RELATIVE EFFICIENCY OF SOLARIZATION AND HERBICIDES FOR WEED CONTROL IN *KHARIF* BLACKGRAM

By

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CERTIFICATE

Ms. **D. SUMA CHANDRIKA** has satisfactorily prosecuted the course of research and that the thesis entitled "**RELATIVE EFFICIENCY OF SOLARIZATION AND HERBICIDES FOR WEED CONTROL IN *KHARIF* BLACKGRAM**" submitted is the result of original research work and of sufficiently high standard to warrant *its presentation* to the examination. I also certify that the thesis or part thereof has not been previously submitted by her for a degree of any university.

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This is to certify that the thesis entitled "**RELATIVE EFFICIENCY OF SOLARIZATION AND HERBICIDES FOR WEED CONTROL IN *KHARIF* BLACKGRAM**" submitted in partial fulfilment of the requirements for the degree of Master of Science in Agriculture in the major field of **AGRONOMY** of the Acharya N.G. Ranga Agricultural University, Hyderabad is a record of the bonafide research work carried out by Ms.**D. SUMA CHANDRIKA** under our guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee.

No part of the thesis has been submitted by the student for any other degree or diploma. The published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly *acknowledged* by the author of the thesis.

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DECLARATION

I, Ms. **D. SUMACHANDRIKA** hereby declare that the thesis entitled **ᶦELATIVE EFFICIENCY OF SOLARIZATION AND HERBICIDES FOR WEED ONTROL IN *KHARIF* BLACKGRAM"** submitted to the Acharya N.G. Ranga gricultural University for the degree of Master of Science in Agriculture in e major field of **Agronomy** is the result of original research work done by e. I also declare that the thesis or any part thereof has not been published arlier in any manner.

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ABSTRACT

Title	:	RELATIVE EFFICIENCY OF SOLARIZATION AND HERBICIDES FOR WEED CONTROL IN *KHARIF* BLACKGRAM
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A *field* experiment entitled "Relative efficiency of solarization and herbicides for weed control in *kharif* blackgram" was conducted at the Agricultural College Farm, Bapatla on clayey soils during *kharif* season of 2001.

The experiment comprising of nine treatments, laidout in randomised block design with four replications. The treatments are Unweeded check (T_1), Weed free (T_2), Soil solarization with 0.05 mm thick transparent polyethylene sheet (T_3), Soil solarization with 0.1 mm thick transparent polyethylene sheet (T_4), Handweeding at 20 days after sowing (DAS) (T_5), Handweeding twice at 20 and 40 DAS (T_6), Benthiocarb @ 0.5 kg a.i. ha^{-1} as pre-emergence application (T_7), Fluchloralin @ 1.0 kg a.i. ha^{-1} as pre-plant incorporation (T_8), and early post-emergence application of imazethapyr

@ 0.1 kg a.i. ha^{-1} (T_9). The test variety of blackgram was LBG-20, released by Regional Agricultural Research Station, Lam, Guntur, Andhra Pradesh.

The results of the experiment indicated that three different groups of weeds viz., grasses, sedges and broad leaved weeds increased upto 45 DAS and decreased at maturity of blackgram crop. In general, the density and drymatter of all groups of weeds was significantly reduced by weed free condition (T_2) followed by handweeding twice at 20 and 40 DAS. Among the herbicides, the total weed density and weed drymatter recorded were lowest with early post-emergence application of imazethapyr @ 0.1 kg a.i. ha^{-1} (T_9) at all the stages of crop growth. The weed control efficiency was maximum with weed free condition (98.0%) followed by handweeding twice at 20 and 40 DAS (93.0%). The two soil solarization treatments viz., T_3 and T_4 recorded weed control efficiencies of 65.0 per cent and 61.0 per cent, respectively.

There was no significant influence of weed control treatments on germination count at seven DAS and crop stand of blackgram at 15 DAS and at maturity.

Plant height and number of branches per plant were higher with weed free condition (T_2) followed by handweeding twice at 20 and 40 DAS (T_6) which was at a par with imazethapyr application @ 0.1 kg a.i. ha^{-1} (T_9). Drymatter production, number of pods per plant and seed yield per plant obtained due to weed free condition were significantly higher followed by handweeding twice at 20 and 40 DAS.

Drymatter production of crop and seed yield were higher in weed free treatment followed by handweeding twice at 20 and 40 DAS. Early post emergence application of imazethapyr @ 0.1 kg a.i. ha^{-1} recorded higher seed yields, compared to the other two herbicide treatments viz., T_7 (Benthiocarb @ 0.5 kg a.i. ha^{-1}) and T_8 (Fluchloralin @ 1.0 kg a.i. ha^{-1}). The two soil solarization treatments T_3 and T_4 were at a par with each other in terms of seed yield. Haulm yield followed the same trend as observed in the case of seed yield.

Lowest weed index (8.3%) was recorded with handweeding twice at 20 and 40 DAS which was at a par with imazethapyr application @ 0.1 kg a.i. ha^{-1} (9.0%). All the parameters of blackgram were more in weed free (T_2) treatment which recorded better growth characters, higher *yield attributes and yield* over other treatments tried whereas handweeding twice at 20 and 40 DAS (T_6) and imazethapyr @ 0.1 kg a.i. ha^{-1} (T_9) were statistically at a par with each other. Lower growth, yield attributes and yield was observed in weedy check treatment.

Among the soil solarization treatments, soil solarization with 0.05mm thick transparent polyethylene sheet (T_3) recorded higher soil temperature *i.e.* 10-12^{0}C over the control, whereas, soil solarization with 0.1 mm thick transparent polyethylene sheet (T_4) recorded 5-8^{0}C increase in soil temperature at all stages of observations.

Thus, the present study clearly indicated that two handweedings at 20 and 40 DAS or imazethapyr application @ 0.1 kg a.i. ha^{-1} was effective for successfully managing the weed interference in *kharif* blackgram. However, on considering economics, fluchloralin @ 1.0 kg a.i. ha^{-1} (BCR-8.46) was found to be a cost effective method of managing weeds in *kharif* blackgram.

LIST OF ABBREVIATIONS

a.i.	:	active ingredient
BCR	:	benefit cost ratio
BPE	:	black polyethylene
^{o}C	:	degree celsius
CD	:	critical difference
cm	:	centimetre (s)
CV	:	coefficient of variation
DAS	:	days after sowing
dSm^{-1}	:	deci siemen per metre
EC	:	electrical conductivity
EC	:	emulsifiable concentrate
g	:	gram (s)
ha	:	hectare
ha^{-1}	:	per hectare
hrs	:	hours
kg	:	kilogram (s)
km	:	kilometre
L	:	litre
m	:	metre
m^2	:	square metre
m^{-2}	:	per square metre
mm	:	millimetre (s)

NS	:	not significant
q	:	quintal
quintal^{-1}	:	per quintal
R.H	:	relative humidity
SEm	:	standard error of mean
spp	:	species
TPS	:	transparent polyethylene sheet
µm	:	micro metre
WSL	:	water soluble liquid
@	:	at the rate of
%	:	per cent
$\sqrt{\ }$	:	square root of

Introduction

CHAPTER I

INTRODUCTION

Pulse crops play an important role in Indian agriculture. Pulses are rich in protein and sustain the productivity of cropping systems. Their ability to use atmospheric nitrogen through biological nitrogen fixation is economically more sound and environmentally acceptable. Pulses account for one fifth of the total area under food grain crops and contribute 1/12th of the total food grain production in the country. The area under pulse crops at present is *22.5 million hectares* with a production of 13.2 million tonnes and productivity about 587 kg ha^{-1} (Agri India Green Pages, 1999).

Blackgram is an important pulse crop in Andhra Pradesh, cultivated both in *kharif* and *rabi* seasons. It is cultivated in an area of 4.30 lakh hectares producing 2.62 lakh tonnes with an average productivity of 609 kg ha^{-1} (Economics and Statistical Bulletin, 1999).

