EFFECT OF SOIL SOLARIZATION ON WEED CONTROL, GROWTH AND YIELD OF GROUNDNUT-POTATO CROP SEQUENCE IN CONJUCTION WITH CULTURAL AND CHEMICAL METHODS OF WEED CONTROL

A

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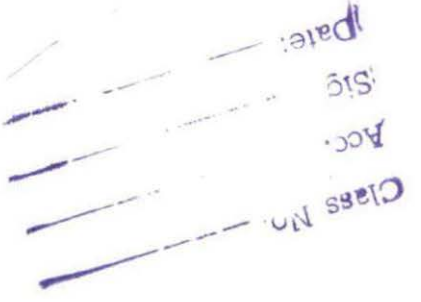

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ABSTRACT

An experiment was conducted during 2003-04 and 20004-05 on loamy sand soil of Agronomy Instructional Farm, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the effect of soil solarization on weed control, growth and yield of groundnut-potato crop sequence in conjunction with cultural and chemical methods of weed control under North Gujarat condition. Treatments consisted of two thicknesses of TPE (0.025 mm and 0.050 mm) with three durations of soil solarization (15, 30 and 45 days) along with cultural (weed free and hand weeding twice plus earthing up) as well as chemical method (Pendimethalin for groundnut and Metribuzin for potato each @ 1.0 kg ha^{-1}) of weed control with standard weedy check as control were studied in randomized block design with four replications.

The results revealed that solarization with TPE 0.025 mm for 45 days increased the soil temperature to an extent of 10.6 ^{0}C and 8.6 ^{0}C over non solarized at 5 and 10 cm depth of soil, respectively. While, among the thickness of TPE, TPE 0.025 mm for 45 days recorded higher soil temperature by 2.4 ^{0}C

and 1.2 ^{0}C at 5 and 10 cm soil depth, respectively over TPE 0.050 mm for 45 days. All SS treatments retained higher soil moisture than non solarized.

TPE 0.025 mm for 45 days increased the status of available N, P, K, Fe, Mn and Cu and decreased the status of the organic carbon, S and Zn in soil.

All SS treatments decreased the fungal, bacterial and actinomycetes population, but more reduction was noted under TPE 0.025 mm for 45 days just after SS, but subsequently there was an improvement in micro biota population after harvest of groundnut.

The minimum count and dry weight of grasses, broad leaved, sedges and total weeds were recorded in weed free, followed by hand weeding twice plus earthing up and TPE 0.025 mm for 45 days at 30 and 60 DAS. While, grasses, broadleaved, sedges and total weed population and dry weight of weeds at 90 DAS and harvest were decreased under weed free, followed by TPE 0.025 mm for 45 days. These treatments also followed the same trend for dry weed biomass. While, maximum WCE was recorded in weed free, followed by TPE 0.025 mm for 45 days. The weed index was lowest under TPE 0.025 mm for 45 days. The reduction of broad leaved was more due to TPE 0.025 mm for 45 days than grasses.

Maximum plant height, number of branches and leaves, leaf area as well as LAI at their respective stages was recorded under TPE 0.025 mm for 45 days, being at par with weed free. While, maximum dry matter accumulation in leaves, stem, pods and TDM was registered under TPE 0.025 mm for 45 days and weed free also found equally effective in this respect. Higher dry weight of root nodule was recorded under TPE 0.025 mm for 45 days which was on par with weed free.

With regards to yield attributing characters, the maximum number of pods (22.24) , pod weight (20.23 g plant^{-1}), test weight (55.00 g), shelling percentage (70.63) and kernel yield (19.63 q ha^{-1}) and pod yield of groundnut (27.68 q ha^{-1}) were registered under TPE 0.025 mm for 45 days and weed free found equally effective for these characters. Likewise, haulm yield observed higher under TPE

0.025 mm for 45 days and was on par with weed free and hand weeding twice plus earthing up.

Higher oil content was recorded under TPE 0.025 mm for 45 days, which was on par with weed free, hand weeding twice plus earthing up, TPE 0.050 mm for 45 days and Pendimethalin 1.0 kg ha^{-1}.

Maximum content of nitrogen, phosphorus, potassium, sulphur, Fe, Mn, Zn and Cu in groundnut haulm was found under TPE 0.025 mm for 45 days and remained equally effective with weed free treatment. On the contrary, higher reduction in content of nitrogen, phosphorus, potassium, sulphur in weeds were recorded due to TPE 0.025 mm for 45 days followed by weed free, whereas, content of Fe, Mn, Zn and Cu in weeds was decreased due to weed free, which being at par with TPE 0.025 mm for 45 days.

Weed free recorded maximum reduction in grasses, broad leaved, sedges and total weeds population as well as dry weight of weeds and dry weed biomass, which remained at par with TPE 0.025 mm for 45 days.

Maximum plant height, number of leaves and leaf area of potato was recorded in the order of TPE 0.025 mm for 45 days > weed free > hand weeding twice plus earthing up.

Yield attributing characters like number of tuber, tuber weight, large size tuber and medium size tuber in potato were registered higher under TPE 0.025 mm for 45 days followed by hand weeding twice plus earthing up and weed free. Whereas, small size tuber yield was recorded higher under weed free followed by hand weeding twice plus earthing up and TPE 0.025 mm for 45 days.

Different weed management treatments tried in this experiment exerted their significant effect of total tuber yield and haulm yield of potato. The maximum total tuber yield was registered under TPE 0.025 mm for 45 days (30.44 t ha^{-1}), which followed by hand weeding twice plus earthing up (29.50 t ha^{-1}) and weed free (28.56 t ha^{-1}). Haulm yield produced maximum in TPE 0.025 mm for 45 days, which was on par with hand weeding twice plus earthing up, weed free and TPE 0.050 mm for 45 days.

Thus, it is concluded that TPE 0.025 mm for 45 days was found effective in controlling weeds as well as producing higher yield and system productivity; and securing maximum net returns, BCR and profitability in groundnut-potato cropping systems, which followed by hand weeding twice plus earthing up and weed free treatment.

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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-POTATO CROP SEQUENCE IN CONJUCTION WITH CULTURAL AND CHEMICAL METHODS OF WEED CONTROL"** submitted by PATEL PRAHLADBHAI PITAMBARDAS in partial fulfillment of the requirements for the award of the degree of **"DOCTOR OF PHILOSOPHY"** in the subject of **AGRONOMY** of the Sardarkrushinagar Dantiwada Agricultural University is a record of bonafide research work carried out by him under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma and other similar title.

(M. M. PATEL)
Major Advisor

Place: Sardarkrushinagar
Date : 9th March, 2007

DECLARATION

This is to certify that the whole of the research work reported in the thesis in partial fulfillment of the requirements for the award of the degree of **DOCTOR OF PHILOSOPHY** in the subject of **AGRONOMY** is the result of investigations done by undersigned under the direct guidance and supervision of **Dr. M. M. PATEL**, Research Scientist, Dry farming Research Station (Arid), Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar and no part of the work has been submitted for any other degree so far.

(P. P. PATEL)

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Date : 9th March, 2007

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I am also indebted to our Director of Research and Dean P.G. for his valuable guidance and ever willing help throughout the course of investigation.

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(P. P. PATEL)

Place: Sardarkrushinagar

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LIST OF ABBREVIATIONS

FYM	:	Farm Yard Manure
@	:	At the rate of
DAP	:	Days After Planting
q	:	Quintal
Fig.	:	Figure
Rs.	:	Rupes
g	:	Gram
%	:	Per cent
N	:	Nitrogen
P, P_2O_5	:	Phosphorus
K, K_2O	:	Potash
NPK	:	Nitrogen, Phosphorus, Potash
kg	:	Kilogram
BCR	:	Benifit : Cost ratio
DAP	:	Diammonium Phosphate
DAS	:	Days After Sowing
cm	:	Centimeter
km	:	Kilometer
mm	:	Millimeter
^0C	:	Degree Celsius
Max.	:	Maximum
Min.	:	Minimum
ha^{-1}	:	Per hecter
No.	:	Number
Viz ;	:	Namely
S. Em $\pm$	:	Standard Error of mean
C.D.	:	Critical Difference
C.V.	:	Coefficient of Variation
et al.	:	et allii ; and others
etc.	:	Et citeras
EC.	:	Electrical Conductivity
dsm^{-1}	:	Decisiemens per meter
t	:	Tonne
TPE	:	Transparent Polyethylene
m^2	:	Square meter
'r'	:	Correlation cofficient

INTRODUCTION

I. INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is the principal oil seed crop and India accounts about 6.86 million hectare area and 5.31 million tones production (CAME,2004). About 91 per cent of the total groundnut area and production are confined to the states of Andhra Pradesh, Gujarat, Karnataka, Tamil Nadu, Maharashtra and Orissa. Gujarat ranks first in groundnut production and grown in area of 19.85 lakhs hectares with an annual production of 18.12 lakhs tones with a productivity of 913 kg ha^{-1} (DAO, 2005).

Groundnut is a rich source of energy, as it contains 40-54 per cent of edible oil, 22-32 per cent of protein, besides carbohydrates and obviously the main stay of the vegetable fat economy of the country. Kernels are also widely acknowledged as the chief and rich source of vegetable proteins.

In India, about 80.1 per cent of groundnut is grown in *kharif* season as rainfed (Patil, 2003). The productivity of *kharif* season is low as compared to the global average might be due to larger area falls under rainfed cultivation and also poor management practices. Yet, there is a scope for increasing productivity by agronomic manipulation, which is essential to meet the demand of ever increasing human population.

Stepping up food production the country involves more intensive cropping resulting in the problem of weed growth, insect pests and diseases. Weeds by their manifold effects harmful on the growing crop plants and interference with land uses were ranked as prime enemies in the crop production. Of the total loss of agricultural produce from various pests in India, weeds alone account for 33 per cent of the yield loss (Bhan and Singh, 1993).

Groundnut being a rainy season crop is seriously invaded by luxuriant growth of variety of weeds and this biotic stress i.e. weeds is one of the major constraint for poor yield of groundnut crop as they compete with the crop plants for moisture, mineral nutrients and space. The severe crop weed competition results in reduction of yield to the tune of 50-70 per cent due to the initial slow

growth of this crop (Bhan *et al*, 1983). The most critical period for crop weed competition is estimated from 45 to 60 days after sowing (Patel *et al*, 1988).

Thus, the crop being a poor competitor especially in early stage is heavily infested by weeds that reduce the yield drastically. Therefore, the control of weeds at proper stage of growth is considered very essential for reducing losses and increasing production. Several measures are adopted for controlling the undue pressure from weeds. Cultural as well as mechanical practices for weeding though effective and commonly used in India, but it is expensive, time consuming, not feasible in all situations, there is always chance of regeneration of weeds and also hinders peg penetration and pod development in groundnut. This created scope for using herbicide in groundnut (Naidu *et al*, 1982). Use of herbicide for controlling weeds is very effective and economical, but due to associated residue hazard, damage on non target organism, evaluation of resistant biotype and polluting the ecosystem have necessitated for the development of alternate non hazardous means of weed management. Moreover, there has been a growing apprehension among ecologists about use of chemicals and recently there was a significant consumer demands for food without chemicals such as organic food.

Innovative approaches to control the pest including weeds are in great demand around the world, particularly those which are cost effective and less harmful to environment. Recently, a new non hazardous method for soil disinfection and solar heating of soil was first described by Katan and co-workers in Israel in 1976. Soil solarization (SS) is a process of hydro thermal disinfections accomplished by covering moist soil with transparent polyethylene (TPE) film during hot summer months. It has several distinct advantages like non hazardous, user friendly environmentally safe and effective on a wide range of pests including soil borne fungi, bacteria, nematodes and weeds. It is a technique of soil preparation before planting/sowing has claimed to be effective and non chemical approach for improving soil and plant health, growth and yields of crop plants (Chen and Katan, 1980; Stapleton and Devay, 1984).

The probable mechanisms involved in the weed control process using soil heating (Rubin and Benjamin, 1984) are:

1. Direct thermal killing of germinating or even dormant seeds;
2. Thermal breaking of seed dormancy followed by thermal killing;
3. Thermally induced changes in CO_2/O_2, ethylene and other volatiles which are involved in seed dormancy release followed by thermal killing;
4. Direct effect of high temperature interacting with toxic volatiles released from decomposing organic matter or seed metabolism;
5. Indirect effects via microbial attack of seeds weakened by sub-lethal temperature.

Beneficial effects of such practices on the control of weeds and other pests with consequent enhancement in crop yields are reported elsewhere, but long term effects extending one or more than one growing season or in succeeding crop is scare. India with a tropical climate having abundant sunshine provides excellent opportunities for soil solarization.

Groundnut-potato-bajra (summer) is the popular crop sequence in surrounding Deesa of the North Gujarat. This sequence is a recommended practice for North Gujarat Agro-climatic zone to secure higher yields as well as net returns than other crop sequences (AGRESCO, 1991). The information on weed control in *kharif* groundnut-potato crop sequence under North Gujarat Agro-climatic condition through soil solarization is not available. By keeping these views, a systematic research work was carried out to determine the efficacy of soil solarization on weed control in *kharif* groundnut and its aftermath effects on *rabi* potato crop. In view of the paucity of adequate research for above crop sequence the present investigation entitled **"Effect of soil solarization on weed control, growth and yield of groundnut –potato sequence in conjunction with cultural and chemical methods of weed control"** was conducted at Agronomy Instructional Farm, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University,

Sardarkrushinagar during the year 2003-04 and 2004-05 with the following objectives.

1. To evaluate the effect of soil solarization on control of weeds and the growth and yield of groundnut and its aftermath effect on potato grown in sequence;
2. To study the effect of soil solarization on physical, chemical and biological properties of soil ;
3. To determine the content of nutrients in groundnut haulm and weeds in groundnut ;
4. To work out comparative economics of different weed management practices.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

Several methods employed for weed management in groundnut and potato crop are depending upon the resources and prevailing conditions of the area. In recent years, much more emphases are placed on development of non-chemical methods of weed control to minimize cost prohibitive input like labour as well as usage of herbicide causing pollution. Soil solarization is more feasible practice for weed management especially in nursery raising, however, long term effects extending for one or more than one growing season is scare. Efforts are, therefore, made here to review various studies carried out in India and abroad more or less related to the present investigation. The review has been highlighted in respect of following aspects.

2.1 Effect of soil solarization

2.1.1 Effect of soil solarization on soil temperature

2.1.2 Effect of soil solarization on soil moisture

2.1.3 Effect of soil solarization on chemical changes in soil

2.1.4 Effect of soil solarization on biological changes in soil i.e Microbial population

2.1.5 Effect of soil solarization on weed control

2.1.6 Effect of soil solarization on crop growth and yield

2.2 Effect of cultural method on weed control

2.3 Effect of chemical method on weed control

2.1 Effect of soil solarization

Use of polyethylene as a mulch is not new to agriculture but has been historically used as a post planting treatment. Black polyethylene sheets are widely used to obtain good weed control amongst other things. However, solarization is different in sense that clear polyethylene films are used as pre-planting treatment. Soil solarization as a pre-planting soil treatment to control

soil borne pathogens and weeds, was first described in 1976 by Katan and Co-worker in Israel. This involves mulching of the soil with clear plastic films so as to trap the solar heat in the surface soil. The resultant temperature increase would be lethal to soil pathogens, nematodes, weeds etc. Hence, this technique has been termed as solar sterilization, solar heating of the soil, or solar pasteurization, plastic or polyethylene mulching or tarping since 1976, but soil solarization is widely accepted and concise. The common mulch for this purpose is transparent polyethylene (TPE) and in some cases polyvinyl chloride. The term, soil solarization (SS) is a hydrothermal process, which brings about thermal and other physical, chemical and biological changes in the moist soil during and even after mulching (Stapelaton and Devay, 1986). This approach to killing weed seeds and propagules seems to have greater potential in tropical and sub tropical regions, where air temperature goes up to 45^0C during summer months.

2.1.1 Effect of soil solarization on soil temperature

Mulching of soil with polyethylene sheet increases the soil temperature and is one of the most prominent physical changes that occur in the soil. Maximum temperatures in upper soil layers under ideal conditions are achieved within 3-4 days after solarization begins (Mahrer, 1979). The upper 15-30 cm of soil show diurnal temperature changes influenced by day and night air temperatures. Typical maximal soil temperatures in solarization plots at 5 cm depth were 8 to 12 ^{0}C higher than in corresponding non solarized plots (Chen and Katan, 1980).In India, Yaduraju (1993) reported that soil solarization process would raise the surface soil temperatures by 8 to 12 ^{0}C as compared to non solarized soil.

2.1.1.1 Effect of soil solarization on soil temperature maxima

The lethal level of soil temperature under transparent polyethylene (TPE) sheet is said to be responsible for soil disinfections. TPE sheet transmits solar radiation and reduces heat convection, water evaporation and transmission of long wave's radiation in the atmosphere, as a results soil temperature raises due to green house effect (Katan, 1980). He, further reported that in mulched soil, heat flows in the cyclic fashion, which means the heat is stored in day time and is lost again at night.

Rise in soil temperature varied depending on the locations, seasons and depths of soil. At Rehorat, Israel, typical maximal temperature at 5 cm in polyethylene mulched plots was 50 ^{0}C (Katan, 1981) and same was 56 ^{0}C at Shean valley of Israel (Jacobsohn *et al.*, 1980).

It is a proven feature that with increases in depth of soil the maximal soil temperature attained through solarization decreases. At Jerusalem, it was observed that soil temperature at surface increased to 56 ^{0}C by solarization and that the pattern of temperature rise at 5 cm closely followed that at the surface (Jacobsohn *et al.*, 1980).

Regarding the season of the year during which effective solarization occurs, Katan(1981) recommended that it should be carried out during intensive solar radiation. Horowitz *et al.* (1983) reported that in Israel, solar heating in three seasons starting in May, September and January increased the soil temperature to 45.3 ^{0}C, 41.9 ^{0}C and 27.7 ^{0}C, respectively. Soil temperature gradually increases after sunrise and reaches a peak in early afternoon followed by cooling until next sunrise (Rubin and Benjamin, 1984).

Soil solarization has been attempted at Delhi, India, at other times of the year by Khandar and Bhowmik (1990) and they observed that soil temperature at 5 cm in mulched plots were 51.7 ^{0}C, 54.4 ^{0}C and 36.5 ^{0}C, during trials conducted in March-May, May-June and January-March, respectively.

The extent of increase in soil temperature upon solarization varied with soil depth and location. Typical temperature rise of 7 ^{0}C at Giza, Egypt (Osman and Sohab, 1983); 10-18 ^{0}C in Israel (Rubin and Benjamin, 1983); 10-12 ^{0}C at Davis, USA (Stapleton et al. 1985); 8.7 ^{0}C at Medlands, Australia (Kaewruang *et al.* 1989) and **in India** 5-12^{0}C at CAZRI, Jodhpur (Lodha and Vaidhya, 1990); at Anand, 6.6 ^{0}C (Patel *et al.* 1991) and 6.4 ^{0}C (Patel, 1994); at Dharwad, 13.8 ^{0}C (Emani, 1991), 10-13 ^{0}C (Habeeburrahaman, 1992), 4.2-8.9 ^{0}C (Chittapur, 1998) and 9.5 ^{0}C (Mudalagiriyappa, 1999a); at Bangalore, 11.5-12.7 ^{0}C (Lalitha, 1999) and 8-12^{0}C (Kiran Kumar *et al.* 2003b); 8-12^{0}C at NRCWS, Jabalpur,(Yaduraju, 1993 and Singh *et al.* 2000); 8.3 ^{0}C at S.K.Nagar, Gujarat (Desai and Dange, 2003); 8 ^{0}C at Annamalainagar, T.N. (Sundari and Sureshkumar, 2003) and 10-12 ^{0}C at Pantnagar (Arora, 2004) have been reported due to soil solarization with transparent polyethylene sheet over non-solarized plot in the hot summer months.

The time required for the attainment of maximum temperature at various depths was also found to vary. Kaewruang *et al.* (1989) reported that temperature reached maximum in upper layer (10 cm) within four to five days but it took five to six days to attain the peak at lower depth (20-45 cm).

An experiment was conducted at College of Agriculture, Dharwad by Chittapur (1998). The results revealed that average temperatures in black clay loam soil in the top 100 mm soil under TPE ranged from 38.3 ^{0}C to 51.8 ^{0}C as against 34.1 to 42.9 ^{0}C with non solarized soils. Further, he also reported higher temperature maxima of 39.8 to 50.6 ^{0}C when polyethylene was in close contact with soil. Rise in soil temperature dropped as the distance between the two surfaces increased. A minimum rise of 36.1 to 46.9 ^{0}C was noticed when 50 mm vertical gap existed between polyethylene surface and soil. Thus, it can be stated that the vertical distance between the soil surface and polyethylene cover significantly influenced the soil temperature maxima.

Lalitha *et al.* (2000). recorded that the soil temperature was significantly higher in soil solarization for 45 days with TPE 0.05 mm (50.9 and 47.7 ^{0}C) as compared to non solarized (39.3 and 35.0 ^{0}C) at 5 and 10 cm soil depths.

A field experiment was conducted at Banglore during 1999-2000 and 2000-2001 to study the effect of SS on weed growth in succeeding *kharif* season sunflower crop and resultant influence on the yield of crop by Chandrakumar *et al.* (2002). From the results, they reported that the increase in soil temperature was 6.0 to 10.4 ^{0}C and 5.0 to 9.4 ^{0}C with 0.05 and 0.10 mm TPE sheets, respectively ,over control when solarization done for 20 to 60 days.

A study was undertaken at the Agricultural College Farm, Department of Agronomy, Bapatla (A.P.) during 2000 on clayey soil by Sumachandrika *et al.* (2003) to study the effect of SS in black gram crop and they reported that soil temperature at 5 cm depth was higher due to solarization in comparison to check. Soil temperature due to 0.05 mm and 0.1 mm thick sheet was 41.0 ^{0}C and 37.7 ^{0}C, respectively and it was 31.5 ^{0}C when no solarization was done.

An investigation was undertaken at the National Research Centre for Weed Science, Jabalpur (M.P) to determine the effect of solarization on weed in succeeding wheat crop after soybean during 1998-99 and 1999-2000 on clay loam soil (Singh *et al.*, 2003). Results revealed that mean maximum soil temperature in mulching with 0.1 mm TPE was recorded 56.4 ^{0}C at surface, 53.6 ^{0}C at 5 cm, 44.3 ^{0}C at 10 cm and 39.4 ^{0}C at 15 cm soil depth which were higher than non solarized plots by 10.2, 9.4, 5.1 and 3.4 ^{0}C, respectively. The maximum soil temperatures observed at different depth of soil and locations in India as well as abroad under TPE are presented here under.

Table : The extent of increase in soil temperature (maximum temperature, ^{0}C) at various locations in India and in the world (at different depth of soils) due to solarization

Sr. No.	Location	Depth of soil (cm)	Maximum soil temperature (^{0}C)	References
A.	**India**			
1.	Salem (Tamil Nadu)	5	44.1	Shivkumar and Marimuthu, (1987)
2.	Varanasi (Uttar Pradesh)	1	54.0	Dwivedi and Dubey, (1987)
		30	44	
3.	Jodhpur (Rajasthan)	5	58.0	Lodha *et al.* (1991)
4.	Dharwad (Karnataka)	5	53.0	Habeeburrahaman and Hosmani, (1996); Chittapur, (2002)
5.	Bangalore (Karnataka)	5	53.1	Lalitha, (1999)
		10	50.7	
		5	48.5	Mudalagiriyappa, (1998)
		10	45.1	
		5	52.8	Basavaraj, (1998)
		10	49.6	
		5	54.8	Kiran Kumar *et al.* (2003)
6.	Anand (Gujarat)	5	60.5	Patel, (1994)
	S.K.Nagar (Gujarat)	10	53.29	Desai and Dange (2003)
7.	New Delhi	5	53.0	Arora, (1998)
8.	Hyderabad (A.P.)	5	53.4	Chauhan *et al.* (1988)
		10	46.6	
		15	38.3	
9.	Jabalpur (MP)	5	49.5	Singh and Yaduraju, (2004)
		15	35.0	
B.	**USA**			
	Stoneville	1	60.0	Egley (1983)
	Lousiana	1	56.0	Standifer *et al.* (1984)
	Texas	2	58.0	Hartiz *el al,* (1985)
		5	53.0	
		10	46.0	
		20	38.0	
		30	36.0	
	Aberdeen	15	41.0	Davis and Sorenson (1986)
	California	-	69.0	Stapleton *el al.* (1997)

C	**Italy**			
	Naples	5	57.0	Aloi and Noviello (1982)
		10	45.0	
	Torino	5	48.0	Garibaldi (1987)
		6	48.0	Tamietti and Garibaldi (1989)
		24	35.6	
D.	**Israel**			
	Shean valley	5	56.0	Jacobsohn *et al.* (1980)
	Bet-Dagon	5	53.0	Katan *el al.* (1983)
		10	45.0	Meron *et al.* (1989)
		30	38.5	
		10	46.0	Sztejnberg *et al.*(1987)
		30	38.0	
		50	37.0	
E	**Germany**			
	S. Germany	5	44.0	Braun *et al.* (1987)
	Gottingen	5	52.0	Tokgonul *et al.* (1997)
		10	46.0	
		15	43.0	
		30	39.0	
F.	**Japan**	10	41.5	Fukul *et al.* (1981)
	Nara Agri. Experiment Staion	5	47.0	Kodama and Fukul (1982)
		10	39.9	
G.	**Pakistan**	0-10	39.2	Ahmed *et al.* (1996)
		10-20	34.3	
		20-30	30.6	
H.	**Hawai**	5	44.0	Regone and Wilson (1988)
		15	35.0	
		30	33.0	
I.	**Sudan**	5	58.0	Braun *et al.* (1988)
J.	Lebanon- Beirut	5	53.0	Sobh and Abou Jawadah (1997)
		15	48.0	
		25	48.0	
K.	Syria -Tel Hadya	5	52-57	Sauerborn *et al.* (1989)

2.1.1.2 Effect of type of polyethylene on temperature maxima

When plastic mulches came into use, black polyethylene films were used for solar heating. Katan *et al.* (1976) have opened a new approach for solar heating by using transparent polyethylene film. The various experiments

conducted have proved efficiency of transparent polyethylene over black and or thin over thick transparent polyethylene in increasing the soil temperature.

Katan (1981) recommended transparent polyethylene for effective solar heating of soil. Under Israel condition, higher soil temperature and better residual weed control effects were obtained with transparent polyethylene than with black plastic. A maximum soil temperature at a depth of 5 cm was increased on an average by 9.3 ^{0}C for black and 17 to 19 ^{0}C for transparent plastic (Horowitz *et al.*, 1983). Mulching of wet soil with transparent polyethylene led to an increase in the soil temperature of the upper layer by 10-18 ^{0}C. But use of black polyethylene caused a significant decrease in soil temperature elevation (Rubin and Benjamin, 1983).

In Salem district, Tamil Nadu, maximum soil temperature recorded in bed covered with transparent polyethylene was 44.1 ^{0}C, followed by 39.6 ^{0}C under black polyethylene mulch as against 37.5 ^{0}C in uncovered plots (Shivakumar and Marimuthu, 1987). Similarly in South West Mexico soil temperature at 23 cm depth reached 49 ^{0}C under transparent film, 41 ^{0}C under black film and 38 ^{0}C with no film (Stapleton and Garza-Lopez, 1988). Soil temperatures, at 15-23 cm depth usually were raised by 10-18 ^{0}C under transparent and 8-12 ^{0}C under black film mulching.

Black polyethylene containing carbon absorbs solar radiation and thus reduces the heating of soil by several degree celsius (De vay, 1991). While studying the effect of solarization in bidi tobacco nursery on loamy sand soil Patel *et al.* (1991b) at Bidi Tobacco Research Station, Gujarat Agricultural University, Anand observed that tarping on wet soil with clear LDPE film increased the temperature by 6.6 ^{0}C at 5 cm depth among different type of plastic.

At Agriculture College, Dharwad (Karnataka), Habeeburrahaman (1992) observed a rise in temperature by 10 to 13 ^{0}C with transparent polyethylene as against 3.5 ^{0}C with black polyethylene. Meti and Hosmani (1994) conducted an experiment during May-June, 1991 at Agricultural Research Station, Nipani

(Karnataka). They found that the highest soil temperature was recorded 53 ^{0}C in transparent PE, while in black PE the temperature recorded was 44 ^{0}C. This indicated that an increase of soil temperature under mulching depends on different type of PE. Patel (1994) showed significant variation due to different type of PE. The 0.025 mm TPE showed significantly higher soil temperature (58.33 ^{0}C) than 0.025 mm black polyethylene (55.22 ^{0}C) at 5 cm depth of soil.

While studying the effect of SS by different type of PE during 1995 at Agriculture University Farm, Dharwad on red soil, Biradar *et al.* (1997) observed that the maximum soil temperature under by TPE and BPE in wet soil was reached to 54 ^{0}C and 42.3 ^{0}C, respectively, on a day of maximum air temperature.

The average temperature in black clay loam in the top 100 mm soil depth under transparent polyethylene ranged from 38.3 ^{0}C to 51.8 ^{0}C as against 35.4 ^{0}C to 42.9 ^{0}C with non-solarized soil (Chittapur, 2002).

A field investigation was carried out at University of Agricultural Sciences, Bangalore, during 1995 and 1996 by Mudalagiriyappa *et al.* (1999a) to study the effect of SS on weed growth and yield of groundnut. The increases in soil temperature due to TPE and BPE were 9.5 ^{0}C and 3.4 ^{0}C, respectively over control. Nanjappa *et al* (2005) reported that soil temperature due to SS for 45 days with TPE 0.05 mm used twice (49.1 ^{0}C and 45.7 ^{0}C) and TPE 0.10 mm twice (48.6 ^{0}C and 45.0 ^{0}C) at 5 and 10 cm depth, respectively was higher compared to weedy check (36.4 ^{0}C and 32.8 ^{0}C).

2.1.1.3 Effect of thickness of TPE on soil temperature

Horowitz *et al.* (1983) reported higher temperature with 0.03 mm polyethylene sheet than 0.1 mm transparent sheet. In Israel, higher soil temperature of 53 ^{0}C was recorded with thin TPE (0.04 mm) by Katan *et al.* (1983). Solar heating of soil with thin (50 μm) transparent polyethylene led to an increase in soil temperature maxima by 7 ^{0}C at Giza, Egypt (Osman and Sohab, 1983). Mulching wet soil with thin TPE (0.04-0.05 mm) increased soil

temperature by 10 to 18 ^{0}C over control whereas, thick TPE recorded low temperature rise (Rubin and Benjamin, 1983). Steplaton and Devay (1986) recorded that thinner film (19 -25 µm) was more effective in solar heating than thicker (50-100 µm) and are proportionally less expensive. At CAZRI, Jodhpur (Rajasthan), solarization with thin transparent polyethylene (50 µm) raised soil temperature to 58 ^{0}C (Lodha, 1989).

Mudalgiriyappa *et al.* (1999a) conducted an experiment during 1995 and 1996 at Main Research Station, Hebbal, University of Agricultural Sciences, Bangalore on sandy loam soil. The results on soil temperature revealed that high soil temperature was achieved by SS through different thickness of TPE. Higher soil temperature observed in 0.050 mm and 0.075 mm TPE were 9.5 ^{0}C and 8.8 ^{0}C for 45 days tarping, respectively as compared to control..

Lalitha *et al* (2000) conducted an experiment at Agronomy Field Unit, Main Research Station, Hebbal, University of Agricultural Sciences, Bangalore on sandy loam soil during 1997-98. The data on soil temperature indicated that the soil temperature significantly higher (50.9 and 47.7 ^{0}C) at 5 cm and 10 cm depth due to SS with TPE 0.05 mm than control (39.3 and 35.0 ^{0}C, respectively).

An investigation was carried out at Main Research Station, Hebbal, University of Agricultural Sciences, Bangalore on sandy loam soil during 1998 by Kiran Kumar *et al.* (2003 b) and recorded 54.84 ^{0}C soil temperature with TPE 0.05 mm during April followed by 0.1 mm.

A field experiment was conducted during 2000 at the Agricultural College Farm, Department of Agronomy, Bapatla (A.P.) on clayey soil by Sumachandrika *et al.* (2003) to study the effect of SS in black gram crop and they reported that soil temperature at 5 cm depth was higher due to solarization in comparison to check. Soil temperature observed due to 0.05 mm and 0.1 mm thick sheet were 41.0 ^{0}C and 37.7 ^{0}C, respectively and 31.5 ^{0}C was recorded under no solarization.

An investigation was undertaken at the National Research Centre for Weed Science, Jabalpur (M.P) to determine the effect of solarization on weed in

succeeding wheat crop after soybean during 1998-99 and 1999-2000 on clay loam soil (Singh *et al.*, 2003). Results revealed that mean maximum soil temperature in mulching with 0.1 mm TPE was recorded 56.4 ^{0}C at surface, 53.6 ^{0}C at 5 cm, 44.3 ^{0}C at 10 cm and 39.4 ^{0}C at 15 cm soil depth which were higher than non solarized plots by 10.2, 9.4, 5.1 and 3.4 ^{0}C, respectively.

Thus, for effective solar heating to soil, polyethylene should be thinnest possible (25-30 μm) due to its better radiation transmittance and cost effectiveness than thicker one. Low density polyethylene sheets are widely used for solar heating because of their flexibility, tensile strength and resistance to puncture and tearing. However, the thinner the mulch, the faster it deteriorates. Very thin polyethylene mulches deteriorated within 6 weeks of solarization.

From above review, it is generalized that soil solarization during summer months resulted in higher soil temperature maxima compared to non-solarized condition. The magnitude of rise in temperature varied with location, seasons, soils, nature, type as well as thickness of polyethylene and duration of solarization. Generally, thinner transparent polyethylene placed close to surface of wet soil retained more of thermal energy to greater depths compared to thick transparent or black polyethylene. Surface soil (0-5 cm) with higher temperature regimes is subjected for greater diurnal variation than deeper layer of soil.

2.1.2 Effect of soil solarization on soil moisture

Adequate soil moisture during soil solarization should be maintained to increase thermal sensitivity of over wintering structures and also to improve heat conduction and stimulation of biological and metabolic process in soil (Katan, 1981).

Nasr-Esfahani (1993) reported the measurement of soil moisture at the expiry of solarization durations (30 and 45 days) and stated that polyethylene mulching prevented the loss of moisture from soil. While there was a loss to the extent of 61.1 to 66.7 per cent in non solarized soils over the initial moisture

content and the loss of soil moisture in solarized soil ranged only from 8.6 to 18.2 per cent.

Arora (1998) reported that all the solarized treatment retained higher soil moisture as compared to control at 0-15 and 15-30 cm depth of soil. But there was no significant difference of polyethylene sheet mulch. Same results were reported by Basavaraj (1998) at Honnaville, Shimoga, Karnataka.

Lalitha *et al.* (2001) reported that all the SS treatments with TPE 0.05 mm [illegible] for 45 days retained higher soil moisture (13 and 14 per cent) at 0-15 cm and 15-30 cm soil depth, respectively over non solarized (8.4 and 10.2 per cent) control. Variation due to SS in different depths was only 5.65 per cent but it was 27.75 per cent in control in both the soil depths.

Moisture contents after SS and per cent loss of moisture over initial moisture content were computed by Khulbe (2000). It is clear from the observations that loss of moisture from mulched soil was very low as compared to non solarized soil. In general, 10-25 per cent moisture loss was observed from mulched soil, but it was above 50-60 per cent in unmulched soil. Same results on moisture content with SS were also reported by Arora (2004) at Pantnagar (Uttranchal).

From above review, it can be generalized that soil solarization retained higher soil moisture compared to control at 0 - 15 and 15-30 cm depth of soil. But, there was no significant difference of the polyethylene mulch.

2.1.3 Effect of soil solarization on chemical changes in soil

Soil mulched with TPE has frequently been reported to contain higher level of soluble mineral nutrients. Chen and Katan (1980) while studying on SS in Israel reported that saturated extracts of the upper soil layer of eight different solar heated soils showed increased concentrations of soluble organic matter and minerals. The greatest increase was observed in NO_3 concentrations. NH_4^+, K^+, $Ca^{++} + Mg^{++}$ and Cl^- were also found to increase. While changes in soil reaction,

total organic matter, $NaHCO_3$, extractable phosphorus and hydraulic conductivity were marginal or inconsistent.

Stapleton and De Vay (1986) reported that summer solarization on six wet soils of four different textures increased concentration of NO_3^-N and NH_4^+-N upto six times then those in non treated soils. Concentration of Phosphorus, K^+, Ca^{++}, Mg^{++} and electric conductivity increased in some of the solarized soil, however, other micronutrients (Fe^{++}, Mn^{++}, Zn^{++}, Cu^{++}) were not increased. Concentration of mineral nutrients in wet soils covered with TPE films but insulated against solar heating were the same as those in non-treated soil. However, no significant differences in the levels of extractable nitrate and sulphate were observed at Canterburry, Newzeland(Haynes,1987).

Kaewrung *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^{++} and organic carbon. NO_3 -N was increased by solarization up to 30 cm depth, but NH_4^+-N was unaffected at any depth at ICRISAT, Hyderabad, India (Chauhan *et al.*, 1988). Daelemans (1989) studied that soil tarping with addition of organic matter revealed that the average total mineral nitrogen content was higher in the tarped plots than in the uncovered ones. There was an increase in NO_3^-N and NH_4^+-N, but organic carbon content was not altered at New Delhi (Yaduraju 1993).

El-Shami (1990) studied the effect of SS with TPE on soil properties in some Egyptian soils. He found that soil texture and N content were not affected by mulching, but Mn, Mg and Cu contents were increased, while Fe, Zn and P contents were decreased.

Patel (1994) reported that organic carbon and total P_2O_5 contents were not increased but total N and total K_2O were significantly increased due to solarization treatments under sandy loam soil. More over, he also observed that Fe, Mn and Cu were significantly increased under solarized soil.

Patel and Patel (1997) reported that pH and EC of sandy loam soil were significantly decreased, while organic matter content (per cent) was significantly increased to the extent of about 67 per cent in solarized soil. Similarly they also reported that total N, available N, P_2O_5 and K_2O were also significantly increased under solarized soil as compared to non solarized soil.

While studying in different soil types and nutrients sources, it has been observed by Yaduraju and Kamra (1997) that the increase in levels of soil nutrients are transient and do not persist long. Therefore, increase in growth response (IGR) following SS is likely to result from reductions of major factors limiting plant growth such as fungal or bacterial pathogens, nematodes soil borne insects or weeds rather than increased mineral nutrient availability.

Arora (1998) reported from New Delhi, India that solarization treatment with polyethylene sheet significantly increase 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 increase in K and EC. Organic carbon content and pH did not vary due to different treatments.

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

A field experiment was conducted at the Main Research Station, Hebbal, University of Agrilcultural Sciences, Bangalore during 1995-1996 and 1996-97 by Mudalagiriyappa *et al.* (1999c) to study the effect of SS on soil properties, growth and yield of groundnut. Results showed that the content of soil nitrate nitrogen and available phosphorus were significantly differed among the treatments. Covering soil with transparent polyethylene of 0.075 mm for 45 days recorded significantly higher nitrate nitrogen (25.25 kg ha^{-1}) which was at par with TPE 0.05 mm (24.54 kg ha^{-1}). These treatments recorded 7.80 kg more nitrate N content than control. Similarly, the available phosphorus content was

significantly higher under TP of 0.05 mm for 45 days (36.55 kg ha^{-1}) than control (32.0 kg ha^{-1}).

Lalitha (1999) reported from Bangalore that soil solarization treatment with 0.05 mm TPE for 45 days reduced the content of organic carbon and sulphur. However, the level of available N, P_2O_5, K_2O, exchangeable Ca, Mg and Na was enhanced over non solarized control.

Khulbe (2000) conducted an experiment at Pantnagar during 1998 and 1999. The study indicated that there is no change in soil pH, but EC was improved significantly. Levels of available phosphorus and potash per hectare did not change. Though, organic carbon also did not change, but total nitrogen increased significantly to the tune of 80 per cent, due to SS.

Kiran Kumar *et al.* (2003) observed that maximum uptake of N, P and K was registered by the crop with the TPE 0.05 mm during April and was the least in the controlled plots after the harvest of the crop and removal of the weeds. Similar trend was observed in case of available soil nutrient status after crop harvest.

Based on the above review, it can be inferred that solarization with transparent polyethylene increased the total N, NO_3–N, NH_4-N, K, Ca, Mg, Na, Cl, Mn, Fe and Cu whereas, organic carbon, sulphur and Zn were decreased while, P was found variable in solarized soil. SS also enhanced the availability of most of nutrients in soil, ultimately, resulting in increased plant growth response in many crop plants.

2.1.4 Effect of soil solarization on biological changes in soil i.e Microbial population

In comparison to most other methods of soil disinfections, the effect of solarization was selective on microorganisms but it is sufficient to mention that the shift in the micro-biota in the soil following solarization is in favour of antagonists.

Solarization had no effect on the association between *Rhizobium* and groundnut roots (Grinstein *et al.*, 1979). Sufficient population of *Rhizobium spp.* required for nodulation on bean roots was survived by solarization in Israel (Katan, 1981).

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

At Varanasi, there was a reduction in total fungi at depth of 0 to 10 cm in solarized soils. Though, it was found to increase when the solarized plots were under the shade (Dwivedi and Dubey, 1987). At ICRISAT, Hyderabad, it was noticed that solarization did not affect rhizobial population or nodulation either in pigeon pea or chickpea crop (Arora, 1998).

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 0-10 cm (3.2 folds) and also increased the population of actinomycetes (1.2 folds) at both depths, (Kaewrang *et al.*, 1989). While, at Colima, Mexico along with fungi the bacterial population was reduced by 60 to 100 per cent in soil solarization plots (Stapleton, 1991).

Chaube and Singh (1991) reported that total fungal population in 45 days solarized soil was ranged from 8.22 to 12.25 X 10^3 per gram of soil as against 82.55 X 10^3 per gram in non solarized soil at Pantnagar.

Lodha *et al.* (1991) reported that the population of total fungi decreased at 5 cm soil depths, therefore only few species of *Aspergillus* and *Penicillium* could

be recorded in the final counts. However, there was manifold increase in total bacterial population for all the depths. Population of all actinomycetes increased initially, but in final counts disappeared. At Dharwad, Habeeburrahaman (1992) reported to increase the population of actinomycetes by 1.2 fold.

Patel and Patel (1998) observed suppression of total fungi and bacterial population with and without host in bidi tobacco nursery. However, rhizobium population was tremendously increased in solarized soil at 86 days after planting of bidi tobacco.

A field experiment was conducted at the Main Research Station, Hebbal, UAS, Bangalore during 1995-96 and 1996-97 by Mudalagiriyappa *et al.* (1999 c). The data on microbial population revealed that the variation in the fungal and bacterial population was observed. Among the various treatments, covering TPE 0.05 mm for 45 days caused significant reduction (53.8 per cent) in fungal population. Bacterial population was more in case of TPE of 0.075 mm and TPE of 0.05 mm for 45 days but at par with control. However, the bacterial population was significantly reduced in TPE of 0.05 mm for 15 days. The population of actinomycetes was not affected due to various soil solarization treatments.

Lalitha (1999) recorded the population on total fungi and bacteria which were affected due to SS. The treatment TPE 0.05 mm for 45 days had significantly lesser number of fungi (7.2×10^4). All the SS treatments recorded significantly less fungal population compared to control. SS did not have significant influence on total bacteria and actinomycetes.

Khulbe (2000) conducted an experiment during 1998 and 1999 at Pantnagar, revealed that population of total fungi declined 70 to 80 per cent sharply, when estimated after 30 days SS and raising first nursery, the population recovered steadily and reduction reached below 50 per cent and then increased by 20 to 30 per cent. Like fungi, total bacteria too, declined sharply after SS but recovery was increased up to 70 per cent over initial count. Transparent

polyethylene had significant effect on microorganisms, while white and red were distinctly superior over black.

Desai and Dange (2003) reported that SS with 25 micron TPE for three weeks during hot summer season reduced the population of *Fuzarium oxysporum* f. sp. Ricinin by 67.25 per cent as compared to non solarized treatment at S.K.Nagar (Gujarat).

While studying the effect of soil solarization during 1999 in vegetable nurseries, Arora, (2004) at Vegetable Research Center, GBPAUT, Pantnagar observed that TPE for eight weeks significantly reduced the total counts of fungi .The counts ranged from 31 to 56 x 10^3 per g soil in non solarized treatments while in solarized treatments count ranged from 13 to 27 x 10^3 per g soil. SS for eight weeks reduced their total bacterial counts c.f.f. (40 to 61.23 x 10^6 to 70 to 99.56 x 10^6) and actinomycetes count (7.33 x 10^5 to 13.30 x 10^5) by almost 50 per cent just after soil solarization, however, after 30 days i.e: after raising a nursery crop, the estimated population showed significant recovery.

From the above review, it is generalized that soil solarization caused significant reduction in antagonistic micro-organism. Population of total fungi was decreased, whereas total bacteria were increased and actinomycetes were found inconsistent in soil.

2.1.5 Effect of SS on weed control

One of the visible effects of SS is to be reported as control of wide spectrum of weeds. Grinstein *et al.* (1979) were the pioneers to notice control of many weed species including *Portulaca oleracea, Amaranthus retroflexus, Xanthium spinosum and Cynadon dactylon* in peanut followed by Katan *et al.* (1980) who reported decreased weed population due to SS in onion fields.

Katan (1981) reported the potential mechanism of weed control through SS is

(1) Direct killing of weed seeds by heat

(2) Indirect microbial killing of seeds weakened by heating

(3) Killing of seeds stimulated to germinate in the moistened mulch soil

(4) Killing of germinating seeds whose dormancy is broken in the heated soil

(5) Through an effect produced by volatiles accumulating under the plastic trap

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

2.1.5.1. Effect of soil solarization on weed emergence

Due to elevated temperature in soil following soil solarization treatment results in reducing the population of soil borne pathogen, nematodes and weeds.

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

Horowitz *et al.* (1983) reported that two to four weeks of soil solarization was sufficient to control annual weeds and was effective for next one year.

Benjamin and Rubin (1982) reported that SS effectively controlled annual weeds, viz., pigweed, nightshade, slowthistle and several grasses .They also found that the effect of SS on weeds might be due to the combination of the high temperature prevailing in the top soil layer and other factors, such as the volatile and toxic product resulting from rapid organic matter decomposition.

Egley (1983) conducted field experiment on SS on silty clay loam soil by means of transparent PE sheets for the period of 1 to 4 weeks in mid summer at

Stoneville (USA). The results revealed that SS through transparent PE significantly reduced the total weed emergence by 64 to 98 percent of *Amaranthus spp., Ipomea* spp., *Trianthema portulacastrum L* and various grass species. However, purple nutsedge (*Cyperu rotundus* L.) emergence was increased by solarization in some instances.

Elmore (1983) observed that the germination of seeds of D*igitaria sanguinalis*, *Malva palviflora*, *Echinochloa crus-galli*, *Chenopodium album*, *Amaranthus retroflexus* and *Solanum nigrum* were controlled at 4 cm depth by solarization with PE sheets for 4 to 6 weeks period (July to August).

The findings of Bell and Elmore (1984) revealed that SS for 6 weeks period gave complete weed control of *Amarathus albus* and *Portulaca oleracea.*

Rubin and Benjamin (1984) conducted two field experiments on loamy sand soil in Israel and found that solar heating of wet soil obtained by using transparent PE during the hot season. Rhizomes of *Cynadon dactylon* L. and *Sorghum halepense* L. were very sensitive to heat treatment, but tubers of *Cyperus rotundus* L. were able to survive at high temperature and it was recommended that longer period of solarization (up to 10 weeks) required for effective control of these weeds.

Cartia (1985) concluded that use of PE film laid on the surface for 30 to 50 days in summer season increased soil temperature and controlled pest, diseases and weeds i.e. *Chenopodium album, Cynadon dactylon*, *Digitaria. sanguinalis*, *Portulaca oleracea* and *Sorghum halepense*. Maximum benefits of solarization can be obtained when the film should be clear, 0.03 mm thick and soil should be moist and well cultivated.

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 in soil by 90 per cent and emergence by 46 per cent in Germany (Braun *et al.* 1987). They further observed that solarization for 60 or more days decreased weed population by 58 per cent, although control of *cyperus rotundus* was

inconsistent. In this context Emani (1991) recommended solarization for one month with thin TPE and two months with thick TPE at Dharwad.

Effective control of grassy weeds was obtained by solarization for six weeks prior to onion planting in Hawaii and the effect was persistent up to three months (Regone and Wilson, 1988). On the contrary, SS was most effective for controlling of broad leaved weeds than sedges and grasses(Reddy et al.,1998). However, solarization for 9 to 10 weeks was reared 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. Orobanchae dry weight was decreased by 90 per cent in both bean and lentil fields in Northern Syria. Yaduraju and Ahuja (1990) reported that soil solarization reduced the emergence of weeds by 75 per cent in summer which was equivalent to two hand weeding and application of pendimethalin (0.75 to 1.5 kg ha^{-1}). Effective control of grassy weeds in succeeding wheat was observed with solarization. *Cyperus rotandus* and *Melilotus indica*, were however, not controlled by solarization treatment but both were less competitive and did not reduce crop yield in soybean-wheat system.

Abu Irmaileh (1991) obtained Orobanchae free tomato plants with solarization with TPE for 45 days and 72.3 per cent reduction in dry weight of Orobanchae was observed by Linke *et al.* (1991).

Solarization with TPE (0.05mm) reduced the seed emergence of *Ageratum conzyoides*, *Euphorbia hirta* and *Amaranthus spinosis* from 54 to 84 per cent (Habeeburrahaman, 1992). At New Delhi, solarization with TPE for 32 days in cowpea crop decreased the emergence of the dominant weed seeds such as *Dactyloctenim aegypticum, Arachne racemosa and Trianthema monogyna* by over 90 per cent. Mulching for 16 days also decreased weed emergence, but to a lesser extent than the 32 days treatment (Kumar et al., 1993).

In another study conducted in USA, effective control of *Digitaria* and *Echinochloa* was observed by Elmore *et al.* (1993) with solarization for 40-50

days. On a similar way of solarization in bidi tobacco, Meti (1993) reported decrease in Orobanchae number and dry weight due to solarization for 40 days particularly with thin (0.05 mm) TPE at Dharwad

Nasr-Efahani (1993) reported that the population of weed was effectively and significantly reduced with solarization for both the periods of 30 and 45 days with various thickness of polyethylene sheets (20, 250, 300 and 400 micron) during the hottest period from 15 May-30 June, 1988 and 1990. All weeds such as *Chenopodim spp.*, *Cirsum vulgare, Cynodon dactylon, Digitaria sanguinalis, Euphorbia hirta, Echinochloa crusgalli, Portulaca qudarifided* and *Solanum nigrum* were nullified from the soil except *Cyperus rotandus*. There was a reduction of 70-90 per cent in weed population whereas the remaining 10-30 per cent was *Cyperus rotandus* only which was partially affected.

An investigation was conducted to study the effect of soil solarization on weed control of groundnut on the soil of MRS, UAS, Dharwad during *kharif* 1995 by Biradar *et al.* (1997). The results showed that there was a significant reduction in weed count and dry weight of weeds even up to the harvest of groundnut due to soil solarization with TPE 0.05 mm for 60 days in wet soil compared to non solarized soil. TPE of 0.05 mm thickness was superior to that of 0.1 mm thickness.

Economou *et al.* (1997) reported that solarization for a period of one month killed all the weed seeds of *Avena sterlis, Bromus diandrus* and *Sinapsis arvensis* within 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 (Haider and Iskandar, 1997).

A filed experiment was conducted during 1995 and 1996 at MRS, Hebbal, UAS, Bangalore on sandy loam soil by Mudalagiriyappa *et al.* (1999 b) to find out the effect of soil solarization on weed dynamics in *kharif* groundnut. They concluded that significant reduction in monocot (88 to 96 per cent), dicot (81 to 94 per cent) and sedge (30 to 40 per cent) weeds due to solarization was noticed at all the stages in treatment of TPE 0.050 mm for 45 days. Whereas, the

highest weed count of monocot (63.33), dicot (53.50) and sedge (43.33) were recorded by the unweeded check at 60 DAS as well as at other stages.

A field experiment was carried out to study the effect of soil solarization for control of weeds in brinjal and chilli nurseries. The effect of six week soil solarization with 100 μm was greater in controlling broad leaved weeds. There was 100 per cent control of *Parthenium spp.*, *Elucine indica* and *Tribulus terrestris* and up to 96 per cent of *Echnocloa crusgali* (IARI, Annual Report, 2001-2002).

Chandra Kumar *et al.* (2002) reported that there was a significant reduction in weed count and weed dry weight at 40 DAS and at harvest. Soil solarization with TPE 0.05 mm and 0.1 mm for 40 days along with one hand weeding significantly reduced the weed count and weed dry weight at all the stages of crop growth over control. The higher weed control efficiency was also observed in TPE 0.05 mm (78.6 per cent) and 0.1 mm (77.7 per cent) along with one hand weeding over weedy check.

Field experiment was conducted during 2000 and 2001 at, Neyveli by Sundari and Suresh Kumar (2003) and reported that different weed flora i.e. *Cleome viscose, Vernonia cinerea, Corchorus olitorious, Cyperus rotandus* and *Echinochloa colonum* were present predominantly in groundnut. Significant reduction in weed population and least weed biomass (86.32 kg ha^{-1}) was recorded with soil solarization 0.05 mm TPE for 40 days which was on par with weed free check. This treatment recorded the highest weed control efficiency of 91.61 per cent over control at 60 DAS.

The experiment was conducted on sandy loam soils of the Main Research Station, Hebbal, University of Agricultural Sciences, Bangalore during 2000 by Soumya *et al.* (2003). The data on total weed dry weight revealed that there was a significant reduction in weed dry weight due to SS over control. At harvest, TPE 0.05 mm for 45 days + 1 Hand Weeding (5.8 q ha^{-1}) and TPE 0.10 mm for 45 days + 1 Hand Weeding (60.6 q ha^{-1}) recorded significantly lower weed dry weight over other treatments.

A field experiment was conducted at the National Research Centre for Weed Science, Jabalpur during 1998-1999 and 1999-2000 on clay loam soil to study the effect of soil solarization on weeds in succeeding wheat crop after soybean by Singh *et al.* (2003). It was revelaed that the experimental field was infested mainly with *Chenopodium album* (50 per cent), *Cichorium intybus* (18 per cent), *Vicia sativa* (10.3per cent), *Convolvus arvensis* (8.8per cent), *Meidcago hispida* (6.7 per cent) and *Phalaris minor* (6.6 per cent). Soil solarization for a period of five weeks significantly reduced all the weeds except *Convolvus arvensis* and gave 100 per cent control of *Phalaris minor*, 89 per cent of *Cichorium intybus,* 85 per cent of *Vicia sativa* and 77 per cent of *Chenopodium album* and *Meidcago hispida* over non solarized control. Soil solarization for five weeks recorded 68.8 per cent reduction in total weed population and 70.8 per cent reduction in weed dry weight over weedy check.

An investigation was under taken at weed control research project, B.A. College of Agriculture, Anand Agricultural University, Anand to find out the efficiency of SS on weed control in okra-wheat crop sequence in loamy sand soil during 2003-04. Results indicated that the lowest dry weight of weed at 30, 45 DAS and at harvest was recorded in treatment of solarization for 30 days in May-June months than non-solarized treatment. Though, dicot weed at 45 DAS was significantly decreased in solarized than non-solarized in succeeding wheat crop (Agresco report, 2004).

A field investigation was carried out at UAS, Bangalore during 2000-2001 rabi by Soumya *et al.* (2004) to study the residual effect of SS on growth and yield of potato. Results indicated that residual effect of weed free treatment to previous crop recorded minimum number of total weeds (29.69) and was on par with TPE 0.05 mm for 45 days + 1 Hand Weeding (30.00). Significantly higher number of weed was recorded due to weedy check (84.67) whereas, minimum total weed dry weight due to residual effect of treatments to previous crop with TPE 0.05 mm for 45 days + 1 Hand weeding (17.09 g) was recorded and was on par with weed free (17.3 g) as compared to weedy check (40.79 g).

The experiments were conducted by Arora (2004) at Floriculture Block and Vegetable Research Center, College of Agriculture, G. B. Pant University of Agricultural and Technology, Pantnagar during 2003 to study the effect of SS in vegetable nurseries for 8 weeks. He reported that SS alone could reduce the weed population. But integration with organic amendments and bioagents increased the effectivity of SS. All the common species of weeds, dominated by *Ageratum conyzoides, Cynodon dactylon, Chenopodium album* and *Parthenimum* spp. occurring naturally were reduced by 95 to 100 per cent, except *Cyperus rotundus* and *Melilotus* spp. In the latter two weeds the reduction was about 50-70 per cent. In a similar study at Pantnagar (Uttranchal), SS with white-transparent polyethylene sheets for four weeks eliminated above weed species by 82.5 to 100 per cent in onion, cabbage, cauliflower and tomato nurseries (Khulbe, 2000).

An experiment was conducted at WCRS, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh during 2003-04 and 2004-05. Results indicated that the different treatments exerted their significant influence on dry weight of weeds. The treatment comprising soil solarization for 30 days proved its superiority by recording significantly the lowest dry weight of weeds (2278 kg ha^{-1}) than the non solarization treatment (3180 kg ha^{-1}) during 2003 and same trend was observed during 2004 (Agresco report, 2004 and 2005).

Nanjappa *et al.* (2005) reported that SS with TPE 0.05 mm used twice for 45 days had significantly lower weed count and weed dry weight (26.7 m^2 and 6.21 g 0.25 m^2,respectively) as compared to weedy check (86.7 m^2 and 21.5 g 0.25 m^2, respectively).

An experiment was conducted at farmer's field by Haripriya and Kamalakannan (2005) to study the effect of SS with TPE 0.05 mm for 40 days in soybean crop. They recorded the highest weed control efficiency for *Echinochloa colunum* (91.85per cent) for *Cleome viscose* (88.06 per cent) for

Trianthema portulacastrum (87.26 per cent) and for *Commelina benghalensis* (80.90 per cent) in 40 days solarized plot.

2.1.5.2 Effect of soil solarization on weed seed bank

The reserves of dormant weed seeds in agricultural soils provide a source of seed for persistent weed problems that often require repeated measures. A reduction in the number of dormant weed seeds in the soil should also correspondingly reduce weed persistence and weed control requirements. Hence, soil solarization would be desirable as a means of reducing the dormant weed seed reserves in the soil. However, solarization was not found effective to eliminate dormant weed seeds from the germination zone. The treatment killed non-dormant seeds and greatly reduced the number of weed seedlings that other wise would have emerged (Egley, 1983). It was also revealed that solarization for one, two, three and four weeks reduced weed seed emergence by 64, 70, 78 and 98 per cent, respectively.

Horowtiz *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. The depth up to which the weed seeds killed upon soil solarization was also found to vary with weed species. In this regard Standifer *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 *Echinochloa crusgalli* up to three to four cm depth. Only solarization for three weeks reduced germination of *Eleusine indica* and *Amaranthus* spp. up to 5 cm and that of composite weed species up to 20 cm depth. Seed population of P*oa annua was* considerably reduced even up to 20 cm soil depth by two weeks of solarization (Silveria *et al.* 1988).

