4.11	1.95	0.69	1.41

DAS = Days after sowing;
TPE = Transparent polyethylene

Appendix 14. Total number of pods per plant, number of filled pods per plant, pod weight (g/plant), pod yield (q/ha), haulm yield (q/ha), shelling (%), 100 kernel weight (g) and kernel yield (q/ha) in groundnut as influenced by solarization treatment.

Treatments	Total No. of pods/ plant		No. of filled pods/ plant		Pod weight (g/plant)		Pod yield (q/ha)		Haulm yield (q/ha)		Shelling (%)		100 kernel weight (g)		Kernel yield (q/ha)	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	18.07	19.34	10.47	13.20	11.79	14.01	11.79	13.78	12.62	17.65	66.24	66.84	32.19	33.70	7.78	9.23
TPE 0.05 mm 30 days	19.69	22.79	13.26	18.26	13.64	17.91	14.08	19.69	13.78	22.52	68.46	69.01	33.69	35.93	9.65	13.59
TPE 0.05 mm 45 days	23.16	24.09	19.41	21.01	16.24	19.61	19.61	23.01	17.98	24.99	71.99	72.91	39.69	45.68	14.12	16.79
TPE 0.1 mm 15 days	17.85	17.30	10.24	12.96	10.16	13.26	10.68	12.78	12.01	16.08	75.02	65.67	29.01	31.07	6.94	8.30
TPE 0.1 mm 30 days	19.34	19.15	13.09	17.42	13.01	15.01	13.24	14.62	13.54	17.11	67.02	67.52	32.46	35.85	9.00	9.79
TPE 0.1 mm 45 days	21.67	22.80	16.39	18.75	14.64	17.62	15.72	18.91	15.79	20.95	69.02	69.37	35.69	38.80	10.85	12.42
Alachlor 1.5 kg a.i./ha	22.56	22.24	18.49	18.64	16.02	17.52	18.12	18.24	17.05	22.98	70.62	70.01	39.69	36.56	12.68	13.47
One hand weeding	22.69	22.19	18.62	19.01	16.32	16.92	18.74	18.01	17.98	21.69	70.01	70.61	38.42	36.42	13.81	14.07
Two hand weedings	25.01	25.94	20.83	22.01	17.90	19.98	23.34	22.52	20.66	25.76	72.01	72.05	41.18	45.96	16.80	16.21
Control	15.98	16.86	8.67	9.68	8.50	9.46	8.50	9.69	12.02	16.27	60.53	62.24	41.18	45.96	5.19	5.91
S.Em±	0.50	0.62	0.48	0.44	0.55	0.33	0.55	0.62	0.14	0.26	0.66	0.60	0.50	0.90	0.66	0.41
C.D. at 5%	1.49	1.85	1.42	1.31	1.63	0.99	1.63	1.84	0.45	0.77	1.97	1.80	1.49	2.68	1.98	1.24

DAS = Days after sowing;
TPE = Transparent polyethylene

Appendix 15. Weed count/m^2 in tomato as influenced by solarization treatments (30 and 60 DAT).