Among the annual agricultural crop loss in India, weeds account for 45 per cent, insects 30 per cent, diseases 20 per cent and others 5 per cent. The magnitude of losses due to weeds in blackgram has been reported to the extent of 50 per cent (Vats and Sawhney, 1981). The emergence and rapid growth of weeds leads to severe crop weed competition for all natural resources, especially, during the early stages of crop growth

Weed competition is a serious factor limiting the yield of blackgram, especially during *kharif* season. Different methods of weed control like physical, cultural, chemical were suggested in blackgram.

Hand pulling is the physical removal or pulling out of weeds by hand and it is very effective against annual and biennial weeds, as they do not regenerate from pieces of roots left in the ground. Handweeding is very economical where, weeds are scattered around, that makes the herbicide use uneconomical or when the herbicides are not effective on a particular weed species. Although cultural methods of weed control are still in practice. their high cost and non availability of labour at the right time and prevailing wet soil conditions during rainy season make the farmer to look for an alternative cheaper and easier methods. Chemical weed control assumes importance under such situations (Gupta, 1993).

Herbicides control weeds even before they emerge from the soil so that crops can germinate and grow in completely weed free environment during their tender, seedling stage which is not possible with physical weed control measures.

Soil solarization is a new soil disinfestation method of controlling soil borne pathogens and weeds, mostly as a pre planting soil treatment. It is achieved by covering the soil with polyethylene sheets during the hot season, thereby heating the soil and killing the pests.

The primary effect of solarization is the increase in soil temperature. Results of the experiments conducted in India and abroad shows that solarization increases the soil temperature by 3 to 18°C over non solarized soil (Chen and Katan, 1980; Fahim *et al.*, 1987 and Lodha *et al.*, 1991) Soil solarization is comparatively cheap, easy and environment eco-friendly weed control technology and it can be employed in agriculture with success. This is a non chemical method which is not hazardous to the user, to the host plant, or to other organisms. It is quite cost effective and have a long term effect. The polyethylene sheet is durable and can be used for more than one season.

In view of the gaining importance of solarization and herbicides for weed control, the present investigation was planned and executed during *kharif* 2000-2001 at the Agricultural College Farm, Bapatla, to study the "Relative efficiency of solarization and herbicides for weed control in *kharif blackgram*" with the following objectives.

1. To study the efficiency of soil solarization and herbicides on weed dynamics in blackgram.

2. To study the impact of various weed control treatments on growth and yield of blackgram crop.

3. To find out a suitable method of weed control in blackgram during *kharif* season.

Review of Literature

CHAPTER II

REVIEW OF LITERATURE

A field experiment was conducted during *kharif* 2000 at Agricultural College Farm, Bapatla to study the effect of different weed management practices on blackgram crop. A brief review of the literature pertaining to weed management in *kharif* blackgram in particular, and other related crops in general, are presented in this chapter.

2.1 WEED FLORA OBSERVED IN BLACKGRAM CROP

Weed species associated with a crop mostly depends upon the soil type, agroclimatic conditions, competing ability of crop and crop management practices.

The weed species that were most commonly found to infest the blackgram crop includes *Dactyloctenium aegyptium*, *Echinocloa colonum* among grasses, *Cyperus rotundus* among sedges and *Trianthema portulacastrum, Amaranthus viridis, Celosia* spp. and *Euphorbia hirta* among broad leaved weeds (Jayakumar *et al.*, 1985; Mohammed Ali and Durai 1987).

Raghavani *et al.*, (1987) conducted an experiment in medium black soils of Junagadh, Gujarat state and reported that important weed flora in blackgram field were *Amaranthus viridis, Convolvulus arvensis, Portulaca oleraceae, Physalis minima, Eclipta prostrata* and *Vernonia cinerea* among the dicots and *Panicum colonum*, *Cyperus rotundus*, *Cyanodon dactylon* among the monocots.

Venkateswarlu *et al.* (1988) reported that *Trianthema portulacastrum*. *Cyperus rotundus*, *Euphorbia hirta*, *Phyllanthus niruri*, *Acalypha indica*. *Eragrostis minor* were the dominant weeds of blackgram grown on clayloam soils of Bapatla in Andhra Pradesh.

Singh *et al.* (1992) summarised the weed flora in blackgram fields and reported that *Cyperus rotundus*, *Commelina benghalensis*, *Setaria glauca*, *Digera muricata*, *Acalypha indica* were the dominant weeds in blackgram cultivated in *kharif* season.

Hooda *et al.* (1993) reported that *Echinocloa colonum*, *Dactyloctenium aegyptium*, *Trianthema portulacastrum*, *Phyllanthus niruri*, *Digeria arvensis* and *Amaranthus viridis* were the important weeds of blackgram in .sandyloam soils of Hissar.

Mishra and Singh (1993) reported that *Echinocloa colonum*, *Cyperus rotundus*, *Cleome viscosa*, *Celosia argentia*, *Cucumis trigonus*, *Eleusine indica* and *Physalis minima* were the major weed flora in blackgram crop in a sandyloam soils of Pantnagar in Uttar Pradesh.

Ramanathan and Chandrasekharan (1998) at Coimbatore in Tamil Nadu studied the weed flora in blackgram crop and found that *Trianthema portulacastrum* in dicots, *Cyanodon dactylon* and *Cyperus rotundus* in monocots.

The major weeds in blackgram fields were *Cyperus rotundus, Eragrostis* spp. *Echinocloa crusgalli,Digera muricata, Commelina benghalensis, Euphorbia hirta* and *Portulaca oleracea* in sandyloam soils at Morena in Madhya Pradesh. (Yadav and Shrivastava, 1998).

2.2 YIELD LOSSES CAUSED BY WEEDS

Estimated losses due to weeds exceed losses from any other pest or disease in crop production. Among the annual agricultural loss in India, weeds account for 45 per cent, insects 30 per cent, diseases 20 per cent and others 5 per cent (Reddy, 1999).

The world food loss due to weeds is estimated to be 287 million tonnes accounting for 11.5 per cent of the total food production (Parker and Fryer, 1975).

Yield losses caused by weeds in blackgram varied from 77 to 87 per cent (Indu Mehta and Bonlia, 1980; Govindra Singh *et al.*, 1982 and Kumar and Singh, 1985).

However, most of the reports indicated that the yield losses caused by the weeds were to the extent of 50 per cent (Vats and Sawhney, 1981).

The experiments conducted at various locations under All India Coordinated Pulse Improvement Project (1985) indicated that yield losses due to weeds in blackgram were 58 per cent while De and Modak (1994) reported that yield reduction caused by weeds in blackgram was upto 38 per cent.

2.3 CRITICAL PERIOD OF CROP WEED COMPETITION IN BLACKGRAM

The emergence and rapid growth of weeds lead to severe crop-weed competition during the early stages of crop growth for getting maximum seed yield of blackgram. It was suggested that the crop should be kept weed free upto four weeks after sowing (Vats and Sawhney, 1981).

Several experimental results from different locations indicated that the critical period for crop weed competition was in the initial 10-45 days after sowing (Mohammed Ali and Durai, 1987; Gogoi *et al.*, 1992; Yellamanda Reddy and Sankara Reddy 1992; Saraswat and Mishra 1993 and De *et al.*, 1995).

Meylemans *et al.* (1994) reported that the most sensitive period for weed competetion was between 3 and 6 weeks after sowing while Jain *et al.* (1997) observed that 20 to 40 days after sowing was the critical period of weed competition in blackgram.

2.4 WEED MANAGEMENT

Different methods of weed management such as solarization, manual weeding and herbicides and their effect on blackgram and associated weeds was studied at different locations of the country. The most relevant and important findings are reviewed hereunder.