Seeds of eight weed species (*Xanthium strumarium, Portulaca oleracea, Sorghum halepense, Ipomea locunosa, Sida spinosa, Amranthus retroflexus, Anoda cristat, Abutulon theophrasti*) were tolerant to 60 ^{0}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 (1-12per cent) of most of the weeds survived up to three days at 70°C. Some (4-30 per cent) seeds of weeds survived up to seven days at 60°C. He also observed promoted germination of certain presumably because high temperature broke dormancy of some hard seeds.

Kumar *et al.* (1993) opined that the solarization effect was restricted to the top (0-5 cm) layer of soil. In another study, Rubin and Benjamin (1993) although observed almost complete prevention of emergence of few weed species viz; *Sinapsis arvensis*, *Amaranthus retroflexus* and *Phalaris paradoxa* but rhizomes of *Cynodon dactylon* and *Sorghum halepense* as well as seeds of *Solanum* and *Abutilon* were less susceptible. Apart from eliminating *Sida spinosa* seeds by 94 per cent from the soil, number of viable weeds seeds in soil was also reduced.

In a notable study at NRCWS, Jabalpur (M.P.), Pandey and Singh (1996) suggested potential of reducing weed incidence by accelerated ageing of seeds in soil seed bank as an eco-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 a simple field experiment which showed 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 (GOD) accumulation. Solarization for 30 days killed all the weed seeds burried in both 5 and 10 cm depths of soil weed seed (Economou *et al.* 1997). They proposed modeling based on degree hours (DH) to explain the germination behavior of weed seeds in response to soil temperature.

A filed experiment was conducted at UAS., Bangalore during 1995-96 and 1996-97 on sandy loam soil by Mudulagiriyappa *et al.* (1998). The result revealed that germination of weed seeds differed significantly due to solarization and their interactions. TPE 0.05 and 0.075 mm for 45 days resulted in

significantly reduction in the germination of *Bidens pilosa* (9.87 per cent) and *Borreria hispida* (98.6 per cent). TPE 0.05 mm for 45 days in the lowest germination of *Cyperus rotundus* (30.3 per cent), *Cynodon dactylon* (26.0 per cent), *Dactyloctenium aegyptium* (38.7 per cent) and *Digitaria marginata* (38.2 per cent) in 5 cm depth.

Haider and Sidahmed (2000) reported that solarization in cabbage crop for 2 to 6 weeks alone killed broomrape seeds at soil surface, but had no significant effect on seeds below the surface. Solarization with chicken manure, however, killed broomrape seeds at all depths.

Peachy *et al.* (2001) reported that SS reduced annual blue grass (*Poa annua* L.) seed survival from 89 to 100 per cent in the upper 5 cm depth of soil, but did not reduce survival below 5 cm.

Mahajan *et al.* (2005) conducted an experiment at the experimental station of Department of Soil and Water Engineering, PAU, Ludhiana during 2004. In the study the weeds recorded were i.e. *Trianthema monogyna, Cyperus rotundus, Commelina benghalensis, Eleusine aegyptiacum, Digera arvensis, Digeteria sanguinalis, Echinochloa* spp. but the *Trianthema monogyna* and *Cyperus rotundus* were the the dominent weeds. SS for 35 or 45 days decreased the emergance of *Trianthema monogyna* and other annual weeds by over 90 per cent.

From the above review, it is generalized that SS with thinner transparent polyethylene sheets for 35 to 45 days was more effective in control of weeds and reduced the emergence of buried weed seeds due to high temperature of soil.

2.1.6 Effect of soil solarization on crop growth and yield

Improvement in crop growth and yield performance due to weed control through soil solarization is an undisputedly established fact. As soil polarization has tremendous effect on soil borne pathogen, nematodes and weeds, the treatment enables the crops better to grow and good yield as compared to non solarized field. Good weed control by solarization has been reported by many researchers.

Increase in yield of groundnut by 52 per cent was reported by Grinstein *et al.* (1979) due to solarization as a result of reduction in weeds. Jacohsohn *et al.* (1980) reported that the SS is very effective in controlling the parasitic weed *orobanche* and 78 t/ha yield of carrot was obtained from solarized plots while no yield was obtained from the non solarized plot. Katan *et al.* (1980) observed improved plant stand, growth and yield by 100 to 125 per cent of onion by solarization due to decreased incidence of weeds and certain soil borne fungal pathogen.

Field experiments were conducted during summer season of 1979 and 1980 on loamy sand soils in Israel by Rubin and Benjamin (1983). The results revealed that solar heating with TPE improved plant growth and increased the yield of wheat and turnip than control. Elmore and Heefketh (1983) conducted field trials at five locations in California (USA) by using clear plastic sheets showed increase in yield of broccoli, tomatoes and melons when compared with untreated but weeded areas.

Altering the plant root environment and resulting in 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). The findings of Fahim *et al.* (1987) revealed that 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. Similarly, increase in seed yield (1.4-3.5 t/ha) even in wilt resistant genotypes of pigeon pea and yield increase of 23 per cent in chickpea was reported by Chauhan *et al.* (1988). Solarization increased sesame crop yield by 72 per cent have been reported by Stapleton and Garza-Lopez (1988) even when no soils pathogen or other pests have been detected. Satour *et al.* (1989) also reported increase in onion yield due to solarization and even disease incidence was also very low in solarized plots.

A field experiment with two solarization treatments and five weed control treatments was conducted by using 100 micron TPE film for 6 weeks during

June-July, 1999, followed by sowing of soybean in July and wheat in November at IARI, New Delhi. From the results Yaduraju and Ahuja (1990) reported that SS had a favourable effect on the growth of soybean and wheat with or without additional weed control measurements. On and average there was about 25 and 42 per cent increase in grain yield of soybean and wheat, respectively with mulch, which was higher. Increase in grain yield to the tune of 150 and 50 per cent than unweeded plots.

While studying the effect of solarization in bidi tobacco nursery on loamy sand soils Patel *et al.* (1991a) at Bidi Tobacco Research Station, Gujarat Agricultural University, Anand observed that tarping with LDPE clear film (among different types of plastic) for two months (April-15 to June-15) significantly gave more transplantable and total seedlings of tobacco which was 219 and 152 per cent higher than control, respectively.

From the other experiment on SS in tobacco nursery, Patel *et al.* (1991b) concluded that tarping with 25 micron LDPE white transparent and LDPE-UV film significantly gave more seedlings height and number of transplantable seedlings by 63.8 and 41.5 per cent over control, respectively. 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. The total dry matter production, leaf area and nodule numbers in groundnut were higher under clear plastic mulch than black plastic mulch and bare soil (Habeeburrahaman,1992).

While studying the effect of soil solarization by using TPE in soybean crop by Kumar *et al.* (1993) at the IARI, New Delhi on sandy loam soil during summer 1990 for 32 days, they reported increased plant height, doubled leaf area and dry weight. Pod number per plant was significantly increased, resulted in to increase the yield of soybean up to 78 per cent following solarization. Cucumber, sorghum, tobacco and tomato plants showed increased plant growth

response in solarized soil compared to non-solarized soil (Gruenzweig *et al.*, 1993)

Four field experiments were conducted during 1988 and 1989 in summer season on silty clay soil at Lamia in Greece by Vizantinopoulos and Katranis (1993). To examine the effect of SS in maize and soybean planted as second season crop. They concluded that soybean and maize grown on solarized plots were out yielded than those grown on clean weeded hoe treatment plots.

Yaduraju (1993) reviewed the role of SS in weed management and reported that it enhanced the availability of nutrients in soil and favour beneficial micro flora, ultimately resulting in increased plant growth response in onion, groundnut, sesame, soybean and bean.

An experiment was conducted by Patel (1994) at the Agronomy Farm, B. A. College of Agriculture, G.AU., during 1993 on sandy loam soils to study the effects of SS on the control of weeds in rice nursery. The results revealed that all SS treatments with 0.025mm TPE for 30 days and hand weeding produced significantly more number of healthy and lower number of yellow rice seedlings. With regards to fresh and dry weights of total and healthy rice seedlings as well as yellow rice seedlings, hand weeding and SS were found superior. Further, he also reported that SS recorded maximum content of chlorophyll (a, b and total) in leaves of rice seedlings.

A field investigation was carried out at UAS, Dharwad by Habeeburrahman and Hosmani (1996) during April 1990 to October 1991 to study the influence of SS on yield in succeeding rainy season sorghum crop. Maximum grain yield (42.3 q ha^{-1}) as well as stover yield (66.3 q ha^{-1}) was recorded by 0.05 mm TPE for 45 days, which was on par with weed free plots and was superior to farmer's practice. The increase in grain yield over non solarized was 92.4, 92.0 and 46.3 per cent due to 0.05 mm TPE for 40 days, weed free and farmer's practices, respectively.

An investigation was carried out by Biradar *et al.* (1997) at Main Research Station, UAS, Dharwad to evaluate the efficacy of SS for weed

management in groundnut during rainy season, 1995. They reported that solarization treatment with 0.05 or 0.1 mm TPE on wet soil for 60 days recorded pod yield of 2.88 t ha^{-1} which was statistically similar to those obtained in the weed free control plot (2.91 t ha^{-1}). The increase in grain yield over non solarized control was 215 per cent due to 0.05 mm TPE on wet soil for 60 days.

Mudalagiriyappa *et al.* (1999c) reported that SS enhanced the plant growth and yield of groundnut. At 75 day, SS with 0.075 mm TPE for 45 days resulted in maximum number of root nodules (124.65/plant) and nodule dry weight (130 g/plant) which were on par with 0.05 mm TPE, but differed significantly from control. Covering with TPE of 0.05 and 0.075 mm recorded significantly higher pod yields (20.64 and 19.60 q ha^{-1}, respectively) over control (4.68 q ha^{-1}). The highest oil content (44.29 per cent) and shelling percentage (73.25) were recorded by TPE 0.05 mm for 45 days. Further, Mudalagiriyappa *et al.* (1999 d) studied the residual effect of SS on growth and yield of potato crop. From the results, they reported that weed free and TPE 0.05 mm for 45 days recoded significantly higher plant height,number of branches and leaf area at 6o DAS compared to control. Maximum tuber yield of potato (29.91 t ha^{-1}) was recorded by TPE 0.05 mm for 45 days, which was at par with weed free check (29.73 t ha^{-1}) and significantly superior than all other treatments.

An investigation was carried out to determine the effect of SS on weeds in succeeding wheat crop after soybean and its resultant influence on the crop growth by Singh *et al.* (2000) at the NRCWS, Jabalpur during 1998-99 and 1999-2001. They reported that SS increased the number of spikes of wheat per unit area. Significantly the highest number of grain per spike (45.5), 1000 grain weight (41.7) and grain yield (5037 kg ha^{-1}) were recorded with SS for five weeks, over non solarized control.

A field experiment was conducted during 1999-2000 and 2000-2001 to study the effect of SS on weed growth in succeeding kharif season sunflower and the resultant influence on the yield of crop by Chandrakumar *et al.* (2002) at Department of Agronomy, UAS, Bangalore They reported that the maximum

seed yield (3180 kg ha^{-1}) was obtained with TPE 0.05 mm for 60 days and was at par with SS for 40 days with either pendimethalin (0.5 kg ha^{-1}) or one hand weeding at 70 DAS. Further, this was significantly superior to non solarized control including weed free check (2652 kg ha^{-1}).

The experiment was conducted on sandy loam soils of the Main Research Station, Hebbal, UAS, Bangalore during 2000 by Soumya *et al.* (2003) to study the effect of SS on growth and yield of *kharif* groundnut. Results indicated that at 60 DAS soil solarization with TPE 0.05 mm for 45 days + 1 Hand Weeding produced significantly more number of branches (7.73), higher leaf area (56.27) and higher total dry matter accumulation (16.45) per plant in groundnut were recorded, however, it was on par with weed free check. Further, they also reported that significantly higher filled pod (16.47) and pod weight (14.52 g) per plant were recorded with 0.05 mm TPE for 45 days + 1 Hand Weeding which was on par with weed free and TPE 0.10 mm for 45 days + 1 Hand Weeding in groundnut crop.

An experiment was conducted at WCRP, B.A. College of Agriculture, AAU, Anand during 2003-04 to study the effect of soil solarization on weed control and yield of okra-wheat cropping sequence. The results reveal that SS for 30 days significantly increased the plant height and yield of okra in *kharif* season but its effect on succeeding wheat crop was found non significant (Agresco report, 2004).

A field investigation was carried out at UAS, Bangalore during rabi season of 2000-2001 by Soumya *et al.* (2004) to study the residual effect of SS on growth and yield of potato. Results revealed that the residual effect of treatments to previous crop with TPE 0.05 mm for 45 days + 1 Hand Weeding recorded maximum number of branches (4.36) and leaf area at 60 DAP (18.22 dm^{-s}) which was on par with weed free. With regards to yield of potato, weed free check recorded significantly higher total tuber yield (26.14 t ha^{-1}) which was on par with TPE 0.05 mm for 45 days + 1 Hand Weeding (25.13 t ha^{-1}).

An experiment was conducted at WCRP, Department of Agronomy, College of Agriculture, JAU, Junagadh during 2003-04 and 2004-05, to evaluate the effect of SS on weed management in *kharif* groundnut on medium black soil condition. Results revealed that the effect of different treatments was found significant on pod and haulm yield of groundnut. Significantly the highest pod yield (2169 kg ha^{-1}) and haulm yield (2910 kg ha^{-1}) were obtained under solarization treatment than no solarization (control) during 2003-04 and similar trends were also obtained for the year 2004-05 (Agresco report, 2004 and 2005).

Mahajan *et al.* (2005) concluded that SS with 50 μm transparent PE for 35 or 45 days produced healthy seedlings of brinjal by increasing dry matter production of seedlings and proved very useful technique for controlling more than half of the weed species recorded without any use of chemicals.

Najappa *et al* (2005) reported that pod yield was varied due to repetitive use of TPE.Among solarized treatments, TPE 0.05 mm twice (23.15 q ha^{-1}) or once (22.15 q ha^{-1}) recorded significantly higher pod yield of groundnut as compared to weedy check (8.52 q ha^{-1}) due to effective control of weeds. Similar trend was observed with respect to number of pods per plant and pod yield per plant.

A field experiment was conducted with groundnut during 2000 and 2001 at Neyveli (TN) by Sundari and Sureshkumar (2005) and reported that significantly the highest pod yield of 2.47 and 2.49 t $ha^{-1}$was recorded in the off season soil solarization for 40 days with 0.05 mm thickness treatment. They also reported better growth of groundnut in terms of its plant height, number of leaves, leaf area and total dry matter accumulation which might have helped in better availability of growth resources to the crop with longer duration of solarization.

From above the review, it can be generalized that soil solarization with transparent polyethylene improved plant growth and ultimately resulting in increased yield and yield component in many crop plants including groundnut and potato.

2.2 Effect of cultural methods on weed control :

Groundnut

An experiment was conducted at Jungadh for two years during *kharif* seasons. The highest pod and dry fodder yield of groundnut were obtained when the crop was hand weeded twice and intercultured with blade harrow. The same trend was also observed in dry weed weight at the end of the season. Data regarding the economics showed that HW + IC was the most profitable (Rs. 1984 ha^{-1}), followed by weed free (Rs. 1487 ha^{-1}) and Lasso @ 2.0 lit. a.i. ha^{-1} (Rs. 734 ha^{-1}) (Kalaria *et al.*, 1976).

A field experiment was conducted at college farm, GAU, Junagadh during *kharif* season by Makwana (1982). The results revealed that the highest pod yield of groundnut (875 kg ha^{-1}) was recorded under weed free condition followed by one hoeing and two hand weedings. Maximum net profit of Rs. 1845 was accrued under one hoeing + two hand weedings, closely followed by Lasso application. These two treatments also recorded minimum removal of plant nutrients (N, P and K) by weeds.

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

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

Malavia and Patel (1989) studied that hand weedings twice at 20 and 40 days after sowing with three interculturing operations at 20, 40 and 60 days after sowing recorded the highest pod yield (12.9 q ha^{-1}) compared to herbicidal treatments (3.5 to 4.40 q ha^{-1}) and unweeded check (2.3 q ha^{-1}).

The maximum number of nodules per plant (93.8) and nodule weight per plant (13.9 g) at 90 days were observed with two hand weedings and three

interculturing 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 ha^{-1} over unweeded control (Murthy *et al.*, 1992).

The results revealed that the remarkably higher pod and haulm yield of groundnut were recorded under weed free treatment, closely followed by two hand weeding and one interculturing at 15-20 and 40-45 DAS (Tank, 1993).

An experiment conducted at Anand, results showed that hand weeding and two intercultivation at 20 and 45 DAS gave higher benefit cost ratio in groundnut (AGRESCO, 1996).

Potato:

Singh (1982) conducted a field experiment to study the effect of periodical manual weeding on tuber yield of potato at Central Research Station Farm, Modipuram, Meerut (U.P.) during 1977-78 and 1978-79. He observed that hand weeding at 25 days with earthing up gave lowest dry weight of weeds and highest tuber yield during both the years.

In potato (*Cv.* Chandramukhi) two hand weeding (30 & 70 DAP) is beneficial for weed control and tuber yield of potato (AGRESCO, 1985).

Hooda (1987), while experimenting at HAU, Hisar during 1981-82 and 1982-83 reported that hand weeding at 25 and 40 DAP in potato gave maximum number of tubers per hill and lowest dry weight of weeds/m^2 in both the year.

Field trial was conducted at Central Potato Research Station, Patna (Bihar) during rabi season of 1982-83. From the results, Singh (1988) reported that earthing up created favourable conditions for root and tuber development and helped in better tuber development resulted in to higher yield of potato.

Bhattacharya *et al.*, (1989) conducted a field experiment during *rabi* season of 1984-85 at Seed Farm, BCKV, Kalyani on gangetic alluvial sandy loam soil. The results revealed that among different treatments, hand weeding twice at 30 and 40 DAP had maximum potentiality in controlling all the sedge, monocot and dicot weeds.

Lal (1990), while experimenting at Modipuram, Meerut (U.P.) during 1981-82 reported that maximum weed control efficiency of 78 per cent was observed in weeding + earthing up treatment at 30 days after planting.

An experiment was conducted on potato field by Nandekar *et al.*, (1990) at Chhindwara during *rabi* seasons of 1986-87 and 1987-88 indicated that, one hand weeding along with one earthing up recorded the maximum plant height at harvest (62.5 cm), highest tuber yield of 216 q ha^{-1} and lowest weed population of 41/m^2.

Sharma (1994) conducted a field experiment during 1988-90 at New Delhi and reported that the maximum tuber yield and net returns were obtained from hand weeding and weed free treatment than other herbicide treatments.

Field trials were conducted on loamy sand soil at Anand during *rabi* 1990-91. Best weed control was achieved with weeding at 30 , 40 and 60 DAP. Total potato tuber yield was increased from 23.96 t ha^{-1} with unweeded control to 25.65 t ha^{-1} with HW at 60 DAP and 35.38 t/ha with 1.0 kg pendimethalin (Patel *et al.*, 1995).

From the foregoing review, it is summarized that two hand weeding (15 or 20 and 40 or 45 DAS) followed by intercultivation in groundnut crop while two hand weeding (25 and 40 DAP) with one earthing up for potato crop are sufficient for keeping the crops weed free and obtaining maximum yield level.

2.3 Effect of chemical methods on weed control:

Groundnut:

A field experiment was conducted at the Instructional Farm, GAU, Junagadh during *kharif* 1988 (Kathad, 1990). The results revealed that the highest pod (2330 kg ha^{-1}) and fodder (4294 kg ha^{-1}) yield of groundnut were recorded under weed free treatment followed by pendimethalin @ 1.0 kg ha^{-1} + One HW & IC at 45 DAS.

From the field experiment conducted at WCRP, Anand, the results revealed that two hand weedings and two interculturings at 20 and 45 DAS gave more remuneration. Under the situation of non availability of labours, pre-emergence application of pendimethalin @ 1.0 kg $ha^{-1}$with one interculturing at 45 DAS provided higher weed control and gave higher yield of groundnut (AGRESCO, 1996).

For effective control of weeds in *kharif* groundnut grown in South Saurashtra, the crop should be hand weeded and intercultured at 20 and 40 DAS. In case of labour scarcity, application of pendemithalin @ 1 kg ha^{-1} along with the hand weeding and interculturing at 30 DAS was found beneficial (AGRESCO, 1997).

Potato:

Hooda *et al.*, (1982) conducted a field experiment at HAU., Hissar during *rabi* season of 1978-79.They recorded the highest number of tubers $plant^{-1}$ (7.22) and significantly the higher tuber yield (395.7 q ha^{-1}) under metribuzin 1.0 kg/ha treated plots, which was closely followed by weed free treatment.

An experiment was conducted at Potato Research Station, GAU, Deesa on sandy loam soil. The results indicated that the pre-emergence application of metribuzin @ 1.0 kg ha^{-1} was proved economically viable in controlling weeds in potato (AGRESCO, 1997).

At Modipuram, Meerut (U.P.), Lal (1990) carried out a field experiment during 1981-82 and 1982-83. He concluded that among the herbicides

metribuzin applied @1.0 kg ha^{-1} resulted in maximum weed control efficiency (76.3 per cent) and minimum weed index (0.71 per cent) during both the years.

An experiment was conducted at Agronomy Instructional Farm, C.P.College of Agriculture, S.K.Nagar on weed control studies in potato during *rabi* season of 2001-2002 on sany loam soil of North Gujarat agro-climatic conditions. From the results, Patel (2002) concluded that maximum plant population, plant height, yield attributing characters viz. yield of tuber per plant (309.72) and total tuber yield (233.33 q ha^{-1}) were recorded with metribuzin @1.0 kgha^{-1} as pre-emergence treatment, Besides weed free condition, metribuzin @1.0 kg ha^{-1} was found more effective in reducing the weed population and resulted in lower dry weight of weeds (49.99 kg/ha), higher weed control efficiency (94.82 per cent) and minimum weed index (-3.19 per cent) with the best net realization (Rs 28649.00 ha^{-1}).

From above review, it is generalized that pendimithalin @1.0 kg $ha^{-1}$and metribuzin 1.0 kgha^{-1}as pre-emergence were recommended for controlling of weeds in *kharif* groundnut and potato, respectively for North Gujarat Agro-climatic condition.

MATERIALS AND METHODS

III. MATERIALS AND METHODS

The details of experimental materials used, procedures followed and techniques adopted during the course of present investigation are described in this chapter.

3.1 EXPERIMENTAL SITE

The field experiment was conducted during *kharif and* **rabi** seasons of the years 2003- 04 and 2004-05 at the Agronomy Instructional Farm, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar in plot no. B-7 and B-11, respectively.

3.2 CLIMATE AND WEATHER CONDITIONS

Geographically, Sardarkrushinagar is situated at 24^0-19' North latitude and 72^0-19' East longitude with an elevation of 154.52 meters above the mean sea level. This centre is located in the North Gujarat Agro-climatic Zone and is characterized by semi-arid climate with extreme cold winter, hot and dry windy summer. In general, monsoon is warm and moderately humid with an average annual rainfall of 550 mm received in about 21 rainy days, most of which is received during July and August. The winter season sets in during October and sets back in February, winter season remains cold and dry. The minimum temperature of the year is reached in the months of December or January and considered as the coldest months of the year. The summer season (March – June) is generally hot and dry. The rising in temperature starts from February and reaches the maximum in the month of May. April and May are the hottest months of the year in North Gujarat Agro-climatic Zone.

The meteorological data for the period of present investigation were recorded from the meteorological observatory of the Department of Meteorology, Agronomy Instructional Farm, C.P. College of Agriculture, Sardarkrushinagar which are enumerated in Tables 1 and 2 and graphically depicted in Fig. 1 and 2, respectively for the years 2003-04 and 2004-05.

Table 1 : Weekly meteorological observations for year 2003-04

Month	Std. Week	Temperature (^{0}C)		Relative Humidity (%)	Wind Speed kmph	Bright Sunshine Hrs day^{-1}	Rain fall (mm)	Evapo ration (mm)	Soil temperature (^{0}C)	
		Max.	Min.						5 cm	10 cm
April 03	14	38.6	23.4	55.3	8	9.7	0	10.7	47.6	9.8
	15	38.1	22.7	62.4	5.9	9.9	0	9.6	47.8	40.4
	16	37.3	23	70.1	6.5	10.1	0	10.1	50	42.3
	17	40	22.2	64	5.9	10.5	0	10.3	51.3	43.5
	18	39.3	21.7	64.4	7.4	9	0	11.8	49.1	41.9
May 03	19	40.6	23.2	60	5.9	10.1	0	10.5	51.3	42.5
	20	42	24.7	73.7	9.5	9.8	0	12.6	50.2	42.7
	21	39	25.5	80.4	11.7	9.3	0	12.4	48.9	42.4
	22	40.1	25.7	77.6	9.1	9.7	0	11.8	51.9	44.3
June 03	23	39.8	27.5	75.3	16.9	6.2	0	13.3	48.5	42.8
	24	39.7	27.1	76.3	10.7	7.7	2.6	10.2	48.6	45.8
	25	33.1	25.9	87.1	8.6	3.2	87.2	5.2	37.5	37.2
	26	37.5	27.6	77.3	12.7	7.5	0	9.7	44.7	43.2
July 03	27	35.8	26.4	86.1	6.6	4.6	39.7	5.9	39.8	39.6
	28	32.9	25.6	89.6	9.7	5.6	155.8	5	38.7	37.8
	29	33.2	25.7	88.1	7.7	5.5	22.2	4.9	37.6	36.9
	30	29.5	25.5	95	10.2	1	154.5	2.4	31.8	31.2
	31	30.4	25.1	93	10.1	2.9	31.5	4.2	35.2	33.6
Aug 03	32	32.6	26.2	94.6	5.8	4.7	31.2	3.9	39.6	37.4
	33	33.2	25.6	89	8.5	5.7	0	6.2	42.6	40.1
	34	32.8	25.6	91.4	7.9	10.2	58.8	4.8	38.9	37
	35	29.4	24.9	95.6	7.5	1.3	25	2.7	33.9	32.6
Sept 03	36	31.9	23.9	92.3	5.4	3.2	0	4.1	40.1	37.4
	37	32.4	24.2	89.6	4.8	5.7	0	5.1	42.2	39
	38	33.1	24.5	93.3	4.6	5.5	93.8	3.6	42.5	39
	39	34.2	24.9	89.7	4.8	8.3	10.3	5	45.9	42.4

Cont....

Oct 03	40	36.4	20.8	85.3	3.3	9.3	0	5.2	46.6	42.7
	41	36.3	19.3	84	3.3	9.7	0	5.6	48.1	40.4
	42	36.5	17.5	74.1	2.6	9.9	0	4.8	47.1	39.1
	43	35.9	14.5	76.1	2.8	10.2	0	4.8	44.8	37.1
	44	35.3	16.6	71.3	3.4	9.8	0	5.7	43.2	36.8
Nov 03	45	35.1	16.6	82.3	2.9	9.3	0	5.4	43.3	36.4
	46	32.6	14.9	70.9	3.2	9.4	0	4.8	40.2	34.2
	47	30.2	14.4	66	7.3	8.3	0	6.3	37.4	31.9
	48	31.4	11.2	83.1	2.6	9	0	4.1	38.1	31.5
Dec 03	49	32.2	12.5	77.9	2.3	9	0	4.2	37.8	31.1
	50	28.9	12.4	77.1	4.9	8.5	0	4.1	34.2	28.9
	51	26.5	10.1	75.4	5.2	8.6	0	4.2	34.3	28.1
	52	25.6	7.4	75.1	4.3	8.8	0	3.7	32.3	26.1
Jan 04	1	26.7	9.2	76.4	4	7.8	0	3.6	32:3	26.4
	2	28.2	9	86.1	3.3	8	0	3.6	34.2	27.3
	3	28.7	10.9	81.9	3.4	6.9	0	3.5	34.5	28.1
	4	25	7.7	81.3	3.9	9.3	0	3.8	34.4	27.4
	5	26.1	8.4	73.4	5.4	9.8	0	4.2	33.8	27.6
Feb 04	6	28.3	8.1	73.6	4.1	10.2	0	4.9	36.6	29.1
	7	31.3	11.4	79.4	4.1	9.9	0	3.3	39.1	31 4
	8	32.7	12.8	82.6	3.1	9.1	0	5.5	41.6	33 4
	9	34.4	12.9	67.8	4	10.1	0	6.9	43.6	35.7
March 04	10	37.3	14.1	60.1	3.8	9.3	0	7.9	44.1	35.9
	11	39.3	17.6	61.9	3.8	10.3	0	8.2	48.5	40
	12	39.6	19	69.9	5.1	10.2	0	10.5	49.1	40.8
	13	37	16.2	66.9	3.6	10	0	8.2	46.5	39.8

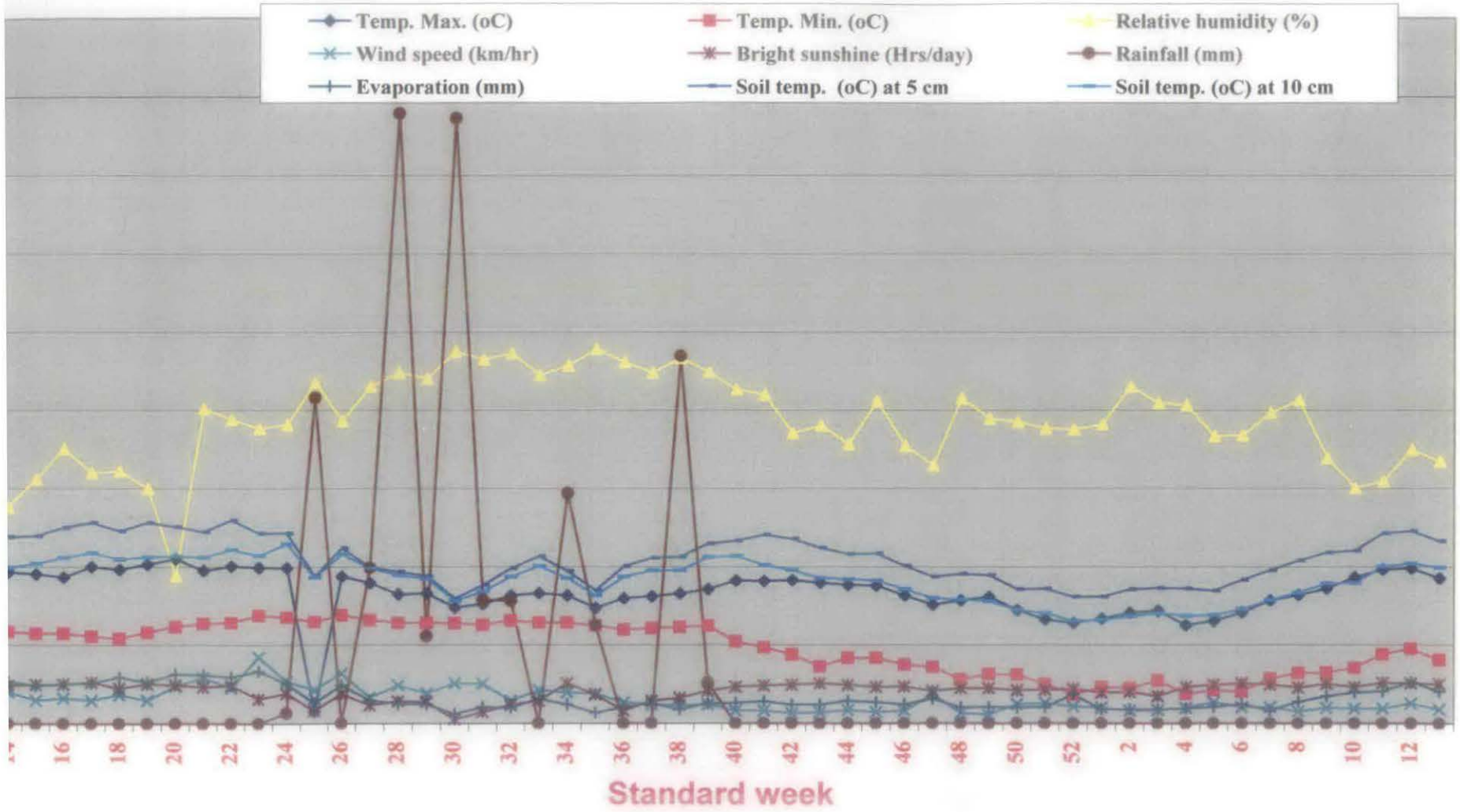


Fig. 1 : Weather chart for the period of investigation (2003-04)

Table 2: Weekly meteorological observations for year 2004-05

Month	Std. Week	Temperature (^{0} C)		Relative Humidity (%)	Wind Speed kmph	Bright Sunshine Hrs day^{-1}	Rain fall (mm)	Evapo ration (mm)	Soil temperature (^{0}C)	
		Max.	Min.						5 cm	10 cm
April 04	14	37.2	21.3	78.3	5.7	8	0	9.1	49.4	41.9
	15	38.6	22.9	73.3	6.8	10	0	10.1	51.2	43.8
	16	37.9	22.3	79.3	8.6	10.1	0	10.5	49.9	42.8
	17	40.1	23.4	68.3	6.4	10	0	10.9	52.6	45.5
	18	40.3	23.3	47.1	6.1	8	0	11.8	52	45.1
May 04	19	38.3	25.8	66.3	7.6	4.5	19.2	8.4	46.9	43.3
	20	37.4	25.5	78.7	8.8	8	0	7.5	46.4	43.7
	21	36.9	26.2	79.7	14.1	6.6	0	10.9	47	42.4
	22	39.5	25.1	78.6	7.3	10.2	0	11	52.6	45.5
June 04	23	39.4	26.2	77.9	10.2	10.1	12.8	11.9	51.4	45.9
	24	37.9	25.8	85.7	7.2	6.9	116	8.5	44.6	42.4
	25	35.2	26.8	80.4	18.8	5	0	8.3	41.4	39.8
	26	36.7	27.1	80.1	12.5	4.6	0	8.8	45.1	40.8
July 04	27	36.8	27.1	81.3	9.5	4.7	3.8	7.9	44.8	40.9
	28	35.8	26.1	80.6	14.1	3.4	0	8.9	44.1	40.7
	29	37	27.2	75.9	10.8	4.6	0	9.5	47.9	43.2
	30	34.9	26.2	80.3	8.5	3.6	1.5	8.2	41.1	41.5
	31	31.4	25	92.4	7.1	0.3	41.9	4	36	34.8
Aug 04	32	30.7	25.1	95.1	7.9	1.2	114	3.5	33.5	32.9
	33	31.1	25.1	91.6	7.5	1.7	13.2	3.9	37.6	35.9
	34	32.4	24.7	88.1	8.8	3	29.9	5.6	39.5	37.8
	35	32.7	23.6	89.9	10.4	3.6	0	5.4	40.1	38.2
Sept 04	36	35.4	24.1	80	4.7	8.5	0	6.6	47.3	42.9
	37	34.3	24.1	86	8.1	7	0	7.1	46.6	41.4
	38	37.2	25.5	80	5.8	8.2	0	7.4	51.3	45
	39	37.7	25.1	79.4	5.5	7.5	5.6	7	48.4	43.6

Cont....

Oct 04	40	34.3	24.6	87	4.7	6.2	10.6	5.2	45.4	42.6
	41	33.2	21.3	91.4	5.2	7.7	26.4	5.8	39.8	38.6
	42	34.9	17.9	79.7	2.7	9.2	0	5.5	40.9	39
	43	35.3	16.1	74	3.2	9.3	0	5.7	40.1	36.2
	44	33.9	16.4	66.3	3.5	7.3	0	5.3	40.1	35.6
Nov 04	45	33.2	14.9	74.3	2.7	7.7	0	4.7	39.4	34.8
	46	34.3	16	68.6	2.8	8.2	0	4.8	40.3	35.8
	47	34	13.7	77.9	2.5	9.6	0	4.4	40.2	35.3
	48	31.8	14.3	75	2.9	8.3	0	4	37.5	32.8
Dec 04	49	31.2	13.7	82.4	2.7	7.4	0	3.8	36.8	32.4
	50	31.4	10.5	80	2	7.9	0	2.7	35.2	30.8
	51	29.6	9.9	82	2.9	8.7	0	2.6	33.9	29.7
	52	27.8	12.4	75.5	3.9	6.1	0	3.3	31.0	27.4
Jan 05	1	24.7	8.2	76.3	6..3	8.3	0	4.2	27.3	23.8
	2	26.5	7.2	84.3	3.3	9.3	0	3.8	28.1	23.9
	3	25.3	7.4	80.3	3.5	8.3	0	3.8	25.8	22.6
	4	24.2	8.5	74.7	4.4	4.9	0	3.6	26.3	22.9
	5.	25.2	9.2	57.7	6.8	9.1	0	5.2	28.6	24.1
Feb 05	6	29.2	13.7	86.0	4.2	7.8	0	4.3	32.1	27.3
	7	29.7	11.6	86.7	5.9	8.4	0	5.4	31.6	27.7
	8	25.2	6.6	81.7	5.9	9.5	0	5.6	28.8	24.7
	9	34.5	16.5	64.9	4.0	8.2	0	6.7	35.7	31.1
March 05	10	32.3	15.4	72.6	5.5	8.3	0	6.9	35.3	31.0
	11	35.5	15.2	62.4	4.8	9.7	0	8.4	38.7	33.5
	12	35.0	16.7	68.1	6.6	10.3	0	9.1	38.9	34.0
	13	36.1	19.2	42.8	7.7	9.9	0	10.0	40.4	35.5

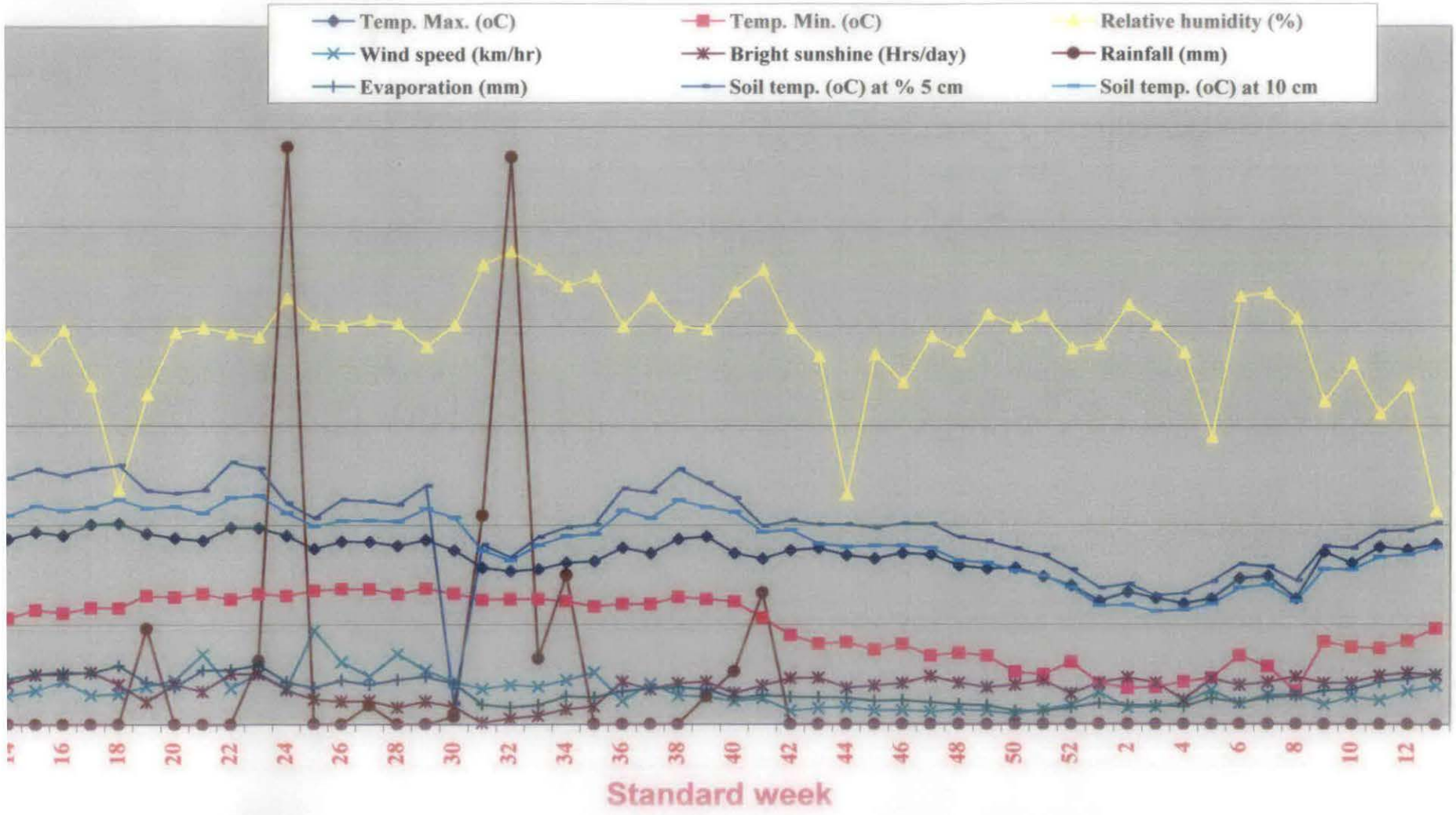


Fig. 2 : Weather chart for the period of investigation (2004-05)

3.3 PHYSICO-CHEMICAL PROPERTIES OF SOIL

The experimental fields have an even topography with a gentle slope and good drainage. The soil samples were collected randomly from different spots of the experimental area to a depth of 0-30 cm before lay out in both the years and a composite soil sample was prepared for each year. These samples were analyzed for their physico-chemical properties. The values of these properties of the soil along with the methods used to determine them are given in Table 3.

Soil analysis showed that the soil of the experimental plot is loamy sand in texture, low in organic carbon and available nitrogen, high in available phosphorus, medium in available potash and deficient in available sulpher while medium in micro-nutrient. Electrical conductivity was very low showing that the soil was free from salinity hazard.

3.4 CROPPING HISTORY

Details regarding cropping history of the experimental plots with respect to crops taken and fertilizers applied during the previous three years of the present investigation are summarized in Table 4.

Table 3 : Physico-chemical properties of the experimental soil

Sr. No.	Particulars	2003-04	2004-05	Method employed
		Values (0-30 cm soil depth)		
A	**I. Physical properties**			
	1. Sand (%)	84.65	84.09	International Pipette Method (Piper, 1966)
	2. Silt (%)	7.91	7.50	
	3. Clay (%)	7.04	8.08	
	4. Textural class	Loamy sand	Loamy sand	
B	**II. Chemical properties**			
	1. Soil pH (1:2.5 soil: water ratio)	7.6	7.8	Potentiometric Method (Jackson, 1973)
	2. Electrical conductivity (dSm^{-1}) at 25 ^0C	0.12	0.15	Schofield Method (Jackson, 1973)
	3. Organic carbon (%)	0.18	0.16	Walkley & Black's Method (Jackson, 1973)
	4. Available nitrogen ($kg\ ha^{-1}$)	160.7	158.8	Alkaline Permanganate Method (Jackson, 1973)
	5. Available phosphorus ($kg\ ha^{-1}$)	60.6	54.4	Olsen's Method (Olsen *et al.*, 1954)
	6. Available potash ($kg\ ha^{-1}$)	190.5	182.1	Flame Photometric Method (Jackson, 1973)
	7. Available sulphur (ppm)	10.0	9.0	Turbidimetry (Jackson, 1973)
	8. Available iron (ppm)	5.75	5.25	DTPA extractable method (Lindsay and Norvell,1969)
	9. Available Manganese (ppm)	9.50	8.25	
	10. Available Zinc (ppm)	0.60	0.55	
	11. Available copper (ppm)	0.47	0.35	

Table 4: Cropping history of the experimental plots

Year	Season	Crop	Nutrients applied (kg ha^{-1})		
			N	P_2O_5	K_2O
Plot No. B-7					
2000-2001	***Kharif***	Fallow	-	-	-
	Rabi	Cumin	30	15	0
	Summer	Fallow	-	-	-
2001-2002	***Kharif***	Cluster bean	20	40	0
	Rabi	Fallow	-	-	-
	Summer	Fallow	-	-	-
2002-2003	***Kharif***	Castor	80	40	0
	Rabi	Fallow			
	Summer	**Soil solarization**			
2003-2004	Kharif	**Groundnut**	12.5	25	0
	Rabi	**Potato**	220	110	220
Plot No. B-11					
2001-2002	***Kharif***	Cluster bean	20	40	0
	Rabi	Fallow	-	-	-
	Summer	Green gram	20	40	0
2002-2003	***Kharif***	Sesamum	25	25	0
	Rabi	Fallow	-	-	-
	Summer	Cowpea	20	40	0
2003-2004	***Kharif***	Green gram	20	40	0
	Rabi	Fallow			
	Summer	**Soil solarization**			
2004-2005	***Kharif***	**Groundnut**	12.5	25	0
	Rabi	**Potato**	220	110	220

3.5 EXPERIMENTAL DETAILS

3.5.1 Treatments

The field experiment was conducted with six soil solarization treatments with two thicknesses of transparent polyethylene (0.025 mm and 0.050 mm) and three durations (15, 30 and 45 days) along with cultural and chemical weed control, weed free and weedy check for comparison are as under.

Treatment Details:

T_1 : TPE 0.025 mm 15 days

T_2 : TPE 0.025 mm 30 days

T_3 : TPE 0.025 mm 45 days

T_4 : TPE 0.050 mm 15 days

T_5 : TPE 0.050 mm 30 days

T_6 : TPE 0.050 mm 45 days

T_7 : Pendimethalin 1.0 kg ha^{-1} (Groundnut) as a pre-emergence
Metribuzin 1.0 kg ha^{-1} (Potato) as a pre-emergence

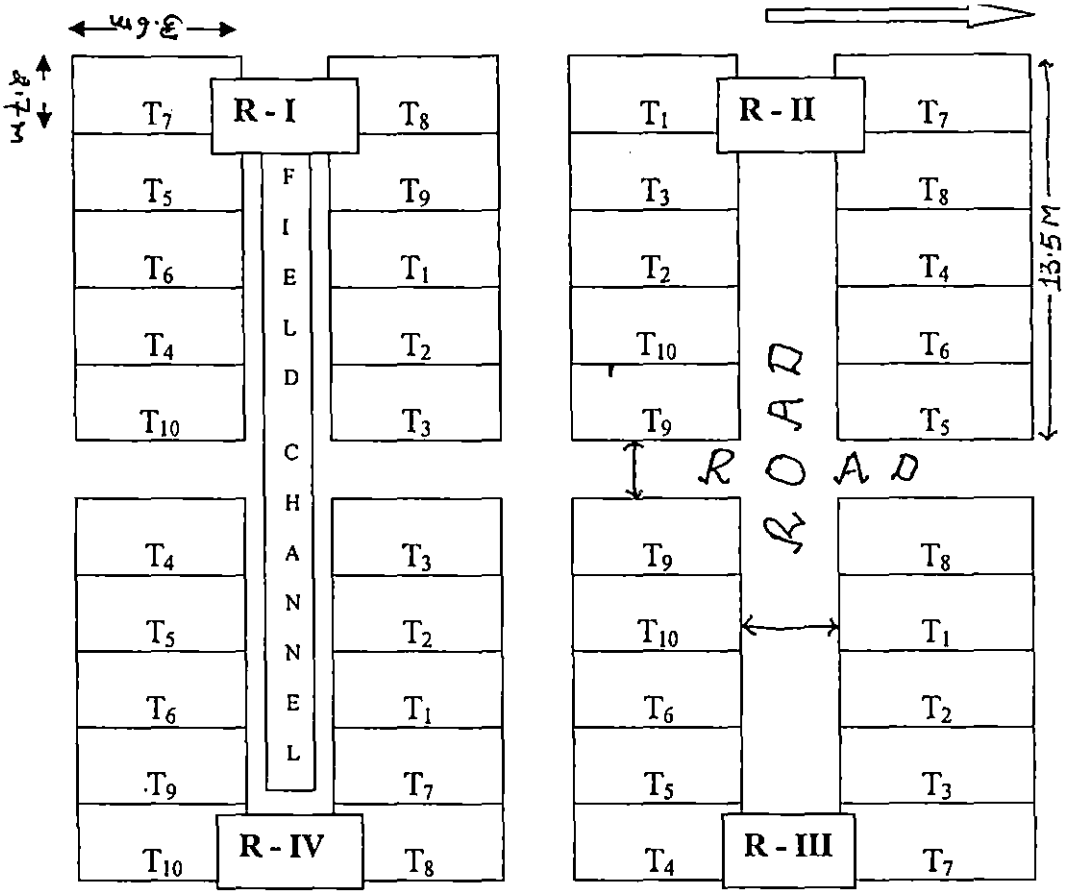
T_8 : Hand weedings twice (20 and 40 DAS) + Earthing up (40 DAS)

T_9 : Weed free

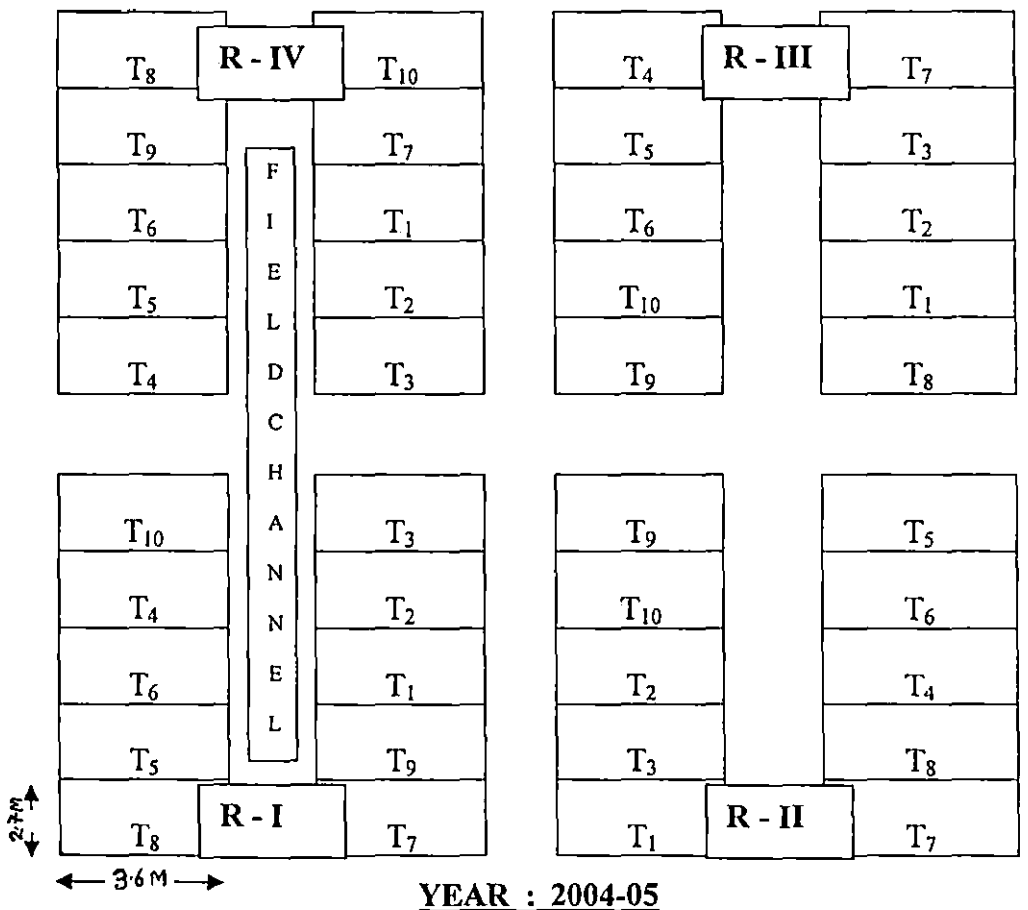
T_{10} : Weedy check (control)

3.5.2 Experimental Design and Lay out

1.	**Experimental design**	:	Randomized Block Design
2.	Number of replication	:	4 (Four)
3.	Plan of lay out	:	Fig.3
4.	Plot size	:	Gross : 3.6 m X 2.7m
			Net : 3.0m X 1.8 m
5.	Number of total plots	:	40 (Forty)
6.	Spacing	:	45 cm X 15 cm
7.	Number of rows in gross plot	:	6 (Six)
8.	Number of rows in net plot	:	4 (Four)
9.	Variety	:	Groundnut: GG.7
			Potato: Kufri Badshah



YEAR : 2003-04



YEAR : 2004-05

Fig.3 : Plan of layout of field experimentation during 2003-04 and 2004-05

3.6 CULTURAL OPERATIONS

The sequence of field operations carried out during the course of investigation are given in Table 5.

3.6.1 Soil Solarization (Tarping)

TPE film of 0.025 mm and 0.05 mm thickness known as linear low density polyethylene were used for soil solarization (SS).The plots were irrigated and dug out manually with the help of spade at *Vapsa* condition. Thereafter, TPE sheet was covered on the surface of moist soil plots as per treatments. The border of all solarized plots was sufficiently heaped with moist soil with a object to prevent blowing of film due to wind and also to make air tight. Then after, soil thermometers were installed in six solarization treatments as well as in a bare soil plot (control plot) beneath the polyethylene sheet at the depths of 5 cm and 10 cm to record soil temperature (Plate 1). Sufficient care was also taken to check the interference of animals. The SS plots were frequently inspected to check the tear up of film due to high temperature.

3.6.2 Soil temperature observation

The soil temperature was recorded daily at 14.40 hours during soil solarization periods at 5 cm and 10 cm soil depth for 2003-04 and 2004-05.

3.6.3 Land preparation

Both the crops, groundnut and potato requires loose and friable soil without clods and stubbles. Hence, the field was cross cultivated by tractor and one planking was done by bullocks to achieve fine tilth. Thereafter, the field experiment was laid out as shown in plan of lay out in Fig. 3 for the year 2003-04 and 2004-05, respectively.

3.6.4 Application of manure and fertilizer

FYM @ 10 t ha^{-1} was applied to first crop only i.e. groundnut crop during both the years and was incorporated in to the soil before spreading of polyethylene sheets. Where as chemical fertilizers were applied as per recommended package of practices for groundnut and potato crop.

Full dose of nitrogen (12.5 kg ha^{-1}) and phosphorus (25.0 kg ha^{-1}) was applied to groundnut crop as a basal dose before sowing in the form of ammonium sulphate and single super phosphate, respectively.

In potato crop, castor cake (500 kg ha^{-1}) as well as full dose of phophorus (110 kg ha^{-1}), potash (220 kg ha^{-1}) and half dose of nitrogen (110 kg ha^{-1}) were applied as a basal dose before planting in form of di-ammonium phosphate, muraite of potash and ammonium sulphate, respectively. The remaining dose of nitrogen (110 kg ha^{-1}) was top dressed in form of urea after 30 DAP.

3.6.5. Seed treatment, spacing, seed rate and sowing/planting

First groundnut seed was treated with chlorpyriphos @ 25 ml/kg of seed to protect against white grub infestation and then after, seed is also treated with rhizobium culture (strain – IGR-40) received from National Research Centre for Groundnut, Junagadh. There after, groundnut seeds (100 kg ha^{-1}) were sown in line at a spacing of 45 cm after opening of shallow furrow manually and seed properly covered with soil. Irrigation was applied just after sowing.

After harvesting of groundnut, potato crop was planted without disturbing the soil. First, tubers of Kufri Badshah variety were cut in pieces, keeping two or three lived eye buds with approximately 25 to 40 gram weight and were treated with Mencozeb before planting to control rotting of seed tubers. The furrows were opened manually at 45 cm apart in the prepared flat beds and castor cake as well as basal application of fertilizer was applied. Cut pieces of potato were planted in opened furrows @ 30 q ha^{-1} and subsequently, deep furrows were opened manually in centre of rows with the help of spade which form ridges and furrows to cover the planted tuber cuttings. Irrigation was applied just after completion of planting.

Table 5: Calendar of field operations during experimental periods for two years

Sr. No.	Particulars		2003-04	2004-05
1.	FYM application and cross cultivation by tractor		25-04-03	28-04-04
2.	Preparation of field lay out		28-04-03	28-04-04
3.	Irrigation to soil solarization treatments (T_1 to T_6)		29-04-03	28-04-04
4.	Cultivation and leveling of solarization treatments and initial soil sampling		30-04-03	29-04-04
5.	Date of TPE spreading and installation of soil thermometer		30-04-03	29-04-04
6.	Date of TPE removal and soil sampling after soil solarization	T_1 & T_4 T_2 & T_5 T_3 & T_6	16-05-03 31-05-03 15-06-03	15-05-04 30-05-04 14-06-04
7.	Sowing/planting dates and seed treatment	Groundnut Potato	24-06-03 22-11-03	06-07-04 15-11-04
8.	Pre emergence application of herbicide	Groundnut Potato	26-06-03 22-11-03	08-07-04 17-11-04
9.	Hand weeding in weed free (T_9)	Groundnut	10-07-03 03-08-03 23-08-03 29-08-03	30-07-04 18-08-04 29-08-04 15-09-04
		Potato	04-12-03 04-01-04 20-01-04	17-12-04 29-12-04 15-01-05
10.	Hand weeding in T_8 20 & 40 DAS	Groundnut	14-07-03 03-08-03	30-07-04 18-08-04
		Potato	14-12-03 04-01-04	7-12-04 28-12-04
11.	Earthing up in T_8 at 40 DAS	Groundnut Potato	03-08-03 05-01-04	18-08-04 28-12-04
12.	Top dressing of nitrogenous fertilizer in potato crop		22.12.03	15-12-04
13.	Irrigation		Weekly scheduled irrigation was given to both the crops	
14.	Plant protection measures	Groundnut Potato	06-09-03 24-01-04	- 20-01-05
15.	Harvesting & Grading	Groundnut Potato	21-10-03 28-02-04	29-10-04 20-02-05
16.	Soil sampling was taken after harvesting of crops	Groundnut Potato	24-10-03 01-03-04	26-11-04 28-02-05

3.6.6 HERBICIDAL APPLICATION

Pendimethalin @ 1.0 kg ha^{-1} in 500 litres of water was applied as pre-emergence in treatment (T_7) with the help of knapsack sprayer with flat phan nozzle in groundnut crop during both the years. Likewise, Metribuzin @ 1.0 kg ha^{-1} in 500 litres of water was applied as pre-emergence in treatment (T_7) with the help of knapsack sprayer with flat phan nozzle in potato crop.

3.6.7 WEEDING AND EARTHING UP

(1) Weeding was not carried out in treatment T_1 to T_6 (solarization treatments), T_7 (herbicidal treatment) and T_{10} (weedy check) after sowing /planting of the crops during both the years of experimentation.

(2) Weeding and earthing up operation were carried out in T_8 as per treatment for groundnut and potato crop.

(3) Hand weeding operations were carried out in the weed free treatment (T_9) at 20, 40, 50 and 60 days after sowing in groundnut crop, like wise, for potato crop, the weeding operations were also performed in weed free treatment (T_9) at 20, 40 and 60 days after planting for both the years.

3.6.8 IRRIGATION

First two irrigations were given immediately after sowing of groundnut and planting of potato crop for satisfactory germination of the crops and subsequent irrigations were given at one week interval to potato and as and when required to groundnut crop.

3.6.9 PLANT PROTECTION MEASURES

Chlorpyriphos was applied @ 1.0 litre ha^{-1} at 70 days after sowing of groundnut crop for control of termite during crop growth period for the year 2003-04.

Mancozeb was sprayed once @ 2.0 kg ha^{-1} at 60 days after planting of potato for control of late blight disease during crop growth period of both the years.

3.6.10 HARVESTING AND GRADING

After attaining proper maturity the groundnut crop was harvested. Before uprooting of groundnut plants, one light irrigation was applied to facilitate the uprooting of plants. Pod yield per plant was recorded from five tagged plants for both the years. Thereafter, border lines were harvested separately and after wards, net area was harvested and kept for sun drying for 4 to 5 days. After sun drying, pods were separated treatment wise in all the replications.