Treatments	30 DAT								60 DAT							
	Monocots		Dicots		Sedges		Total weed		Monocots		Dicots		Sedges		Total weed	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	3.52 (11.89)	3.14 (9.36)	3.46 (11.47)	2.94 (8.14)	4.36 (20.94)	4.44 (19.04)	6.69 (44.30)	0.69 (36.54)	4.52 (19.93)	4.23 (17.39)	3.98 (15.34)	3.72 (13.34)	5.42 (28.88)	4.69 (21.49)	8.04 (64.15)	7.26 (52.20)
TPE 0.05 mm 30 days	2.65 (6.52)	2.52 (5.85)	1.98 (3.42)	1.89 (3.07)	2.79 (7.28)	2.56 (6.05)	4.21 (17.22)	3.93 (14.93)	3.12 (9.23)	2.89 (7.85)	2.59 (6.21)	2.42 (5.33)	3.49 (11.68)	3.19 (9.68)	5.26 (27.12)	4.83 (22.86)
TPE 0.05 mm 45 days	1.25 (1.06)	1.11 (0.73)	1.38 (1.40)	1.35 (1.32)	2.42 (5.36)	2.31 (4.84)	2.88 (7.82)	2.72 (6.89)	2.50 (5.75)	2.32 (4.88)	1.48 (2.69)	1.38 (1.40)	2.70 (6.79)	2.56 (6.07)	3.84 (14.23)	3.44 (11.35)
TPE 0.1 mm 15 days	3.64 (12.75)	3.32 (11.89)	3.52 (11.89)	3.00 (8.50)	4.68 (21.40)	4.38 (18.68)	6.82 (46.04)	6.29 (39.07)	4.64 (21.73)	4.32 (18.16)	4.00 (15.50)	3.74 (13.49)	5.56 (30.41)	4.84 (22.93)	8.21 (66.94)	7.42 (54.58)
TPE 0.1 mm 30 days	2.98 (8.38)	2.91 (7.97)	2.52 (5.85)	2.36 (5.07)	3.08 (8.98)	2.98 (8.38)	4.87 (23.21)	4.68 (21.42)	3.44 (11.33)	3.32 (10.52)	2.73 (6.95)	2.79 (7.28)	4.00 (15.50)	3.86 (14.39)	5.85 (33.78)	5.72 (32.19)
TPE 0.1 mm 45 days	2.59 (6.21)	2.52 (5.85)	2.08 (3.83)	1.90 (3.11)	2.95 (8.20)	2.65 (6.52)	4.33 (18.23)	3.99 (15.48)	3.05 (8.80)	2.82 (7.45)	2.43 (5.40)	2.28 (4.69)	3.50 (11.75)	3.16 (9.49)	5.09 (25.41)	4.70 (21.63)
Alachlor 1.5 kg a.i./ha	2.45 (5.50)	2.58 (6.16)	2.00 (3.50)	1.88 (3.03)	2.86 (7.68)	2.70 (6.79)	4.14 (16.68)	4.03 (15.71)	2.98 (8.38)	2.84 (7.57)	2.01 (3.54)	2.20 (4.34)	3.42 (11.21)	3.20 (9.74)	4.86 (23.13)	4.71 (21.65)
One hand weeding	2.46 (5.55)	2.56 (6.05)	2.01 (3.54)	1.89 (3.07)	2.88 (7.79)	2.64 (6.47)	4.17 (16.88)	4.06 (16.02)	2.99 (8.44)	2.86 (7.68)	2.02 (3.58)	2.19 (4.29)	3.46 (11.48)	3.19 (9.68)	4.89 (23.50)	4.71 (21.66)
Two hand weedings	1.50 (1.75)	1.24 (1.04)	1.34 (1.29)	1.42 (1.52)	2.32 (4.88)	2.40 (5.26)	4.90 (7.90)	2.88 (7.82)	2.42 (5.36)	2.41 (5.31)	1.58 (1.99)	1.62 (2.12)	2.68 (6.68)	2.42 (5.36)	3.24 (10.03)	3.65 (12.79)
Control	3.69 (13.12)	3.48 (11.61)	3.67 (12.97)	3.09 (9.05)	4.98 (24.30)	4.56 (20.29)	7.13 (50.39)	6.44 (40.95)	4.72 (21.78)	4.56 20.29	4.12 (15.47)	3.82 (14.09)	5.56 (30.41)	4.98 (24.30)	8.32 (68.66)	7.69 (58.68)
S.Em±	0.10	0.14	0.12	0.14	0.11	0.07	0.41	0.40	0.15	0.11	0.09	0.15	0.07	0.24	0.33	0.42
C.D. at 5%	0.30	0.41	0.34	0.41	0.32	0.20	1.22	1.19	0.44	0.33	0.26	0.45	0.20	0.73	0.99	1.25

DAT = Days after transplanting; TPE = Transparent polyethylene

Appendix 16. Weed count/m^2 at harvest and weed dry weight (g/0.25 m^2) 30 DAT in tomato as influenced by solarization treatments.