2.4.1 Soil Solarization

Soil solarization is a method of heating moist soil by covering it with plastic sheets to trap the solar radiation.

Solar heating involves the use of heat as a lethal agent for pest control through the use of tarps for capturing solar energy by means of transparent polyethylene soil mulches. Transparent polyethylene was found to be more efficient than the black film in weed control. Existing weed population in the field were diverse including species that may differ in heat sensitivity. In general most of the annual and perennial weeds were effectively controlled by soil solarization (Ajay Arora, 1998).

Chauhan *et al.* (1988) reported a marked decrease in annual weeds in chickpea and pigeonpea due to soil solarization.

Powles *et al.* (1988) observed more effective weed control in South Australia in *Phaseolus vulgaris* through 21 days solarization treatment compared to pre emergence application of chlorthal @ 4.5 kg ha^{-1}. Mulching with transparent polyethylene sheets of two different thicknesses 0.1mm and 0.5mm each tried at different durations i.e 30 and 60 days in groundnut showed significant reduction in weed count and drymatter of weeds (Biradar *et al.*, 1997).

2.4.2 **Manual Weeding**

Handweeding is the most common method of weed control in India for majority of crops. Maximum grain yield of blackgram was achieved by removal of weeds at 21 days after sowing and it was more effective in controlling the weeds (Bisen *et al.*, 1981). Gogoi *et al.* (1991) noted that handweeding twice at 20 and 40 DAS was more effective in controlling weeds in blackgram and comparable with fluchloralin application @ 1.5 kg a.i. ha^{-1} as pre planting incorporation. Handweedings at 20 and 40 DAS and the application of 1 kg fluchloralin were the most effective measures in controlling major weed flora and produced highest yields (Jain *et al.*, 1997).

Ramanathan and Chandrasekharan (1998) conducted an experiment at Coimbatore in Tamil Nadu to identify the suitable weed management techniques in Urdbean during *kharif* season. They observed that two handweedings (1st at 15 DAS and 2nd at 35 DAS) successfully controlled the weeds and resulted in better performance of blackgram crop.

2.4.3 **Chemical Weed Control in Blackgram**

Herbicides are not aimed at substituting physical, biological or good crop husbandry methods of weed control. But they are meant mainly for bridging the gaps in these methods as added production tools in agriculture.

Herbicides reduce the number of tillage operations as well as critical timing needed for such operations, particularly at planting. These chemicals reduce the amount of human effort expended in human weeding. Weeds that are not economically controlled by other methods frequently can be controlled effectively and at relatively low cost with herbicides.

2.4.3.1 **Benthiocarb**

It is a pre-emergence and early post-emergence herbicide used for the control of many annual grasses and broad leaved weeds.

Benthiocarb, a derivative of thiocarbamic acid is an active herbicide that can easily penetrate into the plants and move through xylem. It cause cessation of cell division and plant tissue growth. Germinating weeds, not more than one leaf stage, are most susceptable to this herbicide. Its mobility in soils is low.

Residues of high rates of application of benthiocarb @ 1.0-1.5 kg a.i. ha^{-1} and pendimethalin @ 0.75-1.25 kg a.i. ha^{-1} applied to rice crop suppressed the weeds and resulted in best yields of succeeding pulse crops (Ramamoorthy and Ali, 1988).

Jammejai Sharma (1993) conducted an experiment in sandyloam soils at Regional Research station, Bajaura to evaluate herbicides in peas (*Pisum sativum* L.) in Himachal Pradesh. Benthiocarb applied as pre emergence @ 1.5 kg a.i. ha^{-1} was found as effective as handweeding in controlling weeds and increasing the yield over other treatments.

Bharathi *et al.* (1998) conducted an experiment in sandyloam soils of Bapatla during *kharif* season to study the effect of benthiocarb on yield and yield attributes on blackgram. She reported that SK-1-1 genotype of blackgram recorded the highest seed yield with benthiocarb as pre-emergence application which was on par with handweeding.

2.4.3.2 **Fluchloralin**

Fluchloralin is a dinitroaniline group herbicide having low water solubility and some what volatile. This is used for selective weed control as a pre-plant soil incorporation treatment prior to seed sowing

(Ashton and Crafts, 1981). It controls many weeds like *Cyperus rotundus*, *Digera muricata, Euphorbia hirta, Portulaca oleracea* (Yadav and Shrivastava, 1998).

Soni and Harbans Singh (1988) conducted an experiment on blackgram crop in *kharif* season in sandyloam soils of Jammu. Two handweedings at 15 and 35 days after sowing and fluchloralin 1 kg ha^{-1} pre-plant incorporation in soil recorded higher seed yield and were at par.

Kant *et al.* (1989) conducted an experiment on sandyloam soils of Haryana to study the effect of weed control methods on yield of urdbean Fluchloralin @ 1.0 kg a.i. ha^{-1} incorporated pre sowing resulted in increased yields of blackgram.

A field experiment was conducted at Morena, in Madhya Pradesh during the rainy season on sandyloam soils by Yadav and Shrivastava (1998). They reported that fluchloralin @ 1.25 kg a.i. ha^{-1} (pre-plant incorporation) + 1 handweeding gave significantly higher seed yield over unweeded control.

2.4.3.3 **Imazethapyr**

It belongs to imadazolinone group. It kills weeds by inhibiting the enzyme aceto hydroxy acid synthase which is involved in the synthesis of three branched-chain aliphatic amino acids : isoleucine, leucine and valine. This inhibition causes a disruption in protein synthesis which leads to an interference in DNA synthesis and cell growth. It is readily absorbed through roots and foliage and is translocated through xylem and phloem to the growing points where it accumulates. It is a highly selective herbicide, applied as pre-emergence or early post-emergence (Pandey, 1989). Leguminous crops like groundnut, peas, lentil, pulses soybean show good tolerance to this herbicide application.

Imazethapyr was tested for woolly cup grass (*Erichloa villosa*) in soybeans in 1986 at Sun Prairie, Winconsin. The best treatment tested was 0.1 kg a.i. ha^{-1} of imazethapyr applied at early post emergence which gave good control of *Erichloa villosa* (Schuh and Harvey, 1986).

Imazethapyr effectively controls weeds like *Trianthema portulacastrum, Digitaria adscendens, Leptochloa panicea, Dactyloctenium* spp., *Cyperus rotundus* and *Fimbristylis* spp. (Pandey, 1989).

Chin and Pandey (1991) reported better control of weeds (*Trianthema* spp. *Digera muricata, Portulaca oleraceae, Phyllanthus niruri, Celosia argentina, Leptochloa sinensis* and *Digitaria sanguinalis*) when imazethapyr was applied at 0.075 kg a.i. ha^{-1} in blackgram crop at IARI, New Delhi.

Canevari *et al.* (1989) reported that best yields and good grass control was obtained through application of imazethapyr in Alfalfa at California. Imazethapyr applied at 0.14 kg a.i. ha^{-1} as pre-emergence gave 80 per cent more weed control compared to post-emergence herbicides like chlorimuron and fosmesafen in soybeans (Johnson and Talbert, 1989).

Imazethapyr at 0.15 kg a.i. ha^{-1} was reported to be superior to pre emergence application of pendimethalin at 1.0 and 2.0 kg a.i. ha^{-1} in reducing weed population in blackgram at Kalyani, West Bengal (Das *et al.*, 1990).

Billore *et al.* (1998) reported that imazethapyr @ 0.1 kg a.i. ha^{-1} applied as post-emergence was effective in controlling weed population compared to herbicides like alachlor, trifluralin and pendimethalin.

2.5 WEED COUNT AND WEED DRY WEIGHT

2.5.1 Soil Solarization

Soil solarization for a period of 10 weeks controlled perennial weeds like *Cyperus rotundus, Sorghum halapense* and *Cynodon dactylon* effectively at Jerusalem (Rubin and Benjamin, 1983).