Potato crop was harvested when maturity sign was observed. The border lines were harvested separately. Tuber yield per plant was recorded from five tagged plants. The net plots were harvested using country plough. The tubers were collected from net plot area in each treatment. Tubers were graded into three categories viz. "A" grade (Large size, > 75 g), "B" grade (Medium size, 40- 75 g) and "C" grade (Small size, < 40 g) in each treatment, weighed separately and totaled for tuber yield (q ha^{-1}) for both the years.

3.7 BIOMETRIC OBSERVATIONS

The details of observations recorded and procedure followed during investigation period for both the years are given in Table 6.

Table 6 : Details of collection of experiment data during experimental periods

Sr. No.	Parameters	Procedures
1	**Soil**	
	(a) Soil temperature	Soil temperature was recorded using installed in soil thermometers as well as digital soil thermometer (Plate 4) at 5 and 10 cm soil depths in both covered and non covered plots daily at 14.40 hours and averaged for five days. 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 by gravimetric method at 15 days interval (15, 30 and 45 DAPS).
2	**Weeds**	
	(a) Weed count/m^2	Periodical recording of weed number (grasses, broad-leaved, sedges, and total weed) at 30 days interval from 1.0 m^2 area was done in both groundnut and potato crops.
	(b) Dry weight of weed ($g/0.25m^2$)	Weed dry biomass (grasses, broad-leaved, sedges, and total weed) was recorded periodically at 30 days interval in 0.25 m^2 destructive sampling area (oven dried at 60 $\pm$ 5 ^{0}C). Sun dried dry weed biomass was recorded from the net plot area at harvest for both groundnut and potato crops and expressed in q ha^{-1}.
	(c) Weed control efficiency (%)	$WCE\ (\%) = \frac{\text{Weed dry weight in control plot (kg ha}^{-1}\text{)} - \text{weed dry weight in treated plot (kg ha}^{-1}\text{)}}{\text{Weed dry weight in control plot (kg ha}^{-1}\text{)}} \times 100$
	(d) Weed index	$WI = \frac{\text{Yield of weed free plot (kg ha}^{-1}\text{)} - \text{Yield of treated plot (kg ha}^{-1}\text{)}}{\text{Yield of weed free plot(kg ha}^{-1}\text{)}} \times 100$
3	**Crops**	
	3.1 Groundnut	
	(a) Plant height (cm)	Height of five tagged plants from the base of plant to the tip of main shoot was recorded at 30 DAS & harvest
	(b) Branches	Number of branches of five labeled plants at 30 days and harvest were counted and average per plant was worked out

	(c) Green leaves	Green compound leaves on five labeled plants were counted periodically at 30 days interval and average per plant was worked out
	(d) Leaf area	Leaf area (cm^2) per plant was worked out periodically at 30 days interval by using disc method on dry weight basis.
	(e) Leaf area index	$LAI = \frac{\text{Leaf area}(cm^2)}{\text{Land area } (cm^2)}$
	(f) Dry matter accumulation (g $plant^{-1}$)	Leaves, stem and reproductive parts (g $plant^{-1}$) were separated and dried to a constant weight at 65-70 ^{0}C in oven and weights were recorded separately and totaled at 30 days interval.
	(g) Nodule number and dry weight (g $plant^{-1}$)	Nodules number were counted and oven dried to a constant weight and their dry weights were recorded at 60 and 90 DAS.
	(h) Pod weight (g $plant^{-1}$)	Mean weight of the pods from five plants was taken as pod weight (g $plant^{-1}$) at harvest.
	(I) Number of pods per plant	Average of the number of pods on five plants was recorded as number of pods per plant at harvest.
	(j) Pod yield (q ha^{-1})	The pods from the net plot are separated, dried and their dry weights were recorded. It was expressed as quintals per hectare at harvest.
	(k) Haulm yield (q ha^{-1})	The yield of above ground dry matter per net plot was recorded after drying and weight was recorded and expressed as quintals per hectare.
	(l) Shelling percentage	Worked out by dividing the kernel yield by pod yield and expressed in percentage.
	(m) Test weight (g)	Recorded on randomly picked 100 seeds (g) from net plot yield in groundnut at harvest.
	(n) Kernel yield (q ha^{-1})	Kernel yield (q ha^{-1}) = $\frac{\text{Pod yield (q ha}^{-1}\text{) x Shelling percentage}}{100}$

	(o) Oil content (%)	Oil content was estimated by using Nuclear Magnetic Resonance (NMR) spectrophotometer and expressed in percentage
	3.2 Potato	
	(a) Plant height (cm)	Height of five labeled plant from base of the plant to the tip of main shoot was recorded at 30 DAP & harvest
	(b) Number of leaves	Green leaves on five labeled plants were counted at 6o and 90 DAP and average per plant was worked out
	(c) Leaf area	Leaf area (cm^2) per plant was worked out at 60 and 90 DAP by using disc method on dry weight basis
	(d) Number of tubers per plant	The total number of tubers per plant was recorded from the five tagged plants and then mean number of tubers per plant was worked out at harvest.
	(e) Tubers weight per plant ($g\ plant^{-1}$)	The yield of tuber per plant was recorded from the five tagged plats and then mean yield per plant was worked out at harvest.
	(f) Tuber yield ($t\ ha^{-1}$)	Three grade wise yield (A, B and C) and total weight of potato yield was recorded from net area at harvest and then yield of tuber per hectare in tones was calculated.
	(g) Haulm yield ($q\ ha^{-1}$)	The yield of above ground dry matter per net plot was recorded after drying and weight was recorded and expressed as quintals per hectare.

DAPS = days after polyethylene spreading

3.8 CHEMICAL STUDIES

3.8.1 Soil sample

Initial and final soil samples were taken (0-15 cm depth), dried under sun and ground to fine powder by china clay mortar and sieved with plastic wire mesh to determine organic carbon (%), available nitrogen ($kg\ ha^{-1}$), available phosphorus ($kg\ ha^{-1}$), available potash ($kg\ ha^{-1}$), available sulphur (ppm) and available micronutrients in ppm such as Fe, Mn, Zn and Cu from the soil.

year: 2004-05

year: 2004-05

year: 2003-04

Plate 1: General view of soil solarization and instolation of soil thermometers

3.8.2 Plant analysis

Plant analysis pertaining to content of nutrients in groundnut crop plants as well as weeds was done. Representative samples of plants and weeds collected from each plot at the time of harvest were used for chemical studies. An oven dried samples were powdered separately in a willey mill for analysis in respect of macronutrient viz., N, P, K in per cent, S in ppm and micronutrient viz., Fe, Mn, Zn and Cu in ppm by standard methods.

3.8.3 Methods for chemical analysis

3.8.3.1 Soil analysis

Different standard methods followed to determine different nutrients from the soil are shown in Table 3.

3.8.3.2 Plant analysis

Different standard method used for determination of different nutrient contents for groundnut haulm and weeds are as fallow.

Sr. No.	Plant properties	Method employed
1.	Nitrogen (%)	Modified kjeldahls method (Jackson, 1967)
2.	Phosphorus (%)	Vanedo Molybdophosphoric acid yellow colour method (Jackson, 1967)
3.	Potassium (%)	Flame photometric (Jackson, 1967)
4.	Sulphur (ppm)	Turbidimetry (Chaudhary and cornfield, 1966)
5.	Micronutrient viz., Fe, Mn, Zn and Cu (ppm)	Di-acid extract method (Johnson and Ulrich, 1960); The estimation of these elements was carried out by using Atomic Absorption Flame Emission spectrophotometer, AA-646 (Lindsay and Norvell, 1969)

3.9 MICROBIAL POPULATION

Microbial populations were counted from solarized and weedy check treatments after respective duration of solarization periods and after the harvesting of groundnut crop. From each treatment 10 g of soil was taken from 0-15 cm soil depth and suspensions were made and cultured by using different

media following the 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 total fungi, total bacteria and actinomycetes per gram of oven dry soil.

3.10 CORRELATION STUDY

Simple correlation test was used to find out the relationship between pod yield, growth, yield and yield components of groundnut crop as well as different weed characters.

3.11 ECONOMICS

In order to evaluate most effective and remunerative treatment, relative economics of each treatment was calculated. The gross realization in terms of rupees per hectare was worked out for each treatment considering prevailing market prices of marketable produce. Likewise, net profit was estimated for each treatment considering the cost of cultivation and gross profits for each treatment. Economically to assess the groundnut-potato crop sequence the yield of potato was converted into groundnut equivalent yield at the prevailing price basis (Verma and Mudgal, 1983).

System productivity values in terms of kg ha^{-1} day^{-1} were worked out by total production in a crop rotation divided by 365 days. The profitability values in terms of Rs ha^{-1} day^{-1} was calculated by net monetary returns of the rotation divided by 365 days (Gangwar et al., 2006).

3.12 STATISTICAL ANALYSIS

Statistical analysis for different characters (Steel and Torrie, 1982) was carried out on computer at the Computer Centre, C.P. College of Agriculture, S.D. Agricultural University, Sardarkrushinagar.

Data on weed count and weed dry weight was subjected to (x + 0.5) square root transformation as suggested by Gomez and Gomez (1984) before the statistical analysis.

Standard error of mean (S.Em) and co-efficient of variation (C.V %) were worked out and the same are presented in respective tables.

EXPERIMENTAL RESULTS

IV. EXPERIMENTAL RESULTS

The results of field experiment entitled " **Effect of soil solarization on weed control in groundnut - potato crop sequence in conjunction with cultural and chemical methods of weed control** " conducted during 2003-04 and 2004-05 at Agronomy Instructional Farm, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar are presented in this chapter. The data were subjected to statistical analysis in order to test the significance of the results. The analysis of variance of different characters of pooled results are summarized along with the level of significance in appendices I to VII. The results are presented here in the following main heads.

4.1 Effect of soil solarization on physical, chemical and biological properties of soil

4.2 Effect of soil solarization on weed control in groundnut

4.3 Effect of soil solarization on growth, yield and yield components of groundnut

4.4 Effect of soil solarization on content of nutrients in groundnut haulm and weed

4.5 Effect of soil solarization on weed control in succeeding potato.

4.6 Effect of soil solarization on growth as well as yield components and yield of succeeding potato

4.7 Correlation study

4.8 Economic evaluation

4.1 Effect of soil solarization on physical, chemical and biological properties of soil.

4.1.1. Effect of soil solarization on physical properties of soil

4.1.1.1 Soil temperature

Soil temperature differed significantly at 5 cm and 10 cm soil depth due to soil solarization with transparent polyethylene (TPE) sheet during both the years and in pooled analysis (Table 7 and Appendix I & II).

A perusal of pooled data on soil temperature indicted that maximum soil temperature attained at 35 days after polyethylene spreading (DAPS) due to TPE 0.025 mm for 45 days was 56.6 ^{0}C and 53.3^{0}C at 5cm and 10 cm of soil depths, respectively and was higher over control (46.0^{0}C and 44.7^{0}C at respective depths) by 10.6^{0}C and 8.6^{0}C, respectively.

TPE 0.050 for 45 days recorded 54.6^{0}C and 52.0^{0}C soil temperature at 5 cm and 10 cm soil depth, respectively and the temperature were higher over control by 8.6^{0}C and 7.3^{0}C, respectively.

All SS treatments resulted in higher mean soil temperature 49.8 ^{0}C at 5 cm and 48.9 ^{0}C at 10 cm soil depth as compared to non solarization treatments (43.1^{0}C and 41.0^{0}C) at respective soil depth. Among TPE 0.025 mm solarization treatments, TPE 0.025 mm for 45 days recorded significantly higher mean soil temperature of all DAPS at 5 cm (53.5^{0}C) and 10 cm (51.3^{0}C) over TPE 0.025 mm for 15 days and 30 days solar tarping. Among TPE 0.050 mm treatments, TPE 0.050 mm for 45 days resulted higher mean soil temperature of all DAPS at 5 cm (51.6^{0}C) and 10 cm (49.8^{0}C) soil depth as compared to 15 days and 30 days after solar tarping. However, in general TPE 0.025 mm recorded higher mean soil temperature over TPE 0.050 mm at their respective durations. Soil temperature followed the similar trend in the individual year also (Appendix I and II).

Table 7: Soil temperature (^{0} C) at 5 cm and 10 cm soil depth as influenced by soil solarization treatments (pooled*)

Treatments	5 DAPS		10 DAPS		15 DAPS		20 DAPS		25 DAPS		30 DAPS		35 DAPS		40 DAPS		45 DAPS		Mean		Frequency (%) with temperature exceeding 50^{0}C	
	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	5 cm	10 cm	5 cm	10 cm
T_1 : TPE 0.025 mm 15 days	48.3	45.1	48.9	45.7	51.1	46.2													49.4	45.7	33.3	00.0
T_2 : TPE 0.025 mm 30 days	49.1	46.4	49.7	46.9	51.3	46.9	51.5	50.6	51.4	51.0	52.9	51.0							50.0	48.8	66.6	50.0
T_3 : TPE 0.025 mm 45 days	49.7	48.1	50.2	48.5	52.3	48.7	53.6	51.6	53.2	52.8	55.2	53.1	56.6	53.3	55.1	53.1	55.8	52.6	53.5	51.3	88.9	66.7
T_4 : TPE 0.050 mm 15 days	46.3	44.7	46.8	45.5	49.8	45.8													47.6	46.8	00.0	00.0
T_5 : TPE 0.050 mm 30 days	46.6	45.9	46.7	46.6	50.3	46.8	50.1	49.5	50.8	50.4	51.9	50.7							49.4	48.5	66.4	33.3
T_6 : TPE 0.050 mm 45 days	47.5	46.6	48.2	46.9	50.9	47.3	52.1	50.8	52.0	50.8	52.7	51.4	54.6	52.0	52.7	51.3	53.8	51.1	51.6	49.8	77.7	66.6
T_{10} : Weedy check	40.8	40.3	39.4	38.5	42.7	38.5	40.9	40.7	42.4	41.9	44.6	42.0	46.0	44.7	42.7	42.0	45.5	42.8	43.1	41.0	00.0	00.0
S.Em ±	0.4	0.3	0.4	0.3	0.4	0.3	0.4	0.3	0.4	0.4	0.4	0.4	0.5	0.3	0.4	0.3	0.4	0.3				
CD at 5%	1.1	0.9	1.1	0.8	1.1	0.9	1.2	0.9	1.4	1.1	1.1	1.1	1.4	0.9	1.3	1.0	1.2	1.0				
CV%	3.2	1.9	2.9	1.9	2.0	1.9	2.9	2.0	2.2	2.2	2.0	2.2	2.6	2.0	2.5	2.1	2.3	2.1				

DAPS = Days after polyethylene spreading
TPE =Transparent polyethylene

4.1.1.2 Soil moisture

Soil moisture content differed significantly due to soil solarization at 0-15 cm and 15-30 cm soil depth for all the durations during both the years and in pooled analysis (Table 8 and Appendix III).

An appraisal of pooled data indicated that all the solarization treatments retained significantly higher mean soil moisture of 6.21 per cent and 6.74 per cent at 0-15 cm and 15-30 cm soil depths, respectively over control (2.62 per cent and 3.50 per cent at respective depths) recorded At 15, 30 and 45 DAPS. In general, deeper depth of soil retained higher soil moisture per cent compared to shallow soil depth and soil moisture content was decreased as duration of DAPS increased.

4.1.2 Effect of soil solarization on chemical properties of soil

4.1.2.1 Organic carbon

The level of organic carbon content was significantly influenced by soil solarization during both the years and in pooled results (Table 9).

A perusal of data indicated that the lowest organic carbon content was recorded due to TPE 0.025 mm for 45 days (0.15, 0.12 and 0.13 per cent) compared to all other treatments in first year, second year and in pooled results, respectively. Significantly the highest organic carbon content was recorded in weedy check (0.28, 0.23 and 0.25 per cent) compared to all other treatments, barring TPE 0.050 mm for 15 days in first year, second year and in pooled results, whereas TPE 0.025 mm for 15 days in second year only. In general, soil solarization had significant reduction in organic carbon content in the soil.

4.1.2.2 Available nitrogen

Available nitrogen in the soil differed significantly due to soil solarization in both the years and in pooled results (Table 9).

Table 8 : Soil moisture (%) at 0-15 cm and 15-30 cm depth of soil as influenced by soil solarization treatments (pooled*)

Treatments	15 DAPS		30 DAPS		45 DAPS		mean	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1 : TPE 0.025 mm 15 days	5.81	6.40	--	--	--	--	5.81	6.40
T_2 : TPE 0.025 mm 30 days	6.35	6.78	5.99	6.48	--	--	6.17	6.63
T_3 : TPE 0.025 mm 45 days	6.55	6.85	6.11	6.70	5.55	6.15	6.07	6.57
T_4 : TPE 0.050 mm 15 days	6.16	6.68	--	--	--	--	6.16	6.68
T_5 : TPE 0.050 mm 30 days	6.79	7.16	6.19	6.84	--	--	6.49	7.00
T_6 : TPE 0.050 mm 45 days	7.11	7.60	6.73	7.03	5.73	6.25	6.52 (6.21)	6.96 (6.74)
T_{10} : Weedy check (control)	3.14	4.01	2.58	3.64	2.15	2.86	2.62	3.50
S.Em ±	0.13	0.13	0.11	0.12	0.09	0.13		
CD at 5%	0.41	0.38	0.33	0.37	0.26	0.39		
CV %	8.17	7.09	7.13	7.30	6.76	8.27		

Figure in parenthesis indicates the soil moisture (%) average for all solarized treatments

TPE : Transparent polyethylene
DAPS : Days after polyethylene spreading
* : pooled over two years

Table 9 : Plant nutrient availability as influenced by soil solarization treatments

Treatments	Organic carbon (%)			Available nitrogen kg ha^{-1}			Available phosphorus kg ha^{-1}		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	0.22	0.21	0.22	166.1	166.5	166.3	48.3	44.3	46.3
T_2 : TPE 0.025 mm 30 days	0.19	0.19	0.19	186.7	170.0	178.3	52.8	50.0	51.4
T_3 : TPE 0.025 mm 45 days	0.15	0.12	0.13	191.8	189.0	190.4	55.5	53.5	54.5
T_4 : TPE 0.050 mm 15 days	0.26	0.21	0.23	165.9	164.5	164.8	47.8	44.9	45.9
T_5 : TPE 0.050 mm 30 days	0.22	0.20	0.21	169.3	170.0	169.6	50.5	49.4	49.9
T_6 : TPE 0.050 mm 45 days	0.18	0.18	0.18	186.7	174.8	180.7	52.5	50.3	51.5
T_{10} : Weedy check (control)	0.28	0.23	0.25	147.5	146.0	146.7	44.7	42.6	43.7
S.Em $\pm$	0.008	0.007	0.005	5.8	4.9	3.8	1.01	1.10	0.74
CD at 5%	0.02	0.02	0.02	16.7	14.2	11.6	2.9	3.2	2.3
CV %	7.91	8.65	8.25	6.76	5.92	6.37	4.76	5.29	5.03

TPE : Transparent polyethylene

significantly maximum available nitrogen (191.8, 189.0 and 190.4 kg ha^{-1})in first year, second year and in pooled results, respectively, but it was at par with TPE 0.050 mm for 45 days during first year (186.7 kg ha^{-1}), second year (174.8 kg ha^{-1}) and in pooled results (180.8 kg ha^{-1}).Whereas TPE 0.025 mm for 45 days was also on par with TPE 0.025 mm for 30 days (186.7 kg ha^{-1}) only in first year. Significantly the lowest available nitrogen was recorded in weedy check (147.5 kg ha^{-1} in first year, 146.0 kg ha^{-1} in second year and 146.7 kg ha^{-1} in pooled results) over all other treatments. In general, soil solarization with longer duration (45 days) recorded higher available nitrogen as compared to shorter durations of polyethylene tarping.

4.1.2.3 Available phosphorus

Soil solarization had significant influence on available phosphorus in the soil in first year, second year and pooled results (Table 9).

From the data, it is seen that significantly maximum available phosphorus was recorded with TPE 0.025 mm for 45 days (55.5 kg ha^{-1} in first year and 53.5 kg ha^{-1} in second year) compared to all other treatments, except TPE 0.025 mm for 30 days in first year and TPE 0.050 mm for 45 days in the second year. However, it was significantly superior for available phosphorus (54.5 kg ha^{-1}) over all other treatments in pooled data. Significantly the lowest available phosphorus was recorded in weedy check (44.7 kg ha^{-1} in first year, 42.6 kg ha^{-1} in second year and 43.7 kg ha^{-1} in pooled results) as compared to all other treatments, barring TPE 0.050 mm for 15 days in the second year (44.9 kg ha^{-1}) and in pooled data (45.9 kg ha^{-1}), whereas, TPE 0.025 mm for 15 days in second year (44.3 kg ha^{-1}) only. In general, thinner solarization had significantly high available phosphorus as compared to thicker solarization, and available phosphorus was found to increase with increase in solarization duration.

4.1.2.4 Available potassium

Soil solarization had significant influence on available potassium in the soil in first year, second year and pooled results (Table10).

A perusal of data indicated that TPE 0.025 mm for 45 days recorded significantly the highest available potassium of 242.3, 237.3 and 240.0 kg ha^{-1} in the soil as compared to all other treatments in first year, second year and in pooled results, respectively. While the available potassium was recorded low under weedy check (185.5, 178.0 and 181.9 kg ha^{-1}) as compared to all other treatments, except TPE 0.050 mm for 15 days and TPE 0.025 mm for 15 days in first year, second year and pooled results, respectively. In general, the available potassium was found to increase with thinner solarization also with increase in duration.

4.1.2.5 Available sulphur

The level of available sulphur was significantly influenced by various treatments during first year, second year and in pooled results (Table 10).

An appraisal of data revealed that TPE 0.025 mm for 45 days recorded significantly the lowest available sulphur in the soil (6.53, 6.03 and 6.28 ppm) compared to all other treatments in first year, second year and in pooled results, respectively. While, significantly the highest available sulphur was recorded in weedy check (10.98, 10.93 and 10.95 ppm) as compared to all other treatments in first year, second year and pooled results, respectively. Among the soil solarization treatments, thicker TPE 0.050 mm with shorter duration (15 days) had significantly higher available sulphur (10.00, 10.08 and 10.04 ppm) as compared to other soil solarization treatments.

4.1.2.6 Available iron

A perusal of data (Table 11) indicated that the differences in available Fe status of soil were found significant due to various treatments during first year, second year and in pooled analysis.

Table 10 : Plant nutrient availability as influenced by soil solarization treatments

Treatments	Available potash kg ha^{-1}			Available sulphur kg ha^{-1}		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	203.7	192.0	197.9	8.98	7.88	8.43
T_2 : TPE 0.025 mm 30 days	214.2	209.3	211.8	7.90	7.08	7.49
T_3 : TPE 0.025 mm 45 days	242.3	237.7	240.0	6.53	6.03	6.28
T_4 : TPE 0.050 mm 15 days	202.5	187.6	195.1	10.00	10.08	10.04
T_5 : TPE 0.050 mm 30 days	212.5	208.1	210.3	9.08	8.88	8.98
T_6 : TPE 0.050 mm 45 days	217.8	211.2	214.5	8.05	7.80	7.93
T_{10} : Weedy check (control)	185.9	178.0	181.9	10.98	10.93	10.95
S.Em $\pm$	7.86	8.80	6.10	0.24	0.21	0.16
CD at 5%	22.8	25.4	18.9	0.70	0.60	0.49
CV %	7.57	9.10	8.39	6.32	5.59	5.98

TPE : Transparent polyethylene

It is seen that significantly higher status of available Fe in the soil was found due to TPE 0.025 for 45 days (7.99, 7.18 and 7.84 ppm) as compared to all other treatments, but it was found at par with TPE 0.050 mm for 45 days (7.58, 7.14 and 7.36 ppm) in first year, second year and in pooled analysis, respectively. Statistically it was observed low in weedy check (6.11, 5.82 and 5.96 ppm), which remained at par with TPE 0.025 mm for 15 days and TPE 0.050 mm for 15 days in first year, second year and in pooled analysis, respectively.

4.1.2.7 Available Manganese

The available Mn status of soil (Table 11) was significantly influenced due to soil solarization during both the years and in pooled results.

Data revealed that TPE 0.025 mm for 45 days (10.68, 10.12 and 10.40 ppm) significantly increased the status of available Mn in soil as compared to rest of the SS treatments, barring TPE 0.050 mm for 45 days (10.26, 9.66 and 9.96 ppm) in first year, second year as well as in pooled results, respectively. Significant decrease in status of available Mn was observed in weedy check (9.06, 8.72 and 8.89 ppm) as compared to all other treatments, barring shorter durations of soil solarization in both the years and in pooled results, respectively. In general, the available Mn in soil was increased with increasing duration of SS.

4.1.2.8 Available zinc

The available Zn status of soil (Table 11) was found significant variation due to various treatments in both the years and in pooled results.

A perusal of data revealed that TPE 0.0250 mm for 45 days (0.31, 0.26 and 0.29 ppm) significantly decreased the status of available Zn in soil as compared to all other treatments, except TPE 0.050 mm for 45 day (0.31, 0.30 and 0.31 ppm) in first year, second year and in pooled results, respectively. The status of available Zn was significantly maximum in weedy check (0.63, 0.55 and 0.59 ppm) compared to all other treatments in first year, second year and in

Table 11 : Plant nutrient availability as influenced by soil solarization treatments

Treatments	Available Fe (ppm)			Available Mn (ppm)			Available Zn (ppm)			Available Cu (ppm)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	6.61	6.36	6.49	9.61	9.37	9.49	0.50	0.45	0.47	0.35	0.31	0.33
T_2 : TPE 0.025 mm 30 days	7.13	6.82	6.98	9.81	9.50	9.66	0.35	0.32	0.34	0.45	0.34	0.40
T_3 : TPE 0.025 mm 45 days	7.99	7.18	7.84	10.68	10.12	10.40	0.31	0.26	0.29	0.48	0.42	0.45
T_4 : TPE 0.050 mm 15 days	6.34	6.58	6.46	9.60	9.42	9.51	0.50	0.44	0.47	0.34	0.32	0.33
T_5 : TPE 0.050 mm 30 days	6.75	6.76	6.76	9.76	9.50	9.63	0.33	0.35	0.34	0.43	0.37	0.40
T_6 : TPE 0.050 mm 45 days	7.58	7.14	7.36	10.26	9.66	9.96	0.31	0.30	0.31	0.44	0.38	0.41
T_{10} : Weedy check (control)	6.11	5.82	5.96	9.06	8.72	8.89	0.63	0.55	0.59	0.33	0.31	0.32
S.Em ±	0.22	0.26	0.17	0.27	0.35	0.02	0.02	0.02	0.02	0.02	0.02	0.02
CD at 5%	0.65	0.76	0.53	0.79	0.87	0.06	0.04	0.05	0.04	0.06	0.06	0.05
CV %	6.98	8.35	7.51	5.63	6.54	6.09	7.05	8.67	7.89	10.50	10.79	11.60

TPE =Transparent Polyethylene

pooled results, respectively. In general, the status of available Zn was found to decrease due to soil solarization treatments over weedy check.

4.1.2.9 Available copper

The differences in available Cu status of soil (Table 11) were significant due to various treatments during both the years and in pooled results.

A perusal of data indicated that significantly maximum available Cu status of soil was observed due to TPE 0.025 mm for 45 days (0.48, 0.42 and 0.45 ppm) compared to all other treatments, which being at par with TPE 0.025 mm for 30 days, TPE 0.050 mm for 30 and 45 days in first year, second year and in pooled results, respectively. Significantly minimum status of available Cu was observed in weedy check (0.33, 0.31 and 0.32 ppm) over all other treatments, except shorter durations of SS during first year, second year and in pooled results, respectively. In general, SS either with 30 or 45 days recorded significantly higher mean available Cu in the soil over shorter durations of SS and non solarized treatment.

4.1.3 Effect of soil solarization on biological properties of soil

4.1.3.1 Total fungi per gram of soil

Total fungi after soil solarization (Table 12) and after harvest of groundnut (Table 13) differed significantly due to solarization during both the years and in pooled analysis.

An appraisal of data (Table 12) indicated that significantly the highest total fungi per gram of soil (9.70×10^4, 10.80×10^4 and 10.25×10^4) was recorded in non solarized control as compared to all other treatments in first year, second year and in pooled results, respectively just after soil solarization, except TPE 0.050 mm for 15 days in second year (10.20×10^4) only. The solarized treatment TPE 0.025 mm for 45 days had significantly the lowest number of total fungi (6.60×10^4, 7.40×10^4 and 7.00×10^4) as compared to all other treatments in first year,

Table 12 : Soil microbial population per gram of soil after soil solarization as influenced by soil solarization in groundnut

Treatments	Total fungi (10^4)			Bacteria (10^6)			Actinomycetes (10^5)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	9.00	10.00	9.50	16.00	17.18	16.59	6.40	7.30	6.85
T_2 : TPE 0.025 mm 30 days	7.50	8.50	8.00	16.10	17.20	16.65	6.20	7.10	6.65
T_3 : TPE 0.025 mm 45 days	6.60	7.40	7.00	15.70	15.59	15.65	6.15	6.90	6.53
T_4 : TPE 0.050 mm 15 days	9.18	10.20	9.59	16.38	16.90	16.64	6.10	7.00	6.55
T_5 : TPE 0.050 mm 30 days	9.14	9.95	9.55	15.95	17.13	16.54	5.80	6.80	6.30
T_6 : TPE 0.050 mm 45 days	7.15	8.16	7.66	16.25	17.20	16.73	5.70	6.50	6.10
T_{10} : Weedy check (control)	9.70	10.80	10.25	17.43	19.00	18.21	7.10	8.50	7.80
S.Em ±	0.17	0.26	0.16	0.26	0.36	0.22	0.13	0.19	0.12
CD at 5%	0.51	0.75	0.48	0.75	1.04	0.68	0.40	0.56	0.36
CV %	5.86	7.94	7.10	4.56	5.86	5.35	6.09	7.72	7.11

TPE : Transparent polyethylene

Table 13 : Soil microbial population per gram of soil after harvest of groundnut as influenced by soil solarization

Treatments	Total fungi (10^4)			Bacteria (10^6)			Actinomycetes (10^5)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	10.75	11.75	11.25	22.50	20.50	21.50	7.30	7.10	7.20
T_2 : TPE 0.025 mm 30 days	10.11	10.77	10.44	23.88	21.80	22.84	7.86	7.60	7.73
T_3 : TPE 0.025 mm 45 days	9.66	9.35	9.51	24.95	22.70	23.83	8.20	8.00	8.10
T_4 : TPE 0.050 mm 15 days	12.33	13.00	12.67	22.20	20.10	21.15	7.20	6.90	7.05
T_5 : TPE 0.050 mm 30 days	11.06	10.35	11.36	23.40	21.30	22.35	7.60	7.40	7.50
T_6 : TPE 0.050 mm 45 days	9.60	10.35	9.98	24.00	22.00	23.00	8.08	7.90	7.99
T_{10} : Weedy check (control)	13.65	14.28	13.97	21.58	19.88	20.73	8.70	8.55	8.63
S.Em ±	0.20	0.26	0.17	0.39	0.32	0.25	0.13	0.13	0.09
CD at 5%	0.58	0.77	0.51	1.13	0.94	0.78	0.37	0.38	0.28
CV %	5.16	6.51	5.19	4.78	4.37	4.60	4.70	4.92	4.81

TPE : Transparent polyethylene

second year and in pooled results, respectively just after soil solarization. As the duration of solar tarping increased, the fungal population decreased due to soil solarization.

During the crop growth period, there was improvement in the fungal population in all the treatments as recoded after harvest of groundnut (Table 13). Among different treatments, significantly maximum fungal population of 13.65 x 10^4, 14.28 x 10^4 and 13.97 x 10^4 in first year, second year and in pooled results, respectively was recorded in weedy check over all SS treatments

4.1.3.2 Total bacterial population per gram of soil

Total bacterial population per gram soil after soil solarization and after harvest of groundnut varied significantly due to various treatments in first year, second year and in pooled results (Table 12 and Table 13).

A perusal of data in Table 12 indicated that significantly the highest total bacterial count (17.43 x 10^6, 19.00 x 10^6 and 18.21 x 10^6) was observed in non solarized control as compared to all SS treatments in first year, second year and in pooled results, respectively just after SS. Minimum count was recorded under TPE 0.025 mm for 45 days (15.70 x 10 ^{6}) in first year, but it was at par with rest of SS treatments. However, TPE 0.025 mm for 45 days recorded significantly the lowest bacterial count in second year (15.59 x $10^{6)}$ and in pooled results (15.65 x 10^6).

After harvest of groundnut (Table 13), bacterial count was significantly higher in TPE 0.025 mm for 45 days (24.95 x 10^6, 22.70 x 10^6 and 23.83 x 10^6), barring TPE 0.050 mm for 45 days and TPE 0.025 mm for 30 days during the first year and second year, respectively. However, significantly minimum bacterial count of 21.58 x 10^6, 19.88 x 10^6 and 20.73 x 10^6 was recorded in weedy check over all other treatments, except shorter duration of solarization (15 days) in first year, second year as well as in pooled results, respectively.

4.1.3.3 Actinomycetes per gram of soil

Actinomycetes after soil solarization and after harvest of groundnut differed significantly due to different treatments during first year, second year and in pooled results (Table 12 and Table 13).

Results clearly (Table 12) revealed that significantly maximum count of actinomycetes was recorded in non solarized treatment (7.10×10^5 , 8.50×10^5 and 7.80×10^5) over solarized treatments, just after solarization during first year, second year and in pooled results, respectively. While, TPE 0.050 mm for 45 days registered significantly minimum population of actinomycetes (5.70×10^5 ,6.50×10^5 and 6.10×10^5) in first year, second year as well as in pooled results, respectively, but it was at par TPE 0.050 mm for 15 days and TPE 0.050 mm for 30 days in first year, TPE 0.050 mm for 15 days, TPE 0.050 mm for 30 days and TPE 0.025 mm for 45 days in second year and TPE 0.050 mm for 30 days in pooled results.

After harvest of groundnut crop (Table 13); the population of actinomycetes was found to increase significantly in non solarized (8.70×10^5, 8.55×10^5 and 8.63×10^5) over solarized condition in first year, second year and in pooled results, respectively.

4.2 Effect of soil solarization on weed control in groundnut

4.2.1 Weed flora of experimental plots

Following pre-dominant weed species of grasses, broad leaved and sedges were observed in experimental fields and they were more or less similar in both the years.

Grasses	Broad leaved	Sedges
Digitaria sanguinalis L.Scop	*Boerhavia repanda*	*Cyperus rotundus L*
Dactylocatenium aegyptium	*Phallanthus niruri Linn*	*Cyperus irria L (only in 03-04)*
Eleusine indica	*Portulaca oleracea*	
Cynadon dactylon (L.)Pers	*Tribulus terrestris L*	
Cenchrus biflorus L	*Amaranthus lividis L.*	
Eragrostis major L	*Amaranthus viridis L.*	
	Amaranthus spinosus L	
	Digera arvensis L	
	Tridex procumbens	
	Commelina	
	bengalensis L.	
	Euphorbia hirta	

4.2.2 Weed count per meter square

The data on number of grasses, broad leaved, sedges and total weeds per meter square revealed that significant differences were observed due to various treatments during both the years and also in pooled analysis at 30, 60, 90 DAS and harvest. Original and square root transformed value presented in Tables 14 to 17.

A perusal of data in Table 14 indicated that at 30 DAS, significantly maximum count of grasses, broad leaved, sedges and total weeds were recorded in weedy check during first year (15.92, 15.21, 25.00 and 56.13), second year (24.01, 16.00, 30.25 and 70.46) and in pooled results (19.80, 15.60, 27.56 and 63.29), respectively. However, grasses, broad leaved, sedges and total weeds were observed significantly less number in weed free during first year (0.64, 0.36 1.21 and 2.21), second year (0.65, 0.77, 1.82 and 3.24) and in pooled results

Table 14 : Weed count per m^2 at 30 DAS in groundnut as influenced by various treatments .

Treatments	Grasses			Broad leaved			Sedges			Total weeds		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	3.60	3.95	3.78	2.50	2.75	2.63	3.50	4.20	3.85	5.61	6.39	6.00
	12.96	**15.60**	**14.28**	**6.25**	**7.56**	**6.91**	**12.25**	**17.64**	**14.82**	**31.47**	**40.83**	**36.00**
T_2 : TPE 0.025 mm 30 days	2.50	2.80	2.65	1.95	2.10	2.03	2.90	2.50	2.70	4.30	4.30	4.30
	6.25	**7.84**	**7.02**	**3.80**	**4.41**	**4.12**	**8.41**	**6.25**	**7.29**	**18.49**	**18.49**	**18.49**
T_3 : TPE 0.025 mm 45 days	0.80	1.23	1.01	0.77	1.20	0.99	1.40	1.43	1.41	1.79	2.23	2.01
	0.64	**1.51**	**1.02**	**0.59**	**1.44**	**0.98**	**1.98**	**2.04**	**1.99**	**3.20**	**4.97**	**4.04**
T_4 : TPE 0.050 mm 15 days	3.90	3.94	3.92	2.90	3.30	3.10	4.00	4.20	4.10	6.29	6.64	6.47
	15.21	**15.52**	**15.36**	**8.41**	**10.89**	**9.61**	**16.00**	**17.64**	**16.81**	**39.56**	**44.08**	**41.86**
T_5 : TPE 0.050 mm 30 days	3.30	3.71	3.51	2.30	2.50	2.40	3.30	4.00	3.65	5.20	6.00	5.60
	10.89	**13.76**	**12.32**	**5.29**	**6.25**	**5.76**	**10.89**	**16.00**	**13.32**	**27.04**	**36.00**	**31.36**
T_6 : TPE 0.050 mm 45 days	2.20	2.41	2.30	1.80	1.99	1.90	2.70	2.35	2.53	3.92	3.91	3.91
	4.84	**5.80**	**5.29**	**3.24**	**3.96**	**3.61**	**7.29**	**5.52**	**6.40**	**15.36**	**15.28**	**15.28**
T_7 : Pendimethalin 1.0 kg ha^{-1}	2.45	2.28	2.36	1.90	1.65	1.78	2.70	2.00	2.35	4.11	3.45	3.78
	6.00	**5.19**	**5.56**	**3.61**	**2.72**	**3.16**	**7.29**	**4.00**	**5.52**	**16.81**	**11.90**	**14.28**
T_8 : HW twice plus earthing up	0.85	1.10	0.98	0.98	1.10	1.04	1.41	1.38	1.39	2.10	1.89	1.99
	0.72	**1.21**	**0.96**	**0.96**	**1.21**	**1.08**	**1.98**	**1.90**	**1.93**	**4.40**	**3.57**	**3.98**
T_9 : Weed free	0.80	0.81	0.81	0.60	0.88	0.74	1.10	1.35	1.23	1.49	1.80	1.65
	0.64	**0.65**	**0.65**	**0.36**	**0.77**	**0.55**	**1.21**	**1.82**	**1.51**	**2.21**	**3.24**	**2.72**
T_{10} : Weedy check	3.99	4.90	4.45	3.90	4.00	3.95	5.00	5.50	5.25	7.49	8.38	7.90
	15.92	**24.01**	**19.80**	**15.21**	**16.00**	**15.60**	**25.00**	**30.25**	**27.56**	**56.13**	**70.46**	**63.29**
S.Em +	0.23	0.14	0.13	0.13	0.17	0.11	0.14	0.17	0.11	0.39	0.39	0.27
CD at 5%	0.66	0.42	0.41	0.38	0.50	0.33	0.41	0.49	0.34	1.12	1.12	0.84
CV %	17.42	11.28	14.72	13.36	16.11	14.92	10.01	11.73	10.91	17.48	18.01	17.74

TPE = Transparent polyethylene
DAS = Days After Sowing
Bold letters indicate original value

(0.65, 0.55, 1.51 and 2.72) and it was found superior over all other treatments, except hand weeding twice plus earthing up during first year (0.72, 0.96, 1.90 and 3.57), second year (1.21, 1.21, 1.98 and 4.40) and in pooled results (0.96, 1.08, 1.93 and 3.98, respectively) and TPE 0.025 mm for 45 days during first year (0.64, 0.59, 1.98 and 3.20), second year (1.51, 1.44, 2.04 and 4.97) and in pooled results (1.02, 0.98, 1.99 and 4.04, respectively.

An appraisal of data in Table 15 indicated that at 60 DAS, significantly maximum grasses, broad leaved, sedges and total weeds population were recorded in weedy check during first year (36.00, 24.60, 43.29 and 103.83), second year (35.88, 30.14, 60.37 and 126.33) and in pooled results (36.00, 27.24, 51.65 and 114.80), respectively. While, grasses, broad leaved, sedges and total weeds were registered significantly minimum in weed free in first year (1.00, 1.44, 5.06 and 7.50), second year (1.69, 1.23, 6.91and 9.97) and in pooled results (1.32, 1.34, 5.95 and 8.62), respectively and it was found superior over all other treatments, except hand weeding twice plus earthing up during first year (1.21, 2.65, 5.76 and 9.61), second year (3.61, 2.82, 7.72 and 14.13) and in pooled results (2.25, 2.72, 6.71 and 11.68) and TPE 0.025 mm for 45 days during first year (1.21, 1.69, 5.10 and 8.00), second year (3.61, 2.25, 8.41 and 14.28) and in pooled results (2.25, 1.96, 6.65 and 10.89), respectively.

Data in Table 16 showed that at 90 DAS, significantly maximum count of grasses, broad leaved, sedges and total weeds were found in weedy check during first year (49.00, 32.49, 36.00 and 117.49), second year (52.56, 33.64, 46.24 and 132.48) and in pooled results (50.83, 33.06, 40.96 and 124.85), respectively. Significantly minimum count of grasses, broad leaved, sedges and total weeds were recorded in weed free during first year (1.96, 4.04, 5.66 and 11.62), second year (1.10, 2.56, 8.70 and 12.39) and in pooled results (1.51, 3.28, 7.08 and 11.86), respectively and it was superior over all other treatments, except TPE 0.025 mm for 45 days during first year (2.28, 3.61, 7.02 and 12.82), second year (2.82, 3.24, 9.61 and 15.67) and in pooled results (2.56, 3.42, 8.29 and 14.28), respectively.

Table 15 : Weed count per m^2 at 60 DAS in groundnut as influenced by various treatment.

Treatments	Grasses			Broad leaved			Sedges			Total weeds		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	4.03	4.70	4.36	3.08	3.67	3.38	4.45	4.55	4.50	6.74	7.50	7.12
	16.24	**22.09**	**19.00**	**9.48**	**13.46**	**11.42**	**19.80**	**20.70**	**20.25**	**45.42**	**56.25**	**50.69**
T_2 : TPE 0.025 mm 30 days	3.23	3.75	3.49	2.33	2.62	2.47	3.75	4.50	4.13	5.47	6.41	5.94
	10.43	**14.06**	**12.18**	**5.42**	**6.86**	**6.10**	**14.06**	**20.25**	**17.05**	**29.92**	**41.08**	**35.28**
T_3 : TPE 0.025 mm 45 days	1.10	1.90	1.50	1.30	1.50	1.40	2.26	2.90	2.58	2.83	3.78	3.30
	1.21	**3.61**	**2.25**	**1.69**	**2.25**	**1.96**	**5.10**	**8.41**	**6.65**	**8.00**	**14.28**	**10.89**
T_4 : TPE 0.050 mm 15 days	4.60	4.91	4.76	3.28	3.92	3.60	5.16	6.04	5.60	7.65	8.72	8.18
	21.16	**24.10**	**22.65**	**10.75**	**15.36**	**12.96**	**36.62**	**36.48**	**31.36**	**58.52**	**76.03**	**66.91**
T_5 : TPE 0.050 mm 30 days	4.00	4.35	4.18	2.78	3.59	3.19	4.52	5.23	4.88	6.65	7.69	7.17
	16.00	**18.92**	**17.47**	**7.72**	**12.88**	**10.17**	**20.43**	**27.35**	**23.81**	**44.22**	**59.13**	**51.40**
T_6 : TPE 0.050 mm 45 days	3.00	3.62	3.31	2.21	2.43	2.32	3.66	4.44	4.05	5.22	6.22	5.72
	9.00	**13.10**	**10.95**	**4.88**	**5.90**	**5.38**	**13.39**	**19.71**	**16.40**	**27.24**	**38.68**	**32.71**
T_7 : Pendimethalin 1.0 kg ha^{-1}	3.10	3.51	3.31	2.29	2.14	2.21	3.44	4.24	3.84	5.17	5.90	5.54
	9.61	**12.32**	**10.95**	**5.24**	**4.57**	**4.88**	**11.83**	**17.97**	**14.74**	**26.72**	**34.81**	**30.59**
T_8 : HW twice plus earthing up	1.10	1.90	1.50	1.63	1.68	1.65	2.40	2.78	2.59	3.10	3.76	3.43
	1.21	**3.61**	**2.25**	**2.65**	**2.82**	**2.72**	**5.76**	**7.72**	**6.71**	**9.61**	**14.13**	**11.68**
T_9 : Weed free	1.00	1.30	1.15	1.20	1.11	1.16	2.25	2.63	2.44	2.74	3.13	2.94
	1.00	**1.69**	**1.32**	**1.44**	**1.23**	**1.34**	**5.06**	**6.91**	**5.95**	**7.50**	**9.79**	**8.62**
T_{10} : Weedy check	6.00	5.99	6.00	4.96	5.49	5.22	6.58	7.77	7.18	10.19	11.24	10.72
	36.00	**35.88**	**36.00**	**24.60**	**30.14**	**27.24**	**43.29**	**60.37**	**51.65**	**103.83**	**126.33**	**114.80**
S.Em ±	0.18	0.29	0.17	0.17	0.27	0.16	0.23	0.20	0.15	0.39	0.33	0.26
CD at 5%	0.052	0.84	0.53	0.48	0.77	0.49	0.66	0.59	0.47	1.12	0.97	0.79
CV %	11.69	16.16	14.45	13.21	19.01	16.72	11.79	9.07	10.34	13.89	10.37	12.04

TPE =Transparent polyethylene
DAS =Days After Sowing
Bold letters indicated original value

Table 16 : Weed count per m^2 at 90 DAS in groundnut as influenced by various treatment.

Treatments	Grasses			Broad leaved			Sedges			Total weeds		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	4.50	6.04	5.27	3.50	4.80	4.15	5.40	5.08	5.24	7.85	9.24	8.54
	20.25	**36.48**	**27.77**	**12.25**	**23.04**	**17.22**	**29.16**	**25.80**	**27.45**	**61.62**	**85.37**	**72.93**
T_2 : TPE 0.025 mm 30 days	3.88	4.73	4.31	2.60	3.51	3.06	4.10	4.38	4.24	6.21	7.34	6.78
	15.05	**22.37**	**18.57**	**6.76**	**12.32**	**9.36**	**16.81**	**19.18**	**17.97**	**37.56**	**53.87**	**45.96**
T_3 : TPE 0.025 mm 45 days	1.51	1.68	1.60	1.90	1.80	1.85	2.65	3.10	2.88	3.59	3.96	3.78
	2.28	**2.82**	**2.56**	**3.61**	**3.24**	**3.42**	**7.02**	**9.61**	**8.29**	**12.82**	**15.67**	**14.28**
T_4 : TPE 0.050 mm 15 days	4.80	6.68	5.74	3.97	4.80	4.38	5.65	5.11	5.38	8.41	9.68	9.05
	23.04	**44.62**	**32.94**	**15.76**	**23.04**	**19.18**	**31.92**	**26.11**	**28.94**	**70.72**	**93.70**	**81.90**
T_5 : TPE 0.050 mm 30 days	3.99	6.12	5.06	3.40	4.06	3.73	4.98	4.70	4.84	7.23	8.72	7.97
	15.92	**37.45**	**25.60**	**11.56**	**16.48**	**13.91**	**24.80**	**22.09**	**23.42**	**52.27**	**76.03**	**63.52**
T_6 : TPE 0.050 mm 45 days	3.59	3.00	3.30	2.70	2.45	2.58	3.75	4.30	4.03	5.85	5.79	5.82
	12.88	**9.00**	**10.89**	**7.29**	**6.00**	**6.65**	**14.06**	**18.49**	**16.24**	**24.32**	**33.52**	**33.87**
T_7 : Pendimethalin 1.0 kg ha^{-1}	2.20	2.35	2.28	3.05	2.32	2.69	4.00	4.32	4.16	5.49	5.44	5.46
	4.84	**5.52**	**5.19**	**9.30**	**5.38**	**7.23**	**16.00**	**18.66**	**17.30**	**30.14**	**29.59**	**29.81**
T_8 : HW twice plus earthing up	2.13	2.35	2.24	2.90	2.31	2.61	3.63	4.34	3.98	5.11	5.45	5.2
	4.66	**5.52**	**5.01**	**8.41**	**5.33**	**6.81**	**13.17**	**18.83**	**15.84**	**26.11**	**29.70**	**27.04**
T_9 : Weed free	1.40	1.05	1.23	2.01	1.60	1.81	2.38	2.95	2.66	3.41	3.52	3.46
	1.96	**1.10**	**1.51**	**4.04**	**2.56**	**3.28**	**5.66**	**8.70**	**7.08**	**11.62**	**12.39**	**11.86**
T_{10} : Weedy check	7.00	7.25	7.13	5.70	5.80	5.75	6.00	6.80	6.40	10.84	11.51	11.17
	49.00	**52.56**	**50.83**	**32.49**	**33.64**	**33.06**	**36.00**	**46.24**	**40.96**	**117.49**	**132.48**	**124.85**
S.Em ±	0.21	0.25	0.16	0.17	0.23	0.14	0.23	0.33	0.20	0.39	0.39	0.28
CD at 5%	0.59	0.73	0.50	0.51	0.66	0.44	0.65	0.96	0.61	1.14	1.12	0.85
CV %	11.69	12.21	12.06	11.13	13.56	2.47	9.97	15.47	12.86	12.33	10.97	11.61

TPE =Transparent polyethylene
DAS =Days After Sowing
Bold letters indicated original value

A perusal of data (Table 17 and Fig.4) at harvest indicated that significantly maximum count of grasses, broad leaved, sedges and total weeds were noted in weedy check during first year (65.61, 49.00, 53.29 and 193.21), second year (73.96, 28.09, 78.49 and 155.25) and in pooled results (69.72, 37.82, 65.28 and 173.21), respectively. However, statistically minimum count of grasses, broad leaved, sedges and total weeds were recorded in weed free during first year (6.00, 7.02, 20.70 and 33.72), second year (4.20, 5.29, 23.81 and 33.30) and in pooled results (5.06, 6.15, 22.16 and 33.52), respectively and was superior over all other treatments, except in TPE 0.025 mm for 45 days during first year (4.41, 4.45, 18.57 and 29.81), second year (4.53, 5.06, 20.97 and 28.19) and in pooled results (4.45, 4.75, 19.71 and 28.94), respectively.

4.2.3 Dry weight of weeds

Data on dry weight of weed at 30, 60, 90 DAS and at harvest indicated that dry weight of total weeds, grasses, broad leaved and sedges was significantly influenced by various treatments during both the years and in pooled analysis. At all the stages significantly the lowest weed dry weight was recorded in weed free and significantly the highest was in weedy check Original and square root transformed value presented in Tables 18 to 21.

A perusal of data (Table 18) indicated that at 30 DAS, significantly maximum dry weight of grasses, broad leaved, sedges and total weeds was recorded in weedy check during first year (19.89, 14.59, 7.12 and 41.60 g / 0.25 m^2), second year (25.80, 12.11, 7.02 and 44.89 g/0.25 m^2) and in pooled results (22.75, 13.32, 7.07 and 43.29 g / 0.25 m^2), respectively. While, minimum dry weight of grasses, broad leaved, sedges and total weeds was significantly observed in weed free during first year (0.16, 0.77, 0.92 and 1.84 g / 0.25 m^2), second year (0.81, 0.81, 0.90 and 2.52 g/0.25 m2) and in pooled results (0.42, 0.79, 0.97 and 2.19 g/0.25 m2), respectively and was found superior over all other treatments, except hand weeding twice plus earthing up during first year (0.49, 1.00, 1.56 and 3.02 g / 0.25 m^2), second year (1.00, 0.94, 1.74 and 3.68 g /

Table 17 : Weed count per m^2 at harvest in groundnut as influenced by various treatment.

Treatments	Grasses			Broad leaved			Sedges			Total weeds		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	5.97	6.10	6.04	4.98	4.11	4.54	5.74	7.92	6.83	11.09	9.33	10.21
	35.64	**37.21**	**36.48**	**24.80**	**16.89**	**20.61**	**32.94**	**62.72**	**46.64**	**122.98**	**87.04**	**104.21**
T_2 : TPE 0.025 mm 30 days	4.03	4.90	4.46	4.34	3.30	3.82	4.80	6.85	5.83	9.05	7.61	8.33
	16.24	**24.01**	**19.89**	**18.83**	**10.89**	**14.59**	**23.04**	**46.92**	**33.98**	**81.90**	**57.91**	**69.38**
T_3 : TPE 0.025 mm 45 days	2.10	2.13	2.11	2.11	2.25	2.18	4.31	4.58	4.44	5.46	5.31	5.38
	4.41	**4.53**	**4.45**	**4.45**	**5.06**	**4.75**	**18.57**	**20.97**	**19.71**	**29.81**	**28.19**	**28.94**
T_4 : TPE 0.050 mm 15 days	6.10	6.10	6.10	5.30	4.20	4.75	5.83	8.00	6.92	11.37	9.43	10.40
	37.21	**37.21**	**37.21**	**28.09**	**17.64**	**22.56**	**33.98**	**64.00**	**47.88**	**129.27**	**88.92**	**108.16**
T_5 : TPE 0.050 mm 30 days	5.10	5.98	5.54	4.90	3.70	4.30	5.24	7.50	6.37	10.31	8.77	9.54
	26.01	**35.76**	**30.69**	**24.01**	**13.69**	**18.49**	**27.45**	**56.25**	**40.57**	**106.29**	**76.91**	**91.01**
T_6 : TPE 0.050 mm 45 days	3.93	3.55	3.74	4.30	2.90	3.60	4.72	6.48	5.60	8.71	6.58	7.65
	15.44	**12.60**	**13.98**	**18.49**	**8.41**	**12.96**	**22.27**	**41.99**	**31.36**	**75.86**	**46.29**	**58.62**
T_7 : Pendimethalin 1.0 kg ha^{-1}	3.98	2.93	3.45	4.11	3.13	3.62	4.90	6.18	5.54	8.42	6.51	7.46
	15.84	**8.58**	**11.90**	**16.89**	**9.79**	**13.10**	**24.01**	**38.19**	**30.69**	**70.89**	**42.38**	**55.65**
T_8 : HW twice plus earthing up	3.25	2.90	3.08	3.84	3.08	3.46	4.62	6.15	5.39	8.33	6.61	7.47
	10.56	**8.41**	**9.48**	**14.74**	**9.48**	**11.97**	**21.34**	**37.82**	**29.05**	**69.38**	**43.69**	**55.80**
T_9 : Weed free	2.45	2.05	2.25	2.65	2.30	2.48	4.55	4.88	4.71	5.81	5.77	5.79
	6.00	**4.20**	**5.06**	**7.02**	**5.29**	**6.15**	**20.70**	**23.81**	**22.26**	**33.72**	**33.30**	**33.52**
T_{10} : Weedy check	8.10	8.60	8.35	7.00	5.30	6.15	7.30	8.86	8.08	13.90	12.46	13.18
	65.61	**73.96**	**69.72**	**49.00**	**28.09**	**37.82**	**53.29**	**78.49**	**65.28**	**193.21**	**155.25**	**173.71**
S.Em ±	0.25	0.26	0.18	0.18	0.23	01.5	0.27	0.41	0.25	0.43	0.39	0.29
CD at 5%	0.73	0.76	0.56	0.52	0.67	0.45	0.79	1.18	0.76	1.26	1.11	0.90
CV %	11.11	11.61	11 37	10.49	10.64	10.66	10.42	12.15	11.63	9.33	10.10	9.69

TPE =Transparent polyethylene
DAS =Days After Sowing
Bold letters indicated original value

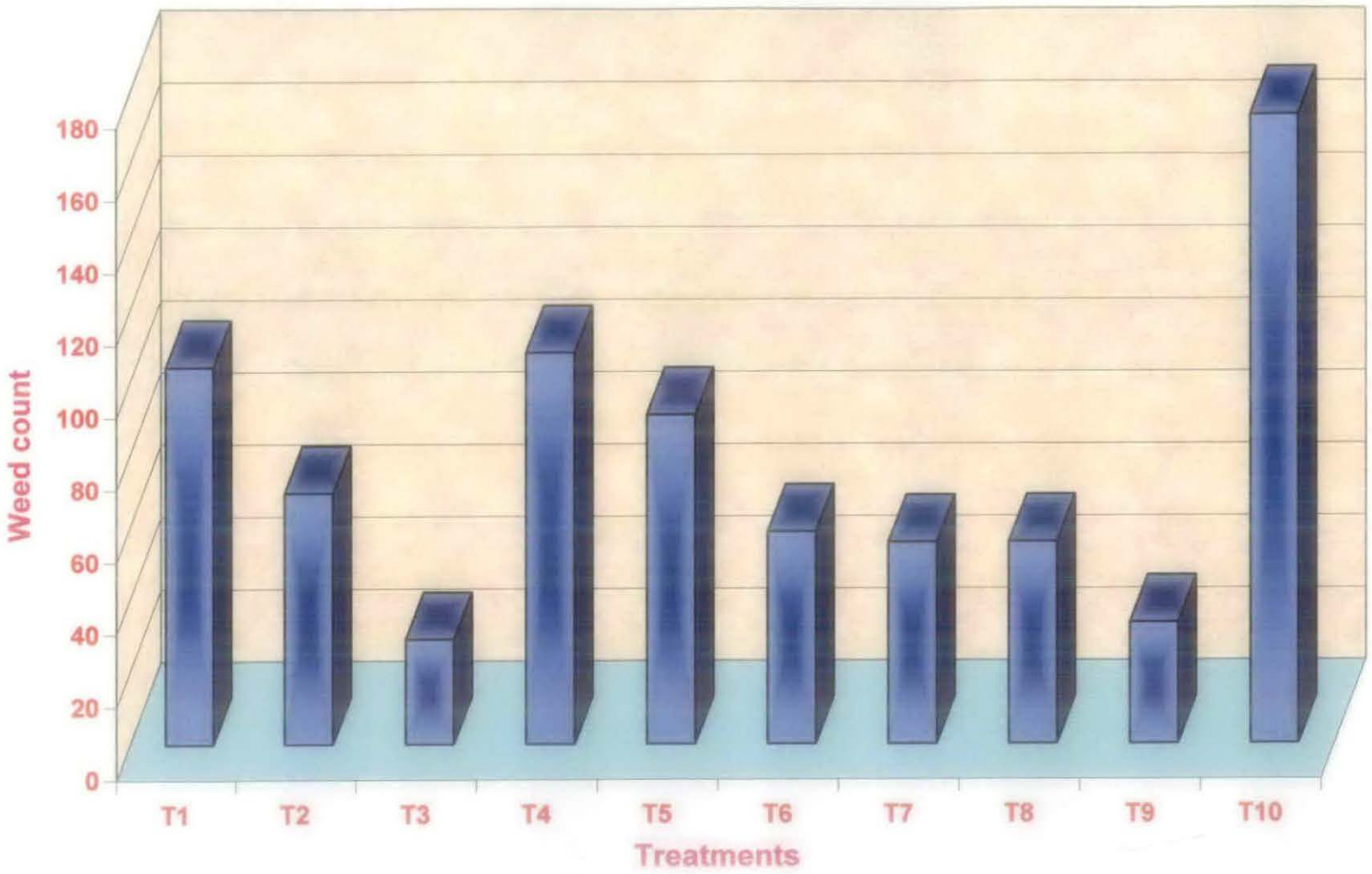


Fig. 4 : Weed count at harvest in groundnut as influenced by various treatments (pooled)

Table 18 : Weed dry weight (g / 0.25 m^2) at 30 DAS in groundnut as influenced by various treatments .