Treatments	Weed count m^2 at harvest								Weed dry weight (g/0.25 m^2) at 30 DAT							
	Monocots		Dicots		Sedges		Total weed		Monocots		Dicots		Sedges		Total weed	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	5.24 (26.96)	5.19 (26.43)	4.09 (16.23)	3.84 (9.99)	5.61 (30.97)	4.90 (23.50)	8.64 (74.16)	7.77 (59.93)	1.94 (3.26)	1.89 (3.07)	1.80 (2.74)	1.64 (2.19)	2.69 (6.74)	2.35 (5.02)	3.46 (11.50)	3.28 (10.28)
TPE 0.05 mm 30 days	3.96 (15.18)	3.62 (12.60)	2.72 (6.89)	2.65 (6.52)	3.84 (14.24)	3.21 (9.80)	6.07 (36.39)	5.42 (28.92)	1.54 (1.87)	1.43 (1.54)	1.37 (1.38)	1.37 (1.38)	1.58 (1.99)	1.46 (1.63)	2.32 (4.90)	2.25 (4.55)
TPE 0.05 mm 45 days	3.46 (11.47)	3.29 (10.32)	2.00 (3.50)	2.98 (3.42)	3.27 (10.19)	2.75 (7.06)	5.07 (25.16)	4.62 (20.80)	1.28 (1.14)	1.22 (0.99)	1.17 (0.87)	1.14 (0.081)	1.24 (1.04)	1.21 (0.96)	1.88 (3.08)	1.89 (2.76)
TPE 0.1 mm 15 days	5.36 (28.24)	5.21 (26.64)	5.36 (16.47)	3.96 (15.18)	5.21 (26.67)	5.02 (19.93)	8.48 (71.38)	7.88 (61.75)	1.96 (3.34)	1.88 (3.07)	1.78 (2.66)	1.79 (2.70)	2.82 (7.51)	2.34 (4.98)	3.55 (12.13)	3.85 (10.73)
TPE 0.1 mm 30 days	4.37 (18.59)	4.04 (15.82)	3.06 (8.86)	3.36 (10.79)	4.31 (18.08)	4.12 (16.47)	6.78 (45.53)	6.66 (43.08)	1.72 (2.46)	1.62 (2.12)	1.54 (1.87)	1.52 (1.81)	1.62 (2.12)	2.02 (3.51)	2.73 (6.94)	2.49 (5.74)
TPE 0.1 mm 45 days	3.97 (15.26)	3.67 (12.97)	2.68 (6.68)	2.98 (8.38)	3.91 (14.78)	3.78 (13.79)	6.10 (36.72)	5.97 (35.14)	1.52 (1.81)	1.39 (1.43)	1.39 (1.43)	1.35 (1.32)	1.52 (1.81)	1.39 (3.46)	2.26 (4.62)	2.16 (4.18)
Alachlor 1.5 kg a.i./ha	3.96 (15.18)	3.68 (13.04)	2.51 (5.80)	3.18 (9.61)	3.64 (12.75)	3.68 (13.04)	5.85 (33.73)	6.02 (35.69)	1.50 (1.19)	1.42 (1.52)	1.42 (1.52)	1.40 (1.46)	1.39 (1.43)	1.99 (3.46)	2.25 (4.55)	2.22 (4.41)
One hand weeding	3.85 (14.32)	3.69 (13.12)	2.48 (5.65)	3.04 (8.74)	3.66 (12.89)	3.55 (12.10)	5.78 (32.86)	5.87 (33.96)	1.75 (1.81)	1.39 (1.43)	1.38 (1.40)	1.42 (1.52)	1.41 (1.49)	1.49 (3.46)	2.24 (4.56)	2.22 (4.41)
Two hand weedings	3.29 (10.32)	3.24 (9.97)	2.09 (3.87)	2.22 (4.43)	3.29 (10.32)	3.01 (8.56)	5.00 (24.51)	4.84 (22.96)	1.24 (1.04)	1.23 (1.01)	1.20 (0.94)	1.16 (0.85)	1.25 (2.83)	1.26 (1.09)	1.87 (3.07)	1.86 (2.95)
Control	5.48 (29.53)	5.28 (27.38)	4.27 (17.73)	4.07 (16.06)	5.69 (31.87)	5.21 (26.64)	8.92 (79.15)	8.40 (70.08)	2.08 (3.82)	1.98 (3.42)	1.84 (2.89)	1.78 (2.67)	2.83 (7.51)	3.90 (8.56)	3.66 (12.89)	3.73 (13.65)
S.Em±	0.13	0.10	0.08	0.20	0.13	0.17	0.21	0.41	0.05	0.04	0.04	0.03	0.05	0.04	0.12	0.11
C.D. at 5%	0.38	0.29	0.25	0.58	0.40	0.51	0.64	1.23	0.15	0.10	0.12	0.07	0.14	0.12	0.35	0.33

DAT = Days after transplanting;
TPE = Transparent polyethylene

Appendix 17. Weed dry weight (g/0.25 m^2) in tomato as influenced by solarization treatments (60 DAT and at harvest).