Soil solarization for 4 to 6 weeks in cool season crops controlled the emergence of winter annual weeds like *Digitaria sanguinalis, Echinocloa crusgalli, Chenapodium album, Amaranthus retroflexus* and *Solanum nigrum* (Elmore, 1983).

Katan (1984) reported reduced population of *Avena* spp *Chenapodium album* and *Sorghum halapense* by 60-100 per cent in cotton fields of Israel.

Cartia (1987) observed that solarization reduced the total weed seeds in the field by 80 per cent and that of *Amaranthus* spp. alone by 100 per cent. Patel *et al.* (1980) reported that soil solarization decreased the number of weeds by 77 per cent and weed dry weight by 60 per cent over control in tobacco at Anand, Gujarat.

Mulching with 100 μm thick polyethylene sheet for 30 days followed by irrigation reduced grass weed population by 67 per cent as reported by

Yaduraju and Ahuja (1990) at IARI, New Delhi. The better effect of polyethylene mulching of wet soil may be due to higher heat conduction of wet soil and greater sensitivity of imbibed weed seeds to heat.

Elmore (1983) reported that *Convolvulus arvensis* was effectively controlled by solarization and supressed for 2-3 weeks afterwards, while population of *Cyperus esculentus* was reduced by 40 per cent. Th reduction in weed count and weed dry weight was more due to 0.05 mm transparent polyethylene sheet than 0.1 mm transparent polyethylene sheet in reducing the emergence of weeds and dry weight. The drastic reduction in weed count and weed dry weight achieved by TPS 0.05 mm on wet soil weight be due to death or damage to weed seeds present in the soils to a greater extent (Biradar *et al.*, 1997).

2.5.2 **Fluchloralin**

Sharma and Rajkhowa (1988) found that pre-emergence application of fluchloralin @ 1.5 kg a.i. ha^{-1} resulted in effective control of grasses and sedges in blackgram.

Soni and Singh (1988) reported that handweeding twice at 15 and 35 days after sowing (DAS) and pre-emergence application of fluchloralin @ 1 kg a.i. ha^{-1} has substantially reduced the weed population and dry weight of weeds in blackgram at Jammu.

Chin and Pandey (1991) recorded that fluchloralin @ 1.0 kg a.i. ha^{-1} in blackgram significantly lowered the total weed population. Fluchloralin

@ 1.25 kg a.i. ha^{-1} produced significantly less dry weight compared to oxyfluorfen and isoproturon in blackgram (Yadav and Shrivastava, 1998).

2.5.8 **Imazethapyr**

Das *et al.* (1990) conducted an experiment in blackgram at Kalyani, West Bengal and reported that imazethapyr application @ 0.15 kg a.i. ha^{-1} was superior in reducing weed populations and weed dry weight over oxyfluorfen and pendimethalin applied as pre-emergence at 0.2 and 2.0 kg a.i. ha^{-1} respectively.

Billore *et al.* (1998) showed that application of imazethapyr @ 0.1kg a.i. ha^{-1} at post-emergence was more effective in controlling weed population in groundnut at NRCS, Indore.

2.5.9 **Weed Control Efficiency**

The weed control efficiency denotes the relative efficiency of weed control practices compared to the unweeded check and is calculated based on weed population or dry weight.

Raghavani *et al.* (1987) conducted an experiment on *kharif* blackgram in medium black soils of Junagadh, Gujarat to test the efficacy of different herbicides in combination with cultural methods for controlling weeds. Highest weed control efficiency of 94.9 per cent was recorded with interculturing at 20 and 40 DAS followed by handweeding.

According to Gogoi *et al.* (1991) the highest weed control efficiency (98.7%) was obtained with two handweedings at 20 and 40 DAS followed by fluchloralin application @ 1.5 kg a.i. ha^{-1} at one DAS (78.0%).

Singh *et al.* (1992) observed the maximum weed control efficiency 83.0 percent with one handweeding at 30 DAS in blackgram.

Jain *et al.* (1997) conducted an experiment at Gwalior in *kharif* season blackgram to study the effect of cultural and chemical methods of weed management on weed dynamics and yield of blackgram. Weed control efficiency reported was higher (80.0%) with handweeding twice at 20 and 40 days after sowing followed by pre-plant incorporation of fluchloralin at 1.0 kg a.i. ha^{-1}.

Billore *et al.* (1998) reported that post-emergence application of imazethapyr @ 0.1 kg a.i. ha^{-1} resulted in better weed control efficiency (71.2%).

2.6 GROWTH PARAMETERS OF BLACKGRAM AS INFLUENCED BY DIFFERENT WEED CONTROL TREATMENTS

2.6.1 Plant height

Selvamani and Sankaran (1989) reported that the height of the primary branches in groundnut increase with increasing weed infestation and it was found to be the highest in unweeded control, the probable reason is that the crop in competition with the weeds had to elongate its stem to get sunlight.

Rajendra Singh and Chaudhary (1992) in an experiment conducted on mungbean at Jobner, Rajasthan revealed greater height of the plant with weedy check, followed by pre-emergence application of fluchloralin @ 1.0 kg a.i. ha^{-1} and pendimethalin @ 0.5 kg a.i. ha^{-1} .

Misra and Mishra (1995) observed greater plant height with unweeded control in blackgram compared to the other treatments viz; handweedings twice at 15 and 30 days after sowing and pre-plant incorporation of fluchloralin @ 1.0 kg a.i. ha^{-1} .

2.6.2. **Drymatter accumulation**

2.6.2.1 **Soil solarization**

Soil solarization with transparent polyethylene sheet for 45 days improved the growth in terms of fresh and dry weights of 'Giza-6' onion seedlings at Cairo (Abd Elrazik *et al.*, 1990). Al Raddad *et al.* (1990) reported that shoot fresh weight and drymatter production of squash increased in solarized field soil as compared to control treatment at Amman, Jordan.

Sudha *et al.* (1997) conducted on experiment at UAS, Bangalore to study the effect of soil solarization on weed control in fingermillet nursery beds, in summer season. It was observed that significantly more plant dry weight was recorded with soil solarization treatment for 30 days with transparent polyethylene (2.02 and 2.84 g per plant at 2nd and 4th week after germination respectively) compared to control. This could be due to the fact that the raised temperature of soil on transparent polyethylene had resulted in better weed suppression.

2.6.2.2 **Handweeding**

Singh *et al.* (1992) reported that the maximum drymatter production in blackgram (5.6 g per plant) was recorded with weed free treatment followed by handweeding at 30 DAS (5.3 g per plant) when compared to unweeded check (4.3 g per plant).

2.6.2.3 Fluchloralin

According to Rao and Rao (1988) the maximum fresh weight of blackgram plant was recorded with the application of fluchloralin @ 1.87 kg a.i. ha^{-1} and it was followed by thiobencarb @ 2.0 kg a.i. ha^{-1} to control weeds.

De *et al.* (1994) reported that 1.0 kg each of fluchloralin and alachlor combined with one handweeding resulted in significantly higher biomass of blackgram (147.67 and 145.34 g m^{-2}). He also reported that herbicides were safe to the production of root nodules and produced more nodules than in unweeded control treatment in blackgram. Higher number of effective nodules (25.7 m^{-2}) were recorded with two handweedings at 25 and 45 DAS Increased aeration of rhizosphere in physical weeding may be the reason for production of more effective nodules in blackgram.

2.7 YIELD ATTRIBUTES AND YIELD AS AFFECTED BY WEED MANAGEMENT TREATMENTS IN BLACKGRAM AND OTHER RELATED CROPS

2.7.1 Yield attributes

Selvamani and Sankaran (1989) reported that number of branches per plant were lowest in unweeded control (3.2) and highest in imazethapyr @ 0.1 kg ha^{-1} (5.3) in groundnut crop on red sandy soil at Coimbatore, TNAU.