Treatments	Grasses			Broad leaved .			Sedges			Total weeds		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	4.00	3.72	3.93	2.75	2.95	2.85	1.80	2.14	1.97	5.17	5.30	5.24
	16.00	**13.83**	**15.44**	**7.56**	**8.70**	**8.12**	**3.24**	**4.57**	**3.88**	**26.72**	**28.09**	**27.45**
T_2 : TPE 0.025 mm 30 days	1.62	1.89	1.76	2.16	2.18	2.17	1.52	1.82	1.67	3.10	3.41	3.25
	2.62	**3.57**	**3.09**	**4.66**	**4.75**	**4.70**	**2.31**	**3.31**	**2.78**	**9.61**	**11.62**	**10.56**
T_3 : TPE 0.025 mm 45 days	0.75	1.13	0.94	0.95	1.13	1.04	1.10	1.13	1.11	1.64	1.95	1.79
	0.56	**1.27**	**0.88**	**0.90**	**1.27**	**1.08**	**1.21**	**1.27**	**1.23**	**2.64**	**3.80**	**3.20**
T_4 : TPE 0.050 mm 15 days	4.30	3.92	4.11	2.99	3.10	3.05	1.87	2.20	2.04	5.56	5.46	5.51
	18.49	**15.36**	**16.89**	**8.94**	**9.61**	**9.30**	**3.49**	**4.84**	**4.16**	**30.91**	**29.81**	**30.36**
T_5 : TPE 0.050 mm 30 days	1.82	1.96	1.89	2.36	2.59	2.48	1.64	1.78	1.71	3.40	3.70	3.55
	3.31	**3.84**	**3.57**	**5.56**	**6.70**	**6.15**	**2.68**	**3.16**	**2.92**	**11.56**	**13.69**	**12.60**
T_6 : TPE 0.050 mm 45 days	1.64	1.66	1.65	1.82	2.03	1.93	1.43	1.45	1.44	2.84	3.00	2.92
	2.68	**2.75**	**2.72**	**3.31**	**4.12**	**3.72**	**2.04**	**2.10**	**2.07**	**8.06**	**9.00**	**8.52**
T_7 : Pendimethalin 1.0 kg ha^{-1}	1.78	1.62	1.70	1.65	1.52	1.59	1.51	1.40	1.45	2.86	2.63	2.74
	3.16	**2.62**	**2.89**	**2.72**	**2.31**	**2.52**	**2.27**	**1.96**	**2.10**	**8.17**	**6.91**	**7.50**
T_8 : HW twice plus earthing up	0.70	1.00	0.85	1.00	0.97	0.99	1.25	1.32	1.28	1.74	1.92	1.83
	0.49	**1.00**	**0.72**	**1.00**	**0.94**	**0.98**	**1.56**	**1.74**	**1.63**	**3.02**	**3.68**	**3.34**
T_9 : Weed free	0.40	0.90	0.65	0.88	0.90	0.89	0.96	0.95	0.96	1.36	1.59	1.48
	0.16	**0.81**	**0.42**	**0.77**	**0.81**	**0.79**	**0.92**	**0.90**	**0.92**	**1.84**	**2.52**	**2.19**
T_{10} : Weedy check	4.46	5.08	4.77	3.82	3.48	3.65	2.67	2.65	2.66	6.45	6.70	6.58
	19.89	**25.80**	**22.75**	**14.59**	**12.11**	**13.32**	**7.12**	**7.02**	**7.07**	**41.60**	**44.89**	**43.29**
S.Em +	0.18	0.14	0.11	0.16	0.17	0.12	0.14	0.15	0.10	0.25	0.26	0.18
CD at 5%	0.52	0.40	0.35	0.45	0.49	0.35	0.42	0.42	0.32	0.74	0.75	0.56
CV %	16.57	11.78	14.22	15.31	16.15	15.75	18.24	17.26	17.73	14.48	15.14	14.80

TPE =Transparent polyethylene
DAS =Days After Sowing
Bold letters indicated original value

0.25 m^2) and in pooled results (0.72, 0.98, 1.63 and 3.34 g / 0.25 m^2) and TPE 0.025 mm for 45 days during first year (0.56, 0.90, 1.21 and 2.64 g / 0.25 m^2), second year (1.27, 1.27, 1.27 and 3.80 g / 0.25 m^2) and in pooled results (0.88, 1.08, 1.23 and 3.20 g / 0.25 m^2), respectively.

An appraisal of data in Table 19 indicated that at 60 DAS, significantly maximum dry weight of grasses, broad leaved, sedges and total weeds was recorded in weedy check during first year (25.60, 13.83, 6.05 and 45.42 g / 0.25 m^2),second year (28.51, 16.40, 7.50 and 52.41 g / 0.25 m^2) and in pooled results (27.04, 15.36, 6.76 and 48.86 g / 0.25 m^2), respectively. Dry weight of grasses, broad leaved, sedges and total weeds was found significantly minimum in weed free during first year (1.23, 0.96, 1.29 and 3.49 g / 0.25 m^2), second year (1.66, 0.90, 1.39 and 3.96 g / 0.25 m^2) and in pooled results (1.44, 0.93, 1.34 and 3.72 g / 0.25 m^2), respectively and was superior over all other treatments, except hand weeding twice plus earthing up during first year (1.63, 1.32, 1.69 and 4.51 g / 0.25 m^2), second year (2.99, 2.25, 1.71 and 6.91 g / 0.25 m^2) and in pooled results (2.25, 1.96, 1.63 and 5.66), respectively and TPE 0.025 mm for 45 days during first year (1.63, 0.88, 1.56 and 3.88), second year (2.25, 1.29, 1.36 and 4.92 g / 0.25 m^2) and in pooled results (1.93, 1.25, 1.46 and 4.37 g / 0.25 m^2), respectively.

From the data (Table 20), it is seen that at 90 DAS, significantly maximum dry weight of grasses, broad leaved, sedges and total weeds was registered in weedy check during first year (27.24, 26.01, 6.76 and 60.06 g/0.25 m2), second year (31.36, 17.64, 7.84 and 56.85 g/0.25 m^2) and in pooled results (29.26, 21.62, 7.29 and 58.36 g / 0.25 m^2), respectively. However, the dry weight of grasses, broad leaved, sedges and total weeds was observed significantly minimum in weed free during first year (1.32, 1.93, 1.96 and 5.21 g / 0.25 m^2), second year (1.51, 1.00, 2.25 and 4.76 g / 0.25 m^2) and in pooled results (1.42, 1.44, 2.10 and 4.98 g/0.25 $m^{2)}$, respectively and was found superior over all other treatments, except TPE 0.025 mm for 45 days during first year (2.31, 1.84, 2.25 and 6.40 g/0.25 m^2), second year (2.50, 2.07, 2.56 and 6.92

Table 19 : Weed dry weight (g / 0.25 m^2) at 60 DAS in groundnut as influenced by various treatment.

Treatments	Grasses			Broad leaved			Sedges			Total weeds		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	3.78	3.68	3.73	3.12	3.14	3.02	1.99	1.95	1.97	5.28	5.21	5.25
	(14.28)	**13.54**	**13.91**	**9.73**	**9.85**	**9.12**	**3.96**	**3.80**	**3.88**	**27.87**	**27.14**	**27.56**
T_2 : TPE 0.025 mm 30 days	1.89	1.89	1.89	2.60	2.58	2.53	1.78	1.62	1.70	3.67	3.59	3.63
	57.00	**3.57**	**3.57**	**6.76**	**6.65**	**6.40**	**3.16**	**2.62**	**2.89**	**13.46**	**12.88**	**13.17**
T_3 : TPE 0.025 mm 45 days	1.28	1.50	1.39	0.94	1.14	1.12	1.25	1.17	1.21	1.97	2.22	2.09
	1.63	**2.25**	**1.93**	**0.88**	**1.29**	**1.25**	**1.56**	**1.36**	**1.46**	**3.88**	**4.92**	**4.37**
T_4 : TPE 0.050 mm 15 days	4.24	3.87	4.06	3.01	3.32	3.21	2.11	2.04	2.08	5.61	5.49	5.55
	17.97	**14.97**	**16.48**	**9.06**	**11.02**	**10.30**	**4.45**	**4.16**	**4.32**	**31.47**	**30.14**	**30.80**
T_5 : TPE 0.050 mm 30 days	2.08	2.19	2.14	2.54	2.83	2.61	1.92	1.75	1.84	3.80	4.54	4.17
	4.32	**4.79**	**4.57**	**6.45**	**8.00**	**6.81**	**3.68**	**3.06**	**3.38**	**14.44**	**20.61**	**17.38**
T_6 : TPE 0.050 mm 45 days	1.69	1.86	1.78	2.09	2.13	2.02	1.72	1.62	1.67	3.19	3.26	3.22
	2.85	**3.45**	**3.16**	**4.36**	**4.53**	**4.08**	**2.95**	**2.62**	**2.78**	**10.17**	**10.62**	**10.36**
T_7 : Pendimethalin 1.0 kg ha^{-1}	1.80	1.84	1.82	2.10	2.07	2.01	1.52	1.68	1.60	3.16	3.24	3.20
	3.24	**3.38**	**3.31**	**4.41**	**4.28**	**4.04**	**2.31**	**2.82**	**2.56**	**9.98**	**10.49**	**10.24**
T_8 : HW twice plus earthing up	1.28	1.73	1.50	1.15	1.50	1.40	1.30	1.31	1.28	2.12	2.63	2.38
	1.63	**2.99**	**2.25**	**1.32**	**2.25**	**1.96**	**1.69**	**1.71**	**1.63**	**4.51**	**6.91**	**5.66**
T_9 : Weed free	1.11	1.29	1.20	0.98	0.95	0.96	1.14	1.18	1.16	1.87	1.99	1.93
	1.23	**1.66**	**1.44**	**0.96**	**0.90**	**0.93**	**1.29**	**1.39**	**1.34**	**3.49**	**3.96**	**3.72**
T_{10} : Weedy check	5.06	5.34	5.20	3.72	4.05	3.92	2.46	2.74	2.60	6.74	7.24	6.99
	25.60	**28.51**	**27.04**	**13.83**	**16.40**	**15.36**	**6.05**	**7.50**	**6.76**	**45.42**	**52.41**	**48.86**
S.Em ±	0.21	0.21	0.16	0.14	0.10	0.09	0.11	0.07	0.07	0.26	0.26	0.18
CD at 5%	0.62	0.62	0.46	0.40	0.29	0.26	0.32	0.21	0.20	0.75	0.75	0.56
CV %	17.66	16.39	17.02	12.63	8.43	10.58	12.76	8.28	10.76	13.77	13..10	13.43

TPE =Transparent polyethylene
DAS =Days After Sowing
Bold letters indicated original value

Table 20 : Weed dry weight (g / 0.25 m^2) at 90 DAS in groundnut as influenced by various treatment.

Treatments	Grasses			Broad leaved			Sedges			Total weeds		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	4.00	4.22	4.11	3.10	3.25	3.18	2.10	2.30	2.20	5.48	5.81	5.65
	16.00	**17.80**	**16.89**	**9.61**	**10.56**	**10.11**	**4.41**	**5.29**	**4.84**	**30.03**	**33.75**	**31.92**
T_2 : TPE 0.025 mm 30 days	2.02	2.07	2.04	2.77	2.99	2.88	1.80	1.92	1.86	3.87	3.96	3.91
	4.08	**4.28**	**4.16**	**7.67**	**8.94**	**8.29**	**3.24**	**3.68**	**3.45**	**14.97**	**15.68**	**15.28**
T_3 : TPE 0.025 mm 45 days	1.52	1.58	1.55	1.36	1.44	1.40	1.50	1.60	1.55	2.53	2.63	2.58
	2.31	**2.50**	**2.40**	**1.84**	**2.07**	**1.96**	**2.25**	**2.56**	**2.40**	**6.40**	**6.92**	**6.76**
T_4 : TPE 0.050 mm 15 days	4.29	4.60	4.45	3.32	1.62	2.47	2.10	2.40	2.25	5.82	6.26	6.04
	18.40	**21.16**	**19.80**	**11.02**	**2.62**	**6.10**	**4.41**	**5.76**	**5.06**	**33.87**	**39.18**	**36.48**
T_5 : TPE 0.050 mm 30 days	2.19	2.32	2.26	2.70	2.94	2.82	1.80	1.99	1.90	3.91	4.24	4.08
	4.79	**5.38**	**5.10**	**7.29**	**8.64**	**7.95**	**3.24**	**3.96**	**3.61**	**15.28**	**17.97**	**16.64**
T_6 : TPE 0.050 mm 45 days	1.86	1.93	1.90	2.04	2.11	2.08	1.70	1.77	1.74	3.31	3.50	3.41
	3.45	**3.72**	**3.61**	**4.16**	**4.45**	**4.32**	**2.89**	**3.13**	**3.02**	**10.95**	**12.25**	**11.62**
T_7 : Pendimethalin 1.0 kg ha^{-1}	1.88	1.77	1.83	2.08	1.80	1.94	1.65	1.90	1.78	3.29	3.35	3.32
	3.53	**3.13**	**3.34**	**4.32**	**3.24**	**3.76**	**2.72**	**3.61**	**3.16**	**10.82**	**11.22**	**11.02**
T_8 : HW twice plus earthing up	1.60	1.66	1.63	1.83	1.70	1.77	1.80	1.94	1.87	3.15	3.32	3.23
	2.56	**2.75**	**2.65**	**3.34**	**2.89**	**3.13**	**3.24**	**3.76**	**3.49**	**9.92**	**11.92**	**10.43**
T_9 : Weed free	1.15	1.23	1.19	1.39	1.00	1.20	1.40	1.50	1.45	2.28	2.18	2.23
	1.32	**1.51**	**1.42**	**1.93**	**1.00**	**1.44**	**1.96**	**2.25**	**2.10**	**5.21**	**4.76**	**4.98**
T_{10} : Weedy check	5.22	5.60	5.41	5.10	4.20	4.65	2.60	2.80	2.70	7.75	7.54	7.64
	27.24	**31.36**	**29.26**	**26.01**	**17.64**	**21.62**	**6.76**	**7.84**	**7.29**	**60.06**	**56.85**	**58.36**
S.Em ±	0.14	0.12	0.09	0.13	0.14	0.10	0.13	0.13	0.09	0.19	0.26	0.16
CD at 5%	0.41	0.35	0.29	0.38	0.40	0.29	0.38	0.38	0.28	0.56	0.75	0.50
CV %	10.69	8.49	9.58	10.05	11.23	10.64	13.99	12.83	13.79	9.32	11.99	10.78

TPE =Transparent polyethylene
DAS =Days After Sowing
Bold letters indicated original value

g/0.25 m^2) and in pooled results (2.40, 1.96, 2.40 and 6.76 g / 0.25 m^2), respectively.

A perusal of data in Table 21 and Fig.5 at harvest indicated that significantly maximum dry weight of grasses, broad leaved, sedges and total weeds was recorded in weedy check during first year (35.40, 18.06, 8.41 and 61.93 g/0.25 m^2),second year (33.64, 18.49, 7.72 and 59.85 g / 0.25 m^2) and in pooled results (34.57, 18.31, 8.06 and 60.94 g / 0.25 m^2), respectively. While, the dry weight of grasses, broad leaved, sedges and total weeds was statistically minimum in weed free during first year (1.90, 2.25, 2.19 and 6.15 g / 0.25 m^2), second year (1.56, 1.44, 2.04 and 5.01 g / 0.25 m^2) and in pooled results (1.72, 1.76, 2.10 and 5.56 g/0.25 m^2), respectively and was found superior over all other treatments, except in TPE 0.025 mm for 45 days during first year (2.19, 2.25, 2.25 and 7.07 g / 0.25 m^2), second year (1.82, 2.40, 2.37 and 6.60 g / 0.25 m^2) and in pooled results (1.98, 2.52, 2.31 and 6.81 g/0.25 m^2), respectively.

4.2.4 Dry weed biomass at harvest

An appraisal of data (Table 22) showed that the weed dry biomass in groundnut at harvest was significantly affected by various treatments during first year, second year and in pooled analysis.

Data on dry weed biomass (Fig 6) indicated that significantly minimum dry weed biomass was registered in weed free (1.23, 1.45 and 1.34 q ha^{-1}), barring TPE 0.025 mm for 45 days (1.90, 2.38 and 2.14 q ha^{-1}) and found superior over all the treatments in first year, second year and in pooled results, respectively. While, weedy check recorded significantly the highest dry weed biomass (22.30, 24.73 and 23.51 q. ha^{-1}) over all other treatments, in first year, second year and in pooled results, respectively.

Table 21 : Weed dry weight (g / 0.25 m^2) at harvest in groundnut as influenced by various treatment.

Treatments	Grasses			Broad leaved			Sedges			Total weeds		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	4.50	4.20	4.35	3.26	3.43	3.34	2.37	2.40	2.38	6.08	6.14	6.11
	20.25	**17.64**	**18.92**	**10.62**	**11.76**	**11.15**	**5.61**	**5.76**	**5.66**	**36.96**	**38.69**	**37.33**
T_2 : TPE 0.025 mm 30 days	2.80	2.80	2.80	2.95	3.10	3.03	2.01	2.20	2.11	4.54	4.72	4.63
	7.84	**7.84**	**7.84**	**8.70**	**9.61**	**9.18**	**4.04**	**4.84**	**4.45**	**20.61**	**22.27**	**21.43**
T_3 : TPE 0.025 mm 45 days	1.48	1.35	1.41	1.50	1.55	1.59	1.50	1.54	1.52	2.66	2.57	2.61
	2.19	**1.82**	**1.98**	**2.25**	**2.40**	**2.52**	**2.25**	**2.37**	**2.31**	**7.07**	**6.60**	**6.81**
T_4 : TPE 0.050 mm 15 days	5.03	5.03	5.03	3.50	3.70	3.60	2.40	2.50	2.45	6.58	6.72	6.65
	25.30	**25.30**	**25.30**	**12.25**	**13.69**	**2.96**	**5.76**	**6.25**	**6.00**	**43.29**	**45.15**	**44.22**
T_5 : TPE 0.050 mm 30 days	3.00	3.00	3.00	3.10	3.50	3.30	2.14	2.30	2.22	4.82	5.15	4.98
	9.00	**9.00**	**9.00**	**9.61**	**12.25**	**10.89**	**4.57**	**5.29**	**4.92**	**23.23**	**26.52**	**24.80**
T_6 : TPE 0.050 mm 45 days	2.10	2.00	2.05	2.80	2.35	2.38	1.85	1.93	1.89	3.69	3.69	3.69
	4.41	**4.00**	**4.20**	**7.84**	**5.52**	**5.66**	**3.42**	**3.72**	**3.57**	**13.61**	**13.61**	**13.61**
T_7 : Pendimethalin 1.0 kg ha^{-1}	2.20	2.10	2.15	1.90	2.08	2.18	1.90	1.90	1.90	3.69	3.57	3.63
	4.84	**4.41**	**4.62**	**3.61**	**4.32**	**4.75**	**3.61**	**3.61**	**3.61**	**13.61**	**12.74**	**13.17**
T_8 : HW twice plus earthing up	2.10	2.00	2.05	1.90	2.10	2.18	1.83	1.85	1.84	3.58	3.50	3.54
	4.41	**4.00**	**4.20**	**3.61**	**4.41**	**4.75**	**3.34**	**3.42**	**3.38**	**12.81**	**12.25**	**12.53**
T_9 : Weed free	1.38	1.25	1.31	1.50	1.20	1.33	1.48	1.43	1.45	2.48	2.24	2.36
	1.90	**1.56**	**1.72**	**2.25**	**1.44**	**1.76**	**2.19**	**2.04**	**2.10**	**6.15**	**5.01**	**5.56**
T_{10} : Weedy check	5.95	5.80	5.88	4.25	4.30	4.28	2.90	2.78	2.84	7.87	7.73	7.860
	35.40	**33.64**	**34.57**	**18.06**	**18.49**	**18.31**	**8.41**	**7.72**	**8.06**	**61.93**	**59.85**	**60.94**
S.Em $\pm$	0.22	0.13	0.12	0.13	0.14	0.10	0.11	0.11	0.07	0.25	0.26	0.18
CD at 5%	0.66	0.38	0.37	0.39	0.41	0.30	0.31	0.30	0.23	0.72	0.75	0.55
CV %	14.33	9.32	11.28	9.93	10.32	10.13	10.36	10.06	10.21	11.79	11.19	10.99

TPE =Transparent polyethylene
DAS =Days After Sowing
Bold letters indicated original value

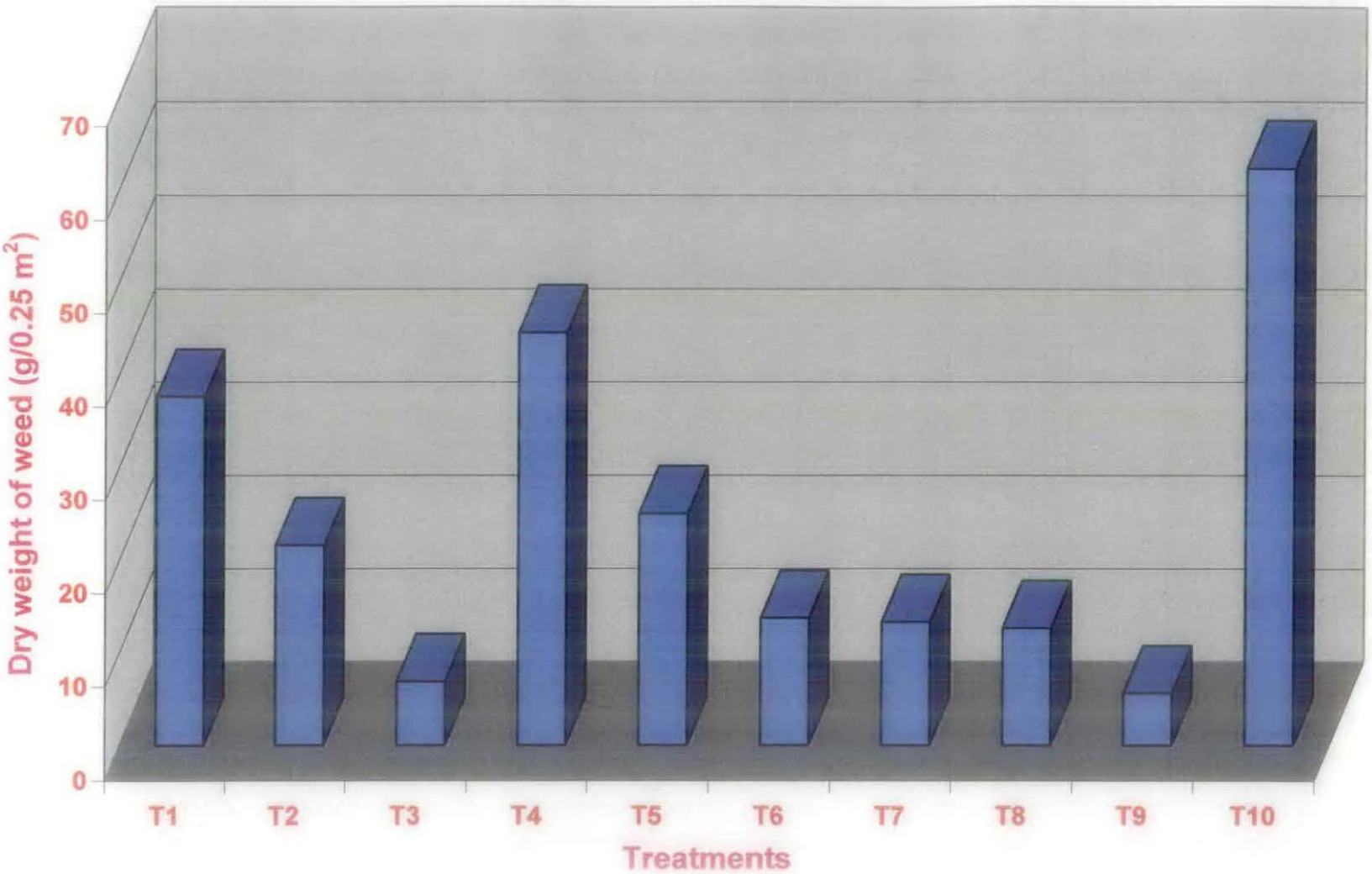


Fig. 5 : Dry weight of weed in groundnut at harvest as influenced by various treatments (pooled)

Table 22 : Weed dry biomass, weed control efficiency and weed index as influenced by various treatments in groundnut .

Treatments	Dry weed biomass (q ha^{-1})			Weed control efficiency (%)			Weed index		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	12.55	14.90	13.33	43.73	39.74	41.73	39.96	51.03	45.49
T_2 : TPE 0.025 mm 30 days	7.40	8.10	7.75	66.81	66.03	66.42	18.77	31.56	25.17
T_3 : TPE 0.025 mm 45 days	1.90	2.38	2.14	91.47	90.37	90.92	-1.59	0.00	-0.80
T_4 : TPE 0.050 mm 15 days	13.75	15.30	14.53	38.34	37.32	37.83	39.47	51.18	45.33
T_5 : TPE 0.050 mm 30 days	7.95	8.96	8.46	64.21	61.74	62.98	12.74	35.13	23.94
T_6 : TPE 0.050 mm 45 days	5.18	6.31	5.74	76.77	74.73	75.75	16.84	15.50	16.27
T_7 : Pendimethalin 1.0 kg ha^{-1}	5.70	6.400	6.05	74.43	74.37	74.40	16.63	15.70	16.17
T_8 : HW twice + earthing up	3.33	3.83	3.58	85.06	84.51	84.78	7.67	11.85	9.76
T_9 : Weed free	1.23	1.45	1.34	94.48	95.87	95.17	--	--	--
T_{10} : Weedy check	22.30	24.73	23.51	--	--	--	62.94	60.58	61.76
S.Em ±	0.44	0.42	0.30	1.87	1.97	1.36	1.03	1.55	0.93
CD at 5%	1.28	1.22	0.94	5.44	5.72	4.19	2.99	4.49	2.86
CV %	11.88	9.09	9.92	5.9	6.32	6.11	9.54	11.36	10.76

TPE =Transparent polyethylene
DAS =Days After Sowing

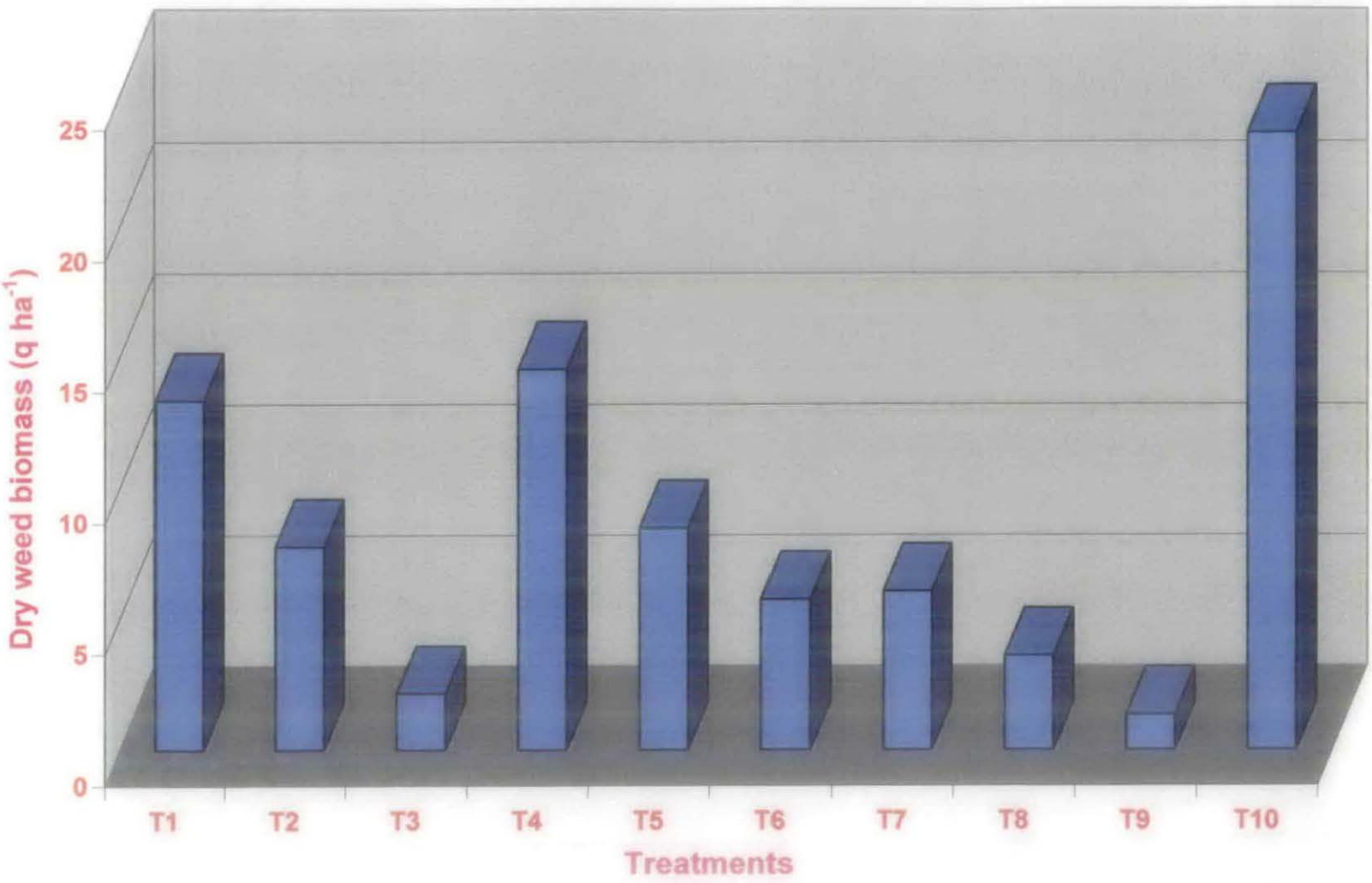


Fig. 6 : Dry weed biomass in groundnut at harvest as influenced by various treatments (pooled)

4.2.5 Weed control efficiency

The data on weed control efficiency (WCE) showed significant differences due to various treatments during first year, second year and in pooled results (Table 22 and Fig. 7).

Data presented in Table 22 indicated that significantly higher WCE (after weed free 94.48, 95.87 and 95.17 per cent) was recorded under TPE 0.025 mm for 45 days (91.47, 90.37 and 90.92 per cent) in first year, second year and in pooled results, respectively. Further, more effective treatment, which had higher WCE was hand weeding twice plus earthing up (85.06, 84.51 and 84.78 per cent) during first year, second year and in pooled results, respectively.

4.2.6 Weed index

The data on weed index in groundnut were significantly influenced by various treatments during first year, second year and in pooled results (Table 22 and Fig.8).

An appraisal of data in Table 22 indicated that maximum weed index was noted in weedy check (62.94, 60.58 and 61.76), followed by TPE 0.025 mm for 15 days (39.96, 51.03 and 45.49) and TPE 0.050 mm for 15 days (39.47, 51.18 and 45.33) in first year, second year and in pooled results, respectively. While, TPE 0.025 mm for 45 days had the lowest weed index (- 1.59, 0.00 and –0.80) compared to all other treatments, in first year, second year and in pooled results, respectively.

4.3 Effect of soil solarization on growth, yield and yield components of groundnut.

4.3.1. Growth and growth components

4.3.1.1 Plant height

Plant height of groundnut crop varied significantly due to various treatments at 30 DAS and harvest during both the years and in pooled results (Table 23).

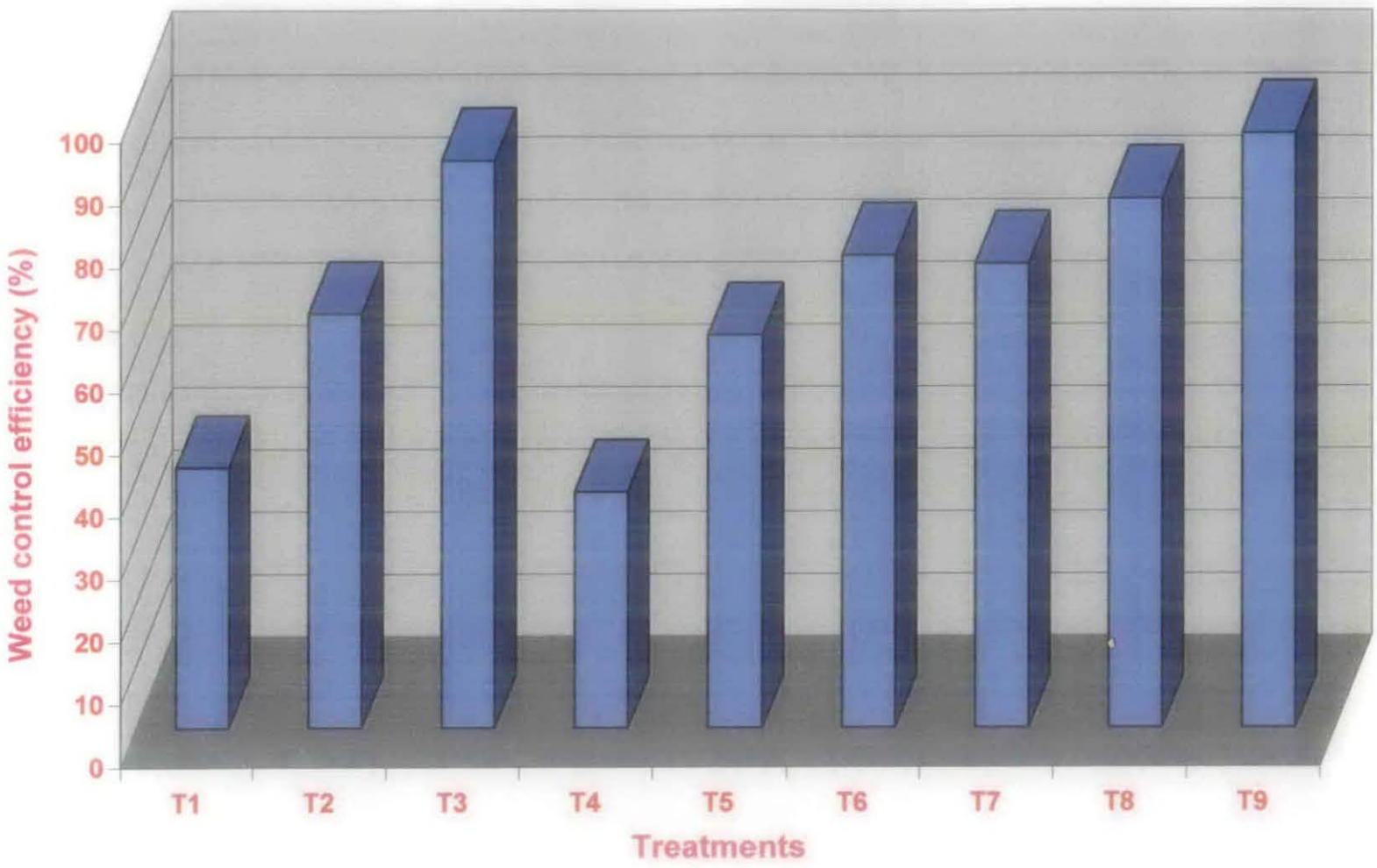


Fig. 7 : Weed control efficiency in groundnut as influenced by various treatments (pooled)

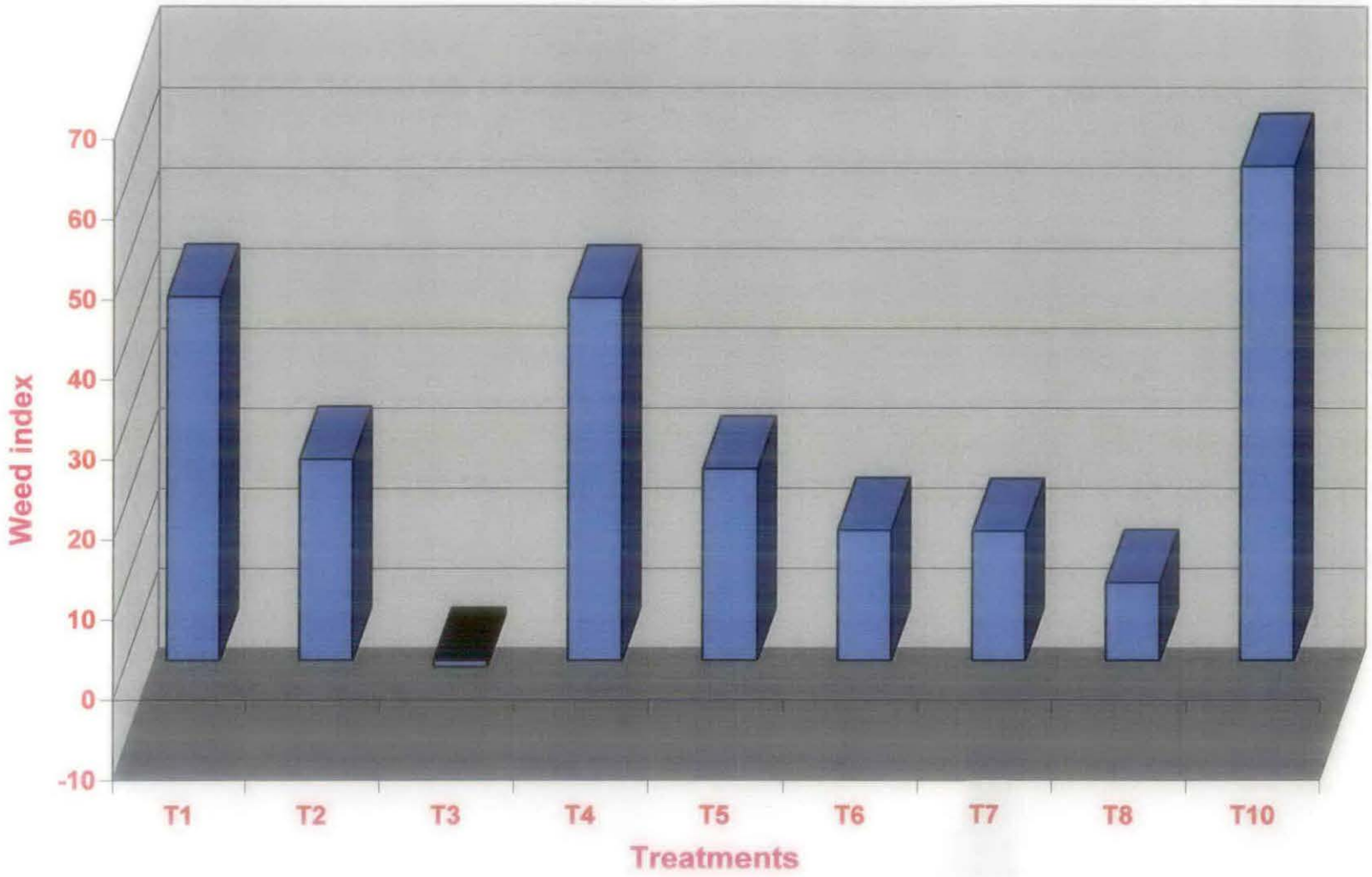


Fig. 8 : Weed index in groundnut as influenced by various treatments (pooled)

Table 23: Plant height (cm) and number of branches per plant in groundnut as influenced by various treatments

Treatments	Plant height (cm)						Number of branches per plant					
	30 DAS			At harvest			30 DAS			At harvest		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	9.82	8.10	8.96	48.38	42.13	45.25	3.06	2.70	2.88	4.98	4.65	4.81
T_2 : TPE 0.025 mm 30 days	10.88	8.13	9.50	49.93	45.88	47.90	3.20	2.85	3.03	5.40	5.20	5.30
T_3 : TPE 0.025 mm 45 days	13.88	11.48	12.68	59.75	55.25	57.50	3.88	3.70	3.79	6.55	6.18	6.36
T_4 : TPE 0.050 mm 15 days	9.75	7.98	8.86	48.10	41.13	44.61	3.02	2.52	2.77	5.10	4.60	4.85
T_5 : TPE 0.050 mm 30 days	11.43	8.13	9.78	52.75	45.38	49.06	3.25	2.78	3.02	5.35	5.00	5.18
T_6 : TPE 0.050 mm 45 days	11.50	9.38	10.44	53.63	50.38	52.03	3.40	2.90	3.15	5.95	5.45	5.70
T_7 : Pendimethalin 1.0 kg ha^{-1}	12.25	8.75	10.50	56.28	49.00	52.64	3.17	2.88	3.03	5.60	5.38	5.49
T_8 : HW twice + earthing up	12.30	10.13	11.21	56.75	51.13	53.94	3.66	3.30	3.48	6.30	5.83	6.06
T_9 : Weed free	13.63	11.25	12.44	56.90	54.00	55.45	3.83	3.68	3.76	6.35	6.10	6.23
T_{10} : Weedy check	7.90	6.70	7.30	41.43	35.50	38.46	2.05	1.80	1.93	4.06	3.60	3.83
S.Em $\pm$	0.56	0.42	0.34	3.37	2.55	2.12	0.22	0.28	0.19	0.31	0.30	0.22
CD at 5%	1.62	1.20	1.07	9.78	7.42	6.51	0.65	0.71	0.55	0.89	0.70	0.67
CV %	9.88	9.24	9.48	12.87	10.91	12.05	13.66	15.00	16.72	11..06	10.53	11.29

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

Statistical analysis of data of first year, second year and in pooled results indicated that significantly maximum plant height was noted at 30 DAS (13.88, 11.48 and 12.68 cm) and at harvest (59.75, 55.25 and 57.50 cm) with TPE 0.025 mm for 45 days and was found superior over all other treatments, except weed free (13.63, 11.25 and 12.44 cm) at 30 DAS and at harvest (56.90, 54.00 and 55.45 cm), respectively. Significantly minimum plant height of groundnut was recorded under weedy check compared to all other treatments in first year, second year and in pooled results at 30 DAS (7.90, 6.70 and 7.30 cm) and at harvest (41.43, 35.50 and 38.46 cm), respectively.

4.3.1.2 Number of branches per plant

Significant differences were observed in the number of branches of groundnut per plant due to different treatments at 30 DAS and harvest during both the years and in pooled results (Table 23).

An appraisal of data indicated that maximum number of branches were registered significantly in groundnut due to soil solarization with TPE 0.025 mm for 45 days at 30 DAS (3.88 and 3.70) and harvest (6.55 and 6.18) compared to all other treatments, which being at par with weed free, hand weeding twice plus earthing up and TPE 0.050 mm for 45 days at 30 DAS and harvest in first year and second year, respectively. However, it was significantly superior for number of branches in pooled results at 30 DAS (3.79) and at harvest (6.36), except weed free (3.76 and 6.23), hand weeding twice plus earthing up (3.48 and 6.06) and TPE 0.050 mm for 45 days (3.15 and 5.70), respectively. Weedy check produced significantly minimum number of branches at 30 DAS (2.05, 1.80 and 1.93) and harvest (4.06, 3.60 and 3.83) over all other treatments in first year, second year and pooled results, respectively.

4.3.1.3 Number of leaves per plant

The number of leaves per plant of groundnut at 30, 60, 90 DAS and harvest differed significantly due to various treatments for first year, second year and pooled results (Table 24).

Data revealed that TPE 0.025 mm for 45 days recorded significantly maximum number of leaves per plant at 30 DAS (13.31 and 11.61), 60 DAS (49.78 and 44.58), 90 DAS (75.65 and 72.50) and harvest (63.25 and 62.50) over all other treatments, barring weed free, hand weeding twice plus earthing up, TPE 0.050 mm for 45 days and pendimethalin at 1.0 kg ha^{-1} in first year and second year, respectively. Moreover, in pooled data, it was revealed that significantly maximum number of leaves in plant where recorded with TPE 0.025 mm for 45 days (12.46, 47.18, 74.08 and 62.88) over all other treatments, except with weed free (12.35, 46.74, 74.86 and 62.04), hand weeding twice plus earthing up (11.63, 43.34, 71.53 and 60.08), pendimethalin 1.0 kg ha^{-1} (11.03, 39.76, 67.02 and 56.16) and TPE 0.050 mm for 45 days (11.45, 41.93, 70.47 and 56.48) at all the respective stages. While, minimum number of leaves per plant were significantly observed in weedy check over all other treatments in first year (7.81, 25.10, 51.43 and 39.03), in second year (5.90, 18.63, 47.20 and 34.25) and in pooled results (6.86, 21.85, 49.32 and 36.64) at all the respective stages.

4.3.1.4 Leaf area

The leaf area per plant at 30, 60, 90 DAS and harvest was influenced significantly by various treatments during both the years as well as in pooled data (Table 25).

TPE 0.025 mm for 45 days recorded significantly maximum leaf area per plant in first year (7.45, 19.58, 28.17 and 21.50 cm^2 $plant^{-1}$) and in second year (7.05, 20.40, 27.63 and 20.97 cm^2 $plant^{-1}$), but it was statistically at par with weed free (7.16, 19.48, 28.17 and 21.46 cm^2 $plant^{-1}$) in first and (7.02, 20.15, 27.44 and 20.35 cm^2 $plant^{-1}$) in second year at 30, 60, 90 DAS and harvest (Table 25).

Table 24 : Number of leaves per plant in groundnut as influenced by various treatments

Treatments	Number of leaves per plant											
	30 DAS			60 DAS			90 DAS			At harvest		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	11.30	8.20	9.75	37.10	30.20	33.56	61.60	58.33	59.97	48.78	43.58	46.18
T_2 : TPE 0.025 mm 30 days	11.55	8.90	10.22	39.20	34.60	36.90	65.19	61.45	63.32	51.20	51.30	51.25
T_3 : TPE 0.025 mm 45 days	13.31	11.61	12.46	49.78	44.58	47.18	75.65	72.50	74.08	63.25	62.50	62.88
T_4 : TPE 0.050 mm 15 days	10.08	8.80	9.94	35.33	28.65	31.99	64.73	58.03	62.78	47.60	41.18	44.29
T_5 : TPE 0.050 mm 30 days	11.73	9.90	10.81	39.00	34.45	36.73	65.30	60.25	65.30	50.45	54.35	52.40
T_6 : TPE 0.050 mm 45 days	12.43	10.47	11.45	45.30	38.55	41.93	73.69	67.25	70.47	57.20	55.75	56.48
T_7 : Pendimethalin 1.0 kg ha^{-1}	11.95	10.11	11.03	43.15	36.38	39.76	70.24	63.80	67.02	54.73	57.60	56.16
T_8 : HW twice + earthing up	12.30	10.96	11.63	45.58	41.10	43.34	73.63	69.43	71.53	59.90	60.25	60.08
T_9 : Weed free	13.15	11.55	12.35	49.35	44.13	46.74	77.40	72.33	74.86	62.13	61.95	62.04
T_{10} : Weedy check	7.81	5.90	6.86	25.10	18.60	21.85	51.43	47.20	49.32	39.03	34.25	36.64
S.Em ±	0.60	0.75	0.48	3.51	3.43	2.45	3.22	3.42	2.35	3.61	2.38	2.17
CD at 5%	1.72	2.19	1.47	10.20	9.97	7.50	9.33	9.92	7.23	10.50	6.91	6.67
CV %	10.28	16.12	12.97	16.57	18.97	17.67	9.15	10.58	9.84	13.49	9.02	11.51

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

Table 25 : Leaf area per plant (cm^2) in groundnut as influenced by various treatments

Treatments	Leaf area (cm^2)											
	30 DAS			60 DAS			90 DAS			At harvest		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	5.61	5.51	5.56	16.33	14.98	15.15	24.44	22.71	23.58	15.35	14.25	18.80
T_2 : TPE 0.025 mm 30 days	6.30	6.39	6.34	17.20	16.75	16.98	25.52	24.94	25.23	16.97	15.18	16.07
T_3 : TPE 0.025 mm 45 days	7.45	7.05	7.25	19.58	20.40	19.99	28.17	27.63	27.90	21.50	20.97	21.24
T_4 : TPE 0.050 mm 15 days	5.78	5.74	5.76	16.30	14.93	15.61	23.47	22.62	23.04	14.47	13.72	14.10
T_5 : TPE 0.050 mm 30 days	6.07	5.71	5.89	16.65	15.50	16.08	23.89	23.54	23.41	17.10	16.46	16.78
T_6 : TPE 0.050 mm 45 days	6.28	6.38	6.33	17.60	17.73	17.66	26.24	25.65	25.95	18.28	15.88	17.08
T_7 : Pendimethalin 1.0 kg ha^{-1}	6.12	6.47	6.30	17.55	17.83	17.69	26.47	24.39	25.43	18.35	17.88	18.11
T_8 : HW twice + earthing up	6.66	6.45	6.55	18.33	17.98	18.15	27.25	24.63	26.09	18.20	17.13	17.67
T_9 : Weed free	7.16	7.02	7.09	19.48	20.15	19.81	28.17	27.44	27.80	21.46	20.35	20.90
T_{10} : Weedy check	5.11	5.00	5.06	14.10	14.25	14.18	21.58	21.05	21.32	11.38	10.33	10.86
S.Em ±	0.17	0.15	0.10	0.33	0.19	0.19	0.29	0.49	0.29	1.09	1.01	0.79
CD at 5%	0.37	0.44	0.31	0.99	0.58	0.58	0.85	1.43	0.88	3.00	2.95	2.44
CV %	4.08	4.93	4.52	3.81	3.13	3.13	2.28	4.01	3.23	14.10	12.54	13.37

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

A perusal of pooled data (Table 25) indicated that TPE 0.025 mm for 45 days registered significantly maximum leaf area per plant (7.25, 19.99, 27.90 and 21.24 cm^2 $plant^{-1}$) as compared to all other treatments, except weed free (7.09, 19.81, 27.80 and 20.90 cm^2 $plant^{-1}$) at 30, 60, 90 DAS and harvest, respectively. While, minimum leaf area per plant was significantly noted in weedy check as compared to all other treatments in first year (5.11, 14.10, 21.58 and 11.38 cm^2 $plant^{-1}$) and second year (5.00, 14.25, 21.05 and 10.33 cm^2 $plant^{-1}$) as well as in pooled results (5.06, 14.18, 21.32 and 10.86 cm^2 $plant^{-1}$) at all the respective stages of crop growth.

4.3.1.5 Leaf area index (LAI)

The leaf area index at 30, 60, 90 DAS and harvest was found significant due to various treatments during both the years and in pooled analysis (Table 26).

Significantly maximum LAI at 30, 60, 90 DAS and harvest was recorded due to TPE 0.025 mm for 45 days (Table 26 and Fig.9) and found superior to all other treatments during first year (1.10, 2.99, 4.19 and 2.15), second year (1.04, 2.90, 4.17 and 1.96) and in pooled results (1.07, 2.95, 4.18 and 2.05) at all the respective stages, except weed free in first year (1.06, 2.91, 4.17 and 2.14), second year (1.04, 2.85, 4.06 and 1.86) and in pooled results (1.05, 2.88, 4.12 and 2.00). Significantly the lowest LAI was observed in weedy check in first year (0.82, 2.29, 3.30 and 1.62), second year (0.76, 2.16, 3.20 and 1.52) and in pooled results (0.78, 2.23, 3.25 and 1.57) at all the respective stages as compared to all other treatments, except TPE 0.025 mm and TPE 0.050 mm for 15 days.

4.3.1.6 Dry matter accumulation in leaves

Dry matter accumulation in leaves at different stages (at 30, 60, 90 and harvest) differed significantly by various treatments in first year, second year and in pooled results (Table 27).

Table 26 : Leaf area Index in groundnut as influenced by various treatments

Treatments	Leaf area index											
	30 DAS			60 DAS			90 DAS			At harvest		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	0.83	0.82	0.82	2.42	2.22	2.32	3.50	3.26	3.38	1.77	1.59	1.65
T_2 : TPE 0.025 mm 30 days	0.93	0.95	0.94	2.55	2.48	2.52	3.78	3.69	3.74	1.86	1.78	1.82
T_3 : TPE 0.025 mm 45 days	1.10	1.04	1.07	2.99	2.90	2.95	4.19	4.17	4.18	2.15	1.96	2.05
T_4 : TPE 0.050 mm 15 days	0.86	0.80	0.83	2.41	2.21	2.31	3.38	3.21	3.30	1.70	1.54	1.62
T_5 : TPE 0.050 mm 30 days	0.90	0.85	0.87	2.47	2.30	2.38	3.54	3.49	3.51	1.68	1.64	1.71
T_6 : TPE 0.050 mm 45 days	0.93	0.94	0.94	2.61	2.63	2.62	3.92	3.80	3.86	1.89	1.79	1.85
T_7 : Pendimethalin 1.0 kg ha^{-1}	0.91	0.96	0.93	2.60	2.64	2.62	3.94	3.71	3.83	1.90	1.77	1.85
T_8 : HW twice + earthing up	0.96	0.96	0.97	2.71	2.66	2.69	4.03	3.85	3.94	2.03	1.79	1.91
T_9 : Weed free	1.06	1.04	1.05	2.91	2.85	2.88	4.17	4.06	4.12	2.14	1.86	2.00
T_{10} : Weedy check	0.82	0.76	0.78	2.29	2.16	2.23	3.30	3.20	3.25	1.62	1.52	1.57
S.Em $\pm$	0.02	0.03	0.01	0.05	0.03	0.03	0.07	0.04	0.04	0.04	0.04	0.03
CD at 5%	0.05	0.07	0.04	0.14	0.09	0.09	0.21	0.13	0.13	0.11	0.10	0.08
CV %	3.74	4.93	4.37	3.81	2.20	3.13	4.01	2.28	3.23	3.99	4.01	4.01

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

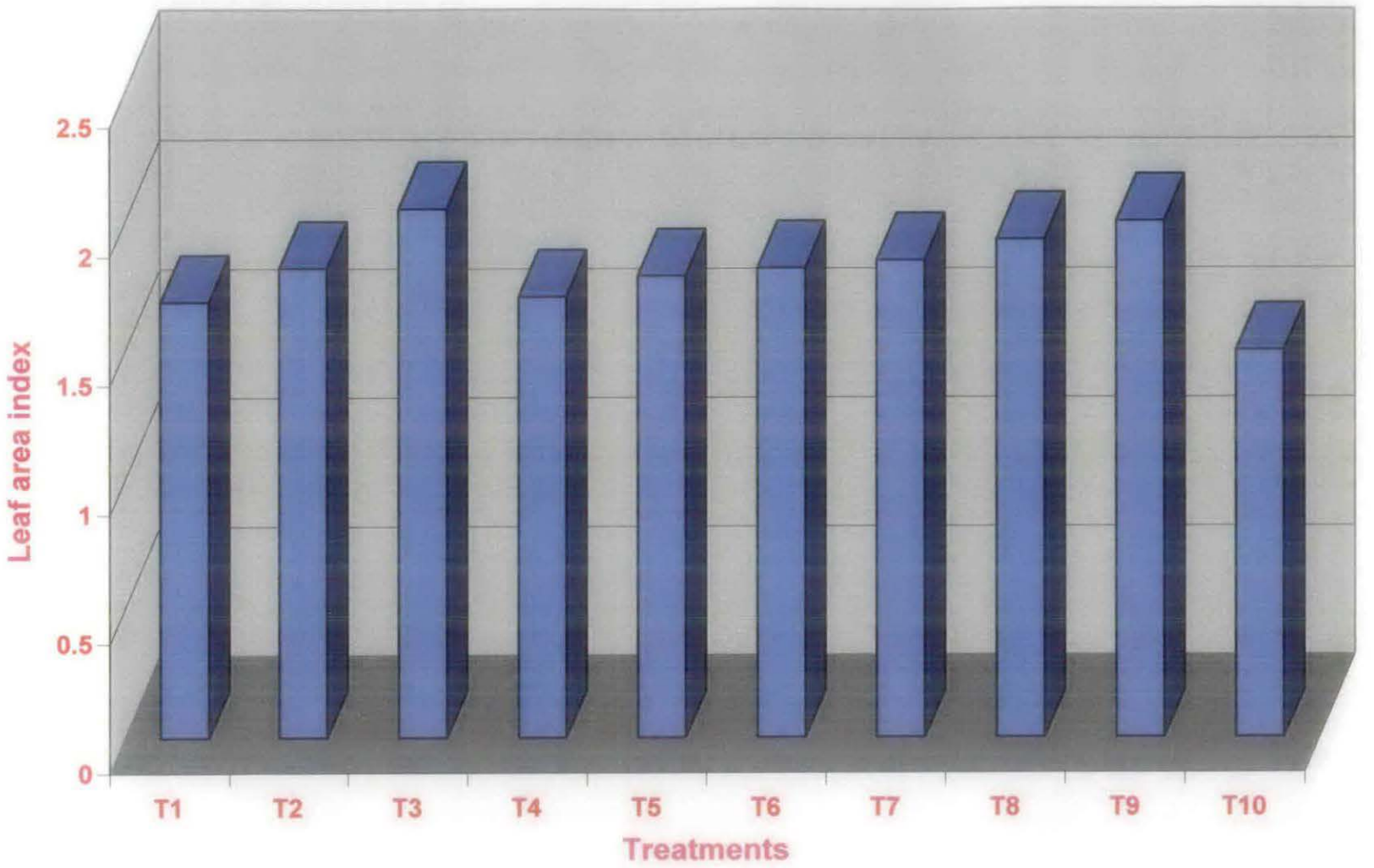


Fig. 9 : Leaf area index at harvest in groundnut as influenced by various treatments (pooled)

Table 27 : Dry matter accumulation in leaves per plant in groundnut as influenced by various treatments

Treatments	Dry matter accumulation in leaves (g plant^{-1})											
	30 DAS			60 DAS			90 DAS			At harvest		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	3.10	2.50	2.80	8.60	7.40	8.00	14.90	12.90	13.90	9.80	8.10	8.95
T_2 : TPE 0.025 mm 30 days	4.10	3.04	3.57	9.90	9.15	9.90	15.60	14.80	15.20	12.10	10.00	11.05
T_3 : TPE 0.025 mm 45 days	6.40	4.20	5.30	14.50	13.50	14.0	20.44	19.00	19.72	19.70	14.00	16.85
T_4 : TPE 0.050 mm 15 days	3.0	2.50	2.75	8.30	8.10	7.70	14.00	12.30	13.15	9.20	8.0	8.60
T_5 : TPE 0.050 mm 30 days	3.95	3.04	3.50	9.60	9.00	9.30	16.00	14.60	15.30	10.65	9.50	10.08
T_6 : TPE 0.050 mm 45 days	5.0	3.30	4.15	11.10	9.79	10.45	17.50	16.45	16.98	13.70	10.85	12.28
T_7 : Pendimethalin 1.0 kg ha^{-1}	5.25	3.40	4.33	11.20	9.90	10.55	17.10	16.40	16.75	14.95	11.90	13.43
T_8 : HW twice + earthing up	5.20	3.20	4.20	11.40	10.90	11.15	17.60	16.30	16.95	14.90	11.92	13.41
T_9 : Weed free	6.20	4.10	5.15	13.90	13.10	13.50	20.10	18.40	19.25	17.75	13.10	15.43
T_{10} : Weedy check	2 .66	2.25	2.45	7.20	6.60	6.90	12.50	11.90	12.20	8.65	7.15	7.90
S.Em $\pm$	0.28	0.20	0.17	0.61	0.55	0.41	0.95	0.87	0.65	1.63	0.71	0.68
CD at 5%	0.80	0.57	0.53	1.77	1.60	1.27	2.76	2.53	1.98	4.72	2.06	2.08
CV %	12.4	12.44	12.61	11.55	11.41	11.5	11.4	11.44	11.43	15.89	13.44	16.02

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

Significantly maximum dry matter accumulation in leaves was noted with TPE 0.025 mm for 45 days and found superior over all other treatments in first year (6.40, 14.50, 20.44 and 19.70 g plant^{-1}) and second year (4.20, 13.50, 19.00 and 14.00 g plant^{-1}) and in pooled results (5.30, 14.00, 19.72 and 16.85 g plant^{-1}), except weed free 6.20 , 13.90, 20.10 and 17.75 g plant^{-1} in first year, 4.10, 13.10, 18.40 and 13.10 g plant^{-1} in second year and 5.15, 13.50, 19.25 and 15.43 g plant^{-1} in pooled results at 30, 60, 90 and harvest, respectively. Dry matter accumulation in leaves was significantly less in weedy check compared to all other treatments in first year (2.66, 7.20, 12.50 and 8.65 g plant^{-1}), second year (2.25, 6.60, 11.90 and 7.15 g plant^{-1}) and in pooled results (2.45, 6.90, 12.20 and 7.90 g plant^{-1}), except TPE 0.025mm for 15 days and TPE 0.050mm for 15 days at all the respective stages during both the years and in pooled data.