Treatments	60 DAT								At harvest							
	Monocots		Dicots		Sedges		Total weed		Monocots		Dicots		Sedges		Total weed	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	2.64 (6.47)	2.27 (4.52)	1.98 (3.42)	1.84 (2.89)	2.86 (7.68)	2.56 (6.05)	4.28 (17.87)	3.86 (14.46)	3.49 (11.68)	2.99 (8.44)	2.42 (5.36)	2.24 (4.52)	2.99 (8.44)	2.88 (7.79)	5.06 (25.08)	4.61 (20.75)
TPE 0.05 mm 30 days	1.65 (2.22)	1.48 (1.69)	1.42 (1.52)	1.36 (1.35)	1.48 (1.69)	1.41 (1.49)	2.90 (7.93)	2.70 (6.83)	1.68 (2.32)	1.62 (2.12)	1.53 (1.84)	1.48 (1.69)	1.58 (1.99)	1.52 (1.81)	3.38 (10.95)	3.02 (8.62)
TPE 0.05 mm 45 days	1.33 (1.27)	1.28 (1.14)	1.18 (0.89)	1.21 (0.96)	1.39 (1.43)	1.27 (1.11)	2.46 (5.59)	2.17 (4.21)	1.54 (1.87)	1.48 (1.69)	1.34 (1.29)	1.30 (1.19)	1.42 (1.52)	1.35 (1.32)	3.03 (8.68)	2.77 (7.20)
TPE 0.1 mm 15 days	2.56 (6.52)	2.31 (4.84)	1.99 (3.46)	1.85 (2.92)	2.86 (7.68)	2.61 (6.31)	4.38 (18.66)	3.95 (15.07)	3.42 (11.19)	3.00 (8.50)	2.45 (5.50)	2.30 (4.97)	3.00 (8.50)	2.89 (7.85)	5.07 (25.19)	4.67 (21.32)
TPE 0.1 mm 30 days	1.82 (2.81)	1.68 (2.32)	1.58 (1.99)	1.54 (1.87)	1.60 (2.06)	1.57 (1.96)	3.21 (9.86)	2.94 (8.15)	1.98 (3.42)	1.82 (2.81)	1.63 (2.16)	1.89 (3.07)	1.78 (2.67)	1.62 (2.12)	3.43 (11.25)	3.38 (1.90)
TPE 0.1 mm 45 days	1.72 (2.46)	1.45 (1.60)	1.44 (1.57)	1.34 (1.29)	1.50 (1.75)	1.47 (1.66)	2.87 (7.75)	2.55 (6.05)	1.84 (2.88)	1.72 (2.46)	1.49 (1.72)	1.47 (1.66)	1.59 (2.03)	1.45 (1.60)	3.18 (9.63)	3.08 (8.99)
Alachlor 1.5 kg a.i. ha	1.68 (2.32)	1.48 (1.69)	1.38 (1.40)	1.35 (1.32)	1.49 (1.22)	1.48 (1.69)	2.98 (8.44)	1.68 (6.70)	1.89 (3.07)	1.75 (2.57)	1.38 (1.40)	1.48 (1.68)	1.60 (2.06)	1.49 (1.72)	3.16 (9.53)	3.07 (8.98)
One hand weeding	1.68 (2.32)	1.42 (1.52)	1.37 (1.38)	1.35 (1.21)	1.48 (1.69)	1.48 (1.69)	2.98 (8.39)	2.70 (8.60)	1.89 (3.07)	1.78 (2.67)	1.42 (1.52)	1.46 (1.63)	1.61 (2.09)	1.48 (1.69)	3.11 (9.68)	3.08 (8.99)
Two hand weedings	1.26 (1.29)	1.08 (1.26)	1.22 (0.99)	1.21 (0.96)	1.38 (1.40)	1.32 (1.24)	2.48 (5.68)	2.23 (4.46)	1.58 (1.99)	1.52 (1.81)	1.32 (1.24)	1.30 (1.19)	1.40 (1.46)	1.36 (1.35)	3.03 (8.69)	2.80 (7.85)
Control	2.74 (8.44)	2.34 (4.98)	2.01 (3.54)	1.86 (2.96)	2.91 (7.97)	2.69 (6.74)	4.52 (19.95)	4.19 (16.68)	3.58 (12.31)	3.02 (8.62)	2.52 (5.85)	2.39 (5.21)	3.01 (8.56)	2.89 (7.85)	5.12 (25.72)	4.81 (22.68)
S.Em±	0.06	0.05	0.05	0.04	0.03	0.05	0.09	0.11	0.05	0.04	0.04	0.05	0.05	0.03	0.04	0.08
C.D. at 5%	0.18	0.15	0.14	0.11	0.08	0.15	0.27	0.33	0.15	0.12	0.12	0.15	0.15	0.06	0.12	0.24