Maximum number of matured pods per plant was noticed in imazethapyr 0.1 kg ha^{-1} treatment which was 2.8 times more than unweeded control. Efficient utilisation of soil moisture and nutrients by crop and favourable conditions increased the yield components which was reflected on pod yield.

Chin and Pandey (1991) observed the highest number of pods per plant with one handweeding followed by pre-emergence application of imazethapyr @ 0.075 kg ha^{-1} on blackgram at IARI, New Delhi. The number of pods per plant, seeds per pod and test weight (1000 seed weight) were significantly higher with handweeding at 30 DAS followed by pre-plant incorporation of fluchloralin at 1.5 kg a.i. ha^{-1} in blackgram at Sehore, Madhyapradesh (Singh *et al.,* 1992).

Jain *et al.* (1997) revealed that cultural treatments i.e two handweedings (20 and 40 DAS) and fluchloralin @ 1.0 kg a.i. ha^{-1} were found equally more effective in blackgram for obtaining higher number of pods per plant, seeds per pod and seed yield per plant.

Yadav and Shrivastava (1998) recorded higher number of pods per plant with handweeding twice at 15 and 35 DAS followed by pre plant incorporation of fluchloralin @ 1.5 kg a.i. ha^{-1} in blackgram.

2.7.2 **Yield**

2.7.2.1 **Handweeding**

Kant *et al.* (1989) from Haryana reported that handweeding twice at 15 and 25 DAS and handweeding once at 25 DAS resulted in greater seed yields compared with unweeded control. Pendimethalin @ 0.75 kg a.i. ha^{-1} as pre-emergence application and fluchloralin incorporated pre sowing @ 1.0 kg a.i. ha^{-1} also increased the yield.

Jain and Jain (1987) reported that two handweeding resulted in yield increase of 157 per cent in blackgram crop and proved to be more effective than inter row cultivation. Higher seed yields of blackgram at Madhyapradesh with handweeding twice (20 and 35 DAS) followed by pre emergence application of pendimethalin @ 0.75 kg a.i. ha^{-1} was reported by Singh and Singh (1988).

De *et al.* (1995) reported 38 per cent higher seed yields of summer blackgram with handweeding twice at 25 and 45 DAS at West Bengal over the unweeded control.

2.7.2.2 **Soil solarization**

Katan (1981) found an increase in yield by 42-60 per cent and 100-300 per cent in peanut and tomato respectively with soil solarization treatment over control.

Chauhan *et al.* (1988) reported that soil solarization markedly increased the seed yield of pigeonpea and chickpea while Abu Irmalieh (1991) obtained enhanced yields of tomato grown in soils solarized with clear polyethylene mulch (0.08 mm thickness) for 6 weeks.

The increase in seed yield of groundnut over non solarized control was 215 per cent due to 0.05 mm thick transparent polyethylene on wet soil for 60 days. The reduction in weed count and weed dry weight might have resulted in better availability of resources which inturn improved yield components and yield (Biradar *et al.*, 1997). It was further reported that there was no significant difference in yield between transparent polyethlene mulching with thicknesses of 0.05mm and 0.1mm for 30 days.

2.7.2.3 **Fluchloralin**

Soni and Singh (1988) reported that two handweedings and fluchloralin @ 1.0kg a.i. ha^{-1} pre plant incorporation in soil recorded higher seed yields of blackgram over oxadiazon and oxyflourfen applied as pre emergence @ 0.75 kg a.i. ha^{-1} .

Parveen kumar *et al.* (1999) reported 70.16 per cent and 71.0 per cent increase in grain yield during 1994 and 1995 respectively due to application of fluchloralin respectively over weedy check in blackgram crop. They also recorded 36.5 and 37.2 per cent more yield in 1994 and 1995 respectively due to handweeding at 25 days after sowing compared to weedy check. The increase in yield attributes and ultimately grain yield of blackgram in these treatments was made possible under the reduced competition between the crops and the weeds.

2.7.2.4 **Benthiocarb**

Application of pendimethalin and benthiocarb each at 1.5 kg a.i. ha^{-1} applied at pre emergence in pea (*Pisum sativum*) were effective to increase the crop yield (Jammejai Sharma, 1993).

2.7.2.5 **Imazethapyr**

Pandey (1989) reported that pre-emergence application of imazethapyr @ 150 g ha^{-1} resulted in maximum increase in blackgram yield followed by imazethapyr application @ 100 g ha^{-1}.

Das *et al.* (1990) reported higher seed yields of blackgram (1.26 t ha^{-1}) with pre-emergence application of imazethapyr @ 0.15 kg a.i. ha^{-1} over pendimethalin and oxyflourfen applied at pre-emergence @ 2.0 kg a.i. ha^{-1} .

Malik and Townley-Smith (1990) obtained 93, 89 and 44 per cent higher seed yields of pulse crops - *Lens culinans*, *Pisum sativum* and *Vicia sativa* respectively with imazethapyr application over control.

Misra and Mishra (1995) recorded higher blackgram yields with fluchloralin @ 1.0 kg a.i. ha^{-1} + handweeding at 15 DAS due to maintenance of higher number of nodules per plant, pods per plant and seeds per pod compared in weed free condition due to less soil disturbance leading to better conservation of moisture that favoured better nodulation and growth of the crop in dry summer.

Maximum seed yield of soybean at NRCS, Indore was recorded with imazethapyr application (post-emergence) @ 0.1 kg a.i. ha^{-1} which was at par with handweeding twice at 20 and 40 DAS (Billore, et al 1998) because of the non inhibitory beneficial effects of herbicides on soil microbial, soil respiratory and enzymatic activities which control transformation of nutrients.

2.8 EFFECT OF SOIL SOLARIZATION TREATMENTS ON SOIL TEMPERATURE

Katan (1980) observed an increase in typical maximal soil temperature in solarized plots by 8-12^{0}C over the corresponding non mulched plots.

Soil solarization with 100μm transparent polyethylene for 6-8 weeks increased soil temperature by 6-10^{0}C in the 0-20 cm profile (Chauhan *et al.*, 1988).

In a study at Dharwad, the maximum soil temperature increased by 13.80^{0}C , 9.7^{0}C and 1.9^{0}C respectively due to thin TPS (0.025 mm), thick TPS (0.05 mm) and BPE (Emani, 1991) and in another experiment the temperature increased by 9.9^{0}C due to 0.05 mm TPS (Harti, 1991). The increase in soil temperature ranged from 11-14.9^{0}C, 5.0 to 6.7^{0}C and 2.9 to 8.5^{0}C after treatment with TPS of 0.05 and 0.1 mm thickness and BPE of 0.125 mm thickness respectively in wet soil situation over non-solarized treatments in red soils at UAS, Dharwad (Biradar 1997).

Ajay Arora (1998) in sandyloam soils at IARI, New Delhi recorded increase in soil temperature by 9^{0}C due to soil solarization with 0.1 mm thick transparent polyethylene.

Sudha *et al.* (1999) conducted a field study in a red sandyloam soil at Bangalore during summer season to study the efficacy of soil solarization for weed control in chilli and capsicum nursery. Transparent polythylene mulch recorded higher soil temperature of 5.8^{0}C at 5 cm depth after 15 days after spreading. The supremacy of transparent polyethylene in raising soil temperature to higher magnitudes might be due to maximum transmittance of incoming shortwave radiation.

2.9 ECONOMICS

The practical utility of any weed control measure can be judged based on its economic feasibility besides its effective weed control.

Soni and Harbans Singh (1988) in their experiment on blackgram found that the maximum net income (Rs. 3416 ha^{-1}) was obtained with two handweedings at 15 and 35 DAS and closely followed by fluchloralin at 1.0 kg ha^{-1} (Rs.3415 ha^{-1}).