4.3.1.7 Dry matter accumulation in stem

The dry matter accumulation in stem showed significant variation due to various treatments at 30, 60, 90 DAS and harvest during first year and second year as well as in pooled analysis (Table 28).

From the data, it is seen that maximum dry matter accumulation in stem was registered with TPE 0.025 mm for 45 days and was statistically superior over all other treatments in first year (7.90, 10.85, 13.90 and 17.55 g plant^{-1}), second year (4.90, 10.56, 13.60 and 15.45 g plant^{-1}) and in pooled results (6.40, 10.71, 13.75 and 16.50 g plant^{-1}) at all respective stages except weed free in first year (7.50, 10.80, 13.50 and 17.15 g plant^{-1}), second year (4.75, 10.20, 12.85 and 15.40 g plant^{-1}) and in pooled results (6.13, 10.50, 13.18 and 16.28 g plant^{-1}) at all the respective stages. Weedy check produced significantly lowest dry matter accumulation in stem at 30 DAS (3.40, 2.40 and 2.90 g plant^{-1}) and 60 DAS (6.10, 6.45 and 6.28 g plant^{-1}) over all other treatments in first year, second year and pooled results, respectively. While significantly minimum dry matter accumulation at 90 DAS (8.60, 8.18 and 8.40 g plant^{-1}) and at harvest (10.23,

Table 28 : Dry matter accumulation in stem per plant in groundnut as influenced by various treatments

Treatments	Dry matter accumulation in stem (g plant^{-1})											
	30 DAS			60 DAS			90 DAS			At harvest		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	4.80	3.08	3.94	7.60	7.91	7.76	9.24	8.97	9.10	12.00	98.50	10.75
T_2 : TPE 0.025 mm 30 days	5.20	3.20	4.20	8.95	9.18	9.07	10.40	10.75	10.58	14.55	10.90	12.73
T_3 : TPE 0.025 mm 45 days	7.90	4.90	6.40	10.85	10.56	10.71	13.90	13.60	13.75	17.55	15.45	16.50
T_4 : TPE 0.050 mm 15 days	4.75	3.10	3.93	7.40	7.80	7.60	9.20	8.65	8.93	11.65	9.10	10.38
T_5 : TPE 0.050 mm 30 days	5.20	3.10	4.15	8.70	8.20	8.45	10.40	9.90	10.15	13.65	10.30	11.98
T_6 : TPE 0.050 mm 45 days	6.50	3.95	5.23	9.10	9.40	9.25	12.50	10.35	11.42	14.35	11.85	13.1
T_7 : Pendimethalin 1.0 kg ha^{-1}	6.80	3.95	5.38	9.00	9.30	9.15	12.80	11.43	12.13	16.47	11.80	14.13
T_8 : HW twice + earthing up	6.90	3.98	5.44	9.00	9.30	9.15	12.90	11.50	12.2	17.15	12.80	14.98
T_9 : Weed free	7.50	4.75	6.13	10.80	10.20	10.50	13.50	12.85	13.18	17.15	15.40	16.28
T_{10} : Weedy check	3.40	2.40	2.90	6.10	6.45	6.28	8.60	8.18	8.40	10.23	8.10	9.17
S.Em $\pm$	0.22	0.22	0.21	0.44	0.45	0.31	0.57	0.581	0.41	0.97	0.60	0.57
CD at 5%	0.63	0.62	0.64	1.27	1.31	0.97	1.65	1.69	1.26	2.82	1.73	1.76
CV %	12.99	12.92	12.74	10.24	10.24	10.25	10.07	11.02	10.53	13.39	10.81	12.62

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

8.10 and 9.17 g plant^{-1}) was recorded in first year, second year and in pooled results, respectively, except TPE 0.025 mm for 15 days and TPE 0.050 mm for 15 days.

4.3.1.8 Dry matter accumulation in pods

Significant differences were observed for dry matter accumulation in pods due to various treatments during both the years and in pooled analysis (Table 29).

An appraisal of data indicated that TPE 0.025 mm for 45 days was found significantly superior as compared to all other treatments in first year (8.60, 15.82 and 21.05 g plant^{-1}), second year (8.10, 14.50 and 14.90 g plant^{-1}) and in pooled results (8.35, 15.16 and 17.98 g plant^{-1}), except weed free in first year (8.30, 15.34 and 18.75 g plant^{-1}), second year (7.98, 14.50 and 14.85 g plant^{-1}) and in pooled results (8.14, 14.92 and 16.80 g plant^{-1}) at 60, 90 DAS and harvest, respectively. Weedy check produced significantly the lowest dry matter accumulation in pods in first year (4.20, 8.86 and 8.70 g plant^{-1}), second year (4.02, 8.10 and 6.90 g plant^{-1}) and in pooled results (4.11, 8.48 and 7.80 g plant^{-1}) over all other treatments at all the respective stages.

4.3.1.9 Total dry matter accumulation

Data on total dry matter accumulation in groundnut presented in Table 30 showed significant differences due to various treatments during both the years and in pooled analysis at 30, 60, 90 DAS and at harvest.

A perusal of data revealed that significantly maximum total dry matter accumulation per plant was registered under TPE 0.025 mm for 45 days over all other treatments during first (14.30, 32.65, 49.86 and 58.30 g plant^{-1}) and second year (9.10, 30.46, 46.40 and 44.35 g plant^{-1}), except weed free in first year (12.45, 33.78, 48.94 and 53.65 g plant^{-1}) and in second year (8.85, 29.70, 45.72 and 43.33 g plant^{-1}) at all the respective stages of crop of growth. However, pooled results (Table 30 and Fig. 10) showed that TPE 0.025 mm for 45 days (11.70, 31.56, 48.13 and 51.33 g plant^{-1}) recorded significantly higher total dry

Table 29 : Dry matter accumulation in pods per plant in groundnut as influenced by various treatments

Treatments	Dry matter accumulation in pods (g plant^{-1})								
	60 DAS			90 DAS			At harvest		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	5.90	7.77	5.84	11.98	10.10	11.04	14.15	12.10	13.13
T_2 : TPE 0.025 mm 30 days	6.00	6.42	6.21	12.83	11.20	12.02	15.30	13.00	14.15
T_3 : TPE 0.025 mm 45 days	8.60	8.10	8.35	15.82	14.50	15.16	21.05	14.90	17.98
T_4 : TPE 0.050 mm 15 days	6.65	5.74	5.70	11.52	9.90	10.71	13.00	11.90	12.45
T_5 : TPE 0.050 mm 30 days	6.99	6.25	6.62	12.69	10.90	11.80	14.20	12.30	13.25.
T_6 : TPE 0.050 mm 45 days	7.02	6.30	6.66	13.55	12.20	12.88	14.80	12.60	13.70
T_7 : Pendimethalin 1.0 kg ha^{-1}	7.00	6.25	6.84	13.70	12.30	13.00	14.70	12.80	13.75
T_8 : HW twice + earthing up	7.05	6.32	6.69	13.80	12.50	13.15	14.75	12.82	13.79
T_9 : Weed free	8.30	7.98	8.14	15.34	14.50	14.92	18.75	14.85	16.80
T_{10} : Weedy check	4.20	4.02	4.11	8.86	8.10	8.48	8.70	6.90	7.80
S.Em $\pm$	0.50	0.47	0.43	0.74	0.62	0.48	1.11	0.71	0.89
CD at 5%	1.40	1.39	1.11	2.00	1.79	1.48	3.28	1.98	2.74
CV %	13.51	16.01	15.45	11.35	10.47	10.98	16.11	11.27	14.86

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

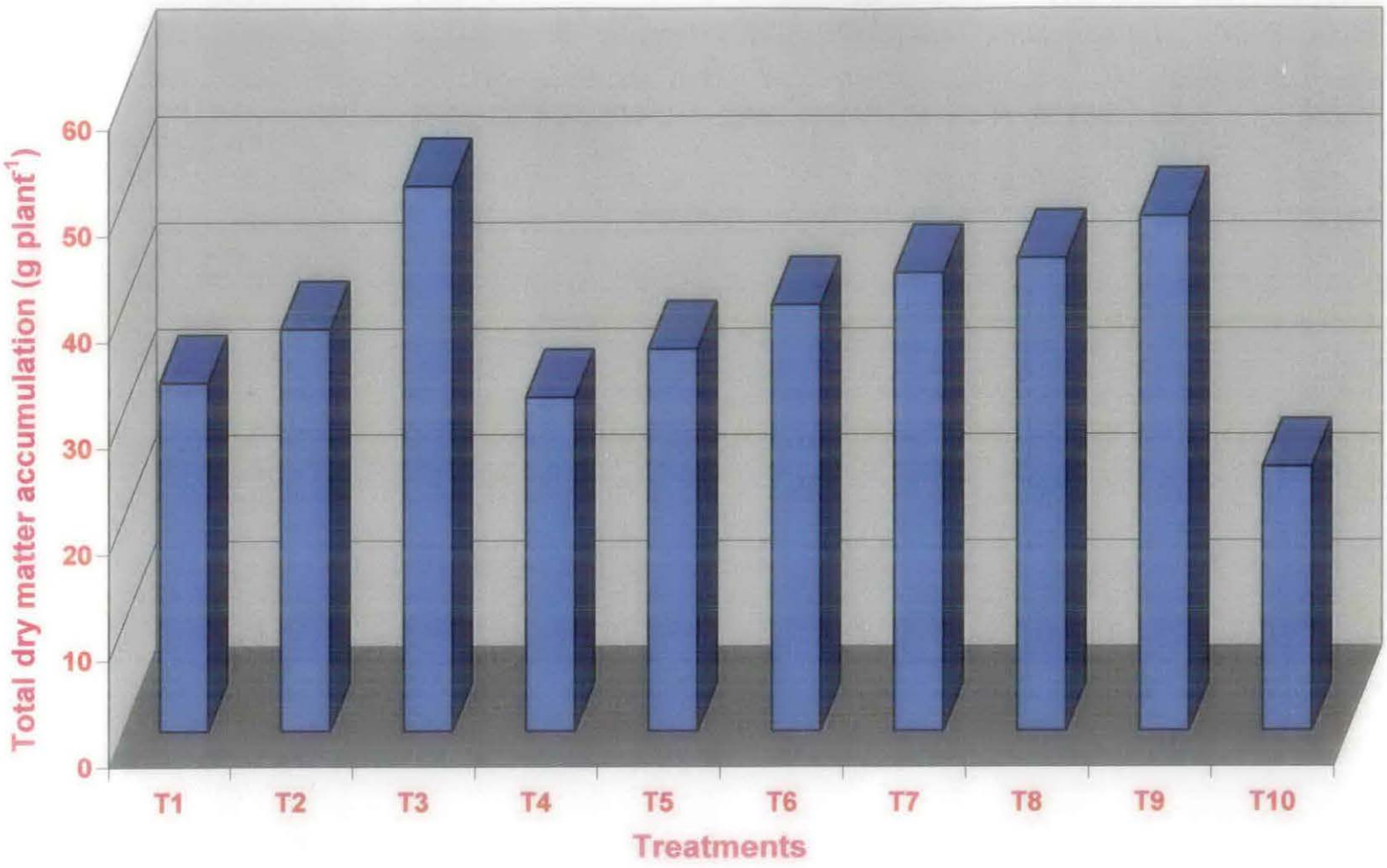


Fig. 10 : Total dry matter accumulation at harvest in groundnut as influenced by various treatments (pooled)

Table 30 : Total Dry matter accumulation per plant in groundnut as influenced by various treatments

Treatments	Total Dry matter accumulation (g plant^{-1})											
	30 DAS			60 DAS			90 DAS			At harvest		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	7.90	5.58	6.84	20.97	19.81	20.39	37.12	33.70	35.41	35.95	29.70	32.82
T_2 : TPE 0.025 mm 30 days	9.30	6.04	7.67	24.47	23.33	23.90	38.83	35.40	37.12	41.85	33.90	37.87
T_3 : TPE 0.025 mm 45 days	14.30	9.10	11.70	32.65	30.46	31.56	49.86	46.40	48.13	58.30	44.35	51.33
T_4 : TPE 0.050 mm 15 days	7.75	5.60	6.68	20.30	19.30	19.80	36.72	33.00	34.86	33.85	29.00	31.43
T_5 : TPE 0.050 mm 30 days	9.15	6.14	7.65	22.25	22.10	22.18	39.09	33.90	36.90	39.50	32.50	36.00
T_6 : TPE 0.050 mm 45 days	11.50	7.30	9.40	26.50	25.32	25.91	42.55	39.95	41.25	44.05	36.30	40.18
T_7 : Pendimethalin 1.0 kg ha^{-1}	12.05	7.35	9.70	26.45	25.715	26.09	42.80	39.75	41.28	47.38	37.50	42.44
T_8 : HW twice + earthing up	12.10	7.45	9.78	26.78	25.40	26.24	43.40	40.20	41.80	47.50	38.60	43.05
T_9 : Weed free	12.45	8.85	11.15	33.78	29.70	31.74	48.94	45.72	47.33	53.65	43.35	48.50
T_{10} : Weedy check	5.70	3.75	4.73	16.26	15.37	15.82	30.96	27.75	29.35	27.58	22.15	24.86
S.Em ±	0.49	0.45	0.34	1.29	1.34	0.93	2.07	1.93	1.41	2.11	1.72	1.36
CD at 5%	1.43	1.31	1.03	3.75	3.88	2.86	5.69	5.41	4.36	6.12	4.99	4.20
CV %	9.51	13.92	11.25	10.39	11.20	10.79	10.05	10.49	10.26	16.93	9.89	10.12

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

matter accumulation as compared to all other treatments, except weed free (11.15, 31.74, 47.33 and 48.50 g plant^{-1}) at all the respective growth stages. Significantly the lowest total dry matter accumulation was recorded in weedy check over all other treatments in first year (5.70, 16.26, 30.96 and 27.58 g plant^{-1}), second year (3.75, 15.37, 27.75 and 22.15 g plant^{-1}) and in pooled results (4.73, 15.82, 29.35 and 24.86 g plant^{-1}) at all the respective stages of crop of growth.

4.3.1.10 Number of root nodules per plant

Number of root nodules recorded per plant at 60 and 90 DAS differed significantly due to various treatments during both the years as well as in pooled analysis (Table 31).

A perusal of data indicated that TPE 0.025 mm for 45 days recorded significantly higher number of root nodules (111.8, 104.3 and 108.1) over all other treatments, except weed free (107.7, 99.2 and 103.5) and TPE 0.050 mm for 45 days (107.8, 97.8 and 102.8) at 60 DAS in first year, second year and in pooled results, respectively. Whereas, at 90 DAS, TPE 0.025 mm for 45 days noted significantly maximum number of root nodules (133.3, 125.5 and 129.4) over all other treatments, except weed free (123.9, 119.8 and 121.8) and TPE 0.050 mm for 45 days (127.8, 111.3 and 119.6) in first year, second year and in pooled results, respectively. However, significantly lowest number of root nodules was observed in weedy check at 60 DAS (73.4, 70.0 and 71.7) and 90 DAS (95.5, 75.3 and 92.9) over all other treatments in first year, second year and pooled data, respectively.

4.3.1.11 Dry weight of root nodules

Dry weight of root nodules per plant at 60 and 90 DAS differed significantly due to various treatments in first year, second year and in pooled analysis (Table 31).

Table 31 : Number of root nodule per plant and dry weight of root nodule per plant in groundnut as influenced by various treatments

Treatments	Number of root nodule per plant						Dry weight of root nodule (g plant $^{-1}$)					
	60 DAS			90 DAS			60 DAS			90 DAS		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	98.5	88.9	93.7	118.6	109.0	113.8	0.10	0.09	0.10	0.11	0.13	0.12
T_2 : TPE 0.025 mm 30 days	101.3	90.2	95.6	121.7	110.5	116.1	0.11	0.10	0.11	0.15	0.14	0.15
T_3 : TPE 0.025 mm 45 days	111.8	104.3	108.1	133.3	125.5	129.4	0.14	0.12	0.13	0.25	0.22	0.24
T_4 : TPE 0.050 mm 15 days	97.2	87.0	92.1	114.9	105.5	110.2	0.10	0.09	0.10	0.14	0.12	0.12
T_5 : TPE 0.050 mm 30 days	100.1	90.3	95.2	119.8	110.2	115.0	0.10	0.10	0.10	0.15	0.14	0.15
T_6 : TPE 0.050 mm 45 days	107.8	97.8	102.8	127.8	111.3	119.6	0.11	0.10	0.11	0.16	0.19	0.18
T_7 : Pendimethalin 1.0 kg ha^{-1}	98.9	88.9	93.9	112.9	102.8	107.8	0.09	0.09	0.09	0.17	0.14	0.14
T_8 : HW twice + earthing up	101.2	90.0	95.9	116.5	106.8	111.6	0.11	0.11	0.11	0.15	0.18	0.17
T_9 : Weed free	107.7	99.2	103.5	123.9	119.8	121.8	0.13	0.12	0.12	0.24	0.20	0.22
T_{10} : Weedy check	73.4	70.0	71.7	95.5	75.3	92.9	0.08	0.07	0.08	0.10	0.10	0.10
S.Em ±	3.42	2.37	2.08	4.91	4.91	3.48	0.003	0.01	0.003	0.002	0.01	0.01
CD at 5%	9.93	6.87	6.41	14.27	14.26	10.71	0.01	0.01	0.01	0.04	0.03	0.03
CV %	6.85	5.23	6.18	8.43	9.12	8.77	6.4	5.8	6.15	11.9	13.7	12.79

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

It is revealed that significantly maximum dry weight of root nodules at 60 DAS was recorded in TPE 0.025 mm for 45 days (0.14, 0.12 and 0.13) over all other treatments except, weed free (0.13, 0.12 and 0.12 g plant $^{-1}$) in first year, second year and in pooled data ,respectively. However, dry weight of root nodules was statistically lowest under weedy check (0.08, 0.07and 0.08 g plant^{-1}) compared to all other treatments, except pendimethalin 1.0 kg ha^{-1} in first year and pooled results only.

With regards to dry weight of root nodules at 90 DAS, TPE 0.025 mm for 45 days (0.25 and 0.22 g plant^{-1}) recorded significantly maximum root nodule dry weight as compared to all other treatments, except weed free in first (0.24 g plant^{-1}) and second year (0.20 g plant^{-1}) as well as TPE 0.050 mm for 45 days in second year (0.19 g plant^{-1}) only. However, it was significantly superior over all other treatments for dry weight of root nodules (0.24 g plant^{-1}) in pooled data, being at par with weed free (0.22 g plant^{-1}). Significantly the lowest dry weight of root nodules at 90 DAS was recorded in weedy check (0.10, 0.10 and 0.10 g plant^{-1}) compared to all other treatments, barring TPE 0.025 mm and TPE 0.050 mm for 15 days in first year, second year and pooled results, respectively.

4.3.2. Yield and yield components of groundnut

4.3.2.1 Number of pods per plant

It was observed that number of pods per plant showed significant variation due to various treatments during both the years and in pooled analysis (Table 32).

An appraisal of data indicated that significantly maximum number of pods were registered under TPE 0.025 mm for 45 days (25.20,19.28 and 22.24 plant $^{-1}$) and was superior over all other treatments, except weed free (25.02, 19.13 and 22.08 plant $^{-1}$) in first year, second year and in pooled results, respectively. While, minimum number of pods per plant was significantly observed under weedy check over all other treatments in first year (13.23 plant $^{-1}$), second year (7.68 plant $^{-1}$) and in pooled results (10.46 plant $^{-1}$).

Table 32 : Number of pods per plant, pod weight per plant , pod yield and haulm yield in groundnut as influenced by various treatments

Treatments	Number of pods per plant			Pod weight (g plant^{-1})			Pod yield (q ha^{-1})			Haulm yield (q ha^{-1})		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	18.13	10.93	14.53	15.05	11.05	13.05	15.90	13.35	14.63	27.69	23.75	25.72
T_2 : TPE 0.025 mm 30 days	20.73	11.03	15.88	17.30	11.10	14.20	23.19	17.26	20.23	33.52	26.85	30.19
T_3 : TPE 0.025 mm 45 days	25.20	19.28	22.24	23.88	16.58	20.23	30.14	25.22	27.68	54.00	42.78	48.39
T_4 : TPE 0.050 mm 15 days	18.21	11.00	14.61	16.75	10.48	13.61	15.38	13.00	14.19	25.97	22.96	24.47
T_5 : TPE 0.050 mm 30 days	19.93	13.03	16.78	17.0	11.55	14.28	19.00	16.36	17.68	36.48	26.85	31.67
T_6 : TPE 0.050 mm 45 days	21.23	13.30	17.27	17.95	12.55	15.25	2374	21.30	22.52	43.75	35.19	39.47
T_7 : Pendimethalin 1.0 kg ha^{-1}	21.60	14.41	18.01	18.95	12.85	15.90	23.80	21.26	22.55	43.81	34.94	40.87
T_8 : HW twice + earthing up	23.10	15.15	19.13	20.08	15.03	17.56	26.36	22.23	24.30	47.73	39.75	43.74
T_9 : Weed free	25.02	19.13	22.08	23.75	15.35	19.55	28.55	25.22	26.88	51.67	42.19	46.93
T_{10} : Weedy check	13.23	7.68	10.46	9.68	8.80	9.24	10.58	9.94	10.26	23.47	18.92	21.20
S.Em ±	0.74	1.24	0.81	0.96	0.51	0.55	1.64	1.04	0.97	2.95	1.80	1.73
CD at 5%	2.01	3.20	2.50	2.79	1.50	1.68	4.59	3.03	3.00	8.57	5.23	5.33
CV %	10.08	17.07	13.55	10.65	8.25	10.09	14.71	11.38	13.53	15.05	11.46	13.84

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

4.3.2.2 Pod weight

The pod weight per plant differed significantly due to various treatments during both the years and in pooled analysis (Table 32).

A perusal of data indicated that significantly maximum pod weight was recorded under TPE 0.025 mm for 45 days over all other treatments in first year (23.88 g plant^{-1}), second year (16.58 g plant^{-1}) and in pooled results (20.23 g plant^{-1}), which was on par with weed free in first year (23.75 g plant^{-1}), second year (15.35 g plant^{-1}) and in pooled results (19.55 g plant^{-1}). While, weedy check had significantly the lowest pod weight in first year (9.68 g plant^{-1}), second year (8.80 g plant^{-1}) and in pooled results (9.24 g plant^{-1}) as compared to all other treatments.

4.3.2.3 Pod yield

It was observed that pod yield of groundnut was significantly influenced due to various treatments during both the years and in pooled analysis (Table 32).

It is seen that maximum pod yield was recorded due to TPE 0.025 mm for 45 days (30.14 and 25.22 q ha^{-1}) and it was significantly superior over all other treatments in first and second year, but it was on par with weed free (28.55 q ha^{-1}) and hand weeding twice plus earthing up (26.36 q ha^{-1}) in first year and weed free (25.22 q ha^{-1}) and H.W. twice (22.23 q ha^{-1}) in second year only. Moreover, in pooled results (Fig. 11), significantly higher pod yield was obtained with TPE 0.025 mm for 45 days (27.68 q ha^{-1}) over all other treatments, barring with weed free (26.88 q ha^{-1}). Significantly minimum pod yield was registered in weedy check as compared to all other treatments in first year (10.58 q ha^{-1}g), second year (9.94 q ha^{-1}) and in pooled results (10.26 q ha^{-1}).

4.3.2.4 Haulm yield

Statistical differences in haulm yield of groundnut were observed due to various treatments in individual year and also in pooled data (Table 32).

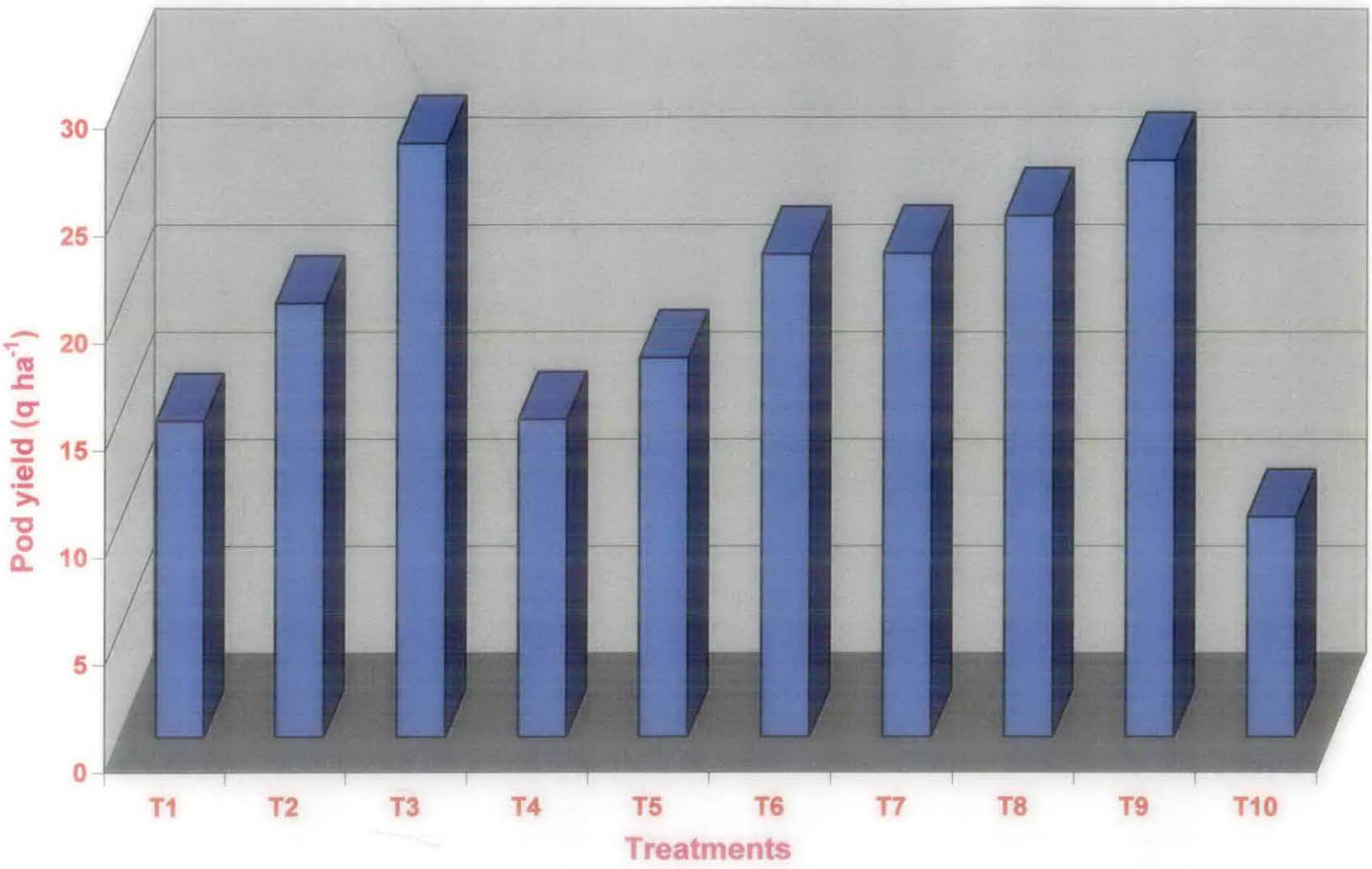


Fig. 11 : Pod yield of groundnut as influenced by various treatments (pooled)

A perusal of data revealed that significantly maximum haulm yield was recorded under TPE 0.025 mm for 45 days (54.00, 42.78 and 48.39 q ha^{-1}) over all other treatments, except weed free (51.67, 42.19 and 46.93 q ha^{-1}), and hand weeding twice plus earthing up (47.73, 39.75 and 43.74 q ha^{-1}), in first year, second year and in pooled results, respectively. Significantly minimum haulm yield was obtained in weedy check (23.47, 18.92 and 21.20 q ha^{-1}) as compared to all other treatments, except TPE 0.025 mm for 15 days (27.69, 23.75 and 25.72 q ha^{-1}) and TPE 0.050 mm for 15 days(25.97, 22.96 and 24.47 q ha^{-1}) in first year, second year and in pooled results, respectively.

4.3.2.5 Shelling percentage

Differences observed in shelling percentage were significant due to various treatments during both the years and in pooled analysis (Table 33).

An appraisal of data indicated that significantly maximum shelling percentage was registered due to TPE 0.025 mm for 45 days (71.25, 70.00 and 70.63 per cent) over all other treatments in first year, second year and in pooled results, respectively. However, it was at par with weed free (70.75, 66.75 and 68.75 per cent) in first year, second year and in pooled results and hand weeding twice plus earthing up (70.25 per cent) in first year only. While, weedy check noted significantly minimum shelling percentage (52.50, 49.15 and 50.83 per cent) as compared to all other treatments in first year, second year and in pooled results, respectively.

4.3.2.6 Test weight

Test weight per plant showed significant variations due to various treatments in first year, second year and in pooled analysis (Table 33 and Fig.12).

Data in Table 33 showed significantly maximum test weight due to TPE 0.025 mm for 45 days (58.00, 52.00 and 55.00 g) as compared to all other treatments, barring weed free (57.50 g), hand weeding twice plus earthing up

Table 33 : Shelling percentage, test weight , kernel yield and oil content in groundnut as influenced by various treatments

Treatments	Shelling percentage			Test weight (g)			Kernel yield (q ha $^{-1}$)			Oil content (%)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	64.00	58.00	61.00	50.00	39.35	44.68	10.97	7.31	9.14	45.97	44.20	45.08
T_2 : TPE 0.025 mm 30 days	66.63	59.00	62.81	50.50	42.00	46.25	15.28	10.18	12.73	48.21	48.19	48.20
T_3 : TPE 0.025 mm 45 days	71.25	70.00	70.63	58.00	52.00	55.00	21.42	17.85	19.63	49.36	48.56	48.96
T_4 : TPE 0.050 mm 15 days	63.50	55.48	59.43	50.00	38.00	44.00	10.25	6.90	8.58	46.00	44.00	45.00
T_5 : TPE 0.050 mm 30 days	65.75	56.75	61.25	50.50	40.00	45.25	15.27	9.41	12.34	47.95	47.91	47.93
T_6 : TPE 0.050 mm 45 days	67.00	58.00	62.50	55.50	42.00	48.75	16.37	13.57	14.97	48.42	48.02	48.22
T_7 : Pendimethalin 1.0 kg ha^{-1}	66.00	64.00	65.00	54.25	40.00	47.13	15.82	13.64	14.73	48.12	47.86	47.99
T_8 : HW twice + earthing up	70.25	60.50	65.38	56.50	42.75	48.10	18.26	13.57	15.91	48.20	48.18	48.19
T_9 : Weed free	70.75	66.75	68.75	57.50	51.00	54.25	20.23	16.80	18.46	48.46	48.52	48.49
T_{10} : Weedy check	52.50	49.15	50.83	45.38	33.00	39.19	7.30	5.70	6.50	44.79	42.49	43.64
S.Em $\pm$	1.47	1.60	1.13	1.45	1.80	1.19	0.83	0.61	0.52	0.77	0.83	0.57
CD at 5%	4.09	4.63	3.50	4.22	4.47	3.63	2.41	1.77	1.59	2.22	2.42	1.74
CV %	4.70	5.23	5.11	5.45	8.95	7.05	11.00	10.62	10.96	3.23	3.55	3.39

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

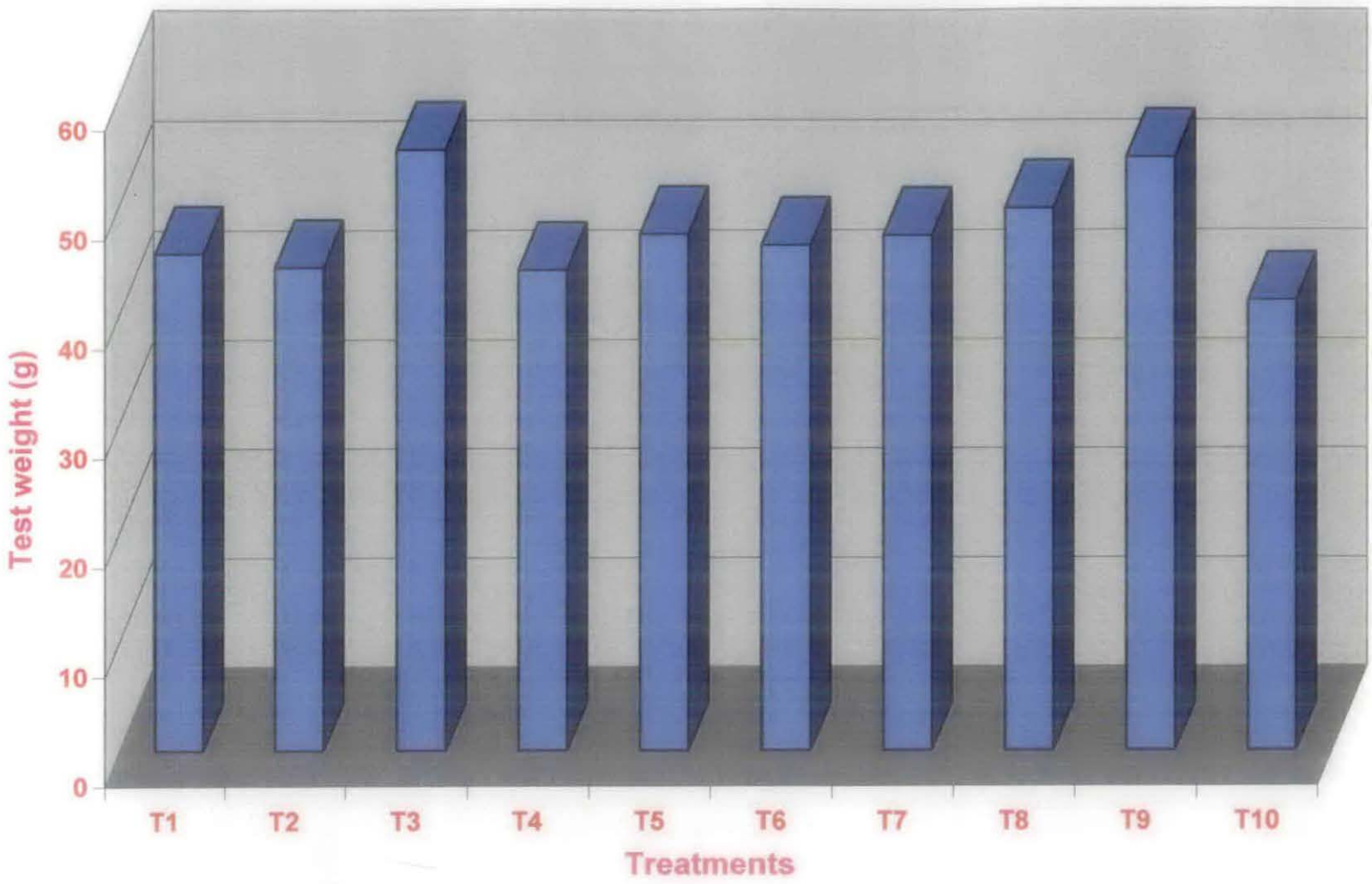


Fig. 12 : Test weight of groundnut as influenced by various treatments (pooled)

(56.50 g), TPE 0.050 mm for 45 days (55.50 g) and pendimethalin 1.0 kg ha^{-1} (54.25 g) in first year. However, it was at par with weed free (51.00 g) in second year and in pooled results (54.25 g) only. Significantly lowest test weight was recorded due to weedy check (45.38, 33.00 and 39.19 g) over all other treatments in first year, second year and in pooled results, respectively.

4.3.2.7 Kernel yield

Kernel yield was influenced significantly due to various treatments in individual year and in pooled analysis (Table 33).

From the data, it is seen that significantly maximum kernel yield was obtained under TPE 0.025 mm for 45 days (21.42, 17.85 and 19.63 q ha^{-1}) over all other treatments, barring weed free (20.23, 16.80 and 18.46 q ha^{-1}) in first year, second year and in pooled results, respectively. Weedy check recorded significantly minimum kernel yield (7.30, 5.70 and 6.50 q ha^{-1}) as compared to all other treatments in first year, second year and in pooled results, respectively.

4.3.2.8 Oil content

Significant differences were observed among the treatments with respect to oil content in groundnut in first year, second year and in pooled analysis (Table 33).

An appraisal of data presented indicated that significantly maximum oil content was registered in TPE 0.025 mm for 45 days (49.36 and 48.56 per cent) in first year and second year, respectively, but it was at par with weed free, TPE 0.050 mm for 45 days, hand weeding twice plus earthing up, TPE 0.025 mm for 30 days, pendimethalin 1.0 kg ha^{-1} and TPE 0.050 mm for 30 days in first year and second year.

A perusal of pooled results (Table 33 and Fig.13) revealed that maximum oil content was recorded in TPE 0.025 mm for 45 days (48.96 per cent), but was found significantly superior over all other treatments, barring weed free (48.49 per cent), TPE 0.050 mm for 45 days (48.22 per cent), hand

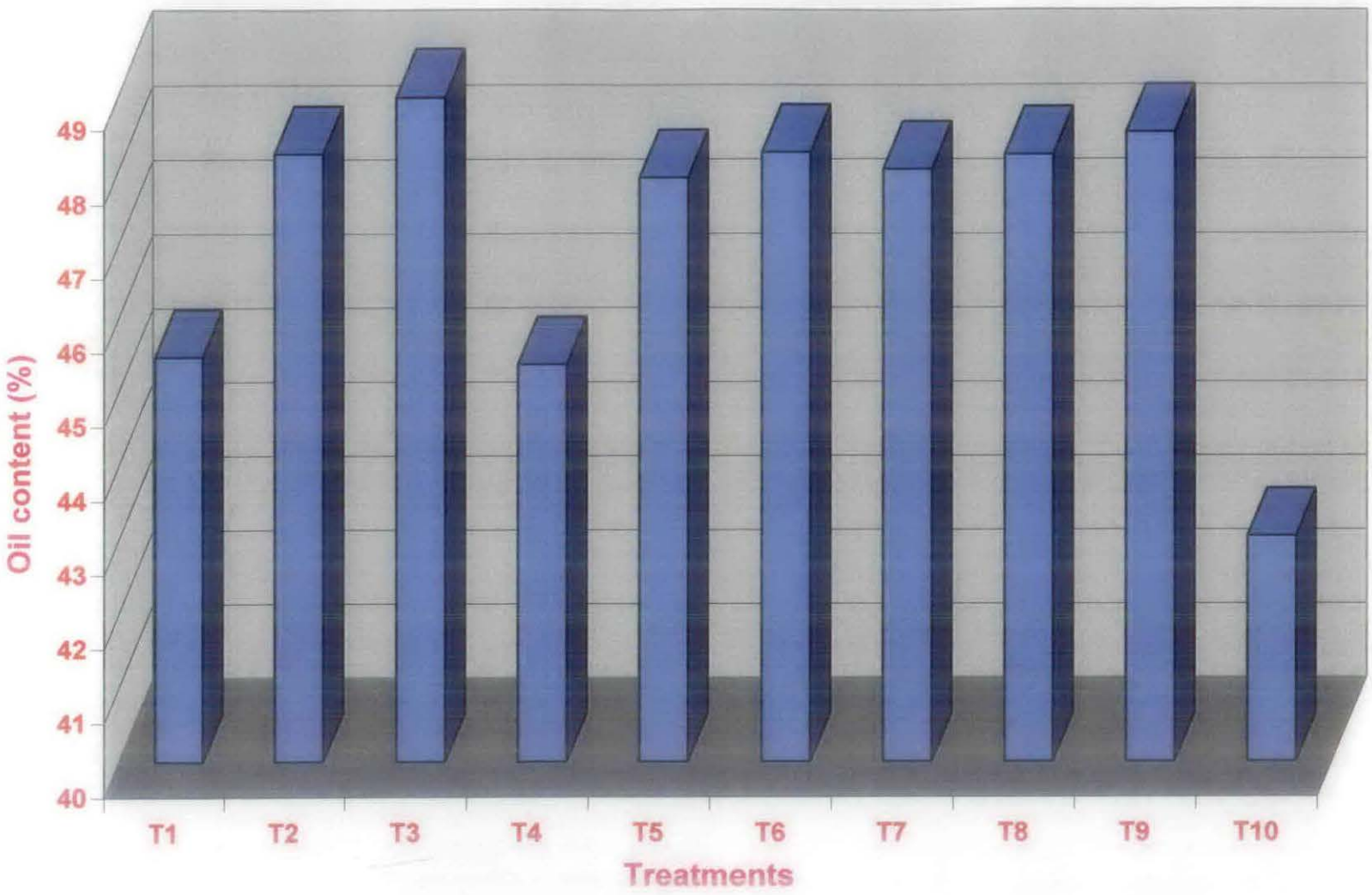


Fig. 13 : Oil content in groundnut as influenced by various treatments (pooled)

weeding twice plus earthing up (48.19 per cent), TPE 0.025 mm for 30 days (48.20 per cent), pendimethalin 1.0 kg ha^{-1} (47.99 per cent) and TPE 0.050 mm for 30 days (47.93 per cent). Weedy check noted significantly minimum oil content (44.79, 42.49 and 43.64 per cent) over all other treatments in first year, second year as well as in pooled analysis and it was on par with shorter durations of SS.

4.4 Effect soil solarization treatments on content of nutrients in groundnut haulm and in weeds

4.4.1 Content of nutrients in groundnut haulm

4.4.1.1 Nitrogen content

Different treatments exerted their significant influence on nitrogen content in groundnut haulm in first year, second year and in pooled analysis (Table 34).

TPE 0.025 mm for 45 days significantly increased the nitrogen content (2.65, 2.31 and 2.48 per cent) in haulm over all other treatments, except weed free in first year (2.59 per cent) as well as in pooled results (2.45 per cent). While, in second year it was at par with weed free (2.30 per cent) and in hand weeding twice plus earthing up (2.25 per cent). Significantly the lowest nitrogen content (1.17, 0.80 and 0.99 per cent) in haulm was recorded under weedy check over all other treatments in first year, second year and in pooled results, respectively.

4.4.1.2 Phosphorus content

The statistical analysis of the data showed significant variation in phosphorus content in groundnut haulm due to various treatments in individual year and in pooled analysis (Table 34).

A perusal of data indicated that TPE 0.025 mm for 45 days significantly increased the phosphorus content (0.30, 0.29 and 0.30 per cent) in haulm over all other treatments, except weed free (0.30, 0.29 and 0.30 per cent) in first year, second year and in pooled results, respectively. Significantly the lowest

Table 34 : Content of nitrogen, phosphorus , potassium and sulphur in groundnut haulm as influenced by various treatments

Treatments	Content of nutrients (%)											
	Nitrogen			Phosphorus			Potassium			Sulphur		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	1.78	1.05	1.42	0.19	0.17	0.18	0.44	0.34	0.39	0.80	0.53	0.66
T_2 : TPE 0.025 mm 30 days	2.20	1.11	1.66	0.24	0.21	0.22	0.58	0.52	0.55	0.83	0.70	0.77
T_3 : TPE 0.025 mm 45 days	2.65	2.31	2.48	0.30	0.29	0.30	0.71	0.64	0.68	1.00	0.88	0.94
T_4 : TPE 0.050 mm 15 days	1.70	1.03	1.37	0.18	0.16	0.17	0.41	0.35	0.38	0.77	0.50	0.64
T_5 : TPE 0.050 mm 30 days	1.96	1.86	1.91	0.19	0.18	0.18	0.48	0.42	0.45	0.83	0.70	0.77
T_6 : TPE 0.050 mm 45 days	2.37	2.04	2.20	0.24	0.23	0.23	0.60	0.55	0.58	0.86	0.84	0.85
T_7 : Pendimethalin 1.0 kg ha^{-1}	2.13	2.04	2.09	0.23	0.22	0.23	0.55	0.56	0.56	0.81	0.63	0.72
T_8 : HW twice + earthing up	2.44	2.25	2.35	0.27	0.25	0.26	0.65	0.61	0.63	0.89	0.78	0.84
T_9 : Weed free	2.59	2.30	2.45	0.30	0.29	0.30	0.70	0.63	0.67	0.98	0.82	0.90
T_{10} : Weedy check	1.17	0.80	0.99	0.15	0.13	0.14	0.40	0.33	0.36	0.73	0.50	0.61
S.Em ±	0.03	0.05	0.04	0.005	0.008	0.005	0.020	0.015	0.013	0.02	0.03	0.02
CD at 5%	0.09	0.13	0.11	0.02	0.02	0.02	0.06	0.05	0.04	0.07	0.09	0.06
CV %	4.37	4.65	4.51	6.41	7.77	7.09	7.11	6.15	6.72	6.73	7.29	7.09

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

phosphorus content (0.15, 0.13 and 0.14 per cent) in haulm was recorded under weedy check over all other treatments in first year, second year and in pooled results, respectively.

4.4.4.3 Potassium content

Potassium in groundnut haulm was significantly influenced by various treatments during both the years and in pooled data (Table 34) .

From the data, it is indicated that TPE 0.025 mm for 45 days significantly increased the potassium content (0.71, 0.64 and 0.68 per cent) in haulm over all other treatments, except weed free (0.70 per cent) and in hand weeding twice plus earthing up (0.65 per cent) in first year and weed free (0.63 per cent) only in second year as well as in pooled results (0.67 per cent). Significantly the lowest potassium content in haulm was recorded under weedy check (0.40, 0.33 and 0.36 per cent) over all other treatments in first year, second year and in pooled results, except shorter durations of solarization, respectively.

4.4.1.4 Sulphur content

The results on sulphur content in groundnut haulm showed significant variations due to various treatments in first year, second year and in pooled analysis (Table 34).

Data indicated that TPE 0.025 mm for 45 days (1.00, 0.88 and 0.94 per cent) significantly increased the sulphur content in haulm over all other treatments, except weed free in first year (0.98 per cent) and in pooled results (0.90 per cent) as well as weed free (0.82 per cent) and TPE 0.050 mm for 45 days (0.84 per cent) in second year. Significantly the lowest sulphur content (0.73, 0.50 and 0.61 per cent) in haulm was recorded under weedy check over all other treatments in first year, second year and in pooled results, respectively, except shorter durations of solarization.

4.4.1.5 Iron content

A perusal of data (Table 35) indicated that the differences in Fe content in groundnut haulm were significant due to various treatments in first year, second year and in pooled analysis.

It is revealed that the TPE 0.025 mm significantly recorded the highest Fe content (940, 825 and 882 ppm) in haulm as compared to all other treatments in first year, second year and in pooled results, respectively, barring weed free (879 ppm) and hand weeding twice plus earthing up (878 ppm) in first year only. Weedy check (431, 304 and 368 ppm) had significantly the lowest Fe content in haulm in first year, second year and in pooled results, respectively.

4.4.4.6 Manganese content

The variable effect of treatments on Mn content in groundnut haulm was found significant in first year, second year and in pooled analysis (Table 35).

A perusal of data indicated that significantly maximum Mn content in haulm was observed in TPE 0.025 mm for 45 days (58.00 and 51.00 ppm) over all other treatments, except weed free (55.50 and 49.00 ppm) and hand weeding twice plus earthing up (54.75 and 48.75 ppm) in first and second year, respectively. However, it was found significantly superior over all other treatments for Mn content (54.50 ppm) in pooled results, except weed free (52.25 ppm). While, significantly the lowest Mn content was observed in weedy check in first year (34.50 ppm), second year (28.50 ppm) and in pooled results (31.50 ppm) as compared to all other treatments.

4.4.1.7 Zinc content

The mean data on Zn content in haulm was significantly influenced by various treatments during both the years and in pooled analysis (Table 35).

Data indicated that significantly maximum Zn content in haulm was observed in TPE 0.025 mm for 45 days (40.75 and 36.75 ppm) as compared to

Table 35 : Content of iron , manganese, zinc, and copper in groundnut haulm as influenced by various treatments

Treatments	Content of nutrients (ppm)											
	Fe			Mn			Zn			Cu		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	505	456	481	43.50	36.50	40.00	29.48	24.73	27.10	10.00	8.75	9.38
T_2 : TPE 0.025 mm 30 days	657	513	585	51.00	43.25	47.13	33.25	28.25	30.75	11.50	10.95	11.23
T_3 : TPE 0.025 mm 45 days	940	825	882	58.00	51.00	54.50	40.75	36.75	38.75	15.00	13.10	14.05
T_4 : TPE 0.050 mm 15 days	518	438	478	41.25	35.00	38.13	27.90	22.30	25.10	9.60	8.50	9.05
T_5 : TPE 0.050 mm 30 days	609	650	630	47.75	43.00	45.38	32.70	27.85	30.28	11.55	10.73	11.14
T_6 : TPE 0.050 mm 45 days	745	671	708	50.50	44.75	47.63	38.80	36.50	37.65	13.30	11.52	12.41
T_7 : Pendimethalin 1.0 kg ha^{-1}	714	482	598	48.75	45.25	47.00	39.60	33.65	36.63	11.25	11.10	11.18
T_8 : HW twice + earthing up	878	707	792	54.75	48.75	51.75	39.00	34.00	36.20	13.88	12.20	13.04
T_9 : Weed free	879	720	800	55.50	49.00	52.25	40.50	35.25	37.88	14.33	13.08	13.71
T_{10} : Weedy check	431	304	368	34.50	28.50	31.50	25.75	18.75	22.25	9.40	8.70	9.05
S.Em $\pm$	21.3	18.6	20.0	1.24	0.95	0.79	0.92	0.82	0.62	0.30	0.24	0.19
CD at 5%	62.0	54.0	44.0	3.60	2.70	2.42	2.67	2.39	1.90	0.88	0.69	0.59
CV %	6.2	5.5	6.3	5.15	4.49	4.88	5.03	5.67	5.48	5.03	4.38	4.75

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

all other treatments in first and second year, respectively, except weed free (40.50 per cent), pendimethalin 1.0 kg ha^{-1} (39.60 per cent), hand weeding twice plus earthing up (39.00 per cent), TPE 0.050 mm for 45 days (38.80 per cent) in first year and it was at par with weed free (35.25 per cent) and TPE 0.050 mm for 45 days (36.50 per cent) only in second year. Whereas, in pooled results, TPE 0.025 mm for 45 days had significantly maximum Zn content (38.75 ppm) over all other treatments, barring weed free (37.88 ppm).While, significantly minimum Zn content was observed in weedy check (25.75, 18.75 and 22.25 ppm) as compared to all other treatments in first, second year and in pooled results, while it was at par with TPE 0.050 mm for 15 days only in first year.

4.4.1.8 Copper content

The variable effect of the treatments was significant for copper content in groundnut haulm in first year, second year and in pooled analysis (Table 35).

An appraisal of data revealed that significantly maximum copper content was recorded under TPE 0.025 mm for 45 days (15.00, 13.10 and 14.05 ppm) in haulm over all other treatments, barring weed free (14.33, 13.08 and 13.71 ppm) in first year, second year and in pooled results, respectively. While copper content was significantly minimum under weedy check (9.40, 8.70 and 9.05 ppm) as compared to all other treatments, except shorter durations of SS either by TPE 0.050 mm or TPE 0.025 mm for 15 days in first year, second year and in pooled results.

4.4.2 Content of nutrients in weeds

4.4.2.1 Nitrogen content

The statistical analysis of the data showed significant variation in nitrogen content in weeds due to various treatments in first year, second year and in pooled analysis (Table 36).

Data revealed that significantly minimum nitrogen content in weeds was recorded with TPE 0.025 mm for 45 days (2.75, 2.80 and 2.78 per cent) over all

Table 36 : Content of nitrogen, phosphorus, potassium and sulphur in weeds influenced by various treatments

Treatments	Content of nutrients (%)											
	Nitrogen			Phosphorus			Potassium			Sulphur		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	4.30	4.70	4.50	0.28	0.29	0.28	2.11	2.24	2.18	0.29	0.31	0.30
T_2 : TPE 0.025 mm 30 days	4.00	3.50	3.75	0.20	0.19	0.21	1.97	2.13	2.05	0.20	0.21	0.21
T_3 : TPE 0.025 mm 45 days	2.75	2.80	2.78	0.14	0.15	0.15	1.78	1.84	1.81	0.17	0.18	0.17
T_4 : TPE 0.050 mm 15 days	4.35	4.60	4.48	0.28	0.30	0.29	2.15	2.26	2.21	0.30	0.30	0.30
T_5 : TPE 0.050 mm 30 days	4.08	3.66	3.87	0.22	0.26	0.24	1.98	2.21	2.09	0.26	0.28	0.27
T_6 : TPE 0.050 mm 45 days	3.40	3.66	3.53	0.19	0.19	0.19	1.98	2.09	2.03	0.19	0.20	0.20.
T_7 : Pendimethalin 1.0 kg ha^{-1}	3.43	3.49	3.46	0.22	0.19	0.20	1.98	2.10	2.04	0.19	0.20	0.20
T_8 : HW twice + earthing up	3.18	3.28	3.23	0.18	0.18	0.18	1.85	1.93	1.89	0.19	0.20	0.20
T_9 : Weed free	2.80	2.84	2.82	0.14	0.14	0.14	1.72	1.78	1.75	0.17	0.18	0.17
T_{10} : Weedy check	5.63	5.88	5.75	0.31	0.34	0.33	2.33	2.65	2.49	0.34	0.38	0.36
S.Em ±	0.12	0.14	0.09	0.08	0.01	0.005	0.06	0.08	0.05	0.008	0.009	0.006
CD at 5%	0.36	0.40	0.29	0.02	0.03	0.02	0.16	0.22	0.15	0.02	0.03	0.02
CV %	6.53	7.19	6.87	7.21	8.40	6.64	5.60	7.22	6.54	7.31	7.72	7.53

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

other treatments, barring weed free (2.80, 2.84 and 2.82 per cent) in first year, second year and in pooled results, respectively. While significantly the highest nitrogen content in weeds was recorded in weedy check (5.63. 5.88 and 5.75 per cent) as compared to all other treatment in first year, second year and in pooled results, respectively

4.4.2.2 Phosphorus content

The variable effect of the treatments was significant for phosphorus content in weeds in first year, second year and in pooled analysis (Table 36).

An appraisal of data indicated that phosphorus content in weeds was recorded minimum with TPE 0.025 mm for 45 days (0.14, 0.15 and 0.15 per cent) and found significantly superior over all other treatments, barring weed free (0.14, 0.14 and 0.14 per cent) in first year, second year and in pooled results, respectively. While, significantly the highest phosphorus content in weed was recorded in weedy check (0.31, 0.34 and 0.33 per cent, respectively) as compared to all other treatments in first year, second year and in pooled results, respectively.

4.4.2.3 Potassium content

Data in Table 36 revealed that the difference in potassium content in weeds was significantly affected due to various treatments in first year and second year as well as in pooled results.

It is seen from the data that significantly minimum potassium content in weeds was observed in weed free (1.72, 1.78 and 1.75 per cent) over all other treatments, barring TPE 0.025 mm for 45 days (1.78, 1.84 and 1.81 per cent) and hand weeding twice plus earthing up (1.85, 1.93 and 1.89 per cent) in first and second year as well as in pooled results, respectively. While, significantly highest potassium content in weeds was registered in weedy check (2.33, 2.65 and 2.49 per cent) in first and second year as well as in pooled results, respectively.

4.4.2.4 Sulphur content

Sulphur content in weeds was significantly influenced by various treatments in first year, second year and in pooled analysis (Table 36).

A perusal of data indicated that significantly minimum sulphur content in weeds was observed in TPE 0.025 mm for 45 days (0.17 and 0.18 per cent) as compared to all other treatments, except weed free (0.17 and 0.18 per cent), hand weeding twice plus earthing up (0.19 and 0.20 per cent), TPE 0.050 mm for 45 days (0.19 and 0.20per cent), and pendimethalin 1.0 kg ha^{-1} (0.19 and 0.20 per cent) in first and second year. However, in pooled results, TPE 0.025 mm for 45 days had significantly minimum sulphur content (0.17 per cent) over all other treatments, barring weed free (0.17 per cent). Significantly the highest sulphur content (0.34, 0.38 and 0.36 per cent) in weeds was recorded due to weedy check as compared to all other treatments in first year and second year as well as in pooled results, respectively.

4.4.2.5 Iron content

The differences in Fe content in weeds (Table 37) were significantly influenced by different treatments during first year and second year as well as in pooled results.

A perusal of data indicated that Fe content in weeds was recorded minimum with weed free (216.3, 220.5 and 218.4 ppm) over all other treatments, barring TPE 0.025 mm for 45 days (220.0, 223.9 and 221.9 ppm) and hand weeding twice plus earthing up (236.6, 228.1 and 232.4 ppm) in first year, second year and in pooled results, respectively. While, significantly the highest Fe content in weeds was recorded in weedy check (337.4, 390.0 and 363.8 ppm) as compared to all other treatment in first year, second year and in pooled results, respectively.