DAT = Days after transplanting;
TPE = Transparent polyethylene

Appendix 18. Weed control efficiency (WCE) in tomato as influenced by solarization treatments.

Treatments	Weed control efficiency (%)					
	30 DAT		60 DAT		At harvest	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	10.78	24.68	10.42	22.59	2.49	8.51
TPE 0.05 mm 30 days	61.98	66.67	60.03	63.44	57.43	61.21
TPE 0.05 mm 45 days	76.11	79.78	71.98	77.46	66.25	68.25
TPE 0.1 mm 15 days	5.89	21.25	4.97	19.33	2.06	5.99
TPE 0.1 mm 30 days	46.16	57.95	40.55	56.37	56.26	51.19
TPE 0.1 mm 45 days	64.16	69.38	61.15	67.61	62.25	60.36
Alachlor 1.5 kg a.i./ha	64.70	67.69	57.69	64.12	62.94	60.40
One hand weeding	64.62	67.69	57.94	63.59	62.36	60.36
Two hand weedings	76.18	78.39	71.53	76.12	66.21	67.59
Control	0.00	0.00	0.00	0.00	0.00	0.00

TPE = Transparent polyethelene;
DAT = Days after transplanting

Appendix 19. Weed dry weight (t/ha) at harvest of tomato as influenced by solarization treatments

Treatments	Weed dry weight (t/ha)	
	1997-98	1998-99
TPE 0.05 mm 15 days	1.00	0.83
TPE 0.05 mm 30 days	0.44	0.34
TPE 0.05 mm 45 days	0.34	0.29
TPE 0.1 mm 15 days	1.01	0.83
TPE 0.1 mm 30 days	0.45	0.44
TPE 0.1 mm 45 days	0.38	0.36
Alachlor 1.5 kg a.i./ha	0.38	0.35
One hand weeding	0.39	0.36
Two hand weedings	0.34	0.31
Control	1.03	0.91
S.Em±	0.01	0.02
CD at 5%	0.03	0.06

TPE = Transparent polyethylene.

Appendix 20. Plant height (cm) and number of branches per plant in tomato as influenced by solarization treatments.

Treatments	Plant height (cm)						Number of branches per plant					
	30 DAT		60 DAT		At harvest		30 DAT		60 DAT		At harvest	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	26.52	26.50	61.03	62.02	66.19	69.20	5.62	6.38	6.05	6.42	6.30	6.48
TPE 0.05 mm 30 days	31.12	33.07	66.98	71.42	72.95	74.25	6.20	7.00	6.80	7.29	7.19	7.31
TPE 0.05 mm 45 days	35.98	38.97	70.72	74.62	75.72	76.89	7.18	7.88	7.85	8.96	8.00	8.21
TPE 0.1 mm 15 days	26.19	26.60	60.20	62.00	65.20	68.89	5.26	5.49	6.00	6.34	6.21	6.24
TPE 0.1 mm 30 days	29.12	29.61	65.21	70.68	70.69	73.89	5.78	6.28	6.155	6.83	6.72	7.21
TPE 0.1 mm 45 days	31.02	34.07	67.27	73.19	73.19	75.01	6.23	7.08	7.00	7.32	7.22	7.60
Alachlor 1.5 kg a.i./ha	30.01	35.05	67.29	72.91	74.01	75.09	6.45	7.06	7.21	7.41	7.54	7.72
One hand weeding	31.04	36.01	68.00	63.01	73.98	7.50.1	6.39	7.00	7.32	7.29	7.29	7.65
Two hand weedings	34.69	38.19	70.92	74.69	75.69	76.21	7.21	7.96	7.94	8.42	8.01	8.21
Control	23.99	23.07	59.41	60.98	64.68	68.93	5.53	5.76	5.60	5.96	5.85	6.21
S.Em±	1.03	1.16	0.55	0.65	0.55	0.17	0.16	0.24	0.15	0.16	0.15	0.13
C.D. at 5%	3.09	3.43	1.66	1.94	1.66	0.51	0.48	0.70	0.45	0.48	0.45	0.39