Ramanathan and Chandrasekharan (1998) reported higher net returns with pendimethalin (1.5 kg a.i. ha^{-1}) + 1 handweeding treatment, (Rs.2386 ha^{-1}) in their experiment on blackgram.

Sudha *et al.* (1999) reported higher B:C ratio of 1.82 in chilli and 1.69 in capsicum with transparent polyethylene for 30 days and was followed by transparent polyethylene for 15 days.

Materials and Methods

CHAPTER - III

MATERIALS AND METHODS

A field experiment was conducted at the Agricultural College Farm, Bapatla during the *kharif*, 2000-01 to study the relative efficiency of solarization and herbicides for weed control in *kharif* blackgram. The materials used and methods followed in conducting the experiment are presented in this chapter.

3.1 LOCATION

The experimental site is situated at the Agricultural College Farm, Bapatla which is located at 15°54'N latitude and 80°30'E longitude at an altitude of 5m above mean sea level and about 7km away from the Bay of Bengal.

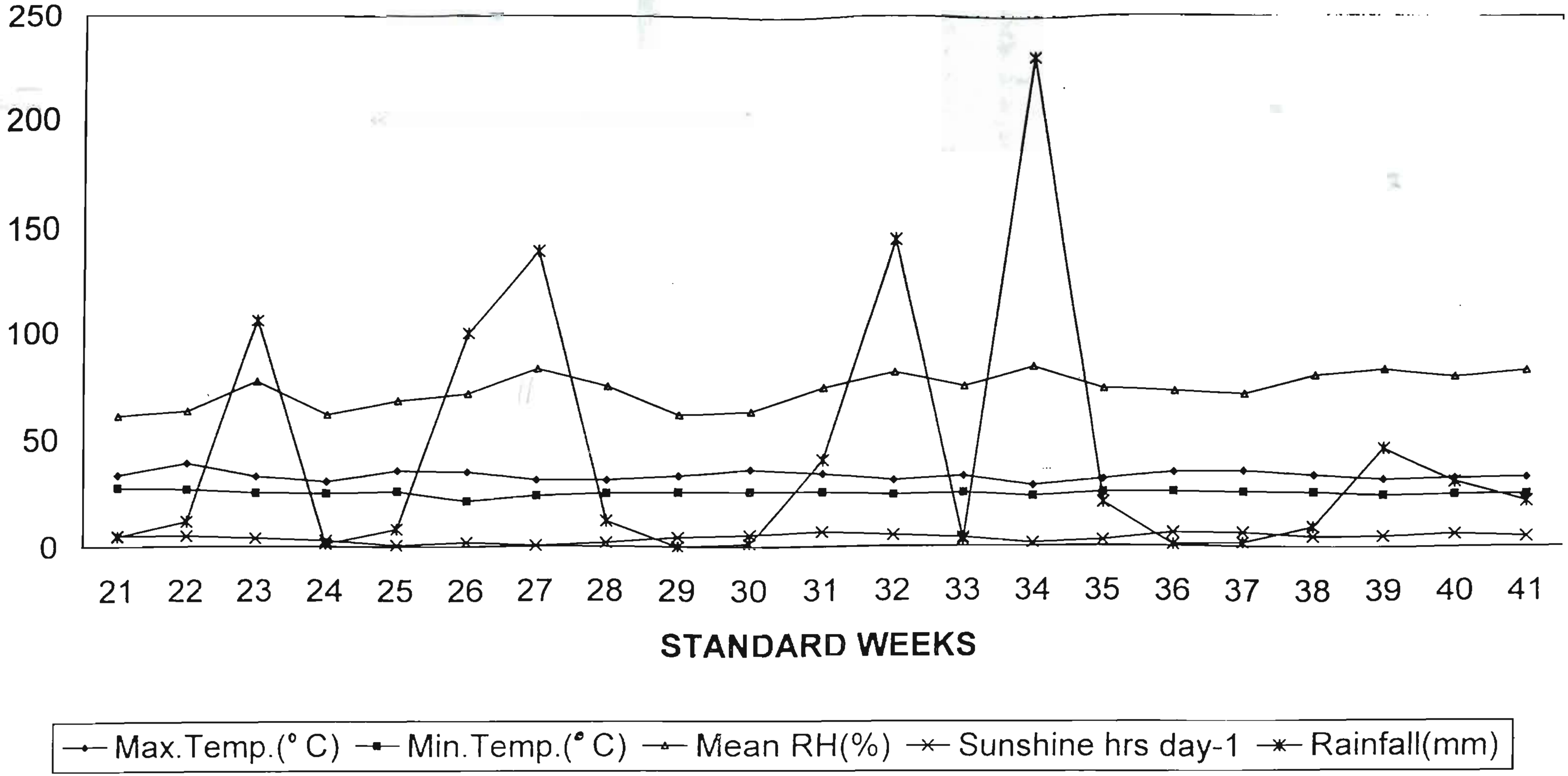
3.2 WEATHER

The weather data during the crop growth period is presented in Table 1. During the crop period the mean maximum and mean minimum temperatures were 33.0°C and 25.1°C, respectively (Fig.1). The maximum temperatures ranged from 28.6°C to 38.7°C and minimum temperatures ranged from 21.4°C to 27.3°C. The mean relative humidity varied between 60.6 per cent to 84.4 per cent Number of sunshine hours during the experimental period ranged from 0.5 to 7.0 . During the period of experimentation a total rainfall of 934.7 mm was received in 35 rainy days.

Table 1. Weather data during the experimentation i.e. *kharif* 2000 (20-05-2000 to 13-10-2000)

Standard meteorological week	Date and month	Mean temperature(°C)		Mean RH(%)	Rainfall (mm)	Sunshine hours per day	Number of rainy days
		Maximum	Minimum				
21	20/5 - 26/5	33.3	27.4	60.6	4.7	5.2	--
22	27/5 - 2/6	38.7	26.7	62.9	11.9	5.1	1
23	3/6 - 9/6	32.8	25.2	77.2	106.4	4.0	4
24	10/6 - 16/6	30.7	25.2	62.0	1.3	3.0	--
25	17/6 - 23/6	35.8	26.3	68.3	8.6	0.87	1
26	24/6 - 30/6	34.9	21.4	71.4	100.1	2.2	5
27	1/7 - 7/7	30.9	23.8	82.6	139.1	0.5	4
28	8/7 - 14/7	31.0	24.8	74.4	12.2	1.85	1
29	15/7 - 21/7	33.3	25.7	61.6	--	4.6	--
30	22/7 - 28/7	36.2	25.9	63.3	1.5	5.7	--
31	29/7 - 4/8	33.8	25.3	74.0	40.2	7.0	1
32	5/8 - 11/8	30.8	24.1	81.0	144.5	5.4	5
33	12/8 - 18/8	33.1	25.3	75.0	3.2	4.3	--
34	19/8 - 25/8	28.6	23.6	84.3	230.4	1.61	4
35	26/8 - 1/9	31.1	25.1	73.2	20.3	2.75	2
36	2/9 - 8/9	34.2	25.3	71.6	1.0	6.4	--
37	9/9 - 15/9	35.0	25.3	70.5	2.0	6.6	--
38	16/9 - 22/9	33.4	25.5	79.6	9.6	5.0	1
39	23/9 - 29/9	31.9	24.6	83.0	46.3	5.4	3
40	30/9 - 6/10	32.3	24.7	79.9	30.7	6.2	1
41	7/10 - 13/10	32.1	24.4	82.2	21.1	4.7	2
	Total	-	-	-	934.7	-	35
	Mean	33.0	25.1	73.3	-	4.21	-

Fig.1 Weekly meterological data during the period of experimentation (20-05-2000 to 13-10-2000)



3.3 SOIL

The experiment was laidout in field number 28 A of the Northern Block The physical and chemical properties of the experimental field are given in Table 2. The experimental site is a clay soil, developed over sandyloam soil. The black soil ranged upto 40-60 cm deep. The soil samples were collected from 0-30 cm depth before conducting the experiment and analysed for the physical and chemical properties.