Table 37 : Content of iron, manganese, zinc and copper in weeds as influenced by various treatments

Treatments	Content of nutrients (ppm)											
	Fe			Mn			Zn			Cu		
	2003-04	2003-04	2003-04	2003-04	2003-04	2003-04	2003-04	2003-04	2003-04	2003-04	2003-04	2003-04
T_1 : TPE 0.025 mm 15 days	263.0	325.8	294.4	39.00	52.5	45.75	16.90	20.78	18.84	15.00	16.00	15.50
T_2 : TPE 0.025 mm 30 days	247.7	287.6	267.6	37.00	39.05	38.02	14.11	17.18	15.64	12.84	14.95	13.84
T_3 : TPE 0.025 mm 45 days	220.0	223.9	221.9	27.50	27.25	27.38	11.50	12.75	11.93	10.80	12.25	11.52
T_4 : TPE 0.050 mm 15 days	287.7	308.0	297.8	41.00	56.25	48.63	17.85	19.90	18.88	15.45	16.35	15.90
T_5 : TPE 0.050 mm 30 days	265.8	290.0	277.9	36.50	46.25	41.38	15.20	18.98	17.09	13.95	15.65	14.80
T_6 : TPE 0.050 mm 45 days	257.8	263.8	260.8	36.50	37.00	36.75	13.08	15.00	14.04	12.00	14.00	13.00
T_7 : Pendimethalin 1.0 kg ha^{-1}	261.0	271.5	266.3	35.25	40.25	37.75	15.18	16.13	15.66	13.45	13.75	13.60
T_8 : HW twice + earthing up	236.6	228.1	232.4	33.00	35.50	34.25	13.00	14.50	13.75	12.00	13.25	12.63
T_9 : Weed free	216.3	220.5	218.4	24.25	27.00	25.63	11.30	12.20	11.75	10.75	12.00	11.38
T_{10} : Weedy check	337.5	390.0	363.8	51.00	62.50	56.75	18.20	21.00	19.60	15.73	16.50	16.11
S.Em $\pm$	8.74	7.58	5.78	1.43	1.73	1.12	0.50	0.48	0.35	0.43	0.59	0.36
CD at 5%	25.76	21.99	17.81	4.15	5.03	3.46	1.46	1.38	1.07	1.24	1.70	1.12
CV %	6.74	5.39	6.05	7.90	8.23	8.11	6.99	5.71	6.31	6.52	8.11	7.45

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

4.4.2.6 Manganese content

Different treatments exerted their significant influence on Mn content in weeds during both the years and in pooled analysis (Table 37).

The statistical analysis of data revealed that weed free significantly decreased the Mn content (24.25, 27.00 and 25.63 ppm) in weeds compared to all other treatments, barring TPE 0.025 mm for 45 days (27.50, 27.25 and 27.38 ppm) in first year, second year and in pooled results, respectively. While, significantly maximum Mn content in weeds was observed in weedy check (51.00, 62.50 and 56.75 ppm) as compared to all other treatments in first year, second year and in pooled results, respectively.

4.4.2.7 Zinc content

The variable effect of different treatments on Zn content was significant in first year, second year and in pooled analysis (Table 37).

A perusal of data revealed that significantly minimum Zn content was recorded in weed free (11.30, 12.20 and 11.75 ppm) in weeds compared to all other treatments, barring TPE 0.025 mm for 45 days (11.50, 12.75 and 11.93 ppm) in first year, second year and in pooled results, respectively. Zn content in weeds was observed significantly maximum in weedy check (18.20, 21.00 and 19.60 ppm) over all other treatments, except TPE 0.050 mm for 15 days and TPE 0.025 mm for 15 days in first year, second year and in pooled results, respectively.

4.4.2.8 Copper content

It is evident from the data (Table 37) that the differences in Cu content in weeds were significantly influenced by different treatments in first year and second year as well as in pooled results.

An appraisal of data indicated that Cu content in weeds was registered minimum in weed free (10.75, 12.00 and 11.38 ppm) and found significantly superior than all other treatments, barring TPE 0.025 mm for 45 days (10.80,

12.25 and 11.52 ppm) in first year, second year and in pooled results, respectively. While, significantly maximum Cu content in weeds was observed in weedy check (15.73, 16.50 and 16.11 ppm) over all other treatments except TPE 0.050 mm for 15 days (15.45, and 15.90 ppm) and TPE 0.025 mm 15 days (15.00, and 15.50 ppm) in first year and in pooled results, respectively, whereas in second year, it was at par with TPE 0.050 mm for 15 days(16.35 ppm), TPE 0.025 mm for 15 days (16.00 ppm), TPE 0.050 mm for 30 days (15.65 ppm) and TPE 0.025 mm for 30 days (14.95 ppm).

4.5 Effect of soil solarization on weed control in succeeding potato

4.5.1 Weed flora of experimental plots

Following pre-dominant weed species of grasses, broad leaved and sedges were observed in experimental fields which are more or less similar in both the year.

Grasses	Broad leaved	Sedges
Digitaria sanguinalis L	*Chenopodium album L.*	*Cyperus rotundus L*
Eragrostis pilosa Beauv.	*Portulaca oleracea L.*	
Cynadon dactylon(L)Pers.	*Tribulus terrestris L.*	
Cenchrus biflorus L	*Amaranthus spinosus L.*	
	Amaranthus viridis L.	
	Argemone maxicana L.	
	Launaea mudicauli H.k.	
	Leucas aspera (Wild.)Spreng.	
	Asphodilus tenuifoilus L.	
	Melilotus alba Lamk	

4.5.2 Weed count per meter square

The data on number of grasses, broad leaved, sedges and total weeds per meter square revealed that significant differences were noted due to various

treatments in first year, second year and in pooled analysis at 30, 60 DAS and harvest. Original and square root transformed value are presented in Tables 38 to 40.

A perusal of data (Table 38) indicated that at 30 DAS, significantly maximum weed count of grasses, broad leaved, sedges and total weeds were recorded in weedy check during first year (13.76, 12.18, 28.09 and 54.09), second year (15.92, 15.76, 31.47 and 63.15) and in pooled results (14.76, 13.97, 29.76 and 58.52), respectively. Whereas, count of grasses, broad leaved, sedges and total weeds were observed significantly less in weed free during first year (0.72, 1.04, 3.06 and 4.82), second year (1.00, 1.10, 3.35 and 5.45) and in pooled results (0.86, 1.06, 3.17 and 5.09) over all other treatments, except hand weeding twice plus earthing up during first year (1.21, 1.16, 4.24 and 6.61), second year (1.36, 1.39, 4.62 and 7.38) and in pooled results (1.29, 1.25, 4.41and 6.96) as well as TPE 0.025 mm for 45 days during first year (1.36, 1.19, 4.49 and 6.96), second year (1.76, 1.35,4.84 and 8.01) and in pooled results (1.54, 1.25, 4.67 and 7.50), respectively.

At 60 DAS (Table 39), grasses, broad leaved, sedges and total weeds population were recorded significantly maximum in weedy check during first year (26.01, 19.18, 37.21 and 90.75), second year (34.81, 24.01, 44.76 and 103.58) and in pooled results (30.41, 21.59, 40.98 and 97.17), respectively. While, minimum count of grasses, broad leaved, sedges and total weeds were listed in weed free during first year (2.40, 1.49, 2.40 and 6.29), second year (3.06, 2.02, 2.43 and 7.78) and in pooled results (2.72, 1.74, 2.56 and 7.02) and was found significantly superior over all other treatments except hand weeding twice plus earthing up during first year (2.62, 2.72, 3.03 and 8.37), second year (3.50, 3.17, 3.61 and 10.28) and in pooled results (3.06, 2.92, 3.32 and 9.32), respectively and TPE 0.025 mm for 45 days during first year (3.06, 1.61, 4.28 and 8.95), second year (4.00, 2.04, 4.75 and 10.76) and in pooled results (3.49, 1.82, 4.54 and 9.86), respectively. At harvest (Table 40) indicated that significantly maximum count of grasses, broad leaved, sedges and total weeds were noted in weedy check during

Table 38 : Weed count per m^2 at 30 DAS in potato as influenced by various treatments .

Treatments	Grasses			Broad leaved			Sedges			Total weeds		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	3.14	3.52	3.33	2.94	3.46	3.20	4.37	4.44	4.40	6.13	6.63	6.39
	9.86	**12.39**	**11.09**	**8.64**	**11.97**	**10.24**	**19.08**	**19.71**	**19.39**	**37.58**	**44.07**	**40.77**
T_2 : TPE 0.025 mm 30 days	2.52	2.90	2.71	1.89	1.98	1.94	2.56	2.77	2.66	4.46	4.05	4.26
	6.35	**8.41**	**7.34**	**3.57**	**3.92**	**3.74**	**6.55**	**7.65**	**7.09**	**19.89**	**16.46**	**18.14**
T_3 : TPE 0.025 mm 45 days	1.17	1.33	1.24	1.09	1.16	1.12	2.12	2.20	2.16	2.64	2.83	2.74
	1.36	**1.76**	**1.54**	**1.19**	**1.35**	**1.25**	**4.49**	**4.84**	**4.67**	**6.96**	**8.01**	**7.50**
T_4 : TPE 0.050 mm 15 days	2.98	2.32	3.15	3.00	3.52	3.26	4.18	4.08	4.13	6.06	6.28	6.17
	11.02	**8.88**	**9.92**	**9.00**	**12.39**	**10.63**	**17.47**	**16.65**	**17.06**	**36.73**	**39.44**	**38.07**
T_5 : TPE 0.050 mm 30 days	2.91	2.44	2.68	2.36	2.52	2.44	2.98	3.08	3.03	4.60	4.78	4.69
	8.46	**5.96**	**7.78**	**5.57**	**6.35**	**5.95**	**8.88**	**9.49**	**9.18**	**21.16**	**22.85**	**21.99**
T_6 : TPE 0.050 mm 45 days	2.52	2.15	2.34	1.90	2.08	1.99	2.65	2.95	2.80	4.20	4.12	4.69
	6.35	**4.62**	**5.45**	**3.61**	**4.33**	**3.96**	**7.02**	**8.70**	**7.84**	**17.64**	**16.97**	**16.48**
T_7 : Pendimethalin 1.0 kg ha^{-1}	2.08	2.15	2.12	1.88	2.00	1.94	2.70	2.86	2.78	4.09	3.89	3.99
	4.33	**4.62**	**4.47**	**3.53**	**4.00**	**3.76**	**7.29**	**8.18**	**7.73**	**16.73**	**15.13**	**15.92**
T_8 : HW twice plus earthing up	1.10	1.17	1.13	1.07	1.18	1.12	2.06	2.15	2.10	2.57	2.71	2.64
	1.21	**1.36**	**1.29**	**1.16**	**1.39**	**1.25**	**4.24**	**4.62**	**4.41**	**6.61**	**7.38**	**6.96**
T_9 : Weed free	0.85	1.00	0.93	1.02	1.05	1.03	1.75	1.83	1.78	2.19	2.33	2.26
	0.72	**1.00**	**0.86**	**1.04**	**1.10**	**1.06**	**3.06**	**3.35**	**3.17**	**4.82**	**5.45**	**5 .09**
T_{10} : Weedy check	3.71	3.99	3.84	3.49	3.97	3.73	5.30	5.61	5.48	7.35	7.94	7.64
	13.76	**15.92**	**14.76**	**12.18**	**15.76**	**13.97**	**28.09**	**31.47**	**29.76**	**54.09**	**63.15**	**58.52**
S.Em $\pm$	0.16	0.16	0.16	0.15	0.13	0.10	0.22	0.20	0.16	0.25	0.28	0.19
CD at 5%	0.46	0.47	0.35	0.43	0.39	0.31	0.64	0.57	0.46	0.75	0.82	0.59
CV %	13.58	14.03	13.84	14.59	11.82	13.36	14.82	12.41	13.60	10.82	12.59	11.74

TPE =Transparent polyethylene
DAS =Days After Sowing
Bold letters indicated original value

Table 39 : Weed count per m^2 at 60 DAS in potato as influenced by various treatments.

Treatments	Grasses			Broad leaved			Sedges			Total weeds		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	4.25	4.88	4.56	3.57	3.79	3.68	4.75	5.33	5.04	7.16	8.05	7.73
	18.06	**27.77**	**20.82**	**12.73**	**14.36**	**13.54**	**22.56**	**28.36**	**25.38**	**51.26**	**64.80**	**59.75**
T_2 : TPE 0.025 mm 30 days	3.06	3.22	3.14	2.38	2.53	2.45	3.30	3.47	3.38	5.35	4.99	5.17
	9.36	**10.34**	**9.85**	**5.64**	**6.38**	**6.00**	**10.89**	**12.01**	**11.44**	**28.62**	**24.90**	**26.73**
T_3 : TPE 0.025 mm 45 days	1.75	2.00	1.87	1.27	1.43	1.35	2.07	2.18	2.13	2.99	3.28	3.14
	3.06	**4.00**	**3.49**	**1.61**	**2.04**	**1.82**	**4.28**	**4.75**	**4.54**	**8.95**	**10.76**	**9.86**
T_4 : TPE 0.050 mm 15 days	4.30	4.75	4.53	3.64	3.75	3.69	4.70	5.46	5.08	7.34	8.17	7.79
	18.49	**22.56**	**20.48**	**13.24**	**14.06**	**13.65**	**22.09**	**29.76**	**25.81**	**53.82**	**66.75**	**60.29**
T_5 : TPE 0.050 mm 30 days	3.25	3.75	3.50	2.65	2.60	2.63	3.85	4.12	3.99	5.69	6.14	5.72
	10.56	**14.06**	**12.25**	**7.02**	**6.76**	**6.89**	**14.82**	**16.17**	**15.88**	**32.38**	**37.70**	**34.99**
T_6 : TPE 0.050 mm 45 days	3.00	3.10	3.05	2.39	2.38	2.34	3.55	3.76	3.45	5.12	5.35	5.24
	9.00	**9.58**	**9.29**	**5.71**	**5.66**	**5.47**	**12.57**	**11.29**	**11.91**	**26.21**	**28.62**	**27.41**
T_7 : Pendimethalin 1.0 kg ha^{-1}	2.75	2.85	2.80	2.00	2.20	2.10	3.22	4.00	3.61	4.80	5.38	5.09
	7.56	**8.12**	**7.84**	**4.00**	**4.84**	**4.41**	**10.35**	**16.00**	**13.02**	**23.04**	**28.94**	**25.91**
T_8 : HW twice plus earthing up	1.62	1.87	1.75	1.65	1.78	1.71	1.74	1.90	1.83	2.89	3.20	3.05
	2.62	**3.50**	**3.06**	**2.72**	**3.17**	**2.92**	**3.03**	**3.61**	**3.32**	**8.37**	**10.28**	**9.32**
T_9 : Weed free	1.55	1.75	1.65	1.22	1.42	1.32	1.55	1.56	1.60	2.51	2.79	2.65
	2.40	**3.06**	**2.72**	**1.49**	**2.02**	**1.74**	**2.40**	**2.43**	**2.56**	**6.29**	**7.78**	**7.02**
T_{10} : Weedy check	5.10	5.90	5.50	4.38	4.90	4.64	6.10	6.69	6.39	9.52	10.17	9.85
	26.01	**34.81**	**30.41**	**19.18**	**24.01**	**21.59**	**37.21**	**44.76**	**40.98**	**90.75**	**103.58**	**97.17**
S.Em +	0.24	0.31	0.19	0.20	0.22	0.15	0.46	0.41	0.31	0.52	0.32	0.30
CD at 5%	0.68	0.89	0.60	0.59	0.63	0.46	1.32	1.18	0.94	1.50	0.93	0.94
CV %	15.57	17.69	16.85	16.03	16.16	16.01	25.12	22.20	23.68	18.02	11.84	15.45

TPE =Transparent polyethylene
DAS =Days After Sowing
Bold letters indicated original value

Table 40 : Weed count per m^2 at harvest in potato as influenced by various treatments.

Treatments	Grasses			Broad leaved			Sedges			Total weeds		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	5.24	5.27	5.25	3.84	4.09	3.97	4.90	5.63	5.27	8.12	8.71	8.31
	27.45	**27.77**	**27.56**	**14.75**	**16.73**	**15.72**	**24.01**	**31.73**	**27.33**	**65.93**	**75.86**	**69.06**
T_2 : TPE 0.025 mm 30 days	3.96	3.62	3.79	2.65	2.72	2.69	3.25	4.10	3.68	6.31	5.54	5.93
	15.68	**13.10**	**14.36**	**7.02**	**7.40**	**7.21**	**10.56**	**16.83**	**13.51**	**39.81**	**30.69**	**35.16**
T_3 : TPE 0.025 mm 45 days	2.10	2.20	2.15	1.75	2.10	1.92	3.03	3.23	3.13	4.08	4.42	4.25
	4.41	**4.84**	**4.62**	**3.06**	**4.41**	**3.68**	**9.18**	**10.43**	**9.80**	**16.64**	**19.53**	**18.10**
T_4 : TPE 0.050 mm 15 days	5.36	5.21	5.29	3.98	4.36	4.67	5.06	5.23	5.15	8.37	8.57	8.47
	28.87	**27.14**	**27.98**	**15.84**	**19.01**	**21.81**	**25.60**	**27.38**	**26.48**	**70.06**	**73.57**	**71.80**
T_5 : TPE 0.050 mm 30 days	4.37	4.04	4.21	3.06	3.36	3.21	4.31	5.34	4.83	6.85	7.49	7.17
	19.09	**10.62**	**17.22**	**9.36**	**11.29**	**10.30**	**18.58**	**28.52**	**23.28**	**46.92**	**56.10**	**54.10**
T_6 : TPE 0.050 mm 45 days	3.67	3.97	3.82	2.68	2.98	2.83	3.78	3.91	3.85	6.05	6.18	6.12
	13.46	**15.76**	**14.59**	**7.18**	**8.88**	**8.01**	**14.29**	**15.29**	**14.78**	**36.60**	**38.19**	**37.15**
T_7 : Pendimethalin 1.0 kg ha^{-1}	3.70	3.91	3.80	2.51	3.18	2.85	3.64	3.80	3.72	5.93	6.17	6.05
	15.28	**13.69**	**14.47**	**6.30**	**10.11**	**8.09**	**13.25**	**14.44**	**13.84**	**35.16**	**37.06**	**36.60**
T_8 : HW twice plus earthing up	2.22	2.60	2.40	2.48	2.32	2.40	3.10	3.36	3.23	4.55	4.83	4.69
	4.92	**6.76**	**5.81**	**6.15**	**5.38**	**5.76**	**9.61**	**11.28**	**10.44**	**20.68**	**23.76**	**22.02**
T_9 : Weed free	1.84	2.20	2.02	2.09	1.70	1.90	2.54	3.11	2.83	3.77	4.17	3.97
	3.38	**4.84**	**4.08**	**4.37**	**2.89**	**3.63**	**6.45**	**9.67**	**8.01**	**14.21**	**17.40**	**15.80**
T_{10} : Weedy check	5.98	6.19	6.08	4.80	5.03	4.91	5.94	6.42	6.18	9.70	10.23	9.93
	35.76	**38.31**	**37.04**	**23.04**	**25.28**	**24.16**	**35.28**	**41.22**	**38.25**	**94.08**	**104.81**	**99.45**
S.Em ±	0.19	0.22	0.14	0.23	0.22	0.16	0.27	0.25	0.18	0.42	0.30	0.26
CD at 5%	0.57	060	0.44	0.67	0.65	0.50	0.78	0.72	0.57	1.22	0.88	0.80
CV %	9.16	11.09	10.06	14.37	14.42	14.39	13.43	11.84	12.62	12.34	9.45	11.09

TPE =Transparent polyethylene
DAS =Days After Sowing
Bold letters indicated original value

first year (35.76, 23.04, 35.28 and 94.08), second year (38.31, 25.28, 41.22 and 104.81) and in pooled results (37.04, 24.16, 38.25 and 99.45), respectively. However, count of grasses, broad leaved, sedges and total weeds were registered minimum in weed free during first year (3.38, 4.37, 6.45 and 14.21), second year (4.84, 2.89, 9.67 and 17.40) and in pooled results (4.08, 3.63, 8.01 and 15.80), respectively and were found significantly superior over all other treatments, except in TPE 0.025 mm for 45 days during first year (4.41, 3.06, 9.18 and 16.64), second year (4.84, 4.41, 10.43 and 19.53) and in pooled results (4.62, 3.68, 9.80 and 18.10) and hand weeding twice plus earthing up weeding twice plus earthing up during first year (4.92,6.15, 9.61 and 20.68), second year (6.76, 5.38, 11.28 and 23.76) and in pooled results (5.81, 5.76, 10.44 and 22.02), respectively.

4.5.3 Dry weight of weeds

A perusal of data on dry weight of weeds at 30, 60 DAS and at harvest indicated that dry weight of grasses, broad leaved, sedges and total weeds was significantly influenced by various treatments during both the years and in pooled analysis. Original and square root transformed value are presented Tables 41 to 43.

It is indicated (Table 41) that at 30 DAS, significantly maximum dry weight of grasses, broad leaved, sedges and total weeds were recorded in weedy check during first year (5.76, 4.41, 8.41 and 20.97 g/0.25 m^2), second year (7.84, 5.76, 11.56 and 25.16 g/0.25 m^2) and in pooled results (6.80, 5.09, 9.99 and 23.07 g / 0.25 m^2), respectively. Whereas, dry weight of grasses, broad leaved, sedges and total weeds was observed minimum in weed free during first year (0.81, 1.21, 1.28 and 3.35 g / 0.25 m^2), second year (1.44, 1.44, 1.51 and 4.25 g / 0.25 m^2) and in pooled results (1.10, 1.32, 1.37 and 3.80 g / 0.25 m^2) and was significantly superior over all other treatments, except hand weeding twice plus earthing up during first year (0.88, 1.21, 1.30 and 3.39 g / 0.25 m^2), second year (1.69, 1.69, 1.77 and 5.06 g / 0.25 m^2) and in pooled results (1.25, 1.44, 1.54 and 4.23 g / 0.25 m^2) and TPE 0.025 mm for 45 days during first year

Table 41 : Weed dry weight (g / 0.25 m^2) at 30 DAS in potato as influenced by various treatments .

Treatments	Grasses			Broad leaved			Sedges			Total weeds		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	1.87	1.92	1.90	1.66	1.88	1.77	2.34	2.54	2.44	3.42	3.69	3.56
	3.50	**3.69**	**3.59**	**2.75**	**3.52**	**3.12**	**5.46**	**6.46**	**5.95**	**11.70**	**13.62**	**12.64**
T_2 : TPE 0.025 mm 30 days	1.52	1.43	1.48	1.39	1.62	1.50	1.46	1.67	1.56	2.52	2.72	2.62
	2.31	**2.04**	**2.18**	**1.93**	**3.62**	**2.26**	**2.13**	**2.77**	**2.44**	**6.35**	**7.40**	**6.86**
T_3 : TPE 0.025 mm 45 days	1.24	1.36	1.30	1.10	1.25	1.18	1.24	1.35	1.30	2.07	2.27	2.18
	1.54	**1.85**	**1.69**	**1.21**	**1.56**	**1.39**	**1.54**	**1.82**	**1.69**	**4.29**	**5.15**	**4.72**
T_4 : TPE 0.050 mm 15 days	1.96	1.88	1.92	1.79	1.78	1.79	2.34	2.82	2.58	3.53	3.82	3.68
	3.84	**3.53**	**3.69**	**3.20**	**3.17**	**3.19**	**5.48**	**7.95**	**6.66**	**12.46**	**14.59**	**13.51**
T_5 : TPE 0.050 mm 30 days	1.78	1.62	1.70	1.52	1.52	1.52	2.02	1.62	1.82	3.09	2.74	2.92
	3.17	**2.62**	**2.89**	**2.31**	**2.31**	**2.31**	**4.08**	**2.62**	**3.31**	**9.55**	**7.51**	**8.50**
T_6 : TPE 0.050 mm 45 days	1.58	1.59	1.49	1.35	1.35	1.35	1.40	1.55	1.48	2.50	2.48	2.49
	2.50	**1.93**	**2.21**	**1.82**	**1.82**	**1.82**	**1.96**	**2.40**	**2.18**	**6.25**	**6.15**	**6.20**
T_7 : Pendimethalin 1.0 kg ha^{-1}	1.55	1.60	1.58	1.40	1.40	1.40	1.99	1.39	1.69	2.88	2.53	2.71
	2.40	**2.56**	**2.48**	**1.96**	**1.96**	**1.96**	**3.96**	**1.93**	**2.86**	**8.29**	**6.40**	**7.32**
T_8 : HW twice plus earthing up	0.94	1.30	1.12	1.10	1.30	1.20	1.14	1.33	1.24	1.84	2.25	2.05
	0.88	**1.69**	**1.25**	**1.21**	**1.69**	**1.44**	**1.30**	**1.77**	**1.54**	**3.39**	**5.06**	**4.23**
T_9 : Weed free	0.90	1.20	1.05	1.10	1.20	1.15	1.13	1.23	1.18	1.83	2.07	1.95
	0.81	**1.44**	**1.10**	**1.21**	**1.44**	**1.32**	**1.28**	**1.51**	**1.37**	**3.35**	**4.25**	**3.80**
T_{10} : Weedy check	2.40	2.80	2.61	2.10	2.90	2.26	2.90	3.40	3.15	4.58	5.02	4.80
	5.76	**7.84**	**6.80**	**4.41**	**5.76**	**5.09**	**8.41**	**11.56**	**9.99**	**20.97**	**25.16**	**23.07**
S.Em $\pm$	0.12	0.10	0.08	0.10	0.12	0.08	0.17	0.11	0.10	0.17	0.18	0.12
CD at 5%	0.36	0.28	0.24	0.28	0.35	0.24	0.50	0.31	0.31	0.50	0.52	0.38
CV %	15.31	12.51	14.03	12.88	16.12	14.58	18.22	11.51	15.36	12.00	12.45	12.23

TPE =Transparent polyethylene
DAS =Days After Sowing
Bold letters indicated original value

(1.54,1.21,1.54 and 4.29 g/0.25 m^2), second year (1.85, 1.56, 1.82 and 5.15 g / 0.25 m^2) and in pooled results (1.69, 1.39, 1.69 and 4.72 g/0.25 m^2), respectively.

• An appraisal of data in Table 42 indicated that at 60 DAS, significantly maximum dry weight of grasses, broad leaved, sedges and total weeds was registered in weedy check during first year (9.00,4 .41, 9.73 and 23.14 g/0.25 m^2),second year (10.24, 6.15, 11.02 and 27.41 g/0.25 m^2) and in pooled results (9.62, 5.24, 10.38 and 25.27 g/0.25 m^2), respectively. While minimum dry weight of grasses, broad leaved, sedges and total weeds was found in weed free during first year (1.17, 1.00, 1.25 and 3.38 g/0.25 m^2), second year (1.59, 3.92, 1.90 and 7.23 g/0.25 m^2) and in pooled results (1.37, 2.22, 1.56 and 5.15 g/0.25 m^2), which was significantly superior over all other treatments, except hand weeding twice plus earthing up during first year (1.21, 1.21, 2.22 and 4.64 g/0.25 m^2), second year (2.43, 1.69, 1.96 and 6.05) and in pooled results (1.82, 1.44, 2.09 and 5.35 g/0.25 m^2) and TPE 0.025 mm for 45 days during first year (1.32, 1.44, 1.61 and 4.37 g/0.25 m^2), second year (1.69, 1.00, 1.93 and 4.62 g/0.25 m^2) and in pooled results (1.51, 1.21, 1.77 and 4.49 g/0.25 m^2), respectively

It is seen that at harvest (Table 43 and Fig.14) significantly maximum dry weight of grasses, broad leaved, sedges and total weeds were recorded in weedy check during first year (15.60, 9.61, 12.25 and 37.46 g/0.25 $m^{2)}$, second year (18.06, 10.56, 15.84 and 44.46 g/0.25 m^2) and in pooled results (16.83, 10.05, 13.99 and 40.87 g/0.25 m^2), respectively. Significantly minimum dry weight of grasses, broad leaved, sedges and total weeds were found in weed free during first year (1.21, 1.32, 1.21 and 3.74 g/0.25 m^2), second year (1.44, 1.44, 1.56 and 4.44 g/0.25 m^2) and in pooled results (1.32, 1.37, 1.39 and 4.09 g/0.25 m^2) over all other treatments, except in TPE 0.025 mm for 45 days during first year (1.56, 1.44, 1.49 and 4.49 g/0.25 m^2), second year (1.96, 1.56, 2.25 and 5.77 g/0.25 m^2) and in pooled results (1.76, 1.51, 1.85 and 5.12 g/0.25 m^2) and hand weeding twice plus earthing up during first year (1.96, 1.35, 1.59 and 4.90),

Table 42 : Weed dry weight (g / 0.25 m^2) at 60 DAS in potato as influenced by various treatment.

Treatments	Grasses			Broad leaved			Sedges			Total weeds		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	2.25	2.60	2.42	1.69	1.86	1.69	2.63	2.71	2.67	3.77	4.16	3.97
	5.06	**6.73**	**5.87**	**2.25**	**3.46**	**2.85**	**6.92**	**7.34**	**7.13**	**14.23**	**17.31**	**15.85**
T_2 : TPE 0.025 mm 30 days	1.45	1.76	1.61	1.36	1.23	1.30	1.41	1.44	1.42	2.34	2.58	2.46
	2.10	**3.11**	**2.58**	**1.85**	**1.51**	**1.69**	**1.97**	**2.07**	**2.02**	**5.48**	**6.66**	**6.05**
T_3 : TPE 0.025 mm 45 days	1.15	1.30	1.22	1.20	1.00	1.10	1.27	1.39	1.33	2.09	2.15	2.12
	1.32	**1.69**	**1.51**	**1.44**	**1.00**	**1.21**	**1.61**	**1.93**	**1.77**	**4.37**	**4.62**	**4.49**
T_4 : TPE 0.050 mm 15 days	2.60	2.45	2.52	1.54	1.90	1.72	2.68	2.86	2.77	4.03	4.21	4.12
	6.76	**5.98**	**6.36**	**2.37**	**3.61**	**2.96**	**7.18**	**8.18**	**7.67**	**16.24**	**17.72**	**16.97**
T_5 : TPE 0.050 mm 30 days	1.70	1.90	1.80	1.34	1.70	1.52	1.57	1.60	1.59	2.67	3.01	2.84
	2.89	**3.62**	**3.24**	**1.80**	**2.89**	**2.31**	**2.46**	**2.56**	**2.51**	**7.73**	**9.06**	**8.07**
T_6 : TPE 0.050 mm 45 days	1.58	1.80	1.64	1.35	1.40	1.38	1.45	1.50	1.48	2.49	2.73	2.61
	2.50	**3.24**	**2.72**	**1.62**	**1.96**	**1.89**	**2.10**	**2.25**	**2.18**	**6.22**	**7.45**	**6.49**
T_7 : Pendimethalin 1.0 kg ha^{-1}	1.60	1.80	1.70	1.35	1.50	1.43	1.48	2.15	1.82	2.39	3.17	2.78
	2.56	**3.24**	**2.89**	**1.00**	**2.25**	**1.56**	**2.19**	**4.62**	**3.29**	**5.71**	**10.05**	**7.73**
T_8 : HW twice plus earthing up	1.16	1.56	1.36	1.10	1.30	1.20	1.49	1.40	1.45	2.15	2.46	2.31
	1.21	**2.43**	**1.82**	**1.21**	**1.69**	**1.44**	**2.22**	**1.96**	**2.09**	**4.64**	**6.05**	**5.35**
T_9 : Weed free	1.08	1.26	1.17	1.00	1.98	1.49	1.12	1.38	1.25	1.84	2.69	2.27
	1.17	**1.59**	**1.37**	**1.00**	**3.92**	**2.22**	**1.25**	**1.90**	**1.56**	**3.38**	**7.23**	**5.15**
T_{10} : Weedy check	3.00	3.20	3.10	2.10	2.48	2.29	3.12	3.32	3.22	4.81	5.24	5.03
	9.00	**10.24**	**9.62**	**4.41**	**6.15**	**5.24**	**9.73**	**11.02**	**10.38**	**23.14**	**27.48**	**25.27**
S.Em ±	0.13	0.17	0.11	0.12	0.09	0.07	0.14	0.08	0.08	0.13	0.17	0.11
CD at 5%	0.38	0.50	0.33	0.33	0.25	0.22	0.41	0.24	0.25	0.38	0.50	0.33
CV %	14.61	18.31	16.71	13.97	11.44	12.88	15.61	8.57	12.33	8.52	11.27	10.00

TPE =Transparent polyethylene
DAS =Days After Sowing
Bold letters indicated original value

Table 43 : Weed dry weight (g / 0.25 m^2) at harvest in potato as influenced by various treatment.

Treatments	Grasses			Broad leaved			Sedges			Total weeds		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	2.83	3.38	3.10	2.42	2.68	2.55	3.00	2.88	2.94	4.78	5.37	5.07
	7.98	11.39	9.61	5.86	7.16	6.49	9.00	8.29	8.64	22.84	28.83	25.70
T_2 : TPE 0.025 mm 30 days	1.60	1.70	1.65	1.48	2.08	1.78	1.68	1.52	1.60	2.75	3.13	2.91
	2.56	2.89	2.72	2.19	4.32	3.16	2.82	2.30	2.56	7.57	9.79	8.44
T_3 : TPE 0.025 mm 45 days	1.25	1.40	1.32	1.20	1.25	1.23	1.22	1.50	1.36	2.12	2.40	2.26
	1.56	1.96	1.76	1.44	1.56	1.51	1.49	2.25	1.85	4.49	5.77	5.12
T_4 : TPE 0.050 mm 15 days	3.00	3.50	3.25	2.62	2.95	2.78	2.22	3.00	2.65	4.66	5.49	5.09
	9.00	12.25	10.56	6.86	8.88	7.73	4.93	9.00	6.81	21.69	30.13	5.91
T_5 : TPE 0.050 mm 30 days	1.60	1.80	1.70	1.80	2.22	2.01	1.74	1.89	1.81	2.96	3.42	3.19
	2.56	3.24	2.89	3.24	4.93	4.04	302	3.57	3.28	8.76	11.69	10.17
T_6 : TPE 0.050 mm 45 days	1.70	1.80	1.75	1.60	1.85	1.73	1.69	1.59	1.54	2.88	2.96	2.92
	2.89	3.24	3.06	2.56	3.42	2.99	2.86	2.53	2.37	8.31	8.76	8.54
T_7 : Pendimethalin 1.0 kg ha^{-1}	1.40	1.70	1.55	1.60	1.85	1.72	2.68	1.56	1.52	3.03	2.83	2.920
	1.96	2.89	2.40	2.56	3.42	2.95	2.82	2.43	2.31	9.09	8.01	8.55
T_8 : HW twice plus earthing up	1.40	1.50	1.60	1.16	1.27	1.22	1.26	1.68	1.49	2.21	2.58	2.40
	1.96	2.25	2.56	1.35	1.61	1.49	1.59	2.82	2.21	4.90	6.65	5.76
T_9 : Weed free	1.10	1.20	1.15	1.15	1.20	1.17	1.10	1.25	1.18	1.93	2.11	2.02
	1.21	1.44	1.32	1.32	1.44	1.37	1.21	1.56	1.39	3.74	4.44	4.09
T_{10} : Weedy check	3.95	4.50	4.10	3.10	3.25	3.17	3.50	3.98	3.74	6.12	6.67	6.39
	15.60	18.06	16.83	9.61	10.56	10.05	12.25	15.84	13.99	37.46	44.46	40.87
S.Em ±	0.13	0.17	0.11	0.13	0.09	0.08	0.14	.08	0.08	0.17	0.15	0.11
CD at 5%	0.38	0.50	0.33	0.38	0.25	0.24	0.41	0.24	0.25	0.50	0.43	0.35
CV %	14.61	18.31	16.71	15.93	11.44	14.06	15.61	8.57	12.33	9.71	8.91	9.35

TPE =Transparent polyethylene
DAS =Days After Sowing
Bold letters indicated original value

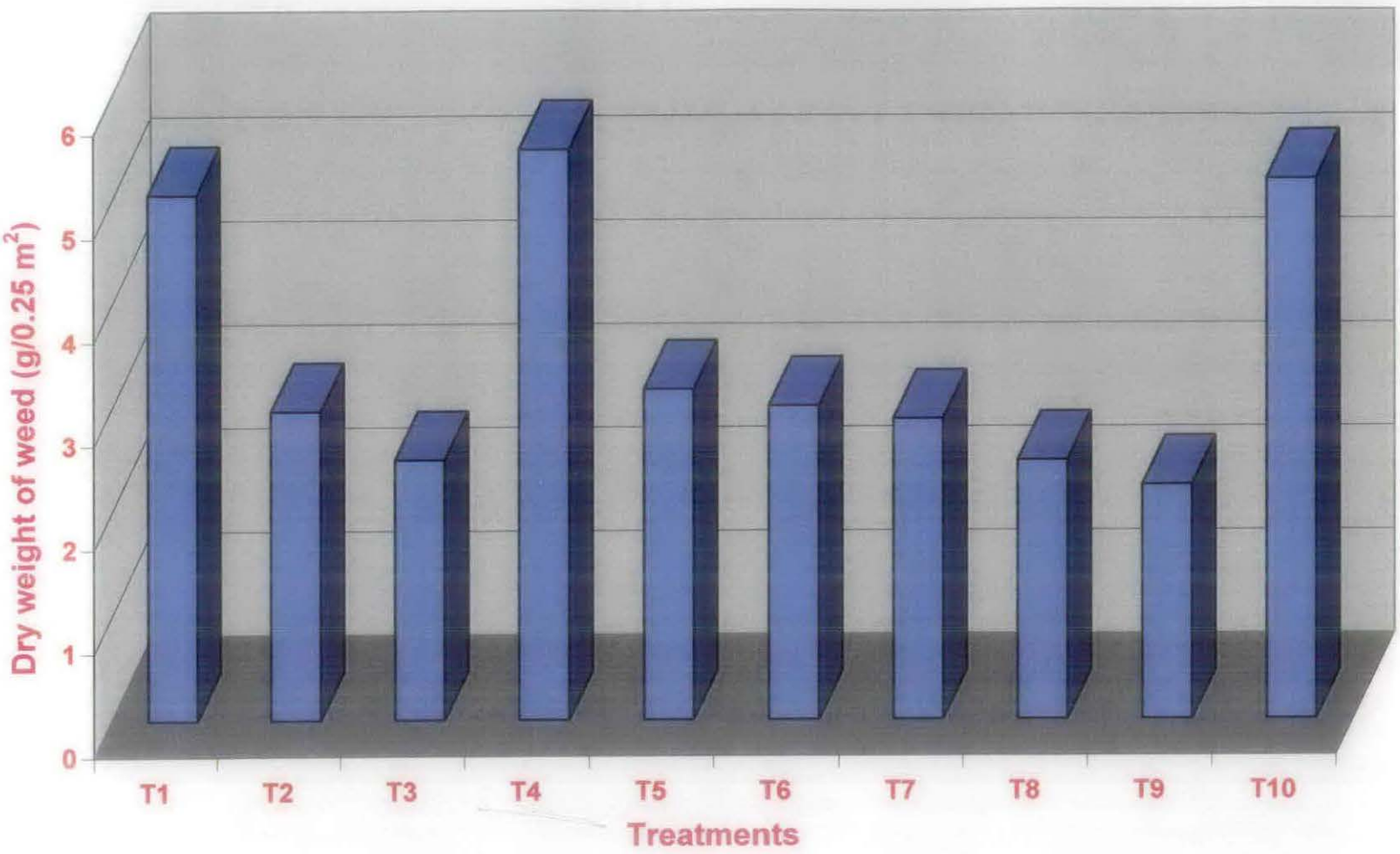


Fig. 14 : Dry weight of weed at harvest in potato as influenced by various treatments (pooled)

second year (2.25, 1.61, 2.82 and 6.05) and in pooled data (2.56, 1.49,2.21 and 5.48), respectively.

4.5.4 Dry weed biomass at harvest

An appraisal of data showed that the dry weed biomass in potato at harvest was significantly affected by various treatments during first year, second year and in pooled analysis (Table 44 and Fig. 15).

A perusal of data indicated that minimum dry weed biomass was registered in weed free (1.49, 1.98 and 1.73 q ha $^{-1}$) and found significantly superior over all the treatments, but it was at par with TPE 0.025 mm for 45 days (2.14, 2.46 and 2.30 q ha $^{-1}$) and hand weeding twice plus earthing up (2.25, 2.70 and 2.48 q ha $^{-1}$) in first year, second year and in pooled results, respectively. Weedy check significantly recorded the highest dry weed biomass (12.17, 13.66 and 12.91 q ha $^{-1}$) over all other treatments in first year, second year and in pooled results, respectively.

4.5.5 Weed control efficiency

The data on weed control efficiency (WCE) showed significant differences due to various treatments during first year, second year and in pooled results (Table 44 and Fig. 16)

Maximum weed control efficiency was observed significantly in weed free (88.51, 85.50 and 86.96 per cent).While TPE 0.025 mm for 45 days registered the WCE of 82.41, 81.99 and 82.20 per cent, being the next best treatment and it was at par with hand weeding twice plus earthing up (81.51, 79.86 and 80.69 per cent) during first year, second year and in pooled results, respectively.

Table 44 : Dry weed biomass and weed control efficiency as influenced by various treatments in potato

Treatments	Dry weed biomass (q ha^{-1})			Weed control efficiency (%)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	7.93	8.93	8.43	34.83	34.62	34.73
T_2 : TPE 0.025 mm 30 days	3.88	4.53	4.20	68.11	66.83	67.47
T_3 : TPE 0.025 mm 45 days	2.14	2.46	2.30	82.41	81.99	82.20
T_4 : TPE 0.050 mm 15 days	8.89	9.45	9.17	27.03	30.81	28.92
T_5 : TPE 0.050 mm 30 days	4.56	5.20	4.88	62.53	61.93	62.23
T_6 : TPE 0.050 mm 45 days	3.28	3.80	3.54	73.04	72.18	72.61
T_7 : Pendimethalin 1.0 kg ha^{-1}	3.07	3.50	3.28	74.79	74.73	74.75
T_8 : HW twice + earthing up	2.25	2.70	2.48	81.51	79.86	80.69
T_9 : Weed free	1.49	1.98	1.73	88.51	85.50	86.96
T_{10} : Weedy check	12.17	13.66	12.91	00	00	00
S.Em ±	0.27	0.25	0.21	0.44	0.43	1.54
CD at 5%	0.78	0.73	0.63	1.28	1.22	4.74
CV %	10.77	8.92	10.53	11.88	9.09	7.36

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

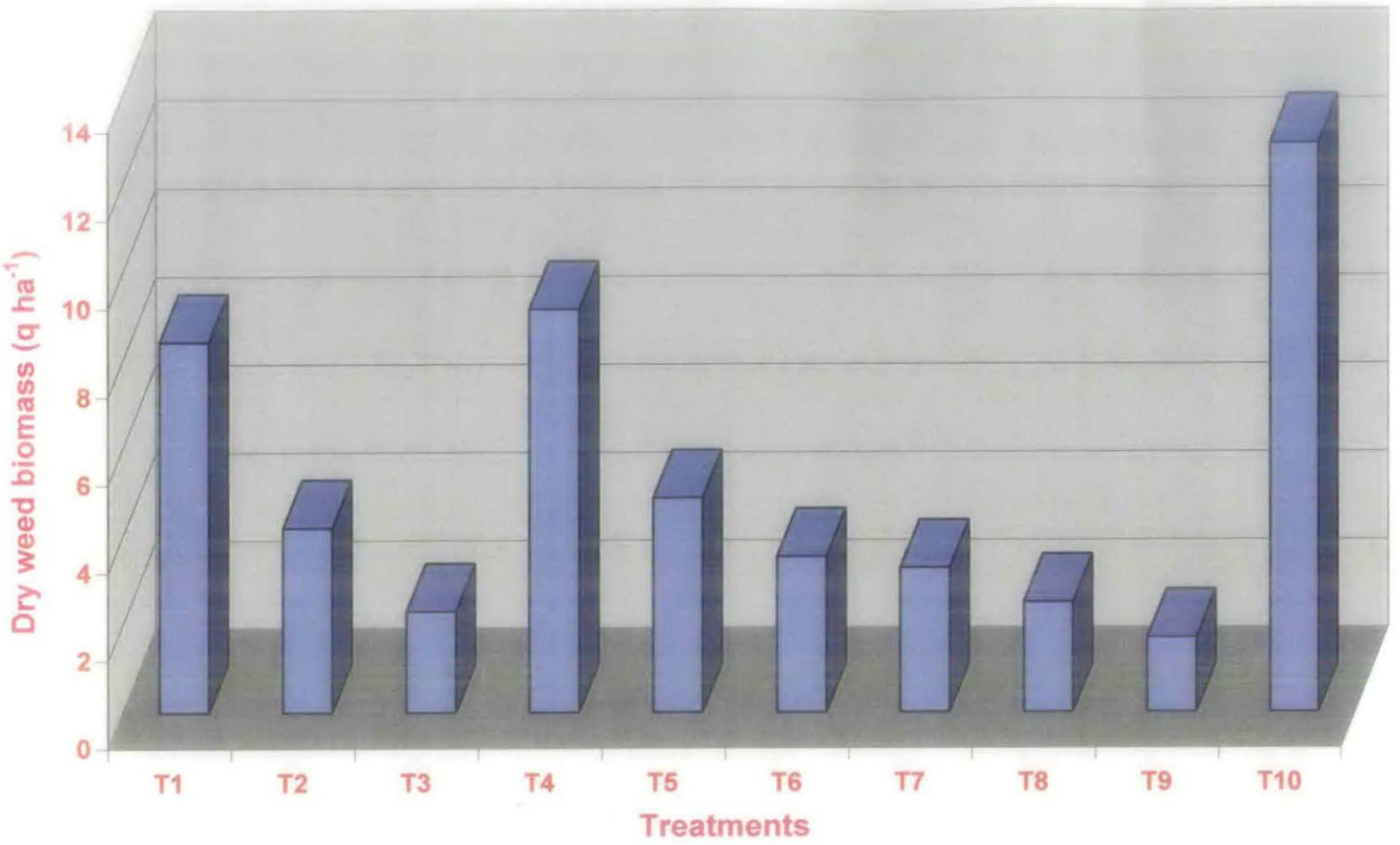


Fig. 15 : Dry weed biomass at harvest in potato as influenced by various treatments (pooled)

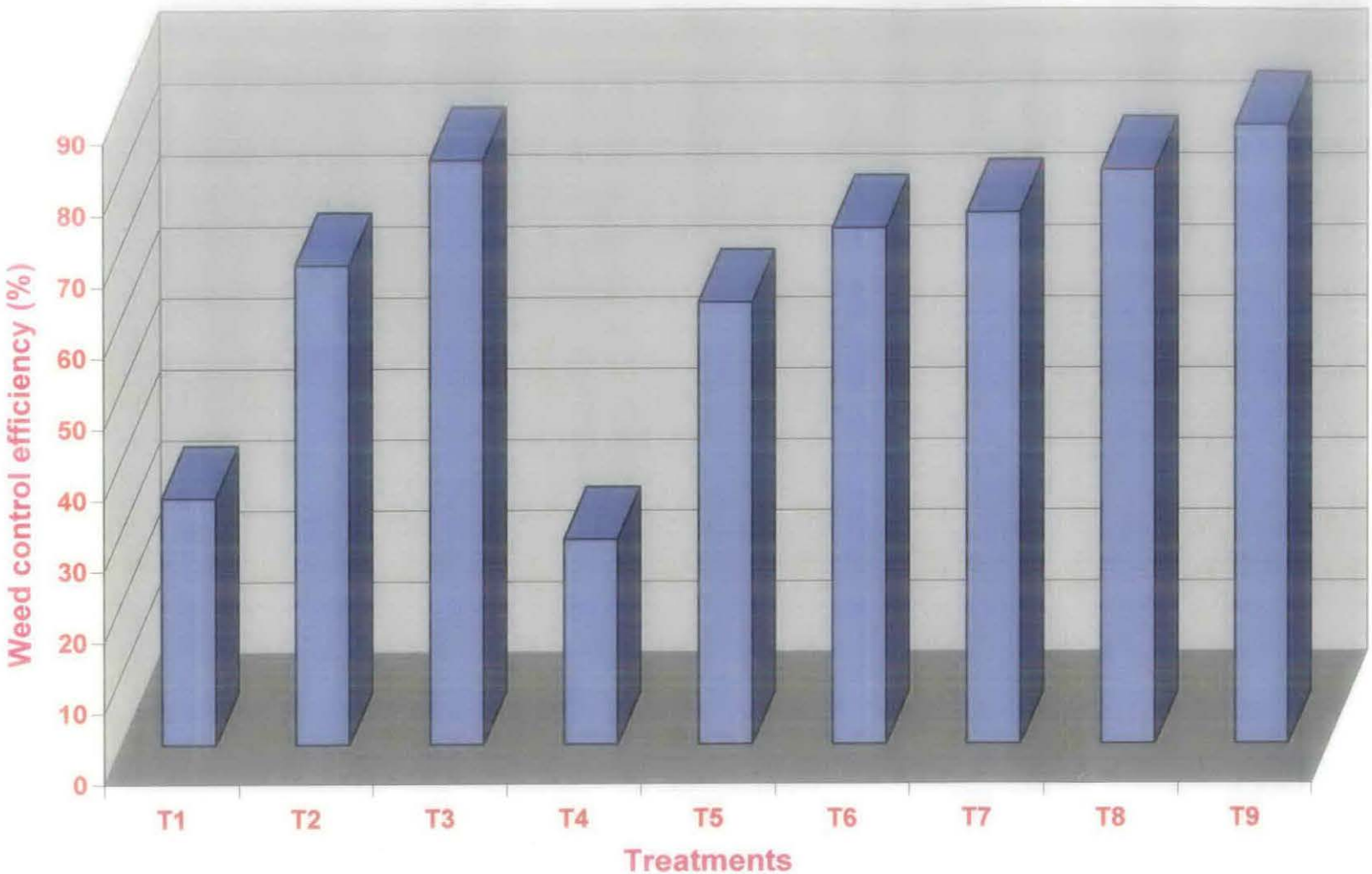


Fig. 16 : Weed control efficiency in potato as influenced by various treatments (pooled)

4.6 Effect of soil solarization on growth as well as yield components and yield of succeeding potato

4.6.1 Plant height

Plant height of potato was varied significantly due to various treatments at 30 DAS and harvest during both the years and in pooled results (Table 45).

Significantly maximum plant height at 30 DAS was recorded under TPE 0.025 mm for 45 days (25.95, 21.60 and 23.78 cm), which was found superior over all other treatments. However, it was at par with weed free (25.80, 21.28 and 23.54 cm), hand weeding twice plus earthing up(24.83, 21.16 and 22.99 cm), TPE 0.050 mm for 45 days (24.35, 19.83 and 22.09 cm) and metribuzin 1.0 kg ha^{-1} (23.23, 19.20 and 21.21 cm) in first year, second year and in pooled results, respectively. Similarly, plant height at harvest was registered significantly maximum in TPE 0.025 mm for 45 days (44.50, 43.20 and 43.85 cm)and found superior to all other treatments, which was at par with weed free (43.15, 41.02 and 42.09 cm), hand weeding twice plus earthing up and (44.40, 42.82 and 43.61 cm), TPE 0.050 mm for 45 days (40.10, 39.55 and 39.83 cm) and metribuzin 1.0 kg ha^{-1} and (38.70, 37.80 and 38.25 cm) in first year, second year and in pooled results, respectively. While, significantly minimum plant height of groundnut was recorded under weedy check(16.30, 15.10 and 15.70 cm) at 30 DAS and (30.30, 27.15 and 28.73 cm) at harvest compared to all other treatments, but it was at par with shorter duration of SS in first year, second year and in pooled results, respectively.

4.6.2 Number of leaves per plant

Number of leaves per plant showed significant variation due to various treatments at 60 and 90 DAS during first year, second year and in pooled results (Table 45).

Data revealed that TPE 0.025 mm for 45 days (40.16, 38.55 and 39.36) recorded significantly maximum number of leaves per plant at 60 DAS over all other treatments, barring hand weeding twice plus earthing up (38.50, 38.22 and

Table 45 : Plant height and number of leaves per plant in potato as influenced by various treatments

Treatments	Plant height (cm)						Number of leaves per plant					
	30 DAS			At harvest			60 DAS			90 DAS		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	19.55	17.15	18.35	33.38	33.60	33.49	24.03	20.60	22.31	18.54	16.10	17.32
T_2 : TPE 0.025 mm 30 days	21.00	18.50	20.25	39.83	36.80	38.31	32.66	23.08	27.87	20.22	18.96	19.59
T_3 : TPE 0.025 mm 45 days	25.95	21.60	23.78	44.50	43.20	43.85	40.16	38.55	39.36	31.72	30.15	30.94
T_4 : TPE 0.050 mm 15 days	20.65	17.00	18.82	30.70	33.20	31.95	23.60	20.85	22.23	16.07	15.58	15.82
T_5 : TPE 0.050 mm 30 days	21.15	18.25	20.20	38.10	35.05	36.58	32.00	29.17	30.58	19.40	18.48	19.94
T_6 : TPE 0.050 mm 45 days	24.35	19.83	22.09	40.10	39.55	39.83	37.46	33.10	35.28	26.13	24.61	25.37
T_7 : Metribuzin 1.0 kg ha^{-1}	23.23	19.20	21.21	38.70	37.80	38.25	27.29	29.58	28.43	21.95	19.65	20.80
T_8 : HW twice + earthing up	24.83	21.16	22.99	44.40	42.82	43.61	38.50	38.22	38.36	31.47	29.47	30.47
T_9 : Weed free	25.80	21.28	23.54	43.15	41.02	42.09	37.90	35.13	36.51	30.90	28.97	29.94
T_{10} : Weedy check	16.30	15.10	15.70	30.30	27.15	28.73	19.45	17.30	18.38	15.40	13.20	14.30
S.Em ±	1.50	0.92	0.88	2.20	2.47	1.65	1.58	2.14	1.45	1.17	1.61	0.99
CD at 5%	4.35	2.66	2.71	6.40	7.16	5.10	4.60	7.04	4.45	3.93	4.67	3.06
CV %	13.35	9.67	12.00	11.52	13.30	12.42	10.33	16.06	13.46	10.35	15.18	12.85

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

38.36) and weed free (37.90, 35.13 and 36.51), and TPE 0.050 mm for 45 days (37.46, 33.10 and 35.28) in first year, second year and in pooled data, respectively. Number of leaves per plant at 60 DAS was observed significantly minimum in weedy check (19.45, 17.30 and 18.38)) as compared to all other treatments, which was at par with at par with shorter duration of SS in first year, in second year and pooled results, respectively. Whereas, at 90 DAS, TPE 0.025 mm for 45 days (31.72, 30.15 and 30.94) had significantly maximum number of leaves per plant over all other treatments, barring hand weeding twice plus earthing up (31.47, 29.47 and 30.47) and weed free (30.90, 28.97 and 29.94) and in first year, second year and in pooled data, respectively. Significantly minimum number of leaves per plant was observed in weedy check (15.40, 13.20 and 14.30) over all other treatments, but it was at par with shorter duration of SS in first year, second year and in pooled results, respectively.

4.6.3 Leaf area

The leaf area per plant at 60 and 90 DAS was influenced significantly by various treatments during first and second year as well as in pooled data (Table 46).

It is revealed that TPE 0.025 mm for 45 days (30.10, 28.46 and 29.28 cm^2 $plant^{-1}$) recorded significantly maximum leaf area at 60 DAS over all other treatments, which being at par with weed free (29.95, 27.15 and 28.55 cm^2 $plant^{-1}$), hand weeding twice plus earthing up (29.80, 28.46 and 29.13 cm^2 $plant^{-1}$) and TPE 0.050 mm for 45 days (27.20, 19.30 and 23.25 cm^2 $plant^{-1}$) in first year, second year and in pooled data, respectively. Significantly minimum leaf area per plant at 60 DAS were observed in weedy check (16.20, 14.50 and 15.35 cm^2 $plant^{-1}$) over all other treatments, but it was at par with shorter durations of SS in first year, second year and in pooled results, respectively. While, at 90 DAS, TPE 0.025 mm for 45 days (28.56, 27.97 and 28.26 cm^2 $plant^{-1}$) had significantly maximum leaf area over all other treatments, barring hand weeding twice plus earthing up (29.38, 28.11 and 28.74 cm^2 $plant^{-1}$) and weed free (27.05, 26.68 and

Table 46 : Leaf area per plant (cm^2) , number of tuber per plant and tuber weight per plant in potato as influenced by various treatments

Treatments	Leaf area (cm^2)						Number of tuber ($plant^{-1}$)			Tuber weight (g)		
	60 DAS			90 DAS								
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	19.00	17.10	18.05	18.23	15.70	16.96	4.90	4.25	4.58	211.9	198.0	204.9
T_2 : TPE 0.025 mm 30 days	24.15	18.64	21.39	22.60	22.58	22.59	5.23	4.60	4.91	255.3	230.2	242.8
T_3 : TPE 0.025 mm 45 days	30.10	28.46	29.28	28.56	27.97	28.26	6.48	5.80	6.14	327.8	293.3	310.6
T_4 : TPE 0.050 mm 15 days	18.10	16.60	17.35	16.99	15.02	16.01	4.80	4.19	4.49	209.4	198.5	203.9
T_5 : TPE 0.050 mm 30 days	23.65	18.73	20.90	22.12	21.17	21.65	5.13	4.59	4.86	230.1	216.3	223.2
T_6 : TPE 0.050 mm 45 days	27.20	19.30	23.25	23.85	21.95	22.90	5.65	4.83	5.24	269.3	2458.1	257.2
T_7 : Metribuzin 1.0 kg ha^{-1}	23.15	17.60	19.38	22.14	22.45	22.30	5.63	4.85	5.24	261.2	241.3	251.5
T_8 : HW twice + earthing up	29.80	28.46	29.13	29.38	28.11	28.74	6.23	5.78	6.01	319.4	290.2	304.8
T_9 : Weed free	29.95	27.15	28.55	27.05	26.68	26.86	5.95	5.43	5.69	315.9	285.6	300.7
T_{10} : Weedy check	16.20	14.50	15.35	15.94	14.05	14.99	4.30	3.90	4.10	176.1	159.3	167.7
S.Em ±	1.11	1.43	0.91	1.58	1.23	0.97	0.28	0.27	0.20	12.82	15.1	9.91
CD at 5%	3.20	4.18	2.80	4.59	3.57	3.00	0.82	0.78	0.60	37.2	43.9	30.5
CV %	9.15	14.37	11.61	13.83	11.26	12.27	10.49	11.20	10.82	10.48	11.77	11.16

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

26.86 cm^2 $plant^{-1}$) in first year, second year and in pooled data, respectively. Significantly minimum leaf area per plant at 90 DAS were observed in weedy check (15.94, 14.05 and 14.99 cm^2 $plant^{-1}$) over all other treatments, but it was at par with shorter durations of SS in first year, second year and pooled results, respectively.

4.6.4 Number of tubers per plant

Number of tubers per plant in potato differed significantly due to various treatments during first year, second year and in pooled results (Table 46)

A perusal of data indicated that significantly maximum number of tubers per plant was recorded under TPE 0.025 mm for 45 days (6.48, 5.80 and 6.14), over all other treatments, except hand weeding twice plus earthing up (6.23, 5.78 and 6.01) and weed free (5.95, 5.43 and 5.69) in first year, second year and in pooled results, respectively. However, number of tubers per plant was recorded significantly minimum due to weedy check (4.30, 3.90 and 4.10) over all other treatments, being at par with shorter durations of solarization in first year, second year and in pooled data, respectively.

4.6.5 Tuber weight per plant

All the treatments differed significantly with respect to tuber weight per plant during in first year, in second year and in pooled results (Table 46).

Significantly maximum tuber weight per plant was recorded due to TPE 0.025 mm for 45 days (327.8, 293.3 and 310.6 g $plant^{-1}$) over all other treatments except hand weeding twice plus earthing up (319.4, 290.2 and 304.8 g $plant^{-1}$) and weed free (315.9, 285.6 and 300.7 g $plant^{-1}$) in first year, second year and in pooled results, respectively. Weedy check had significantly minimum tuber weight per plant (176.1, 159.3 and 167.7 g $plant^{-1}$) over all other treatments, except shorter durations of solarization in first year, second year and in pooled data, respectively.

4.6.6 Grade wise tuber yield of potato

Significant differences were noticed in grade wise (large size, medium size and small size) tuber yield of potato due to various treatments during first year, second year and in pooled results (Table 47 and Fig.17).