TPE = Transparent polyethylene; DAT = Days after transplanting

Appendix 21. Number of leaves per plant and leaf area (dm^2/plant) in tomato as influenced by solarization treatments.

Treatments	Number of leaves per plant						Leaf area (dm^2/plant)					
	30 DAT		60 DAT		At harvest		30 DAT		60 DAT		At harvest	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	8.12	8.19	26.93	29.64	29.00	28.16	2.35	2.45	4.72	5.21	5.75	5.99
TPE 0.05 mm 30 days	10.24	10.86	32.19	36.01	31.98	32.61	3.01	31.54	5.68	6.54	6.72	7.02
TPE 0.05 mm 45 days	12.89	13.00	35.54	28.64	35.91	34.82	3.88	3.90	6.65	6.99	7.74	8.54
TPE 0.1 mm 15 days	8.00	8.12	26.19	29.00	29.00	28.00	2.19	2.24	4.64	5.01	5.64	5.84
TPE 0.1 mm 30 days	9.50	9.60	32.01	35.44	31.11	31.22	2.78	2.70	5.25	5.95	6.27	6.52
TPE 0.1 mm 45 days	10.62	10.98	33.32	37.04	32.51	33.02	3.19	3.17	5.70	6.47	6.75	7.03
Alachlor 1.5 kg a.i./ha	11.27	11.68	34.01	37.91	33.01	33.02	3.49	3.12	6.10	6.32	7.29	7.39
One hand weeding	10.98	11.34	34.99	36.72	32.89	32.96	3.24	3.14	6.12	6.31	7.20	7.48
Two hand weedings	12.99	13.04	36.91	39.01	35.29	35.09	3.99	3.86	6.62	7.09	7.69	8.01
Control	7.01	7.82	28.87	28.01	27.86	26.92	1.99	2.01	4.35	4.96	5.30	5.49
S.Em±	0.38	0.46	0.36	0.52	0.47	0.61	0.13	0.15	0.15	0.17	0.15	0.17
C.D. at 5%	1.12	1.38	1.08	1.55	1.38	1.79	0.39	0.45	0.45	0.52	0.45	0.51

TPE = Transparent polyethylene
DAT = Days after transplanting

Appendix 22. Leaf area index and days taken for 50 per cent flowering in tomato as influenced by solarization treatment.

Treatment	Leaf area index						Days taken for 50 % flowering	
	30 DAT		60 DAT		At harvest			
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	0.52	0.54	1.05	1.16	1.28	1.33	29.46	30.62
TPE 0.05 mm 30 days	0.66	0.70	1.26	1.45	1.49	1.56	31.21	32.94
TPE 0.05 mm 45 days	0.86	0.87	1.47	1.55	1.72	1.89	34.43	35.60
TPE 0.1 mm 15 days	0.48	0.50	1.03	1.13	1.25	1.29	28.43	30.77
TPE 0.1 mm 30 days	0.62	0.60	1.16	1.32	1.39	1.45	29.98	32.28
TPE 0.1 mm 45 days	0.71	0.71	1.26	1.44	1.50	1.56	32.55	33.99
Alachlor 1.5 kg a.i./ha	0.78	0.69	1.35	1.40	1.59	1.64	33.01	34.19
One hand weeding	0.72	0.69	1.36	1.40	1.60	1.66	33.52	33.69
Two hand weedings	0.88	0.85	1.47	1.58	1.71	1.78	33.98	34.61
Control	0.44	0.45	0.96	1.09	1.17	1.22	25.88	29.17
S.Em±	0.05	0.05	0.04	0.03	0.04	0.07	0.052	0.54
C.D. at 5%	0.14	0.15	0.11	0.09	0.11	0.21	0.16	1.62