Mechanical analysis of soil indicated that the soil texture was clay. The chemical analysis of soil indicated that the soil was slightly alkaline in reaction, low in organic carbon, medium in available nitrogen, phosphorus and high in potassium.

3.4 CROPPING HISTORY OF THE EXPERIMENTAL FIELD

The details of the crops grown in the experimental field during the previous years are presented in Table 3.

3.5 EXPERIMENTAL DETAILS

The experiment to study the relative efficiency of solarization and herbicides for weed control in *kharif* blackgram was laid in randomised block design with nine treatments, replicated four times at Agricultural College Farm, Bapatla in field number 28A.

Table 2. **Physical and chemical properties of the experimental soil**

Property	Value (0-30 cm depth)	Method Adopted
Physical Properties		
Sand (%)	34.64	International pipette method (Piper, 1966)
Silt (%)	19.00	
Clay (%)	46.36	
Textural Class	Clay	
Chemical Properties		
pH(1:2.5 Soil water suspension)	7.95	Glass electrode pH meter (Jackson, 1973)
EC (dSm^{-1})	0.60	Conductivity bridge (Richards, 1954)
Organic Carbon (%)	0.65	Wet digestion method (Walkely and Black, 1934)
Available Nitrogen ($kg\ ha^{-1}$)	282.2	Alkaline potassium permanganate Method (Subbiah and Asija, 1956)
Available P_2O_5 ($kg\ ha^{-1}$)	41.0	Olsen's extractant method (Olsen *et al.* 1954)
Available K_2O ($kg\ ha^{-1}$)	565.0	Neutral normal Ammonium acetate method (Jackson, 1973)

Table 3. **Cropping history of the experimental field**

Year	*kharif*	*rabi*	Summer
1997-98	Fallow	Soybean	Fallow
1998-99	Fallow	Greengram	Fallow
1999-2000	Fallow	Bengalgram	Fallow
2000-2001	Present investigation		

3.5.1 DETAILS OF THE TREATMENTS

T_1	-	Control i.e unweeded check
T_2	-	Weed free (Weed free condition maintained by handweeding at weekly interval upto 60 DAS)
T_3	-	Soil solarisation with 0.05mm thick transparent polythylene sheet
T_4	-	Soil solarisation with 0.1 mm thick transparent polyethylene sheet
T_5	-	Handweeding at 20 DAS
T_6	-	Handweeding at 20 and 40 DAS
T_7	-	Benthiocarb @ 0.5 kg a.i. ha^{-1} (pre-emergence application)
T_8	-	Fluchloralin @ 1.0 kg a.i. ha^{-1} (pre-plant incorporation)
T_9	-	Imazethapyr @ 0.1 kg a.i. ha^{-1} (early-post emergence application)

Replications	:	Four
Design	:	Randomised block design
Gross plot size	:	4.8 x 3.0 m^2
Net plot size	:	3.8 x 1.8 m^2

3.6 VARIETAL DESCRIPTION - LBG-20

Most popular variety during *kharif* season, released by Regional Agricultural Research Station, Lam Farm was used in the experiment and its characters are detailed below. LBG-20 is a non-season bound variety developed by crossing Netiminimu with T-9. The plant habit looks like T-9 with smooth pods and shining black seeds like Netiminimu.

It is recommended in uplands either as rainfed or irrigated dry crop. It is moderately resistant to yellow mosaic virus. Its duration is 70-75 days with a yield potential of 15-16 q ha^{-1}.

3.7 CULTIVATION DETAILS

3.7.1 Field Preparation

The experimental field was ploughed to fine tilth with a power tiller. The stubbles were removed and the field was finally levelled and plots were laid out according to the layout plan (Fig.2).

3.7.2 Fertilizers

The crop was fertilized with 20-40-0 kg NPK ha^{-1} in the form of urea and single super phosphate broadcasted and incorporated in the plots as basal application.

3.7.3 Seeds and Sowing

Good quality seeds were procured form Regional Agricultural Research Station, Lam Farm, Guntur. Seeds were sown on 27.7.2000 by dibbling in the furrows opened by a hand hoe made for the purpose and the field was irrigated lightly to get uniform germination.

3.7.4 Herbicides

The details of various herbicides used in the present investigation are furnished in the Table 4.

Fig.2 **LAY OUT PLAN OF THE EXPERIMENT**

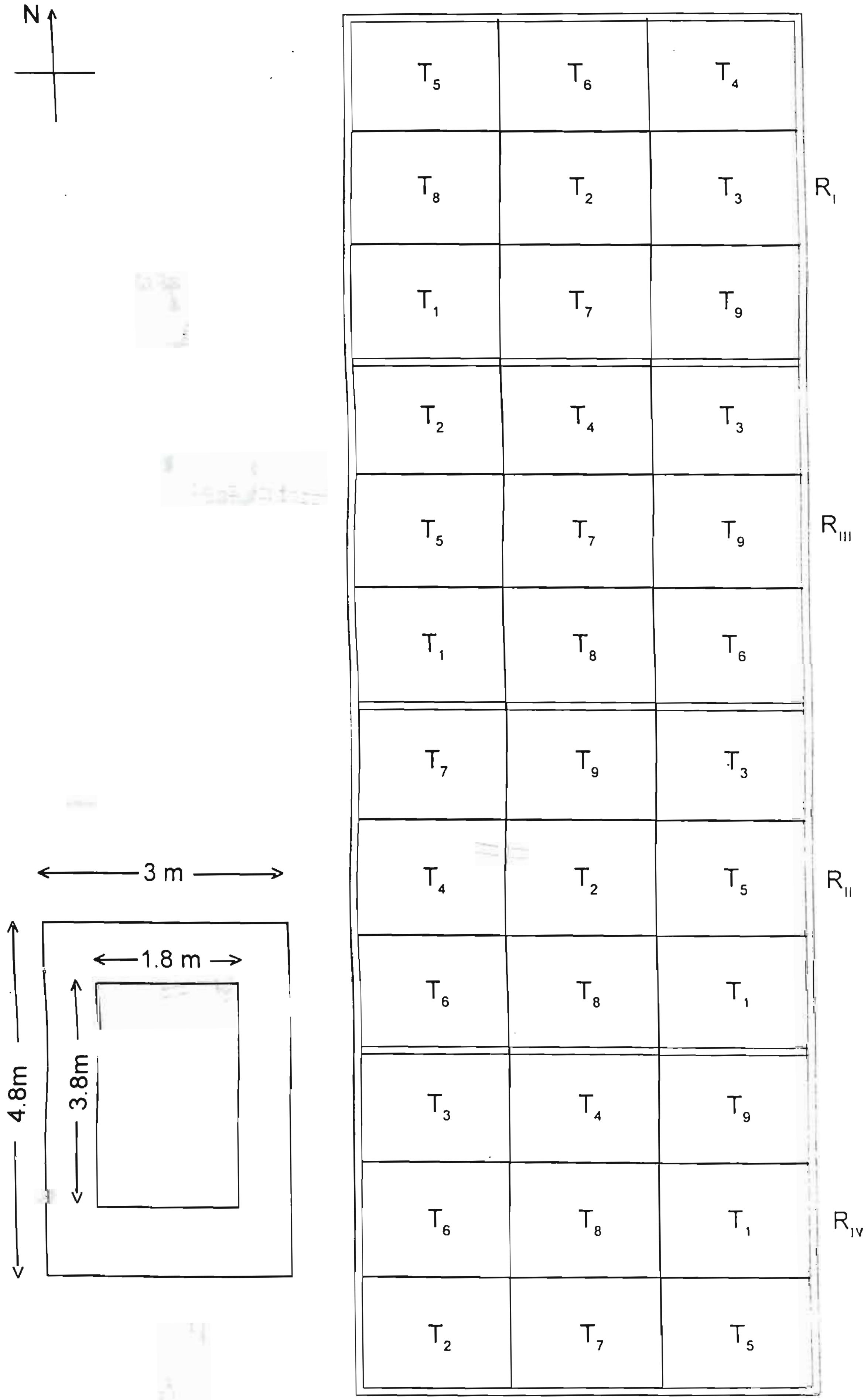


Table 4. **Details of herbicides used in the experiment**

Name of the Chemical	Trade Name	Rate of application	Time of application
Benthiocarb	Saturn 50 EC	0.5 kg ai ha^{-1}	Pre-emergence
Fluchloralin	Basalin 45 EC	1.0 kg ai ha^{-1}	Pre-plant incorporation
Imazethapyr	Pursuit 10% WSL	0.1 kg ai ha^{-1}	Early post-emergence