From data it is revealed that the yield of large size ('A' grade) tuber was significantly maximum in TPE 0.025 mm for 45 days (19.00, 18.48 and 18.74 t ha^{-1}), which was at par with hand weeding twice plus earthing up (18.90, 18.38 and 18.64 t ha^{-1}) and weed free (18.25, 17.10 and 17.68 t ha^{-1}) over all other treatments in first year, second year and in pooled results, respectively. Weedy check registered significantly minimum tuber yield (8.56, 7.26 and 7.91 t ha^{-1}), barring with shorter durations of solarization during first year, second year and in pooled results, respectively.

While, significantly maximum tuber yield of medium size ('B'grade) was recorded by TPE 0.025 mm for 45 days (8.40,8.16 and 8.28 t ha^{-1}) over all other treatments, but it was at par with hand weeding twice plus earthing up (7.43, 7.25 and 7.34 t ha^{-1}) and weed free (7.20, 7.00 and 7.10 t ha^{-1}), whereas significantly the lowest medium size tuber yield was observed in weedy check (2.89, 2.16 and 2.52 t ha^{-1}) in first year, second year and in pooled results, respectively.

With regards to small size ('C'grade) tuber yield, weed free (4.03, 3.53 and 3.78 t ha^{-1}) produced significantly maximum tuber yield as compared to all other treatments, which was at par with hand weeding twice plus earthing up (3.96, 3.08 and 3.52 t ha^{-1}), TPE 0.025 mm for 45 days (3.72, 3.12 and 3.42 t ha^{-1}) and TPE 0.050 mm for 45 days (3.80, 3.00 and 3.40 t ha^{-1}) in first year, second year and in pooled results, respectively. Weedy check recorded significantly minimum tuber yield (2.03, 1.80 and 1.92 t ha^{-1}) in first year, second year and in pooled results, respectively, except TPE 0.025 mm for 15 days (2.66 t ha^{-1}) in first year only.

Table 47 : Grade wise tuber yield of potato as influenced by various treatments

Treatments	Grade wise tuber yield of potato (t ha^{-1})								
	Large size ("A "grade)			Medium size ("B " grade)			Small size ("C "grade)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	9.98	8.84	9.41	4.76	3.80	4.28	2.66	2.48	2.57
T_2 : TPE 0.025 mm 30 days	14.65	13.48	14.06	5.28	5.18	5.23	2.84	2.76	2.80
T_3 : TPE 0.025 mm 45 days	19.00	18.48	18.74	8.40	8.16	8.28	3.72	3.12	3.42
T_4 : TPE 0.050 mm 15 days	9.73	8.52	9.13	4.47	3.77	4.12	2.50	2.16	2.33
T_5 : TPE 0.050 mm 30 days	13.24	12.69	12.97	5.17	5.10	5.14	2.80	2.65	2.73
T_6 : TPE 0.050 mm 45 days	15.77	15.73	15.75	5.78	5.43	5.60	3.80	3.00	3.40
T_7 : Metribuzin 1.0 kg ha^{-1}	14.38	14.38	14.76	5.34	5.33	5.33	2.77	2.54	2.66
T_8 : HW twice + earthing up	18.90	18.38	18.64	7.43	7.25	7.34	3.96	3.08	3.52
T_9 : Weed free	18.25	17.10	17.68	7.20	7.00	7.10	4.03	3.53	3.78
T_{10} : Weedy check	8.56	7.26	7.91	2.89	2.16	2.52	2.03	1.80	1.92
S.Em ±	0.68	0.71	0.49	0.45	0.43	0.31	0.21	0.22	0.15
CD at 5%	1.97	2.06	1.51	1.30	1.24	0.95	0.65	0.64	0.48
CV %	10.44	10.17	10.28	15.85	15.97	15.91	13.69	16.63	15.06

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

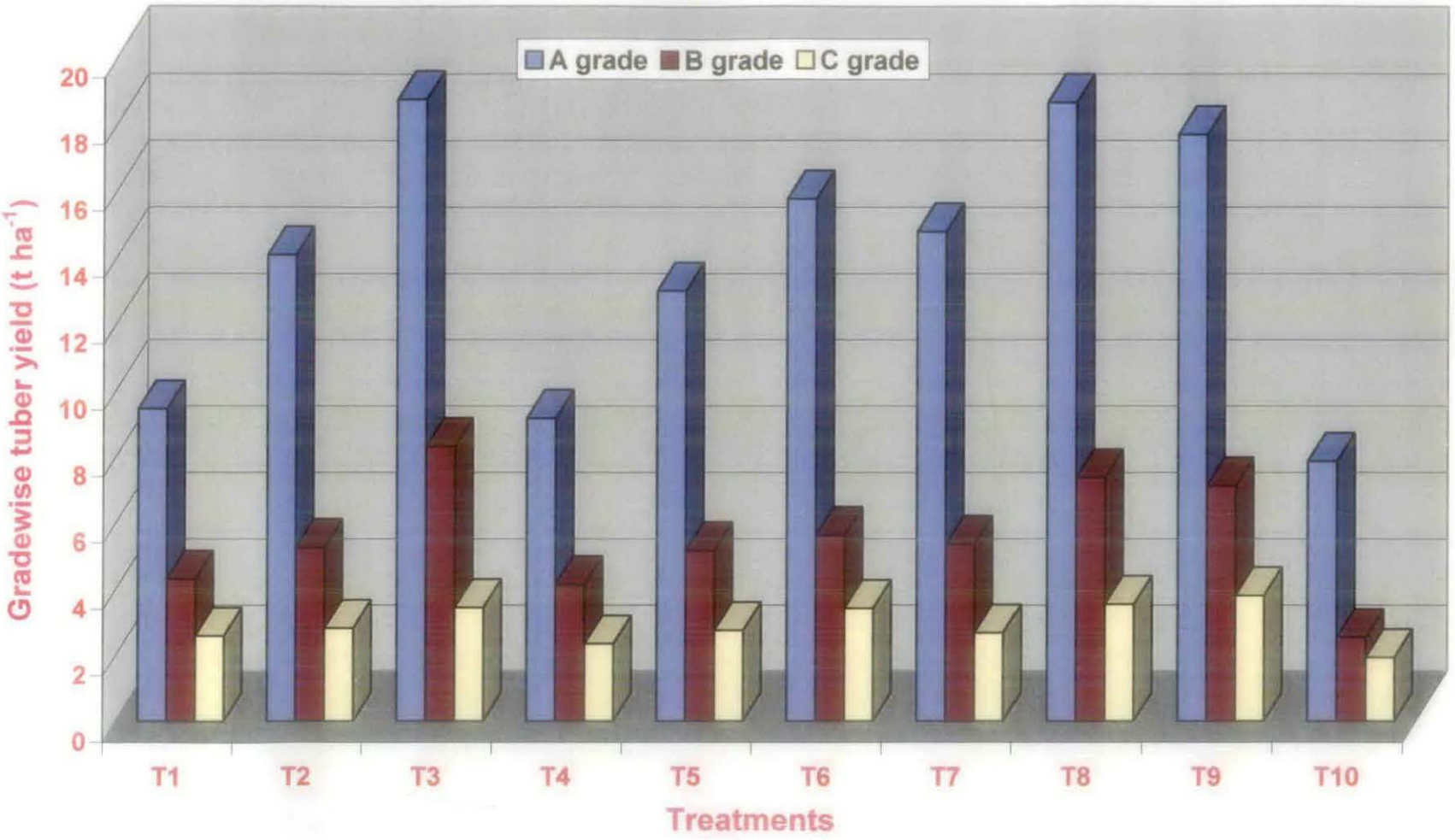


Fig. 17 : Gradewise tuber yield in potato as influenced by various treatments (pooled)

4.6.7 Total tuber yield of potato

Total tuber yield of potato differed significantly due to various treatments in first year, second year and in pooled results, respectively (Table 48 and Fig. 18).

A perusal of data indicated that significantly maximum tuber yield was registered under TPE 0.025 mm for 45 days (31.12, 29.76 and 30.44 t ha^{-1}) as compared to all other treatments, which being at par with hand weeding twice plus earthing up (30.29, 28.71 and 29.50 t ha^{-1}) and weed free (29.48, 27.63 and 28.56 t ha^{-1}) in first year, second year and in pooled results, respectively. However, significantly the lowest tuber yield was registered in weedy check (13.48, 11.22 and 12.35 t ha^{-1}) in first year, second year and in pooled results, respectively.

4.6.8 Haulm yield

Significant differences were observed in haulm yield due to various treatments during first year, second year and in pooled results (Table 48).

Data in Table 48 showed that significantly maximum haulm yield was recorded in TPE 0.025 mm for 45 days (71.15 and 62.58 q ha^{-1}), except hand weeding twice plus earthing up (70.25 q ha^{-1}) and weed free (69.10 q ha^{-1}) in first year, whereas, hand weeding twice plus earthing up (61.10 q ha^{-1}), weed free (61.05 q ha^{-1}), TPE 0.050 mm for 45 days (60.60 q ha^{-1}), TPE 0.025 mm for 30 days (58.60 q ha^{-1}), metribuzin 1.0 kg ha^{-1} (57.90 q ha^{-1}) and TPE 0.050 mm for 30 days (55.40 q ha^{-1})in second year. While, in pooled result, it produced significantly maximum haulm yield (66.86 q ha^{-1}), which was statistically at par with hand weeding twice plus earthing up (65.68 q ha^{-1}), weed free (65.08 q ha^{-1}) and TPE 0.050 mm for 45 days (61.88 q ha^{-1}). Significantly minimum haulm yield was recorded in weedy check (42.30, 41.40 and 41.85 q ha^{-1}) during first year, second year and in pooled results, respectively as compared to all other

Table 48 : Total tuber yield and haulm yield in potato as influenced by various treatments

Treatments	Total tuber yield (t ha $^{-1}$)			Haulm yield (q ha $^{-1}$)		
	2003-04	2004-05	Pooled	2003-04	2004-05	Pooled
T_1 : TPE 0.025 mm 15 days	17.40	15.12	16.26	54.00	51.90	52.95
T_2 : TPE 0.025 mm 30 days	22.77	21.34	22.05	61.20	58.60	59.90
T_3 : TPE 0.025 mm 45 days	31.12	29.76	30.44	71.15	62.58	66.86
T_4 : TPE 0.050 mm 15 days	16.70	14.45	15.57	52.50	48.48	50.49
T_5 : TPE 0.050 mm 30 days	21.21	20.44	20.88	57.11	55.40	56.26
T_6 : TPE 0.050 mm 45 days	25.35	24.16	24.75	63.15	60.60	61.88
T_7 : Metribuzin 1.0 kg ha^{-1}	23.25	22.25	22.75	63.90	57.90	60.90
T_8 : HW twice + earthing up	30.29	28.71	29.50	70.25	61.10	65.68
T_9 : Weed free	29.48	27.63	28.56	69.10	61.05	65.08
T_{10} : Weedy check	13.48	11.22	12.35	42.30	41.40	41.85
S.Em $\pm$	1.04	1.00	0.74	2.08	2.61	1.67
CD at 5%	3.0	3.0	2.3	6.0	7.6	5.1
CV %	9.29	9.43	9.36	6.88	9.31	8.10

TPE : Transparent polyethylene
DAS : Days after sowing
HW : Hand weeding twice (at 20 & 40 DAS) plus earthing up at 40 DAS

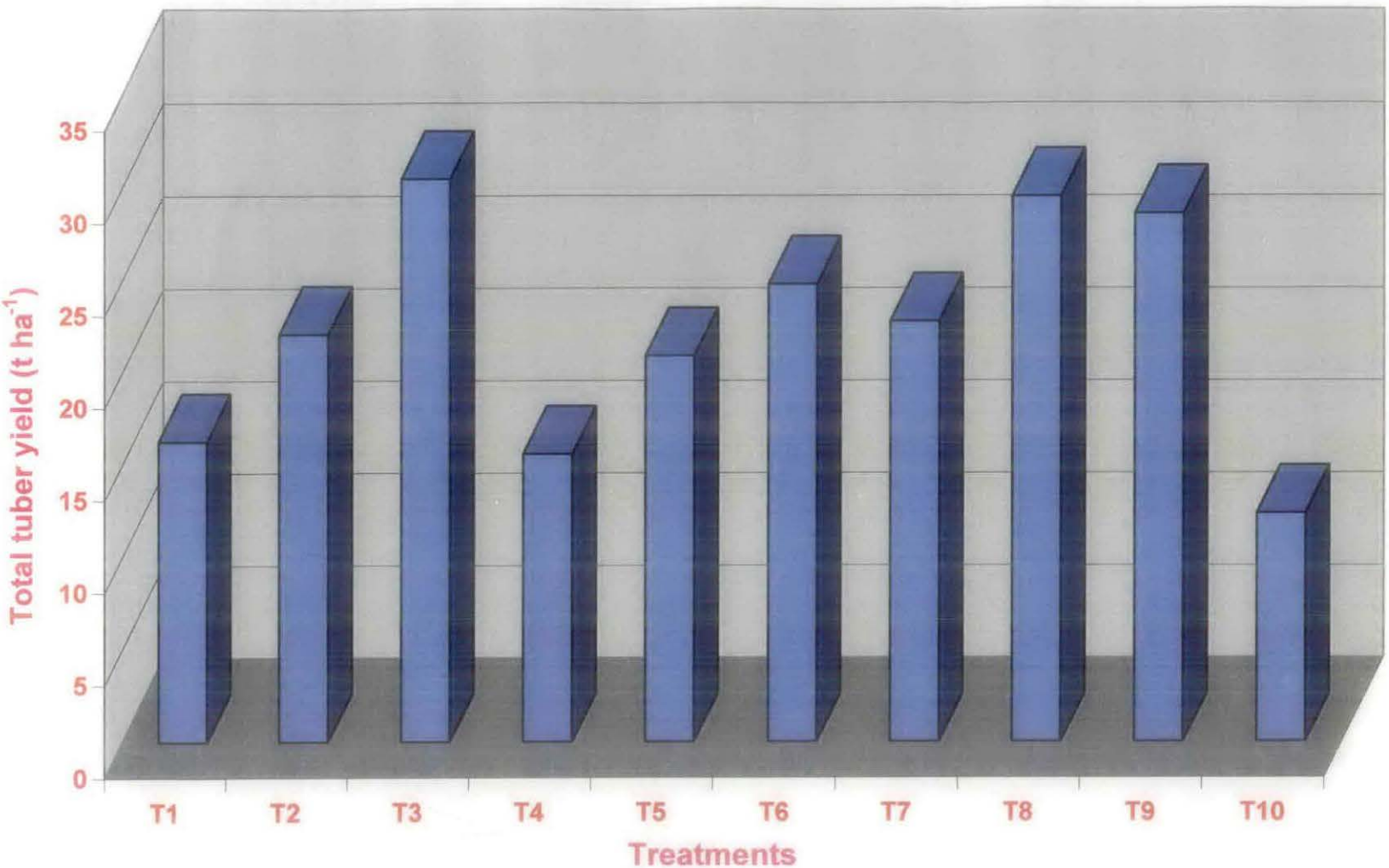


Fig. 18 : Total tuber yield in potato as influenced by various treatments (pooled)

treatments, barring TPE 0.050 mm for 15 days (48.48 q ha^{-1}) in second year only.

4.7 Correlation study

Yield is a complex quantitative character depending on different interrelated characters may show different association either positive or negative. Correlation reflects the extent of association between a particular character and the yield of crop, hence correlation coefficient (r) was computed between pod yield of groundnut and growth attributes *viz*; plant height, number of branches, number of leaves, leaf area, LAI, total dry matter accumulation at harvest; yield attributes *viz*; number of pods per plant, pod weight per plant, shelling percentage, test weight, kernel yield and different weed characters *viz*; weed count per m^2 at harvest, weed dry weight (g/0.25 m^2) at harvest, dry weed biomass (q ha^{-1}), weed control efficiency (%) and weed index.

The "r" values presented in Table 49 revealed that pod yield (q ha^{-1}) was positively and significantly highly correlated with various growth as well as yield attributes and weed control efficiency, while different weed characters, such as weed count, weed dry weight, dry weed biomass and weed index negatively but significantly highly correlated with pod yield of groundnut.

4.8 Economic evaluation

The details of mean gross return, total cost of cultivation, system productivity and profitability, net return and benefit cost ratio (BCR) of groundnut-potato cropping system as influenced by different treatments over two years are given in Table 50 and economics of different treatments are furnished in Appendices IV and V.

A perusal of data in Table 50 indicated that the highest net return (1,37,513 Rs ha^{-1}), BCR (2.61), system productivity (92.79 kg ha $^{-1}day^{-1}$) and profitability (376.7 Rs ha $^{-1}day^{-1}$) were registered in TPE 0.025 mm for 45 days

followed by hand weeding twice plus earthing up (1,29,260 Rs ha^{-1}, 2.80 BCR, 89.07 kg $ha^{-1}day^{-1}$ and 354.1 Rs $ha^{-1}day^{-1}$, respectively) and by weed free (1,27,522 Rs ha^{-1}, 2.41 BCR, 87.17 kg $ha^{-1}day^{-1}$ and 349.8 Rs $ha\ day^{-1}$ respectively. The lowest net return (10,700 Rs ha^{-1}), BCR (1.13), system productivity (37.23 kg $ha^{-1}day^{-1}$) and profitability (29.3 Rs $ha^{-1}day^{-1}$) was recorded under weedy check.

Table 49: Correlation coefficient ("r") between ground nut yield and growth and yield attributing characters as well as weeds

Sr. No.	Characters	"r" values
1	Plant height (cm)	0.972**
2	Number of branches	0.985**
3	Number of leaves	0.974**
4	Leaf area (cm^2)	0.969**
5	LAI	0.870**
6	Total dry matter accumulation (g $plant^{-1}$) at harvest	0.989**
7	Number of pods $plant^{-1}$	0.869**
8	Pod weight $plant^{-1}$	0.961**
9	Shelling percentage	0.943**
10	Test weight (g)	0.881**
11	Kernel yield (q ha^{-1})	0.991**
12	Weed count at harvest	-0.976**
13	Weed weight (g /0.25 m^2) at harvest	-0.989**
14	Dry weed biomass (q ha^{-1})	-0.964**
15	Weed control efficiency (%)	0.945**
16	Weed index	-0.987**

** Significant at 1 % level

e 50 : System productivity and economic analysis for groundnut – potato cropping system as influenced by various treatments (Pooled)

nents	Yield (q ha^{-1})			Groundnut equivalent yield (q ha^{-1})	System productivity (kg ha^{-1} day^{-1})	Gross return (Rs ha^{-1})	Total cost of cultivation (Rs ha^{-1})	Net return (Rs ha^{-1})	BCR	Profita-bility (Rs ha^{-1} day^{-1})
	Pod yield of groundnut	Haulm yield of groundnut	Potato tuber							
PE 0.025 mm 15 days	17.14	25.72	162.26	181.94	50.67	118402	85168	33234	1.39	91.1
PE 0.025 mm 30 days	23.19	30.19	220.50	246.23	67.46	143171	85168	58003	1.68	158.9
PE 0.025 mm 45 days	30.14	48.39	304.4	338.69	92.79	222681	85168	137513	2.61	376.7
PE 0.05 mm 15 days	17.28	24.47	155.5	175.08	47.97	114537	88861	25676	1.28	70.3
PE 0.05 mm 30 days	19.00	31.68	208.8	230.15	63.05	153570	88861	64709	1.73	177.3
E 0.05 mm 45 days	23.74	39.47	247.5	274.62	75.24	164493	88861	76032	1.85	208.3
ndimethalin 1.0 kg ha^{-1} oundnut) Metrtibuzin kg ha^{-1} (potato)	23.80	40.87	227.5	254.80	69.81	176155	82433	93722	2.13	256.8
nd weeding 20 & 40 S + Earthing up 40 DAS	26.36	43.72	295.00	325.11	89.07	210328	84468	129260	2.58	354.1
eed free	28.55	46.93	285.60	318.17	87.17	210595	87073	127522	2.41	349.8
Veedy check	10.58	21.20	123.50	135.90	37.23	88478	77778	10700	1.13	29.3

DISCUSSION

V. DISCUSSION

An attempt has been made to discuss the pooled results of the present study in this chapter and to find out the 'cause' and 'effect' relationship for the variations observed due to different treatments, as far as possible. For the shake of convenience, the chapter is divided in to following sub- heads.

5.1 Effect of weather

5.2 Effect of various treatments

5.2.1 Physical, chemical and biological properties of soil

5.2.2 Weed growth

5.2.3 Yield of groundnut

5.2.4 Content of nutrients in groundnut haulm and weeds

5.2.5 Weed control in aftermath potato

5.2.6 Growth and yield of aftermath potato

5.3 Correlation study

5.4 Economics evaluation

5.5 Future line of work

5.1 Effect of weather

The Weather condition (Fig. 1 and 2) was conducive for growth and development period of groundnut and aftermath potato crop during both the years. However, first year was relatively more congenial owing to more rainy days and rainfall as well as less evaporation during growth period of groundnut, which reflected in higher growth and yield as compared to second year. Moreover, second year was more warmer than first year, mean maximum temperature during 36^{th} to 39^{th} standard week was (36.5 ^{0}C) as compared to first year (32.9 ^{0}C) during its grand growth stage and peg penetration as well as pod formation period, which also affected the growth and development of crops. Likewise, during first year, the weather condition was conducive for potato at vegetative phase. The mean maximum temperature (27.0 ^{0}C) was lower during 50^{th} to 52^{nd} standard weeks at vegetative phase as compared to second year

(29.9 ^{0}C), which affected the vegetative growth of potato and as a result of this variation, the yield of potato was less in second year. Moreover, there was chilling effect on crop in the second year. Thus, these climatic condition in second year affected the growth and yield of potato as compared to first year.

5.2 Effect of various treatments:

5.2.1 Physical, chemical and biological properties of soil.

5.2.1.1 Soil temperature

Maximum soil temperature at 5 cm and 10 cm depth of soil during the soil solarization (SS) period differed due to SS over non solarized. Maximal soil temperature of 56.6 ^{0}C and 53.3 ^{0}C was recorded with TPE 0.025mm for 45 days solarization, whereas in bare soil it was 46.0 ^{0}C and 44.7 ^{0}C at 5 and 10 cm depth of soil, respectively at all DAPS. SS with TPE 0.025 mm for 45 days increased the maximal soil temperature by 10.6 ^{0}C and 8.6 ^{0}C over that of bare soil at 5 and 10 cm depth of soil, respectively. Higher soil temperature under the TPEs could be attributed to the ability of transparent sheets to transmit the short wave solar radiation across the polyethylene film and generating heat waves, thus, raising soils temperature eventually. Higher soil temperature under TPEs has been reported by many workers (Katan, 1981 and Raj and Kapoor, 1993). The increase in the soil temperature was least at 10 cm depth due to decrease in the rate of transmission of solar heat as the depth of the soil increases. The higher soil temperature in the surface layer over deeper layer has been reported by Kodma and Fukul (1982), Rubin and Benjamin (1983), Chauhan *et. al* (1988), Sauerborn *et. al* (1989), Biradar (1996), Habeeburrahaman and Hosmani (1996), Basvaraj (1998), Chittapur (1998), Mudalagriyappa (1998), Singh *et al.*(2000) and Lalitha *et al.* (2001).

Among the thickness, TPE 0.025mm (Thinner) recorded higher mean soil temperatures of 51.0 ^{0}C and 49.5 ^{0}C at 5 and 10 cm soil depth, while in TPE 0.050 mm (Thicker), it was 48.6 and 48.3 ^{0}C, respectively. This increase is to the

tune of 2.4 and 1.2 ^{0}C, at 5 and 10 cm soil depth, respectively over thicker one. The higher soil temperatures under TPE 0.025 mm (thinner) would be attributed to favourable properties such as better radiation transmittance as well as low reflection and absorption of solar radiation. Many researchers have reported higher efficiency of thin TPE over thick TPE to increase soil temperature (Chen and Katan 1980; Melero *et al.*,1989; Lodha, 1989; Harti 1991; Habeeburrahman, 1992; Meti, 1993; Basavaraj, 1998; Mudalagiriyappa, 1999a ; Lalitha *et al.*, 2001; Kiran Kumar *et al.*, 2003 b and Soumya *et al.*, 2003).

From Table 7, it is clear that frequency of soil temperature maxima above 50 ^{0}C during soil solarization was to the tune of 88.9 per cent in TPE 0.025 mm for 45 days at 5 cm soil depth. Similarly the corresponding per cent was 77.7 with TPE 0.050 mm for 45 days. Thus, it was found that thinner TPE was comparatively more effective than thicker one, owing to the maximum radiation transmittance and more number of days with higher air temperature during SS. These observation are in conformity with those reported by Horowitz *et al.*(1983), Kumar *et al.*(1993), Biradar (1996) and Mudalagiriyappa *et al.*, (1999 a)

During 2003-04, slightly higher soil temperature was recorded than 2004-05 (Appendix I and II). This was mainly due to more number of standard weeks with higher air temperature maxima above 40.0 ^{0}C and more sun shine hours per day during 2003-04 and there was off season precipitation during solarization period in 2004-05, which has lower down the soil temperature.

5.2.1.2 Soil moisture

From the Table 8, it is seen that all the solarization treatments retained higher soil moisture (6.20 and 6.71 per cent at 0-15 cm and 15-30 cm soil depths, respectively) over non solarization control (2.62 and 3.51 per cent at 0-15 cm and 15-30 cm soil depths, respectively). Yaduraju (1993) advocated pre- solarization irrigation as 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 for higher soil moisture. Thus the non solarized control recorded lower soil moisture as compared to solarized.

5.2.1.3 Plant nutrients in soil

The influence of soil solarization on nutrient status of soil is believed to be due to soil temperature. In present study, estimation of organic carbon and available nutrients (N, P_2O_5 , K_2O, S, Fe, Mn, Zn and Cu) was worked out for evaluating the effectiveness of different SS treatments, in relation to status of soil just after completion of solarization. All the SS treatments decreased the content of organic carbon (%), sulphur (ppm) and Zn (ppm). While, the content of available N, P_2O_5 , K_2O, Fe, Mn and Cu was found to increase in soil irrespective of either thickness of TPEs or duration of SS after SS. TPE 0.025 mm for 45 days showed lower mean level of organic carbon (0.13 %), sulphur (6.28 ppm) and Zn (0.35 ppm) as compared to non-solarized (control), which is to the tune of 52.0, 42.6 and 44.0 per cent, respectively. The decrease in S and Zn might have liberated during the decomposition of organic matter and subjected to transformation process. Zn might also converted into relatively more fixed form due to inter-conversion among the various formation leading to less extraction with DTPA extractant. Further, the light textured soil might caused relatively higher downward movement of the nutrients including S towards lower profile leading to less available content as a results of soil solarization process. However, the changes are expected to be normal with time due to equilibrium processes continuously taking place in the soil. Whereas, the mean level of available N, P_2O_5, K_2O , Fe, Mn and Cu in soil was improved. An increase of 43.7 N kg ha^{-1}, 10.8 P_2O_5 kg ha^{-1}, 58.1 K_2O kg ha^{-1}, 1.62 ppm Fe, 1.31 ppm Mn and 0.13 ppm Cu was observed ,which is to the tune of 29.8,

24.7, 30.6, 27.2, 14.7 and 40.6 per cent over non-solarized control. The increase in content of above nutrients could be mainly attributed to the effect of higher soil temperature observed under TPE resulted in faster degradation of organic matter and increased solubility of nutrients. Mobilization of nutrients from the organic matter took place by micro organisms due to congenial environment provided by tarping during the first week of solarization and also microbes after death might have added to the nutrient pool. Under plastic film, higher soil moisture (Table 8), resulted in solubilizing the nutrients, which might have moved upwards by capillary movement and increase in pH might have made the nutrients available (Heynes, 1987). These results are akin to those reported by Chen and Katan (1980), Stapleton et al. (1985), Patel (1994), Patel and Patel (1997), Basvaraj (1998), Mudalagiriyappa *et al.* (1999c), Lalitha (1999) and Khulbe (2000).

5.2.1.4 Microbial population

The microbial population (total fungi, bacteria and actinomycetes) of soil was affected by various treatments just after soil solarization and after harvest of crop. It was observed (Tables 12 and 13) that SS with TPE 0.25 mm for 45 days resulted in reduction of the fungal, bacterial and actinomycetes population substantially, to the tune of 31.7, 14.1 and 16.3 per cent, respectively, when assessed just after SS. After harvest of groundnut, microbial population was reassessed and there was almost complete recovery and substantial increase was observed in most of the cases. This is obviously due to thermal inactivation of this micro flora as they could not tolerate the impact of increased soil temperature (Table 7), which is more lethal to propagules existing at different niches in soil. Similar observations have also been reported by many researchers. Reduction in fungal population was reported by Cartia (1987), Lalitha (1999), Mudalgiriappa *et al.*, (1999c) Khulbe (2002) and Desai and Dange (2003) to the tune of 53.0, 53.8, 68.57, 80.0 and 67.25 per cent, respectively. While 50.0 per cent reduction in bacterial population as well as actinomycetes were also

reported by Arora (2004). Thereafter, there was substantial increase in fungal, bacterial and actinomycetes population during the growth of groundnut (Table 13). This increase in microbial population is might be due to favourable condition available during growth period of crop for multiplication of microbes. Lalitha (1999) also reported more number of fungai and bacteria at harvest of groundnut. Similar observations were reported in different crops by Stapleton and Devay (1986), Stapleton (1991), Khulbe (2002) and Arora (2004).

5.2.2 Weed growth

The effect of various treatments on count and dry weight of weeds, weed control efficiency and weed index in groundnut are discussed here.

Dry weed biomass at harvest (Table 22) and count and dry weight of weeds was recorded maximum in weedy check due to uncheck weed growth. Whereas, reduction in dry weed biomass at harvest was recorded in weed free (1.34 q ha^{-1}) and TPE 0.025 mm for 45 days (2.14 q ha^{-1}), which was to the tune of 94.3 and 90.9 per cent, respectively over weedy check. This was due to the lowest weed count and dry weight of weeds was recorded in these treatments (Table 14 to 21). The lowest weed count and dry weight of weeds was recorded in weed free treatment. Reduction in weed count was observed to the tune of 96.7, 96.3, 94.5 and 95.7 per cent in grasses ; 96.3, 95.7, 96.0 and 83.3 per cent in broad leaved ; 80.9, 88.4, 82.7 and 66.7 per cent in sedges and 87.7, 92.5, 90.5 and 92.4 per cent in total weeds, whereas reduction in dry weight of weeds to the tune of 98.2, 94.7, 92.1 and 95.1 per cent in grasses, 94.1, 94.4, 94.3 and 95.8 per cent in broad leaves, 95.9, 80.2, 71.2 and 74.0 per cent in sedges and 84.7, 92.4, 90.0 and 90.9 per cent in total weeds was recorded over weedy check at 30, 60, 90 DAS and harvest, respectively. This was because of nature of treatment i.e. four weeding were carried out and no weed was allowed to grow. Thus, weed free conditions was found to be the best treatment for weed control, but it is labourious, time consuming and costly operation.

Next in line for reducing weed number and dry weight of weeds was soil solarization with TPE 0.025 mm for 45 days, which reduced the weed count to the tune of 90.4, 93.7, 92.8 and 93.6 per cent in grasses; 95.8, 94.8, 92.4 and 86.9 per cent in broad leaved ; 78.3, 87.7, 79.7 and 67.9 per cent in sedges; 93.6, 90.5, 88.6 and 83.5 per cent in total weeds compared to weedy check at 30, 60, 90 DAS and harvest , respectively. Similarly the TPE 0.025 mm for 45 days also recorded the reduction in dry weight of grasses by 93.9, 93.9, 91.3 and 94.30 per cent; of broad leaved by 91.8, 91.9, 90.9 and 86.2 per cent; of sedges by 82.6, 78.7, 67.1 and 71.3 per cent and total weeds by 92.6, 91.1, 88.1 and 88.8 per cent at 30, 60, 90 DAS and harvest over weedy check, respectively.

The extent of reduction in weed count and dry weight of weeds at all the stages was in the order of TPE 0.025 mm for 45 days > TPE 0.050 mm for 45 days > TPE 0.025 mm for 30 days > TPE 0.050 mm for 30 days > TPE 0.025 mm for 15 days > TPE 0.050 mm for 15 days > and weedy check. Rise in temperature maxima was also in the same order. The increase in temperature to lethally higher levels by TPE 0.025 mm with longer duration might have affected the viability of weed seeds present in the soil to a greater extent. Braun et al., (1987) also reported reduction in count of weeds up to harvest of groundnut with the TPE for 40 or 60 days.

Comparing the reduction in weed count and dry weight of weeds of grasses, broad leaved, and sedges, it was observed (Table14 to 21) that the extent of reduction was more in board leaved than in grasses .This might be due to susceptibility of broad leaved to solarization because of the thinner seed coat (Reddy *et al.*1998). Lower efficiency of solarization in controlling perennials with underground propugules was also observed by Braun et al.(1988), Regone and wilson (1988) and Stapleton and Garza-Lopez (1988).

From above results, it is evident that solarization with TPE 0.025 mm for 45 days is highly effective in reducing weed number and dry weight of weeds (Table 14 to 21). This reduction in weed population and dry weed biomass due to SS could be attributed to indirect killing of the weed seeds weakened by sub

lethal heating through microbial activity, direct killing of the seed stimulated to germinate in the moistened mulched soil and killing of germinating seeds, whose dormancy is broken in the heated soil. Reduction in weed dry weight at harvest of groundnut was also reported by Habeeburrahaman (1992), Biradar *et al.* (1997), Mudalagiriyappa *et al.*, (1999) , Lalitha *et al.*, (2001), Sundari and Suresh kumar (2003) and Nanjappa *et al.*,(2005) to the tune of 80.0, 94.2 , 82.0 , 88.9, 91.6 and 71.2 per cent due to TPE 0.050 mm for 40 to 60 days, respectively.

Maximum WCE (Table 22) was recorded in weed free (95.17 per cent) followed by TPE 0.025 mm for 45 days (90.92 per cent). This might be due to continuous weed free conditions in weed free treatment as well as significantly effective control of weeds under TPE 0.025 mm for 45 days to the tune of 93.61, 86.9, 67.9 and 83.5 per cent in grasses, broad leaved, sedges and total weeds as compared to weedy check, respectively (Table 18 to 21). These results are corroborative with the findings of Biradar *et al.*, (1997), Mudalagiriyappa *et al.*, (1998), Lalitha *et al.*, (2001), Soumya *et al.*, (2003) as well as Sundari and Suresh kumar (2003) in groundnut crop. While, the weed index was noted minimum with TPE 0.025 mm for 45 days (-0.80). Mudalagiriyappa., (1998) also reported lower weed index in groundnut due to SS.

Remarkable reduction in weed count and dry weight of weeds was observed during 2003-04 in spite of more rain during crop growth periods compared to 2004-2005 (Table 1 and 2). This is mainly attributed to more number of days with higher soil temperature maxima exceeding 50 ^{0}C with 88.9 per cent frequency during solarization and there was less gap between SS and sowing of groundnut.

5.2.3 Yield of groundnut

The differences in pod yield were found significant due to different treatments during both the years as well as in pooled data (Table 32). Pod yield of groundnut was recorded higher in soil solarization with TPE 0.025 mm for 45

days (30.14, 25.22 and 27.68 q ha^{-1}) followed by weed free (28.55, 25.22 and 26.88 q ha^{-1}) over weedy check (10.58, 9.94 and 10.26 q ha^{-1}) in first year, second year and in pooled results, respectively. This increase in pod yield was to the tune of 184.9, 153.7 and 169.8 per cent with TPE 0.025 mm for 45 days followed by weed free (169.8, 153.7 and 161.9 per cent) over weedy check in first year, second year and in pooled results, respectively. Yield increase in TPE 0.025 mm for 45 days could be attributed to increase in the main contributor like number of pods (22.24 $plant^{-1}$), pod weight (20.23 g $plant^{-1}$) and test weight (55.0 g $plant^{-1}$), which is closely followed by weed free for number of pods (22.08 $plant^{-1}$), pod weight (19.55 g $plant^{-1}$) and test weight (54.25 g). Higher dry matter accumulation in pods (Table 29) observed in these treatments might have helped in proper filling of pods through better development of kernels and thus increasing the test weight. This leads to increase the shelling percentage recorded in TPE 0.025 mm for 45 days (70.63 %) and weed free (68.75 %). Biradar (1996), Mudalagiriyappa *et al.*, (1999) and Lalitha (1999) have also observed higher shelling percentage due to TPE 0.050 mm for 45 to 60 days. This higher yield could also be attributed to higher content of plant essential nutrients viz. N, P, K, S, Fe, Mn, Zn and Cu in groundnut haulm (Table 34 and 35). This might be due to higher WCE and dry matter accumulation as well as improvement in the availability of nutrients under soil solarization, which contributed towards growth and development of plant.

Yield increase in TPE for 45 days and in weed free situation was also observed by Yuduraju and Ahuja (1990), Biradar *et al.*, (1997), Mudalagiriyappa *et al.*, (1999), Lalitha *et al.*,(2001), Soumya *et al.*, (2003), Sunderi and Sureshkumar (2003), Agresco report (2003-04) and Nanjappa *et al.*,(2005). Minimum pod yield (10.26 q ha^{-1}) was recorded under weedy check, which might be due to unchecked weed growth and decrease in yield attributes viz., number of pods (Table 32), pod weight (Table 32), test weight (Table 33), shelling percentage (Table 33) and kernel yield (Table 33). This might be due to unhealthy competition between crop, plant and weeds with respects to

moisture, space and nutrients under weed check. Yield reduction in groundnut under uncontrolled weed situations was also observed earlier by Murthy *et al.* (1992), Biradar (1996), Mudalagiriyappa *et al.,* (1999) and Lalitha et al.; (2001).

The maximum haulm yield (Table 32) in TPE 0.025 mm for 45 days (48.39 q ha^{-1}) and weed free (46.93 q ha^{-1}) could be attributed due to least competition with weeds as well as vigorous crop growth (Plate 2) as seen in the form of taller plants (Table 23), more number of branches (Table 23), more number of leaves (Table 24), leaf areas (Table 25) and higher dry matter accumulation in plants (Table 27 to30). This increase in haulm yield at harvest under TPE 0.025 mm for 45 days and weed free was to the tune 128.2 and 121.3 per cent over weedy check. The per cent increase in plant height and number of branches at harvest was 49.5 and 66.1 per cent under TPE 0.025 mm for 45 days and 44.2 and 62.7 per cent under weed free, respectively over weedy check. The per cent increase in leaf area of groundnut due to TPE 0.025 mm for 45 days as well as in weed free over weedy check at harvest was 95.6 per cent and 92.5 per cent, respectively. This was consequent to the luxuriant vegetative growth initially due to non competition between weeds and crop in cultural practices treatments and high temperature in thinner TPE affected weed seed germination and induced weed suppression in solarized plots. The increased number of leaves, leaf area and LAI mainly attributed to higher leaf retention even at harvest.

The increase in total dry matter accumulation in TPE 0.025 mm for 45 days and in weed free at harvest was to the tune of 106.5 and 95.1 per cent, respectively, compared to weedy check. This was an additive effect of higher dry matter accumulation in leaves, stem and pods as observed in groundnut under TPE 0.025 mm for 45 days and weed free. Better growth of groundnut in terms of increased availability of macro and micro plant nutrients as well as reduction in weed growth might have helpful in the better availability of growth resources to the crop with longer duration of solarization. The resources availability in turn might have been increased on account of reduction in weed

50 DAS 90 DAS

TPE 0.025 mm for 45 days

(Good growth of plant and root nodules)

50 DAS 90 DAS

Weed free

(Good growth of plant and root nodules)

50 DAS 90 DAS

Weedy check

(Poor growth of plant and root nodules)

Plate 2: Performances of groundnut crop under TPE 0.025 mm for 45 days, weed free and weedy check at 50 DAS and 90 DAS

growth by higher temperature under TPE 0.025 mm for 45 days and absence of weeds in weed free plots at all the growth stages of groundnut, which drastically reduced the competition for growth factors, and it helped the crop to put forth more number of leaves, expose more leaf area for harvesting solar energy and thus accumulating more dry matter. These findings are in accordance with those reported by Habeeburrahaman (1992), Biradar *et al.,* (1997), Mudalagiriyappa *et al.,* (1999a), Lalitha *et al.,* (2001) Soumya *et al,*.(2003) Agresco report (2003-04) and Nanjappa *et al.*,(2005) .

The increase in dry weight of root nodules per plant at 90 DAS under TPE 0.025 mm for 45 days and in weed free (Plate 2) was to the tune of 140.0 and 120.0 per cent, respectively compared to weedy check, which might be due to minimum weed competition resulted in better growth of root nodules and plants. Mudalagiriyappa *et al.,* (1999 c) and Lalitha (1999) also reported higher dry weight of root nodules in groundnut due to soil solarization. Soil solarization 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 (Chen and Katan, 1980; Stapleton and Devay, 1986).

The minimum haulm yield (Table 32 and Plate 2) in weedy check (21.20 q ha-1) attributed to least growth attributes of plants might be due to maximum competition between weeds and crop for growth resources.

The highest oil content (Table 33) was obtained under TPE 0.025 mm for 45 days (48.96 per cent) followed by weed free (48.49 per cent) over weedy check (43.64 per cent). This respective increase in oil content was to the tune 12.2 and 11.1 per cent over weedy check, which might be due to higher shelling per cent and kernel yield. This is in agreement with the findings of Yaduraju and Ahuja (1990), Biradar (1996) and Mudalagiriyappa *et al.,* (1999 b).

Based on the growth and yield components of groundnut as test crop discussed above, it is to be emphasized that soil solarization with TPE 0.025 mm for 45 days reduced the weed competition and increased the availability of

nutrients, resulted in better growth and remarkable increase in yield attributes, ultimately leading to higher yields.

5.2.4 Content of nutrients in groundnut haulm and weeds

5.2.4.1 Content of nutrients in groundnut haulm

Maximum content of N, P, K S Fe, Mn, Zn and Cu in groundnut haulm (Table 34 and 35) was observed in case of SS with TPE 0.025 mm for 45 days, which followed by weed free compared to weedy check (control). The increase in content of N, P, K, S, Fe, Mn, Zn, and Cu in groundnut haulm due to TPE 0.025 mm for 45 days as well as weed free was to the tune of 150.0, 114.2, 88.8, 54.1, 139.6, 731.9, 74.2 and 52.2 per cent as well as 147.4, 114.2, 86.1, 47.5, 117.3, 65.8, 70.2, and 51.5 per cent, respectively, over weedy check. This increase in content of macro and micro nutrients in groundnut haulm was might be due to reduction in weed growth and population altering the plant root environment, higher resource availability and better crop response in terms of higher dry matter of crop (Stapleton and Garza-Lopez, 1988; Gruenzweig *et al.*, 1993). SS is assumed to improve availability of N, P, K as well as Fe, Mn, and Cu. These results are in confirmation with the findings of Patel (1994) who reported that content of N, K, Fe, Mn and Cu in rice seedlings was increased by SS with thinner TPE. Kiran kumar *et al.* (2003 a) also reported maximum uptake of N,P,K by tomato crop with TPE 0.05 mm for two months solarization.

5.2.4.2 Content of Nutrients in weeds .

From the data (Tables 36 and 37), it is seen that the content of P, K,S Fe, Mn, Zn and Cu in weeds was recorded minimum in weed free followed by TPE 0.025 mm for 45 day, whereas, content of nitrogen in weeds was observed minimum in TPE 0.025 mm for 45 days, which followed by weed free. This reduction in content of N, P, K, S, Fe, Mn, Zn, and Cu in weeds due to weed free and TPE 0.025 mm for 45 days was to the extent of 50.9, 57.6, 29.7, 52.8, 40.0, 54.8, 40.1 and 29.4 per cent and 51.6, 54.5, 27.3, 52.8, 39.0, 51.8, 39.1,

28.5 per cent , respectively over weedy check. Above results showed that weed free and SS with TPE 0.025mm for 45 days caused pronounced effect on content of macro and micro nutrients in weeds. This might be due to reduction in dry matter of weeds, which ultimately resulted in low uptake of nutrients. These findings are in agreement with the findings of Patel (1994) who reported the lowest content of P, K, Fe, Zn and Cu in weeds under SS with thinner TPE. Biradar (1996) also recorded lower uptake of N, P, K in weeds, when groundnut crop was solarized with TPE 0.050 mm for 60 days. Kiran kumar *et al.* (2003) reported minimum uptake of N, P, K by weeds in solarized plots with TPE 0.050 mm for two months SS..

5.2.5 Weed control in aftermath potato

Maximum reduction in dry weed biomass at harvest (Table 38) was recorded in weed free (1.73 q ha^{-1}), TPE 0.025 mm for 45 days(2.30 q ha^{-1}) and hand weeding twice plus earthing up (2.48 q ha^{-1}), which was to the tune of 86.6, 82.2 and 80.8 per cent, respectively over weedy check in pooled results. This reduction was observed in above treatments due to significant reduction in weed count and dry weight of weeds at 30, 60 DAS and harvest in both the years.

The lowest weed count and dry weight of weeds at harvest was recorded due to weed free. The reduction in weed count was to the tune of 87.4, 78.6, 70.8 and 78.9 per cent in grasses, broad leaved, sedges and total weeds at harvest (Table 40). While, reduction in dry weight of grasses, broad leaved, sedges and total weeds was to the tune of 81.4, 86.4, 73.9 and 81.1 per cent over weedy check at harvest, respectively (Table 43). This was because of no weed allowed to grow due to nature of treatment. Thus, weed free conditions proved to be the best treatment for weed dry weight, but it is laborious, time consuming and costly operation.

Next most effective treatments for reducing weed number and dry weight of weeds was soil solarization with TPE 0.025 mm for 45 days, which reduced the

weed count (Table 40) to the tune of 85.7, 83.1, 71.2 and 79.4 per cent in grasses, broad leaved, sedges and total weeds at harvest compared to weedy check, respectively. Similarly the TPE 0.025 mm for 45 days, also recorded 75.6, 81.2, 71.6 and 76.8 per cent reduction in dry weight (Table 43) of grasses, broad leaved, sedges and total weeds at harvest over weedy check, respectively.

Owing to the long weed free condition, there was significant reduction in weed dry biomass at harvest, resulted in considerable increase in weed control efficiency in potato (Table 38). Maximum WCE was recorded in weed free (86.96 per cent), followed by TPE 0.025 mm for 45 days (82.2 per cent) and hand weeding twice plus earthing up (80.69 per cent). These results are corroborative with the findings of Mudalagiriyappa *et al.,* (1999d) and Soumya *et al.,* (2004).

From the above results, it is evident that solarization with TPE 0.025 mm for 45 days is highly effective in reducing weed number and dry weight of weeds in second season. This type of reduction in weed population and dry weed biomass due to SS could be attributed to indirect killing of the weed seeds weakened by sub lethal heating through microbial activity, direct killing of the seed stimulated to germinate in the moistened mulched soil; and killing of germinating seeds whose dormancy is broken in the heated soil. Similar results with weed control for longer periods i.e. second season were obtained in sequential crop through solarization as reported by Mudaalgiriyappa (1998) in French bean after groundnut, Mudalagiriyappa *et al.,* (1999) in potato after groundnut, Singh *et al.,* (2000) in wheat after soybean, Lalitha *et al.,* (2001) in tomato after groundnut and Soumya *et al.,*(2004) in potato after groundnut reported significant reduction in weed dry weight due to TPE 0.050 mm for 45 days at harvest in potato after groundnut.

Between these two years study, comparatively better reduction in weed count and dry weight of weeds was observed in 2003-04. This was mainly attributed to more number of days with higher temperature maxima (Table 7 and Appendices – I & II) during solarization and less weed infestation in preceding crop.

5.2.6 Growth and yield of aftermath potato

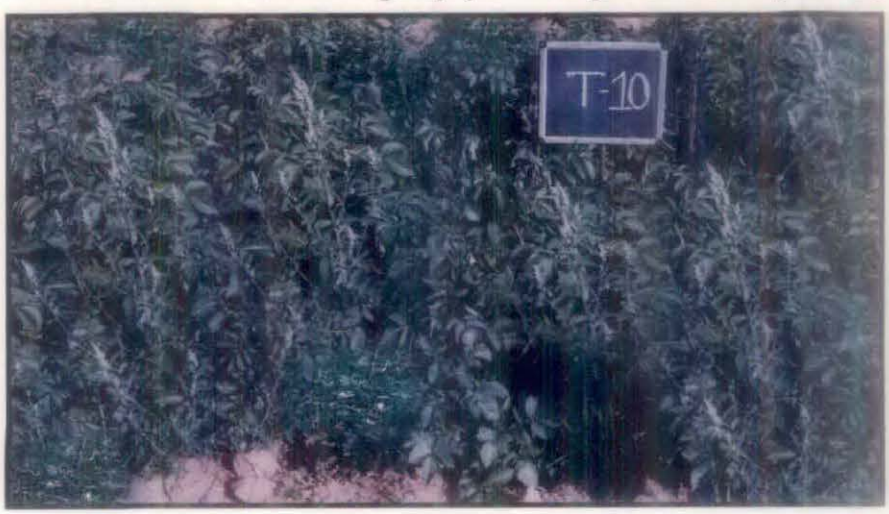
TPE 0.025 mm for 45 days, weed free and hand weeding twice plus earthing up recorded maximum plant height (Table 45) at harvest in potato over weedy check, which was to the tune of 52.6, 44.8 and 51.8 per cent respectively. Higher leaf area (Table 46) over weedy check was noted under TPE 0.025 mm for 45 days, hand weeding twice plus earthing up and weed free to the extent of 93.4, 91.9, and 87.4 per cent at 60 DAP and 89.1, 88.5 and 80.4 per cent at 90 DAP, respectively. The increase in plant height and leaf area under these treatments was mainly attributed consequent to the luxuriant vegetative growth (Plate 3) due to the less weed emergence and induced weed suppression. SS with thin TPE has been found to enhance growth of crop plants, which could be attributed to chemical and biological changes in the soils and less weed crop competition, whereas, in hand weeding twice plus earthing up due to weeding was carried out at 20 and at 40 DAP with earthing up at 40 DAP and in weed free due to regular weeding at 20 days interval. There was higher leaf retention even at harvest. These findings are in accordance with the findings of Mudalagiriyappa *et al.*,(1999d) and Soumya *et al.*, (2004) with TPE 0.050 mm per 45 days in succeeding potato crop.

Plant height and leaf area were recorded minimum under weedy check. This might be due to the severe competition by weeds for resources during crop weed competition period which made unavailability of nutrients, space and moisture in required quantity to crops which reflects on the crop growth. Similar results were also recorded by Patel (2002) in potato at S.K.Nagar.

It is evident from the Table 48 that maximum total tuber yield of potato was registered under TPE 0.025 mm for 45 days (31.12, 29.76 and 30.44 t ha^{-1}), followed by hand weeding plus earthing up (30.29, 28.71 and 29.50 t ha^{-1}) and weed free (29.48, 27.63 and 28.56 t ha^{-1}) in first year, second year and in pooled results, respectively. This increase in total tuber yield was to the tune of 130.9, 165.7 and 146.4 percent in TPE 0.025 mm for 45 days, followed by hand weeding plus earthing up 124.4, 155.9 and 137.8 per cent and weed

TPE 0.025 mm for 45 days(Good growth of plant)

HW twice + earthing up(Good growth of plant)



Weedy check
(Poor growth of plant)

Plate 3: Performances of succeeding potato crop under TPE 0.025 mm for 45 days, HW twice + earthing up and weedy check at 60 DAS

free 118.7, 146.3 and 106.8 per cent over weedy check in first year, second year and in pooled results, respectively. The increase in total potato tuber yield under above treatments was consequence of their favourable effect on growth components viz. plant height, number of leaves and leaf area are indicators of better availability of growth resources, which ultimately helped in better translocation of metabolites to the tubers. The resource availability in turn might have been increased on account of reduction in weed growth by higher temperature achieved in those treatments is an end results of their favourable effect on yield components, such as number of tubers per plant, tuber weight plant and size of tubers.

The numbers of tubers per plant was recorded higher due to TPE 0.025 mm for 45 days, hand weeding twice plus earthing up and weed free over weedy check, which was to the tune of 49.8, 46.3 and 38.8 per cent, respectively. Likewise, the increase in tuber weight per plant under TPE 0.025 mm for 45 days, hand weeding twice plus earthing up and weed free over weedy check, was to the extent of 85.2, 81.8 and 79.4 per cent, respectively.

With regards to grade wise tuber yield (Table 47), TPE 0.025 mm for 45 days recorded higher yield of large size tuber (139.0 per cent) and medium size (228.5 per cent) compared to weedy check. Whereas, yield of small size tuber (90.1 per cent) was higher in weed free than weedy check. These, grade wise higher yield reflect in total tuber yield production. Better development of tubers due to higher leaf number, leaf area and haulm yield in a situation of lesser weed competition might have been contributed in higher number of tuber and tuber weight per plant as well as grade wise tuber yield, which in turn recorded higher total tuber yield by these treatments.

Based on growth and yield of potato , it is evident that solarization with TPE 0.025mm for 45 days resulted in great improvement in growth as a result remarkable increase was observed in various yield components, ultimately leading to higher yield. The increase in yield of succeeding potato crop after groundnut as a result of weed control through solarization in concomitant to those reported by Mudalagiriyappa *et al,* (1999 d) and by Soumya *et al.*, (2004).

Yield increase in sequential crop by solarization was also reported by Mudalagiriyappa (1998) in French bean after groundnut, Singh *et al.* (2000) in wheat after soybean and by Lalitha *et al.* (2001) in tomato after groundnut.

The reduction in weed growth due to SS treatments and the associated in improvement of growth and increase in yield was better during 2003-04 as compared to 2004-05. This might be mainly because of the prevalence of higher temperature during 2003-04. This might have also helped the crops to put forth maximum growth before weeds seeds present in the soil could germinate fully.

5.3 Correlation study

It is seen from the data in Table 49 that pod yield of groundnut had the highly positive correlation with growth components i.e. plant height, number of branches, number of leaves, leaf area, LAI and total dry matter accumulation as well as yield attributes viz., number of pods per plant, pod weight per plant , shelling percentage, test weight, kernel yield and weed control efficiency. While, weed count, dry weight of weed and dry weed biomass was negatively correlated with pod yield of groundnut.

5.4 Economic evaluation

Perusal of data in table 50 indicated that the highest net return (137513 Rs ha^{-1}), BCR (2.61), system productivity (92.79 kg $ha^{-1}day^{-1}$) and profitability (376.7 Rs $ha^{-1}day^{-1}$) were registered in TPE 0.025 mm for 45 days, followed by hand weeding twice plus earthing up (129260 Rs ha^{-1}), (2.80), (89.07 kg $ha^{-1}day^{-1}$) and (354.1 Rs $ha^{-1}day^{-1}$), respectively, and by weed free (127522. Rs ha^{-1}), BCR (2.41), (87.17 kg $ha^{-1}day^{-1}$) and (349.8 Rs^{-1} $ha^{-1}day^{-1}$), respectively. The lowest net return (10700 Rs ha^{-1}), BCR (1.13), system productivity (37.23 kg $ha^{-1}day^{-1}$) and profitability (29.3 Rs $ha^{-1}day^{-1}$) was recorded under weedy check.

5.5 Future line of work

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

1. As there is a possibility of solarized plots being contributed with weed seeds by irrigation, efforts can be made to know the extent of such contribution.
2. Integration of SS with other methods such as inclusion of one or two hand weeding after sowing and post emergence herbicidal weed control
3. Biological activity and oxygen diffusion rate in soil needs to be estimated to know the exact reason for changes in biological and soil nutrient status after SS.

SUMMARY AND CONCLUSION

VI. SUMMARY AND CONCLUSION

An experiment was conducted during 2003-04 and 20004-05 on loamy sand soil of Agronomy Instructional Farm, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to study the effect of Soil solarization on weed control, growth and yield of groundnut-potato crop sequence in conjunction with cultural and chemical method of weed control under North Gujarat Agro climatic condition. Treatments consisted of two thicknesses of TPE (0.025 mm and 0.050 mm) with three durations of soil solarization (15, 30 and 45 days) along with cultural (weed free and hand weeding twice plus earthing up) as well as chemical method (Pendimethalin for groundnut and Metribuzin for potato each @ 1.0 kg ha^{-1}) of weed control with standard weedy check as control were studied in randomized block design with four replications. The climatic conditions were almost favourable for both the crops during both the years. The salient findings obtained with respect to treatments effects presented and discussed in the foresaid chapters and the salient features are summarized hereunder:

Soil solarization:

1. Significantly higher soil temperature (53.5^{0}C and 51.3^{0}C at 5 and 10 cm soil depth, respectively) was recorded under TPE 0.025 mm for 45 days at all the DAPS than non solarized.
2. All solarized treatments retained higher mean soil moisture content at deeper depth compared to shallow soil depth and as duration increased, soil moisture content decreases.
3. Soil solarization with TPE 0.025 mm for 45 days had the lowest soil organic carbon content, available sulphur and Zn compared to weedy check.
4. Soil solarization with TPE 0.025 mm for 45 days improved available nutrients (nitrogen, phosphorus and potassium) in soil over non solarized, except TPE 0.050 mm for 45 days in case of available nitrogen.

5. The available nutrients (Fe, Mn and Cu) content was increased under TPE 0.025 mm for 45 days over all other treatments, but it was at par with TPE 0.050 mm for 45 days, whereas, the available Zn content was decreased under TPE 0.025 mm for 45 days barring TPE 0.050 mm for 45 days .
6. All soil solarization treatments caused significant reduction in fungal, bacterial and actinomycetes population as compared to non solarized treatment, but higher reduction was observed under TPE 0.025 mm for 45 days just after soil solarization. While at harvest of groundnut, there was an improvement in microbial population under all soil solarization treatments

Groundnut:

7. Grasses, broad leaved, sedges and total weeds population at 30 and 60 DAS was decreased under weed free as compared to all other treatments, but it was at par with hand weeding twice plus earthing up and TPE 0.025 mm for 45 days.
8. There was significant reduction in weed count of grasses, broad leaved, sedges and total weeds population at 90 DAS and harvest due to weed free over all other treatments, which was at par TPE 0.025 mm for 45 days.
9. With regards to dry weight of weeds at 30 and 60 DAS, there was significant reduction in grasses, broad leaved, sedges and total weeds under weed free followed by hand weeding twice plus earthing up and TPE 0.025 mm for 45 days.
10. Dry weight of grasses, broad leaved sedges and total weeds at 90 DAS and harvest was decreased under weed free as compared to all other treatments, which being at par with TPE 0.025 mm for 45 days.
11. Comparing the broad leaved and grasses, the extent of reduction due to soil solarization with TPE 0.025 mm for 45 days was more in case of broad leaved weeds than grasses.