TPE = Transparent polyethylene; DAT = Days after transplanting

Appendix 23. Dry weight of leaves (g/plant) and dry weight of stem (g/plant) in tomato as influenced by solarization treatments.

Treatments	Dry weight of leaves (g/plant)						Dry weight of stem (g/plant)					
	30 DAT		60 DAT		At harvest		30 DAT		60 DAT		At harvest	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	12.44	14.33	15.82	18.00	16.80	18.72	11.50	12.10	20.54	21.00	21.40	22.19
TPE 0.05 mm 30 days	16.39	18.23	21.04	24.62	20.56	21.98	15.61	16.98	23.64	27.99	24.19	26.31
TPE 0.05 mm 45 days	20.10	24.79	28.31	28.62	23.49	26.01	19.86	20.15	29.48	30.99	31.00	31.86
TPE 0.1 mm 15 days	11.96	12.09	15.00	18.71	16.70	17.72	11.24	12.00	18.74	21.98	19.69	21.09
TPE 0.1 mm 30 days	14.50	16.99	20.61	26.26	18.63	20.15	13.68	14.81	21.32	25.79	22.12	22.37
TPE 0.1 mm 45 days	16.48	19.89	22.96	26.45	20.56	22.58	15.77	16.98	23.90	27.99	24.55	26.31
Alachlor 1.5 kg a.i./ha	17.62	19.89	23.96	26.49	21.01	21.98	17.90	16.01	25.42	27.21	25.96	26.01
One hand weeding	17.82	20.01	23.01	26.01	21.12	21.65	16.98	17.24	24.01	26.19	25.01	26.19
Two hand weedings	20.44	24.18	27.69	29.89	24.42	26.01	19.98	20.19	29.06	30.96	30.91	31.00
Control	10.48	13.94	14.50	16.33	16.01	16.29	9.50	10.01	18.40	19.81	19.90	20.92
S.Em±	0.66	1.32	0.79	0.73	0.65	0.82	0.71	0.73	0.87	0.74	0.82	0.90
C.D. at 5%	1.97	3.91	2.35	2.17	1.93	2.43	2.09	2.17	2.58	2.20	2.43	2.61

TPE = Transparent polyethylene; DAT = Days after transplanting

Appendix 24. Fruit weight (g/plant) and total dry weight (g/plant) in tomato as influenced by solarization treatments.

Treatments	Fruit weight (g/plant)				Total dry weight (g/plant)					
	60 DAT		At harvest		30 DAT		60 DAT		At harvest	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	39.06	41.96	54.19	68.01	23.94	26.43	75.42	80.96	92.39	108.92
TPE 0.05 mm 30 days	42.98	50.62	69.01	75.01	32.00	35.21	87.66	103.23	113.76	123.30
TPE 0.05 mm 45 days	54.48	55.61	75.17	80.19	39.86	44.94	112.28	115.22	129.64	138.06
TPE 0.1 mm 15 days	38.63	40.09	53.16	68.00	23.2	24.09	72.37	80.78	89.55	106.81
TPE 0.1 mm 30 days	41.82	50.00	67.69	75.70	28.18	31.80	83.75	102.59	109.20	118.23
TPE 0.1 mm 45 days	45.09	53.16	70.39	77.41	32.25	36.87	91.95	107.96	115.20	126.30
Alachlor 1.5 kg a.i./ha	50.42	54.01	72.19	77.01	35.52	35.90	99.80	107.71	119.16	125.00
One hand weeding	49.62	53.98	71.98	77.19	34.80	37.25	96.64	106.18	118.28	125.03
Two hand weedings	54.69	55.69	75.95	80.10	40.42	44.37	111.44	114.64	131.28	137.20
Control	36.40	41.30	53.01	67.10	19.98	23.95	69.30	77.47	88.92	104.31
S.Em±	1.08	0.45	0.93	0.58	1.40	1.82	2.39	1.39	2.16	1.89
C.D. at 5%	3.19	1.35	2.78	1.71	4.18	5.43	7.15	4.17	6.43	5.66

Appendix 25. Total number of tomato per plant, number of markatable tomato per plant, total tomato weight (g/plant), markatable tomato weight (g/plant), total tomato yield (t/ha), markatable tomato yield (t/ha) and specific gravity (w/v) in tomato as influenced by solarization treatments.