12. Weed free causing maximum extent of dry weed biomass reduction, which was similar to that of soil solarization with TPE 0.025 mm for 45 days compared to all other treatments.
13. Weed free treatments had maximum weed control efficiency compared to all other treatments, followed by soil solarization with TPE 0.025 mm for 45 days.
14. Soil solarization with TPE 0.025 mm for 45 days had the lowest weed index as compared to all other treatments, while weedy check had the highest weed index, followed by TPE 0.025 mm for 15 days and TPE 0.050 mm for 15 days.
15. Maximum plant height per plant was found under TPE 0.025 mm for 45 days at 30 DAS and harvest, but it was equal with weed free.
16. Maximum number of branches per plant was noted under TPE 0.025 mm for 45 days at 30 DAS and harvest, being at par with weed free, hand weeding twice plus earthing up and TPE 0.050 mm for 45 days.
17. In case of number of leaves per plant in groundnut at 30, 60, 90 DAS and harvest, it was found maximum in TPE 0.025 mm for 45 days over all other treatments except weed free, hand weeding twice plus earthing up, TPE 0.050 mm for 45 days and pendimethalin 1.0 kg ha^{-1}.
18. Maximum leaf area and leaf area index per plant at 30, 60, 90 DAS and harvest was registered in TPE 0.025 mm for 45 days as compared to all other treatments, but it was statistically at par with weed free.
19. TPE 0.025 mm for 45 days had maximum dry matter accumulation in leaves and stem per plant at 30, 60, 90 DAS and harvest being at par with weed free.
20. Dry matter accumulation in pods per plant at 60, 90 DAS and harvest was registered maximum in TPE 0.025 mm for 45 days as compared to all other treatments, barring weed free.

21. Maximum total dry matter accumulation per plant at 30, 60, 90 DAS and harvest was recorded under TPE 0.025 mm for 45 days over all other treatments, however, it was at par with weed free.
22. Higher number of root nodules per plant was recorded in TPE 0.025 mm for 45 days, but it was equal to that of weed free. Whereas, at 90 DAS, it was observed higher under TPE 0.025 mm for 45 days, which was at par with weed free and TPE 0.050 mm for 45 days.
23. Dry weight of root nodules per plant was noted maximum under TPE 0.025 mm for 45 days at 60 DAS and 90 DAS over all other treatments, except weed free.
24. Maximum number of pods and pod weight per plant was observed under TPE 0.025 mm for 45 days compared to all other treatments, except weed free.
25. Significantly the maximum pod yield was recorded under TPE 0.025 mm for 45 days (30.14 q ha^{-1}) over all other treatments in pooled results, but it was at par with weed free (28.55 q ha^{-1}). Likewise the maximum haulm yield was registered under TPE 0.025 mm for 45 days compared to all other treatments; however, it was at par with weed free and hand weeding twice plus earthing up.
26. Higher shelling percentage, test weight and kernel yield was recorded under TPE 0.025 mm for 45 days and found superior as compared to all other treatments, but it was at par with weed free.
27. In case of oil content in groundnut, it was recorded higher under TPE 0.025 mm for 45 days, which was found at par with weed free, hand weeding twice plus earthing up, TPE 0.050 mm for 45 days, pendimethalin 1.0 kg ha^{-1} and TPE 0.050 mm for 45 days.
28. Content of nitrogen, phosphorus, potassium and sulphur in groundnut haulm was increased under TPE 0.025 mm for 45 days over all other treatments; however, it was at par with weed free.

29. Content of Fe, Mn, Zn and Cu in groundnut haulm was improved under TPE 0.025 mm for 45 days over all other treatments, but it was found equal with weed free treatments.
30. Soil solarization with TPE 0.025 mm for 45 days and weed free was equally effective for reduction of nitrogen, phosphorus, potassium and sulphur uptake in weeds as compared to all other treatments.
31. Content of Fe, Mn, Zn and Cu in weeds was decreased under weed free over all other treatments, which being at par with TPE 0.025 mm for 45 days.

Potato:

32. Higher reduction was observed in grasses, broad leaved, sedges and total weeds population at 30 and 60 DAS and harvest due to weed free, which was at par with hand weeding twice plus earthing up and TPE 0.025 mm for 45 days.
33. With regards to dry weight of weeds at 30 and 60 DAS and harvest, there was significant reduction in grasses, broad leaved, sedges and total weed followed by hand weeding twice plus earthing up and TPE 0.025 mm for 45 days.
34. Weed free noted maximum reduction of dry weed biomass and it was similar to that of TPE 0.025 mm for 45 days and hand weeding twice plus earthing up as compared to all other treatments.
35. Weed free treatment recorded maximum weed control efficiency followed by soil solarization with TPE 0.025 mm for 45 days and hand weeding twice plus earthing up over all other treatments
36. Maximum plant height at 30 DAS and harvest was noted under TPE 0.025 mm for 45 days as compared to all other treatments except weed free, hand weeding twice plus earthing up, TPE 0.050 mm for 45 days and metribuzin 1.0 kg ha^{-1}.

37. More number of leaves and leaf area per plant at 60 and 90 DAS was registered under TPE 0.025 mm for 45 days over all other treatments, but it was found statistically at par with weed free, hand weeding twice plus earthing up and TPE 0.050 mm for 45 days.
38. Number of tuber and tuber weight per plant was recorded significantly maximum under TPE 0.025 mm for 45 days as compared to all other treatments, except hand weeding twice plus earthing up and weed free.
39. In case of grade wise tuber yield of potato, large size and medium size tuber yield was registered maximum due to TPE 0.025 mm for 45 days over all other treatments, barring hand weeding twice plus earthing up and weed free.
40. With regards to small size tuber yield, weed free produced maximum small size tuber as compared to all other treatments, which was at par with hand weeding twice plus earthing up, TPE 0.025 mm for 45 days and TPE 0.050 mm for 45 days.
41. Significantly maximum total tuber yield of potato was secured under TPE 0.025 mm for 45 days (30.44 q ha^{-1}) and found superior over all other treatments, but it was on par with hand weeding twice plus earthing up (29.50 q ha^{-1}) and weed free (28.56 q ha^{-1}).
42. Haulm yield was produced maximum in TPE 0.025 mm for 45 days over all other treatments, which was statistically at par with hand weeding twice plus earthing up, weed free and TPE 0.050 mm for 45 days.

Economics:

43. The highest net return, BCR, system productivity and system profitability for groundnut - potato crop sequence was secured under TPE 0.025 mm for 45 days, followed by hand weeding twice plus earthing up and weed free.

Conclusion

From the results obtained in this investigation, it is concluded that soil solarization with TPE 0.025 mm for 45 days increased soil temperature and helped in effective controlling of weeds with better release of nutrients particularly available N, P_2O_5, K_2O, Fe, Mn and Cu in soil. Consequently, soil solarization with TPE 0.025 mm for 45 days has improved pod and tuber yield of groundnut-potato sequence on loamy sand soil with higher net return, BCR, system productivity and profitability under North Gujarat Agro climatic Zone.

REFERENCES

References

Abu-Irmaileh, B.E., (1991). Weed control in squash and tomato fields by soil solarization in the Jordan Valley. *Weed Res.* **31** : 125-133.

Agresco (1985). AICRP on Weed control, Gujarat Agricultural University, Anand.

Agresco (1997). AICRP on Potato, Potato Research Station , Gujarat Agricultural University, Deesa.

Agresco (1991). AICRP on Potato, Potato Research Station , Gujarat Agricultural University, Deesa.

Agresco (1996). AICRP on Weed control, Gujarat Agricultural University, Anand.

Agresco (1997). Department of Agronomy, College of Agriculture, Gujarat Agricultural University, Junagadh.

Agresco (2004). AICRP on weed control, Gujarat Agricultural University , Anand.

Agresco (2004-2005).Weed Control Research Project, Gujarat Agricultural University, Junagadh.

Ahmad, Y., Hameed, A. and Aslam, M., (1996). Effect of soil solarization on corn stalk rot. *Pl. Soil.* **179** : 17-24.

Annual Report, (2002). I.A.R.I., New Dlhi.

Arora, A. (1998). Soil solarization : Effects on soil moisture, soil temperature and chemical properties of the soil. *Crop Res.* **16** (I) : 41-49.

Arora, R. K. (2004). Studies on the effect of soil solarization and its integration with bio agent and organic amendment on damping off of vegetable seedling in nurseries and microbial changes in soil. M.Sc (Agri) Thesis, GBPUA&T, Pantnagar

Allen, O.N. (1953). Experiments in soil bacteriology. Burgess Publ. Co., Minnepolis.

Aloi, B. and Noviello, C. (1982). Solar heating and control of soil inhibiting plant pathogens. Annals della Facolla Agraria della University degli studi di Napoli Postica, **16** : 151-158.

Basavaraj, H, K. (1998) Weed management in chilli-maize cropping sequence through soil solarization. Ph.D. Thesis, University of Agricultural Sciences, Bangalore.

Benjamin, A. and Rubin, B.(1982).Soil solarization as a means of weed control. *Phytoparasitica.* **10** (4) :280.

Bell, C.E and Elmore. C. L. (1984). Soil solarization as a weed control method in fall planted Cantaloupes. *Hort.Abstr.* **54** (6) :334

Bhhn, V. M. and Singh, V. P.(1993). Integrated weed management an approach. Proc. Int. Symp., *Indian Soc. Weed.Sci.* Nov. 1820, **Vol. I** : 259-97.

Bhan, V. M.,Yadav, S. K. and Singh, S. P. (1983). Oxidiazole and pendimethalin for weed control in groundnut. *Tropical pest Management.* **289** (3) : 274-276.

Bhattacharya, S. P., Baidya, D. and Mandal, k., Bikash (1989). Relative performance of different herbicides for controlling of weeds in potato in plains of West Bengal *J. Indian Potato Assoc.* **16** (1 & 2) : 24-28.

Biradar, I. B. (1996). Effect of soil solarization on weed control and its aftereffects on growth and yield of groundnut in red soil. M.Sc. (Agri.) Thesis,University of Agricultural Sciences, Dharwad.

Biradar, I. B., Hosmani, M. M. and Chittapur, B. M. (1997). Soil solarization as new tool for weed control groundnut. *Indian J. weed Sci.* **29** : 170-173.

Biradar, I. B. and Hosmani, M.M. (2001). Effect of soil solarization on weeds. *Karanataka Journal of Agricultural Science.* **13** (3): 712-715

Braun,M., Kock, W. and Steifvaler, M. (1987). Solarization for soil sanitation, possibilities and limitations, demonstrated traits in Southern Germany and the Sudan. Gesunde. Pflanzen, **39** : 301-309.

Braun, M., Kock, W. Mussa, H. H., Steifvaler, M.(1988). Solarization for weed and pest control possibilities and limitation in weed control in vegetable production. Proceedings of meetings of the EC experts group, Stuttgard. 28-31 October, 1986, Rottendrum,Balkome : 169-178.

Cartia, G. (1985). Solar heating of the soil for the control of pests and perennial weeds. *Colture Protelle.* **14** (3) :37-42.

*Cartia, G. (1987). Results of soil solarization in sicily. Difesa della plante. **10**: 189-194.

Chandra kumar, Nanjappa, H. V., Ramachandrappa, B. K. and Prasad kumar, H. M. (2002). Weed management through soil solarization in sunflower. *Indian J. weed Sci.* **34** (3&4) : 231-235.

Chaube, H. S. and Singh, U. S. (1991). Plant Diseases Management: Principles and Practices, CRC Press, FL.USA, 329pp

Chaudhary, I. A, and Cornfield, A. H. (1966). The determination of total sulphur in soil and plant material analysis. **91** : 528-530.

Chauhan, Y.S., Nene, Y.L., Johansen, G., Haware, M.P., Saxena. N.P., Sardar singh, Sharma. B.B., Sahrawat, K. L., Burford, J. R., Rupela. O.P., Kumar Rao, J. V .D. K. and Sithanatham, S.(1988). Res. Bulletin No. 11. International Crops Research Institute for Semi-arid Tropics, Patancheru, Andhra Pradesh.

*Chen, Y. and Katan, J. (1980). Effect of solar heating of soil by transparent polyethylene mulching on their chemical properties. *Soil Sci.* **130** : 271-277.

Chittapur, B. M. (1998). Ph. D. Thesis, University of Agricultural Sciences, Dharwad

Chittapur, B. M.(2002). Soil solarization, temperature dynamics of soil- A review *Agric. Review.* **23** (3): 202-205.

CMIE (2004). Centre for Monitoring Indian Economy.

*Daelemans, A. (1989). Soil solarization in West Cameroon: Effect on weed control, some chemical properties and pathogens in the soil. *Acta Horticulture.* **255** : 169-175.

D.A.O. (2005). District wise Area, Production and yield per hectare of important food and non–food crops in Gujarat State. Directorate of Agriculture, Gujarat State, Krushibhavan, Gandhinagar. pp 39.

Davis. J.R. and Sorenson, L.H.. (1986). Influence of soil solarization of moderate temperature on potato genotypes with differing resistance to Vericillium dahhae. *Phytopathology.* **76** : 1021- I 026.

Desai, A. G. ansd Dange, S. R. S. (2003). Effect of soil solarization on fusariun wilt of castor. *Agsic. Sci .Digest.* **23** (1):20-22.,

Devay, J.E. (1991). Historical review and principles of soil solarization. FAO Plant Production and Protection paper. ***100*** : 1-15.

Dwivedi, R.S. and Dubey, R. C. (1987). Effect of soil solarization on the population dynamics of Macrophomina phaseloino (TASS) Gord and Genera Soil mycoflora. *Int. J. Trop. Pl. Disease*, **5** : 67-73.

Economou, G., Mavrogiannopoulos, G. and Pasptis, E.A.(1997). Soil solarization for controlling *Arena sterilis*, *Bromus diantms* and *Sjnapis arvenis* in greenhouse in Greece. In : Proc. 2nd Int. Conf. On soil solarization and integrated management of soil borne pests, 16-21 March, Alleppo, Syria, p. 21.

*Egley, G. H. (1983). Weed seed and seedling reductions by soil solarization with transparent polyethylene sheet. *Weed Sci.* **31** : 404-409.

Egley, G.H.(1990). High temperature effects on germination and survival of weed seeds in soil. *Weed Sci.* **38** : 429-435.

*Elmore. C .L..and Heefketh, K.A. (1983). Soil solarization : An integrated approach to weed control. *Hort. Abstr.* **54** (6) :325.

*Elmore. C.L. (1983). Solarization for weed control in vegetable crops. *Hort. Abstr.* **53** (12) : 827.

*Elmore. C.L.. Roncoron, J. A. and Giraud, D.D. (1993). Perennial weeds respond to control by soil solarization. *California Agric.* **47** (1) : 19-21.

El-Sami, M, A,(1990). Soil solarization and plant disease management. I.monitoring of soil temperature in solarized soil in relation to some soil properties. *Agril. Res. Rev.* **68** (3) : 589-599.

Emani, E. (1991). Soil solarization and mulching for weed management in cowpea (*Vigna unguiculata* L.). M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad.

*Fahim, M.M., Osman, A.R., El-Attar, A.II and Mabrouk, M.S.M.(1987). Root-rot of common bean and its control by chemical and physical means. *Egyptian J. Phytopathology.* **19** : 71-83.

Fidanza, M.A., Dernoeden, P.H. and Zhang. M. (1996). Degree days for predicting smooth crabgrass emergence in cool-season. *Crop Sci.* **36** : 990-996.

*Fukul, T., Kodama, T. and Nakanishi, Y. (1981). Soil sterilization by solar heating against soil-borne disease in a Vengl house - IV : Soil sterilization in the open by solar heating with polyethylene mulch. Bull. Nara. *Agri. Exptl. Stn.*, **12** : 109-119

Gangwar, B., Katyal, V.,Anand, K.V. (2006). Stability and Efficiency of different cropping system in Western Himalayan Region. *Indian Journal of Agricultural Science.* **76** (2) : 135-37.

Gamliel, A., Fadar, E. and Katan. J. (1989). Soil solarization to improve yield of Gypsopltllain monoculture systems. *Acta Horticulture.* **255** : 131-133.

*Gamliel. A. and Katan. (1991). Microbial mechanisms involved in the increased plant growth in solarized soil. *Phytoparasitica.* **19** . 254.

*Garibaldi. A. (1987). The use of plastic material for solar healing of soil. *Coultre Protette,* **16** : 25-28.

Gomez, K.A. and Gomez. A. A. (1984). Statistical procedure for Agriculture Research. An IRRI book Wiley- inter science publication. New York, USA, p. 680.

Grinstein. A., Katan, J., Razik, A., Zeydan and Elad. Y. (1979). Control of *Sclerotium rolfsi* and weeds in peanuts by solar heating of the soil. *Pl. Disease Reporter.* **63** : 1056-1059.

Gruenzweig, J. M,.Kabinowitch, H. D. and Katan, J. (1993). Physiological and development aspects of increased plant growth in solarized. *Soils. Ann. app. Biol.* **22** : 579-591.

Habeeburrahaman, P.V. (1992). Investigations on soil solarization for weed control. Ph.D. Thesis, University of Agricultural Sciences. Dharwad.

Habeeburrahaman, P.V. and Hosmani., M.M. (1996). Effect of solarization in summer on weed growth and yield of succeeding rainy season sorghum. *Indian J. Agron.* **41**(1) : 54-57.

*Haidar, M.V. and iskanda.(1997). Soil solarization for weed control of dodder and other weeds in Luebanon., In : Proc. 2nd Int. Conf. on soil solarization and integrated management of soil borne pests, 16-21 March. Aleppo, Syri. p.21.

Haidar, M. A,and Sidahmed, M. M.(2000).Soil polarization and chicken manure for control of Orobanche and other weeds in Laebanon ,*Crop Prot.***16:169-173.**

Hankin, L., Pill, D.E. and Stephens, G.R. (1982). Effect of mulches on bacterial population and enzyme activity ill soil and vegetable yields. *PI. Soil.* **64** : 193-201.

Haripriya, K and Kamlakanan. S (2005). Weed management in soybean through soil solarization –A non chemical method. Nation Biennial Conference, ISWS., P.A.U., April, 6-9.

Harti, M.C.(1991). Influence of soil solarization and weed management in cowpea (*Vigna unguiculata* L.). M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Dharwad.

Hartiz, T.K., Bogle, C.R. and Villalon, B. (198). Response of pepper and muskmelon to row solarization. *Hort. Sci.* **20** : 699-701.

Haynes, R.J. (1987). The use of polyethylene mulches to change 5011 micronutrients as revealed by enzyme activity and biomass. N, S and P. *Biol. Fertl. Soils,* **5** : 235-240.

*Hilderland. D.M.M. (1985). Soil solar heating for control of damping off of fungi and weeds at the Colaurado State forest service nursery. *Tree Planter's* Notes, **36** : 28-34.

Horowitz, M., Regev. Y. and Herzlinger, G. (1983). Solarization for control of weeds. *Weed Sci.* **31** : 170-179.

Hooda, R. S.,Pandita,M.L.,and Sindhu,A.S. (1982). Herbicidal control of weeds in potato cv.Chandramukhi. *Pesticides.* **16** (10) : 13-14.

Hooda, R. S. (1987). Studies on chemical control of weeds in potato. *Indian J. Agron.* **32** (1) : 111-112.

Jackson, M.L. (1967). Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi, p.183-192

Jackson, M.L. (1973). Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi, p. 498.

Jacobsohn. R., Greenberger, A., Katan. J., Levi, M. and Alon, H. (1980). Control of Egyptian broom rape and other weeds by means of solar heating of soil by polyethylene mulching. *Weed Sci.* **28** : 312-318.

Jhonson, C. M. and Ulrich, A.(1960). Analytic methods for use in plant analysis. *Cal.Agr. Exp.sta.Bull.* **766** : 57-58.

Kaewrung. W., Sivasithamparam, and Hardy, G.E. (1989). Use of soil solarization to control root-rots in Gerbera. *Biol. Fertl. Soils.* **8** : 38-47.

Kalaria, K. K., Patel, P. K. and Mori, J. D. (1976). Performance of Tenoran, Lasso, Tok E-25 and mechanical treatmentsin weed control in groundnut. *GAU Res.J.* **2** (1):29-33.

Kandap, S. M., Usharani, Reddy, B. B., Swami, K. R., Rao, A. P. and Reddy, G Venketashwaram. (1989). Effectiveness of herbicides and cultural methods for the control of weeds in Spanish and Virginia habit groups of groundnut. *J. Oil seed Res.* **6** : 128-132.

Katan J. (1980). Solar pasteurization of soils for disease control status and properties. *Pl. Disease.* **64** : 450-454.

Katan J. (1981). Solar heating of soil for control of soil home pests. Ann. Rev. *Phytopathology.* **19** : 311-336.

Katan, J. and Devay, J.E. (1995). Soil solarization. CRC Press Boca Raton. Ann. Arbor Baston, London.

Katan, J., Fishler. G. and Grinstein, A. (1983). Short and long term effects on soil solarization and crops sequence on Fusarium wilt and yield of cotton in Israel. *Phytopathology.* **73** : 1215-1219.

Katan, J., Greenberger, A., Alon, H. and Grinstein, A. (1976). Solar heating by polyethylene mulching for the control of disease caused by soil borne pathogens. *Phytopathology.* **66**: 683-688.

*Katan, J, Rotem, L., Finkel, Y. and Daniel, J. 1980. Solar heating for the control of pink root-rot and other soil-borne disease in onions. *Phyloparasitica.* **8** : 39-50.

Kathad, N. K. (1990). Intrgrated weed management on *kharif* groundnut, M.Sc. (Agri.) Thesis, Gujarat A gricultural University, S .K.Nagar.

Kavani, H. D., Malaviya, D. D., Raghvani, B. R., Patel, J. C. and Ray, B. (1986). Integration of fluazifop with cultural practice in to the weed management of groundnut. *Indian J. Weed Sci.* **17** (1) : 39-42.

Khandher, R.R. and Bhowmic, T .P.. (1990). Org..XI Int.Cong.use of plastic in agriculture, New Delhi, E-128-133.

Khulbe, D. (2000). Soil Solarization effect on soils nutrients, microorganisms and plant growth response. Ph.D. Thesis, G.B.P.U.A. & T., pp.220.

Kirankumar,V.V., Nanjappa, H.V.and Ramchandrappa, B.K. (2003a). Effect of soil solarization on yield nutrient uptake and balance sheet of nutrient in tomato. *Crop Res.* **25** (2) : 253-258.

Kirankumar,V.V., Nanjappa, H.V. and Ramchandrappa ,B.K. (2003b). Effect of soil solarization for a period of one month during march, april, may on weed control and yield of tomato. *Crop Res.* **25** (2) : 259-265.

Kodama., T. and Fukul, T.(1982). Application of solar heating with plastic film mulching in the out door field for control of Fusarium wilt of strawberry. Annual Phytopathology Society, Japan, **48** : 689-701.

Kumar, B., Yaduraju, N.T. and Prasad. D. (1993). Effect of soil solarization on weeds and nematode under tropical Indian conditions. *Weed Res.* **33** : 423-429.

Lal, S.S. (1990). Direct and residual effect of varying levels of herbicides for controlling the weeds in potato-black gram crop sequence. *Indian J. Weed Sci.* **22** (3 & 4): 1-5

Lalitha, B.S. (1999). Ph.D. Thesis, University of Agricultural Sciences, Bangalore.

Lalitha, B.S., Nanjappa, H.V.,Nagaraj, K.H. and Anand, T.N. (2000). Effect of soil solarization on weed control and yield of groundnut. *Current Research.* University of Agricultural Sciences Bangalore. **29** (3/4) : 47-48.

Lalitha, B.S., Nanjappa, H.V.,Nagaraj, K.H. and Anand, T.N. (2001). Effect of soil solarization on weed dynamics and yield of groundnut- tomato crop sequences.Mysors J.agric.Sci. **35** : 226-231.

Lindsay, W.L. and Norvell, W.A.(1969). Development of a DTPA micronutrient soil test. Soil Sci. Soc. Am. Proc. **35** (4) : 600-602.

Lindsey, J.T. and Shahid, N. (1996). The effect of soil warming on plant environment. *Pl. soil,* **182** : 339-343.

*Linke, K.H., Saxena, M.C., Suaberborn, J. and Masri, H. (1991). Effect of soil solarization on the yield of food legumes and pest control (Personal communication), ICARDA, Aleppo, Syria.

Lodha, S. (1989). Soil solarization for the control of *Macrophomina Phaseolina* in arid soil. Indian Phytopathol. **42** : 170-171.

Lodha, S., Mahendra Singh and Sharma, B.M. (1991). Solarization brings down soil-borne pathogens in arid soils. *Indian Fmg.* **10** : 12-13.

Lodha , S. and Vaidya, A. (1990). Influence of soil solarization on the viability of *Fusarium solani* in an arid environment. Arid Soil Research and Rehabilitation, **4** : 199-202.

Mahajan G., Bhatia, R .K. and Singh, K. G. (2005). Soil solarization :A non chemical approach for weed management in brinjal nursery. National Biennial Conference, ISWS, P.A.U., Ludhiana, April 6-9,:133-134.

Mahrer, Y (1979).Prediction of soil temperature of asoil mulched with transparent polyethylene. *Journal of Applied meteorology.* **18** :1263-1267.*Soil Science*

Makwana, K. U. (1982). Chemical and cultural methods of weed control in groundnut. M. Sc. (Agri.) Thesis, Gujarat Agricultural University, S. K. Nagar.

Malavia, D.D. and Patel, J.C. (1989). Effect of cultural and chemical weed control on weed parameters in groundnut yield and nodulation of groundnut. *Indian J. Agron.***34** (2) : 205-208.

*Melero, 1.M., Gonzaler, R, Gomez, J., Bejaramo, J. and Basallote, M.J. (1989). Solarization of soils in Andallusia using plastic film. Plasticulture. **82** : 73-82.

Meron, M., Filler, Y., Cohen, Y. Gristein. A., Gamliel, A. Chen. Y. and Katan. J. 1989. Solarization and fumigation for reclamation of organic soils. *Acta Horticulture*. **255** : 117-124.

Meti, S.S.(1993). Control of Orobanche in bidi tobacco. M.Sc. (Agri.) Thesis. University of Agricultural Sciences, Dharwad.

Meti, S.S. and Hasmani, M. M. (1994). Broom rape control in bidi tobacco by soil solarization. *Crop. Res.* **20** (1) : 67-70.

Mudalagiriyappa, M. (1998). Soil solarization for weed management in groundnut based cropping system. Ph. D. Thesis. University of Agricultural Sciences. Bangalore.

Mudalagiriyappa, Nanjappa, H.V. and Ramachandrappa, B.K. (1998). Effect of soil solarization on weed seed germination. *World weeds* **Vol. V** : 229-232.

Mudalagiriyappa, Nanjappa, H.V. and Ramachandrappa, B.K. (1999a). Effect of soil solarization on weed growth and yield of *kharif* groundnut (*Arachis hypogaea*). *Indian Journal of Agronomy*. **44** : 396-399.

Mudalagiriyappa, Nanjappa, H.V. and Ramachandrappa, B.K. (1999b). Effect of soil solarization on weed dynamics in *kharif* groundnut. *Indian J. Weed Sci.* **31** (1-2). : 35-37.

Mudalagiriyappa, Nanjappa, H.V. and Ramachandrappa, B.K. (1999 c). Effect of soil solarization on certain soil properties, growth and yield of groundnut. *J. Oil seeds* Res. **16** (2) : 250-252.

Mudalagiriyappa, Nanjappa, H.V. and Ramachandrappa, B.K. (1999d). Residual effect of soil solarization on growth and yield of potato. *J. Indian Potato Assoc.* **26** (1 & 2) : 63-64.

Murthy, B.G., Agasimanl C.A. and Pratima, N. C. (1992). Influence of herbicides on yield, quantity and economics in rainfed groundnut. *J. Oil seed Res.* **11** (2) : 285-286.

Naidu, L.G. K., Sankara Reddi, G.H. and Sundar Rajan. (1982). Effect of weed competition in rainfed groundnut (*Arachis hypogaea* L.). *Indian.J. weed Sci.* **17** : 50-52.

Nandekar, D.N., Savarkar, S .D.,Sharma, T .R. and Sharma, R. C .(1999). Efficacy of herbicides for controlling weed flora of potato on satpura region of Madyapradesh. *J. Indian potato Assoc.* **17** (3-4): 192-194.

Nanjappa, H.V.,Ramchandrappa, B.K., Soumya.T.M.and Sanjay, M.T.(2005). Repetitive use of transparent polyethylene for soil solarization in groundnut. National Biennial conference ISWS., P.A.U., Ludhiana, April 6-9. p 129-30.

Nasr-Esfahani,M.,(1993.).Soil solarization for control of weeds in .Pantnaga.In.Proc.Symp. Indian Society of Weed Sciences, Hissar III :233-237.

Olsen, S.R., Cole, G. V., Wetanabe, F.S, and Dean, L.A, (1954). Estimation of available phosphorus in soils by Extraction with sodium bicarbonate.USDA.,Cir .No. 939, p 19..

Osman, A R. and Sohab. A. F. 1983. Control of *Rhizoctonia solani* by soil solarization. *Acta Horticulture*. **152** : 285-291.

Pandey, D.K. and Singh, V.P. 1996. Reduction in weed incidence through accelerating agency of seeds in soil seed bank. *Indian J. weed Sci.* **28** : 74-76.

Patel, B.K. and Patel, H.R. (1997). Effect of nematicide, soil solarization, rabbing and green manuring on some physical and chemical properties of soil in nematode infested bidi tobacco nursery. *Tob.Res.* **23** (1 & 2) : 19-26.

Patel, B.G. (2002).Weed control studies in potato. M.Sc.(Agri) Thesis, Gujarat Agricultural University, Sardarkrushinagar.

Patel, B.K. and Patel, H. R. (1998). Effect of soil solarization, rabbing , nematicidse, and green manuring on population densities of soil microbes in bidi tobacco. *J. mycol. Pl. Pathol.* **28** (3):279-283.

Patel, D.J., Patel, H.V. and Patel, S.K. (1991b). Comparative efficacy of LSPE films covers for soil solarization in control of root- knot nematodes in tomato nurseries. *Plasticulture.* **3** :33-36.

Patel, D.J., Patel, H.R., Patel, S.K. and Makwan, M.G. (1991a). Soil solarization through clear polyethylene tarping for management of root knot disease in tobacco nursery. *Tob.Sci.* **35** :63-64.

Patel, N.M., shah,P.M. and Patel P.T. (1995). Comparative effect of different herbicides in potato cv. Khufri Badshah *J. Indian potato Assoc.* **22** (1-2) : 74-76.

Patel,R.G., Patel R.B.,Patel H.C. and Patel T. D. (1988). Crop weed competition in summer groundnut under clayey soils of south Gujarat. GAU Res. J. **14** (1) : 52-54.

Patel, P.P.(1994). Weed management in Rice nursery. M.Sc. Thesis. Gujarat Agricultural University.,Anand

Patil, S.A. (2003). Groundnut production-Present status and future strategies in proceedings of National Workshop on Groundnut technology. Feb. 6-7, 2003. Organized by UAS, Dharwad at Raichur.

Peachey, R.E., Pimkerton, J. N., Ivors, K,L., Miller, M.L. and Moore, L. W.(2001). Effect of soil solarization cover crops and methan on field emergence and survival of buried annual blue grass (*Poa annua*) seeds. *Weed technol.* **15** : 81-88.

Piper, C.S. (1966). Soil and Plant Analysis. Academic Press, New York and Hans Publications, Bombay.

Raj, H. and Kapoor, J.J. (1993). Soil solarization for the control of tomato wilt pathogen. Zeintshrift Pflanzenkrank Leifen and Pflanzenschetz. **100** : 652-61.

Rathi, G.S., Sharma. R.S. and Dubey, M. P. (1986) Studies on integrated weed control in rainfed groundnut. *Indian J. weed Sci.* **18** (4): 220-225.

Reddy, C. N., Reddy, M.D., Devi, M .P. (1998). Solarization for weed control in vegetable nurseries. *Indian J. weed science.* **30** :88-89

Regone,' D. and Wilson, 1.E. (1988). Control of weeds, nematodes and soil-borne pathogens by soil solarization. Alfua Agril. Bull. **13** : 1320.

Rubin, B. and Benjamin, A. (1983). Solar heating of the soil: Effects on weed control and soil incorporated herbicides. *Weed Sci.* **31** : 819-825.

Rubin, B. and Benjamin, A .(1984). Solar heating of the soils: involvement of environmental factors in the weed control process. *Weed Sci.* **32** : 138-142.

*Salman. H.M. and Gorski, S.F. (1985). The effects of clear and black polyethylene mulches on the soil environment. Research Circular, Ohio Agricultural Research and Development Centre, **288** : 7-9.

Satour, M.M., Abdel-Rahim, M.F., Grinstein. A., Robinowitc, H.B. and Katan, J. (1989). Soil solarization in onion fields in Egypt and Israel: short and long term effects. *Acta Horticulturae.* **235** : 151-159.

Sauerborn, J., Linke, K.H., Saxena, M.C. and Kock, W. (1989). Solarization. a physical method for weeds and parasitic plants (*Orobanche* spp.) in Mediterranean Agriculture. *Weed Res.* **29** : 391397.

Schreiner, R.P., Ivors, K.L. ,Pinkerton, J.N. (2001) . Soil solarization reduces arbuscular mycorrhizal fungi as a consequence of weed suppression. *Mycorrhiza* . **11** : 273-277

Sharma, J.P. (1994). Production potential and economics of potato under different schedules of irrigation levels of potassium and methods of weed control. *J. potassium Res.* **10** (3) : 278-281.

Silveria, H.W., Gomes, R.,Agutar, L.,Gixinhas, M.L., Bica, J. and Bica, M. (1988). Soil polarization under polyethylene film cultivation of lettuce and onion. Plasticulture. **85** : 35-42.

Singh, B.N. (1982). Effect of periodic manual weeding in potato. *Indian J. Agron.* **27** (3) : 291-293.

Singh Kamla (1988). Evaluation of pre-emergence herbicides for weed management in potao. *Indian J. Weed Sci.* **20** (1) : 53-57.

Singh, V.P., Dixit, A., Prasabdabu, M.B.B. and Mishra, J.S. (2000). Effect of period of soil solarization and weed control measures on weed growth and yield of soybean (*Glycine max* L.). Extended summaries, (in) International Conference on Managing Natural Resources for Sustainable Agricultural

production in the 21st country. Feb. 14-18, 2000; New Delhi, India **vol. 3** : 1457-1459

Singh, V.P.,Misra, J.S., Dixit, A. and Yaduraju, N.T. (2003).Residual effect of different durations of soil solarization and weed control measures on weed growth and productivity of wheat in wheat-soybean system. *Indian J. weed Sci.* **35** (3&4) : 221-224.

Singh, V.P. and Yaduraju, N. T. (2004). Soil solarization : A novel technique of weed management. pp. 1-23.

Sivakumar, M. and Marimuthu.(1987). *Indian J. Nematology*, **17** : 58-59.

Sobh, H. and Abou-Jawadah, Y. (1997). Effect of soil solarization on soil-borne pathogens in Lebanon. In. Proc. second Int. Conf. Soil Solarization and Integrated Management of Soil-borne pest, 16-21st March, Aleppo. Syria.

Soumya. T.M., Nanjappa, H.V., Ramachandrappa, B.K. (2003). Effect of soil solarization on growth and pod yield of *kharif* groundnut. Crop Research. **26** (2) : 240-242.

Soumya.T.M., Nanjappa,H.V.,Ramachandrappa, B.K. (2004). Growth ad yield of potato as influenced by residiual effect of soil polarization.*Mysore J.Agric.Sci.* **38** (4):509-513.

Standifer, L. O., Wilson, P. W. and Sorbewt, R. P. (1984). Effect of soil solarization on soil weed seed population. *Weed Sci.*. **32** (5) : 569-573.

Stapleton, I.I. (1991). Soil solarization in tropical agriculture for pre and post- plant applications. FAO Plant Production and Protection, Paper, No. **109** : 222-228.

Stapleton, J.J. (1997). Modes of action of solarization and biofumigation., 2nd Int. Council. Soil Solarization and Integrated Management of Soil borne pests. 16-21st March, Neppo, Syria.

Stapleton, J.J. and Devay, J.E. (1984). Thermal components of soil solarization as related to change in soil and root micro flora and increased plant growth response. *Phytopath.* **73** : 1429-1436.

Stapleton, J.J. and Devay, J.E. (1986). Soil solarization: A new non chemical approach for management of plant pathogens and pests. *Crop Prot.* **5** : 190-198.

Stapleton, J.J. Ferguson, L. and Mickenry, M.V. (1997) Comparison of solarization techniques to disinfest soil for containerized nursery production. In : Proc. 2nd Int. Cong on Soil borne pests, 16-21 March, Aleppo, Syria, pp. 7.

Stapleton, J.J. and Garza-Lopez. J.G. (1988). Mulching of soils with transparent and black polyethylene films to increase growth of annual and perennial crops in South Western Mexico. *Tropical Agriculture.* 65 : 29-33.

Stapleton, J.J., Quick J. and Devay, J.E. (1985). Soil solarization effects on soil properties. Crop fertilization and plant growth. *Soil Biol. Biochem.* **17** : 369-373.

Steel, R. G. D, and Torrie, J. H.(1982): Principles an d procedures of statistics, Mc Graw Hill -Book Company, New Delhi.

Sumachnanrika, D.,Venkteswarlu B., Aubbaaiah,G.and Swarajyalaxmi,G. (2003). Relative efficiency of soil solarization and herbicide for weed control in *kharif* black gram. Indian J. weed Sci. **35** (1&2) : 139-140.

Sundari, A. and Sureshkumar, S.M. (2003). A non-pesticidal cultural method for controlling weed in groundnut-soil solarization. *Crop-Res.* **26** (3): 429-431.

Sundari, A.and Sureshkumar, S.M. (2005). A non-pesticides cultural method for controlling weed in irrigated groundnut-soil solarization. National Biennial conference ISWS., P.A.U., Ludhiana, April6-9.

Sztejnberg, A. Freeman, S, Chft, I. and Katan, L. (1987). Control of *Rosellinia nectatrixin* soil and in apple orchard by solarization, *PI. Disease.* **71** : 365-369.

*Tamietti, G. and Garibaldi, A. (1989). The use of solarization against *Rhizoctonia solani* under green house conditions in Liguria. Informatore Fito pathologico..**39** : 43-45.

Tank, U. N. (1993). Comparative efficacy of fluaziop-p-ethyl on spectrum of weeds in groundnut and its residual effect on succeeding crop wheat . Ph. D. Thesis, GAU, S.K.Nagar.

Tokgonol. S., Cinar. S. and Rudolpi L K. (1997). The effect of soil solarization on bacterial canker of tomato in the \1editcr Taneall region of Turkey. In. Proc. Ind. Int. Conf. Soil Solarization and Integrated Management of soil-borne pests, 16-21 March, Aleppo. Syria.

Verma, S.P. and Mudgal, S.C, (1983). Production potential and economics of fertilizer a as resource constrains in maize-wheat sequences, *Himachal Journal of Agricultural Research.* 9 (2) : 89-92.

Vizatntinopoulos,S., Katranis. N. (1993). Solarization in Greece. *Weed Res.* **33** : 225-230.

Yaduraju, N.T and Ahuja, K.N. (1990). Weed control through soil solarization. *Indian J. Agron.***35** (4) : 440-442.

Yaduraju, N.T (1993). The role of soil solarization in weed management. In. proc. Int. Sym., Indian Society of Weed Sciences, Hissar.**Vol. I** : 343-349.

Yaduraju, N.T. and Kamra, A. (1997). Soil solarization- A novel non- chemical method of pest control. In Ecological Agriculture and Sustainable Development. *Indian Ecological Society,* Chandigarh, **2** : 189-20.

APPENDICES

Appendix I: Soil temperature (^{0} C) at 5 cm soil depth as influenced by soil solarization treatments

Treatments	5 DAPS		10 DAPS		15 DAPS		20 DAPS		25 DAPS		30 DAPS		35 DAPS		40 DAPS		45 DAPS	
	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
T_1 : TPE 0.025 mm 15 days	48.3	48.2	51.6	46.2	53.3	49.0												
T_2 : TPE 0.025 mm 30 days	49.3	49.1	52.5	46.9	53.5	49.3	51.5	51.8	51.5	52.9	53.5	52.4						
T_3 : TPE 0.025 mm 45 days	49.9	50.1	52.8	47.65	54.5	50.3	53.3	53.9	53.2	53.9	55.4	55.0	55.9	57.3	52.9	57.4	55.4	556
T_4 : TPE 0.050 mm 15 days	46.6	45.9	49.0	44.2	51.1	48.5												
T_5 : TPE 0.050 mm 30 days	47.5	46.1	49.5	44.4	51.7	49.0	51.1	51.0	50.9	50.8	52.2	51.6						
T_6 : TPE 0.050 mm 45 days	47.5	43.3	51.6	44.9	52.4	49.5	51.8	52.5	52.0	52.3	52.8	52.8	52.8	56.4	49.9	55.5	52.9	54.6
T_{10} : Weedy check	41.8	41.9	42.0	38.8	46.3	40.7	41.8	42.0	43.5	44.3	46.0	45.3	46.9	47.2	44,5	47	47.5	47.5
S.Em $\pm$	0.49	0.63	0.54	0.41	0.47	0.51	0.60	0.46.	0.41	0.39	043	054	0.56	0.69	0.54	0.65	0.57	0.54
CD at 5%	1.42	1.93	1.55	1.19	1.36	1.47	1.75	1.34	1.22	1.17	1.26	1.57	1.64	2.0	1.56	1.87	1.66	1.58
CV%	2.74	4.05	3.08	2.61	1.87	2.21	2.55	1.96.	1.98	1.81	1.82	2.21	2.36	2.85	2.29	2.68	2.35	2.24

DAPS = Days after polyethylene spreading
TPE =Transparent polyethylene

Appendix II. Soil temperature (^{0} C) at 10 cm soil depth as influenced by soil solarization treatments

Treatments	5 DAPS		10 DAPS		15 DAPS		20 DAPS		25 DAPS		30 DAPS		35 DAPS		40 DAPS		45 DAPS	
	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05	2003-04	2004-05
T_1 : TPE 0.025 mm 15 days	46.2	46.0	44.8	45.8	48.0	45.60												
T_2 : TPE 0.025 mm 30 days	47.1	47.0	45.0	46.9	49.0	46.9	50.2	51.1	51.7	51.0	50.7	51.4						
T_3 : TPE 0.025 mm 45 days	48.3	48.1	47.8	48.1	49.9	47.7	51.6	51.6	53.0	52.6	53.0	53.3	5.15	55.20	51.0	55.1	51.7	53.4
T_4 : TPE 0.050 mm 15 days	45.9	44.8	43.6	44.9	49.9	47.7												
T_5 : TPE 0.050 mm 30 days	46.8	45.9	44.9	46.2	48.3	45.8	49.2	50.1	50.4	50.3	50.1	51.3						
T_6 : TPE 0.050 mm 45 days	47.1	46.9	45.7	46.8	49.7	46.0	49.8	51.6	51.0	50.8	51.0	52.0	50.1	53.5	48.9	53.6	50.4	51.8
T_{10} : Weedy check	39.1	40.2	40.2	41.3	40.9	38.6	41.8	41.4	13.9	42.1	42.0	44.1	42.7	44.8	10.3	45.7	42.7	45.0
S.Em ±	0.38	0.39	0.40	0.40	0.52	0.41	0.46	0.41	0.50	0.47	0.51	0.46	0.47	0.41	0.47	0.48	0.45	0.48
CD at 5%	1.11	1.13	1.15	1.15	1.51	1.19	1.33	1.19	1.46	1.38	1.47	1.33	1.38	1.19	1.37	1.39	1.31	1.38
CV%	1.76	1.99	1.82	1.80	2.33	1.91	2.07	1.84	2.24	2.12	2.28	2.04	2.13	1.79	2.17	2.10	2.06	2.11

DAPS = Days after polyeth2.28ylene spreading
TPE =Transparent polyethylene

II

Appendix- III Soil moisture (%) at 0-15 cm and 15-30 cm depth of soil as influenced by soil solarization treatments

Treatments	15DAPS				30 DAPS				45 DAPS			
	2003-04		2004-05		2003-04		20004-05		2003-04		20004-05	
	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
T_1 : TPE 0.025 mm 15 days	5.93	5.70	6.63	6.18								
T_2 : TPE 0.025 mm 30 days	6.30	6.40	6.88	6.68	6.18	5.80	6.56	6.40				
T_3 : TPE 0.025 mm 45 days	6.53	5.58	6.95	6.75	6.35	5.80	6.80	6.60	5.60	5.50	6.23	6.08
T_4 : TPE 0.050 mm 15 days	6.33	6.00	6.80	6.55								
T_5 : TPE 0.050 mm 30 days	6.70	6.88	7.30	7.03	6.13	6.25	6.98	6.70				
T_6 : TPE 0.050 mm 45 days	7.00	7.23	7.95	7.25	6.70	6.75	7.10	6.95	5.90	5.55	6.38	6.13
T_{10} : Weedy check (control)	3.27	3.02	4.20	3.83	2.63	2.53	3.78	03.50	2.20	2.10	2.98	2.75
S.Em ±	0.20	0.19	0.18	0.17	0.15	0.15	0.17	0.17	0.13	0.10	0.19	0.17
CD at 5%	0.57	0.52	0.52	0.50	0.45	0.42	0.49	0.49	0.38	0.30	0.55	0.50
CV%	8.58	7.45	7.04	7.14	7.26	7.01	7.66	6.78	7.35	6.06	8.48	8.05

TPE :Transparent polyethylene
DAPS : Days after polyethylene spreading

Appendix- IV Analysis of variance (M.S.S.) for different character of groundnut crop (pooled)

Sr No.	Character	Replication (6 d.f.)	Year (1d.f.)	Treatments (9 d.f.)	Year x Treatments (9 d.f.)	Pooled error (54 d.f.)
1	Organic carbon in soil after SS	0.24	0.39	1.48	01.11	0.03
2	Available nitrogen in soil after SS	172.91	585.90	1249.55	78.99	114.25
3	Available phosphorus in soil after SS	8.43	19.31	670.99	3.71	4.44
4	Available potash in soil after SS	2739.58	75.08	2148.04	64.14	301.31
5	Available sulphur in soil after SS	0.28	1.62	37.16	0.32	0.20
6	Available iron after SS	0.89	3.35	2.96	0.48	0.24
7	Available manganese after SS	4.94	2.62	2.37	0.14	0.32
8	Available zinc after SS	0.04	0.00	0.16	0.02	0.05
9	Available copper after SS	0.00	0.03	0.02	0.00	0.09
10	Grasses weed count 30 DAS	0.70	0.03	14.10	0.34	0.14
11	Broad leaved weed count 30 DAS	0.65	0.53	8.12	0.09	0.09
12	Sedge weed count 30 DAS	0.20	0.03	14.37	0.47	0.10
13	Total weed count 30 DAS	0.60	0.34	36.02	0.42	0.60
14	Grasses weed count 60 DAS	0.39	4.57	19.90	0.13	0.24
15	Broad leaved weed count 60 DAS	0.49	1.90	11.96	0.21	0.20
16	Sedge weed count 60 DAS	0.34	8.71	17.64	0.19	0.19
17	Total weed count 60 DAS	0.38	14.80	47.30	0.10	0.52
18	Grasses weed count 90 DAS	0.53	7.82	31.39	1.75	0.21
19	Broad leaved weed count 90 DAS	0.25	0.60	12.31	1.00	0.17
20	Sedge weed count 90 DAS	1.82	1.31	10.31	0.44	0.32
21	Total weed count 90 DAS	0.83	8.84	47.89	0.47	0.61

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22	Grasses weed count At harvest	1.21	0.01	31.37	0.47	0.26
23	Broad leaved weed count At harvest	0.29	17.14	10.41	0.54	0.17
24	Sedge weed count At harvest	5.61	46.96	9.61	1.07	0.48
25	Total weed count At harvest	2.17	42.69	44.00	0.79	0.69
26	Grasses weed 30 DAS dry wt.	0.14	0.47	17.69	0.20	0.10
27	Broad leaved weed 30 DAS dry wt.	0.30	0.04	7.21	0.06	0.11
28	Sedge weed 30 DAS dry wt.	0.32	0.24	2.01	0.05	0.08
29	Total weed 30 DAS dry wt.	0.27	0.28	24.27	0.10	0.27
30	Grasses weed 60 DAS dry wt.	035	0.19	14.78	0.10	0.18
31	Broad leaved weed 60 DAS dry wt.	0.08	0.71	7.45	0.03	0.06
32	Sedge weed 60 DAS dry wt.	0.08	0.00	1.56	0.04	0.03
33	Total weed 60 DAS dry wt.	0.27	0.79	21.90	0.17	0.27
34	Grasses weed 90 DAS dry wt.	0.23	0.84	14.96	0.03	0.07
35	Broad leaved weed 90 DAS dry wt.	0.23	0.18	8.77	0.24	0.07
36	Sedge weed 90 DAS dry wt.	0.07	0.56	1.08	0.01	0.07
37	Total weed 90 DAS dry wt.	0.21	0.46	22.56	0.07	0.21
38	Grasses weed At harvest	0.45	0.20	19.67	0.02	0.11
39	Broad leaved weed At harvest	0.27	0.01	7.07	0.08	0.08
40	Sedge weed At harvest	0.28	0.04	1.47	0.02	0.04
41	Total weed At harvest	0.26	0.01	25.85	0.06	0.26
42	Total Weed dry wt.	4.94	24.53	372.25	1.20	0.74
43	Weed control efficiency	164.41	22.52	6798.35	4.45	14.82
44	Weed index	12.84	625.35	3361.58	142.24	6.92
45	Plant height 30 DAS	1.66	107.79	22.56	1.04	0.97
46	Plant height At harvest	212.26	586.01	267.91	5.43	35.79
47	No. of branching 30 DAS	0.43	4.37	2.38	0.14	0.25
48	No. of branching At harvest	0.64	1.69	4.87	0.08	0.37

Cont...

49	No. of leaves 30DAS	0.98	101.30	23.29	1.18	1.84
50	No. of leaves 60 DAS	413.88	775.64	317.41	5.72	48.31
51	No. of leaves 90 DAS	281.58	638.79	223.64	6.43	44.06
52	No. of leaves At harvest	683.93	13.94	435.92	23.47	37.50
53	Leaf area 30 DAS	0.11	0.03	2.58	0.10	0.08
54	Leaf area 60 DAS	24.21	0.46	28.72	1.69	4.19
55	Leaf area 90 DAS	65.36	38.86	32.42	0.59	6.53
56	Leaf area At harvest	39.05	8.63	199.30	1.71	4.88
57	Leaf area index 30 DAS	31.0	7.1	166.2	1.51	3.99
58	Leaf area index 60 DAS	0.04	0.13	0.54	0.01	0.02
59	Leaf area index 90 DAS	0.12	0.22	0.85	0.02	0.06
60	Leaf area index At harvest	0.01	0.26	0.21	0.03	0.01
61	DM of leaves 30 DAS	0.81	35.52	7.72	1.01	0.23
62	DM of leaves 60 DAS	5.68	18.10	43.08	0.41	1.35
63	DM of leaves 90	19.63	43.79	47.91	0.44	3.32
64	DM leaves of harvest	32.81	149.52	88.52	7.65	3.65
65	DM of stem 30 DAS	0.22	131.79	13.37	0.28	0.35
66	DM of stem 60 DAS	7.11	1.34	16.46	0.37	0.79
67	DM of stem 90 DAS	43.29	10.53	26.57	1.08	1.33
68	DM of stem at harvest	1.77	243.46	60.32	2.04	2.60
69	DM of pods 60 DAS	4.69	0.94	10.46	0.38	0.72
70	DM of pods 90 DAS	6.13	32.72	37.10	1.59	1.85
71	DM of pods at harvest	12.65	141.01	60.12	4.17	6.33
72	Total DM 30 DAS	1.79	293.26	41.70	2.18	0.89
73	Total DM 60 DAS	37.13	21.76	192.61	4.74	6.91
74	Total DM 90 DAS	143.13	325.14	318.01	1.31	16.05
75	Total DM at harvest	205.92	838.06	481.38	32.79	14.84

Cont...

76	No. of nodule 60 DAS	59.18	1706.07	760.41	11.28	34.62
77	No. of nodule 90 DAS	493.88	2300.51	1077.76	37.09	96.60
78	Nodule wt. 60 DAS	0.0015	0.002	0.001	0.001	0.001
79	Nodule wt. 90 DAS	0.006	0.001	0.009	0.001	0.001
80	No. of pods	9.04	1140.65	100.55	3.28	4.18
81	Pod weight per plant	3.41	605.55	84.28	8.23	2.38
82	Pod yield	27.12	321.98	254.46	6.50	7.60
83	Haulm yield q ha^{-1}	119.90	1182.38	776.50	18.79	30.76
84	Shelling percentage	93.73	725.89	240.14	19.12	10.31
85	Test weight	13.27	2548.15	147.05	20.90	11.32
86	Kernel yield kg ha^{-1}	44.30	263.98	146.67	3.51	2.12
87	Oil content pooled	7.66	5.67	28.82	0.59	2.56

Appendix- V Analysis of variance (M.S.S.)for different character of potato crop (pooled)

Sr No.	Character	Replication (6 d.f.)	Year (1d.f.)	Treatments (9 d.f.)	Year x Treatments (9 d.f.)	Pooled error (54 d.f.)
1	Grasses weed count 30 DAS	0.22	0.65	7.37	0.21	0.10
2	Broad leaved weed count 30 DAS	0.33	0.76	5.23	0.14	0.10
3	Sedge weed count 30 DAS	0.50	1.47	6.71	0.25	0.21
4	Total weed count 30 DAS	2.10	4.28	52.97	0.80	0.70
5	Grasses weed count 60 DAS	15.28	2.85	39.08	0.94	0.39
6	Broad leaved weed count 60 DAS	0.31	1.69	10.65	0.35	0.18
7	Sedge weed count 60 DAS	0.46	12.43	14.44	0.25	0.30
8	Total weed count at 60 DAS	0.50	0.30	35.07	0.37	0.56
9	Grasses weed count at harvest	0.40	1.94	4.78	0.10	0.21
10	Broad leaved weed count at harvest	0.42	0.02	6.12	1.07	0.21
11	Sedge weed count at harvest	1.97	1.09	8.36	060	0.44
12	Total weed count at harvest	0.38	14.80	47.30	0.10	0.52
13	Grasses weed dry weight 30 DAS	0.10	0.07	1.13	0.10	0.12
14	Broad leaved weed dry weight 30 DAS	0.10	0.02	0.58	0.04	0.05
15	Sedge weed dry weight 30 DAS	0.10	0.10	3.31	0.24	0.08
16	Total weed dry weight 30 DAS	1.17	32.69	34.00	0.37	0.60
17	Grasses weed dry weight 60 DAS	0.16	0.57	2.23	0.01	0.09
18	Broad leaved weed dry weight 60 DAS	0.01	0.03	0.98	0.05	0.03
19	Sedge weed dry weight 60 DAS	0.10	0.43	3.28	0.09	0.05
20	Total weed dry weight at 60 DAS	0.27	0.79	21.90	0.17	0.27

Cont...

21	Grasses weed dry weight at harvest	0.12	1.25	4.94	0.08	0.08
22	Broad leaved weed dry weight at harvest	0.28	0.27	4.01	0.18	0.09
23	Sedge weed dry weight at harvest	0.08	0.27	3.08	0.15	0.06
24	Total weed dry weight at harvest	0.21	0.46	22.56	0.07	0.21
25	Dry weed biomass	3.33	8.94	107.64	0.23	0.27
26	Weed control efficiency	96.58	3.52	647.44	5.93	18.91
27	Plant height 30 DAS	67.61	243.25	56.24	2.59	6.16
28	Plant height At harvest	21.06	24.98	194.76	12.26	21.88
29	No. of leaves 60 DAS	48.22	4.22	496.36	17.31	16.81
30	No. of leaves 90 DAS	94.79	39.33	355.11	6.12	7.91
31	Leaf area 60 DAS	80.56	344.04	3.12	212.97	6.59
32	Leaf area 90 DAS	91.23	482.01	8.13	277.2	8.68
33	Number of tuber per plant	0.52	7.57	3.57	0.04	0.31
34	Tuber weight per plant	5083.6	9533.1	18580.56	125.23	768.82
35	Large size tuber	81.31	22.28	87.94	2.73	2.84
36	Medium size tuber	8.03	1.96	209.48	2.43	41.24
37	Small size tuber	1.00	3.62	2.64	0.18	0.19
38	Total tuber yield	66.83	063	199.99	2.18	5.64
39	Haulm yield	124.09	364.02	462.12	21.76	37.59

Appendix VI: Economics of various treatments in groundnut –potato crop sequences during 2003-04

Treatments	Gross income (Rs ha^{-1})		Total gross income (Rs ha^{-1})	Total cost (Rs ha^{-1})		Gross total Cost (Rs ha^{-1})	Net income (Rs ha^{-1})	CBR
	Groundnut	Potato		Groundnut	Potato			
T_1 : TPE 0.025 mm 15 days	33291	87000	120291	30040	48518	78558	11771	1.53
T_2 : TPE 0.025 mm 30 days	44451	113850	158301	30040	48518	78518	79783	2.01
T_3 : TPE 0.025 mm 45 days	59338	155600	214988	30040	48518	78558	136430	2.73
T_4 : TPE 0.05 mm 15 days	33271	83500	116771	33540	48518	82058	34717	1.42
T_5 : TPE 0.05 mm 30 days	44419	106050	151024	33540	48518	82058	86996	1.84
T_6 : TPE 0.05 mm 45 days	46920	126750	173670	33540	48518	82058	91612	2.11
T_7 : Pendimethalin 1.0 kg ha^{-1} (groundnut) Metrtibuzin 1.0 kg ha^{-1} (potato)	47481	116250	163731	24440	51518	75958	87773	2.15
T_8: Hand weeding 20 & 40 DAS + Earthing up 40 DAS	51970	151450	203420	24980	50403	75383	128037	2.69
T_9 : Weed free	56285	197400	203685	25040	51555	76595	127099	2.65
T_{10} : Weedy check	21506	67400	88906	23040	48518	71558	17348	1.24

Selling price of groundnut pod Rs. 17.00 kg^{-1} and potato tuber Rs. 5.00 kg^{-1}

Appendix VII: Economics of various treatments in groundnut –potato crop sequences during 2004-05

Treatments	Gross income (Rs ha^{-1})		Total gross income (Rs ha^{-1})	Total cost (Rs ha^{-1})		Gross total Cost (Rs ha^{-1})	Net income (Rs ha^{-1})	CBR Groundnut
	Groundnut	Potato		Groundnut	Potato			
T_1 : TPE 0.025 mm 15 days	25792	90720	116512	30747	61028	91777	24775	1.26
T_2 : TPE 0.025 mm 30 days	35095	128040	163135	30747	61028	91777	71358	1.77
T_3 : TPE 0.025 mm 45 days	51813	178560	230373	30747	61028	91777	138576	2.51
T_4 : TPE 0.05 mm 15 days	25602	86700	112302	34635	61028	95663	16639	1.17
T_5 : TPE 0.05 mm 30 days	33475	122640	156115	34635	61028	95663	60452	1.63
T_6 : TPE 0.05 mm 45 days	43618	144960	188578	34635	61028	95663	92915	1.97
T_7 : Pendimethalin 1.0 kg ha^{-1} (groundnut) Metrtibuzin 1.0 kg ha^{-1} (potato)	43689	136500	180189	24370	64537	88907	92627	2.02
T_8: Hand weeding 20 & 40 DAS + Earthing up 40 DAS	45776	172260	218036	24320	63232	87552	130484	2.49
T_9 : Weed free	51724	165780	217504	24970	64581	89551	127953	2.42
T_{10} : Weedy check	20730	67320	88050	22970	61028	83998	4052	1.04

Selling price of groundnut pod Rs. 18.00 kg^{-1} and potato tuber Rs. 6.00 kg^{-1}

CERTIFICATE

This is to certify that I have no objection for supplying to any scientist only one copy of any part of this thesis at a time through reprographic process, if necessary for rendering reference service in library or documentation centre.

(P. P. PATEL)

Place: Sardarkrushinagar
Date : 9th March, 2007


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