Treatment	Total number of fruits per plant		Number of markatable fruits per plant		Total fruit weight (g/plant)		Marketable fruit weight (g/plant)		Total fruit yield (t/ha)		Marketable fruit yield (t/ha)		Specific gravity (w/v)	
	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999	1997-1998	1998-1999
TPE 0.05 mm 15 days	31.50	32.40	26.19	30.44	1.12	1.17	0.94	0.95	16.12	17.61	12.37	14.05	0.86	0.89
TPE 0.05 mm 30 days	38.46	42.19	37.67	42.00	1.45	1.58	1.27	1.35	19.59	22.01	17.21	20.26	1.09	1.09
TPE 0.05 mm 45 days	41.01	48.61	41.42	45.10	1.89	1.86	1.59	1.78	23.94	26.96	23.56	24.98	1.24	1.29
TPE 0.1 mm 15 days	32.36	31.98	25.98	29.61	1.10	1.14	0.93	0.95	16.00	17.42	12.19	14.00	0.85	0.87
TPE 0.1 mm 30 days	35.91	40.90	35.88	39.46	1.34	1.23	1.12	1.16	19.04	21.21	15.00	19.52	0.99	1.00
TPE 0.1 mm 45 days	38.46	44.70	38.65	42.30	1.53	1.55	1.25	1.37	20.59	23.00	19.28	21.26	1.07	1.08
Alachlor 1.5 kg a.i./ha	39.61	44.15	40.90	42.30	1.64	1.58	1.34	1.38	21.32	22.64	18.49	20.27	1.09	1.09
One hand weeding	38.98	44.26	40.31	41.19	1.63	1.54	1.35	1.36	22.01	22.19	19.72	20.19	1.03	1.09
Two hand weedings	42.62	47.19	44.19	43.29	1.89	1.87	1.52	1.78	23.69	25.98	22.89	23.45	1.24	1.24
Control	28.90	31.64	28.46	29.04	0.98	1.01	0.82	0.74	15.12	15.82	10.09	12.34	0.79	0.81
S.Em±	0.86	0.85	0.93	0.96	0.05	0.05	0.04	0.07	0.35	0.61	0.76	0.58	0.02	0.03
C.D. at 5%	2.55	2.51	2.70	2.84	0.15	0.15	0.12	0.21	1.05	1.79	2.28	1.72	0.06	0.08

TPE = Transparent polyethylene
DAT = Days after transplanting

Appendix 26. Price of inputs and outputs used in economic analysis.

Items	Unit	Price (Rs)	
		1997-98	1998-99
1 **Certified seeds**			
Tomato	100 g	75.00	75.00
Groundnut	kg	25.00	25.00
2 **Manure/fertilizer**			
FYM	tonnes	300.00	350.00
Urea	kg	3.66	3.80
SSP	kg	2.85	2.92
MOP	kg	3.70	3.90
3 **Plant protection chemicals**			
Monocrotophas	litre	450.00	450.00
Ridomyl	kg	1570.00	1570.00
Cypermethrin	litre	900.00	900.00
Alachlor	litre	240.00	24.00
4 **Labour charges**			
Men hours	Day of 8 hours	36.00	36.00
Women hours	Day of 8 hours	36.00	36.00
Bullock pair	Day of 8 hours	60.00	60.00
Tractor charge			
Ploughing	1 hour	75.00	75.00
Transportation	1 hour	60.00	60.00
5 **Transparent polyethylene**			
0.05 mm	m	2.00	2.00
0.10 mm	m	4.00	4.00
6 **Outputs**			
Groundnut pods	kg	14.00	14.00
Tomato	kg	4.00	5.00
Groundnut haulm	tonnes	60.00	60.00