3.7.5 **Solarization Treatment**

The plots of solarization treatment were ploughed with a power tiller and irrigated to saturation. Then the plots were covered with polyethylene sheets of 0.05 mm and 0.1mm thickness as per the treatments. The polyethylene sheets were removed after 30 days and no weeding was done in these solarized plots afterwards.

3.7.5 **Plant protection measures**

A minor incidence of tobacco caterpillar (*Spodoptera litura* Fab.) was observed when the crop was at flowering stage which was controlled by spraying 0.2 per cent monocrotophos.

3.7.6 **Harvesting and Threshing**

The crop was harvested at maturity. First the border rows were harvested and bulked. The crop from net plots was harvested and sun dried. The harvested material from each net plot was carefully bundled, tagged, weighed and transported to threshing floor. Threshing was done plotwise and seeds were cleaned, dried and weighed separately for each net plot and computed to kg ha^{-1} at nine per cent moisture level.

3.7 **OBSERVATION DURING THE EXPERIMENTATION**

The details of observations taken during the experimentation are given below in Table 5.

Table 5. **Observations taken during the experimentation**

S. No.	Observation	Periodicity
1.	Germination count (number of plants m^{-2})	7 DAS
2.	Plant stand (number m^{-2})	15 DAS, maturity
3.	Plant height (cm)	At maturity
4.	Number of branches per plant	At maturity
5.	Drymatter accumulation (g m^{-2})	30 DAS, 60 DAS
6.	Number of pods per plant	At maturity
7.	Number of seeds per pod	At maturity
8.	1000 seed weight (g)	At maturity
9.	Seed yield per plant (g)	At maturity
10.	Seed yield (kg ha^{-1})	After harvest
11.	Haulm yield (kg ha^{-1})	After harvest
12.	Harvest index (%)	After harvest
13.	Weed count (number m^{-2})	30 DAS, 45 DAS At maturity
14.	Weed biomass (g m^{-2})	30 DAS, 45 DAS At maturity
15.	Weed Control efficiency (%)	
16.	Weed index (%)	
17.	Soil temperature (°C) (in the solarized plots)	Weekly during solarization

3.8 COLLECTION OF EXPERIMENTAL DATA

3.8.1 Observation on Weeds

3.8.1.1 Weed count

Density of sedges, grasses and broad leaved weeds were recorded at 30, 45 DAS and at maturity from the quadrats of 1m x 1m in each net plot The weed count was expressed as number per square metre. These three groups were added to obtain total weed population per square metre.

3.8.1.2 Weed drymatter (g m^{-2})

The grasses, sedges and broad leaved weeds collected at 30, 45 DAS and at maturity in a quadrat of lm x lm area were dried under sun and in hot air oven at 60°C till constant weight and expressed in g m^{-2} as weed drymatter.

3.8.1.3 Weed Control Efficiency (%)

Weed control efficiency (WCE) was calculated using the formula of AICRPWC (1988) and expressed in percentage.

$$WCE (\%) = \frac{DWC - DWT}{DWC} \times 100$$

Where DWC = Dry weight of weeds in unweeded control

DWT = Dry weight of weeds in weed control treatment.

3.8.1.4 **Weed Index (%)**

Weed index is calculated by using the formula given hereunder (AICRPWC,1988).

$$WI = \frac{X - Y}{X} \times 100$$

Where X = Yield from minimum weed competition plot

Y = Yield from treatment plot.

3.8.2 **Preharvest Observations on Crop**

3.8.2.1 **Germination count**

The total number of seedlings emerged are counted in net plots seven days after sowing and recorded as germination count.

3.8.2.2 **Plant stand**

The number of plants in net plots were counted at 15 days after sowing and at maturity and expressed as plant stand.

3.8.2.3 **Plant height**

Plant height (cm) was measured from the ground level to tip of the top most leaf at maturity.

3.8.2.4 **Number of branches per plant**

The number of branches of ten tagged plants were counted at maturity.

3.8.2.5 **Drymatter accumulation (g m^{-2})**

Two plants meant for dry matter sampling were pulled along with root system from second row on one side of the plot. After separating the root system, the plants were first shade dried and then oven dried at 60°C till constant weight was recorded. The weights were recorded and reported in g m^{-2} at 30, 60 DAS and at maturity.

3.8.3 **Post Harvest Observations**

3.8.3.1 **Number of pods per plant**

Total number of pods harvested from ten observational plants were counted and average value was taken.

3.8.3.2 **Number of seeds per pod**

Number of seeds per pod was calculated by dividing the number of seeds with number of pods obtained from all the pods of ten tagged plants.

3.8.3.3 **1000 seed weight (g)**

A random sample of 1000 seeds from the net plot yield was drawn and weighed and expressed in grams.

3.8.3.4 **Seed yield per plant (g)**

The seed yield as noted from ten tagged plants from each net plot was noted and average weight (g) was taken.

3.8.3.5 **Seed yield (kg ha^{-1})**

Seed yield obtained from each net plot including the ten tagged plants was sundried thoroughly and weighed and it was reported in kg ha^{-1}.

3.8.3.6 **Haulm yield (kg ha^{-1})**

Haulm yield was obtained by deducting the weight of seed yield from the total biomass yield of the net plot and expressed in kg ha^{-1}.

3.8.3.7 **Harvest index (%)**

Harvest index was calculated for each treatment by using the formula.

$$\text{Harvest index} = \frac{\text{Seed yield}}{\text{Total biological yield}} \times 100$$

3.9 **SOIL TEMPERATURE STUDIES**

Soil temperatures were recorded by using soil thermometers from the solarization treatment plots as well as a control plot at weekly intervals from 5 cm depth of soil.

3.10 ECONOMICS

The economics of different weed management treatments were calculated by taking into the current input costs and output prices.

3.11 STATISTICAL ANALYSIS

Experimental data was subjected to statistical analysis using Fisher's method of analysis of variance as outlined by *Panse* and *Sukhatme* (1978). Critical difference was worked out at P=0.05 level to test the significance of the treatment effects wherever "F" test was significant.

Results

CHAPTER IV

RESULTS

A field experiment entitled "Relative efficiency of solarization and herbicides for weed control in *kharif* blackgram" was conducted during *kharif* season of 2000-01 at Agricultural College Farm, Bapatla. The data obtained on various weed and crop parameters as affected by different weed control treatments are presented in this chapter.

4.1 OBSERVATIONS ON WEEDS

4.1.1 Weed Flora in Blackgram

Major weed flora of the experimental plots during the course of investigation were collected, identified and presented in Table 6.

Table 6. Weed flora of the experimental field during the crop growth period

	Botanical Name	Family
A.	Grasses:	
	Cynodon dactylon	Gramineae
	Digitaria sanguinalis	Gramineae
	Eragrostis minor	Gramineae
B.	Sedges:	
	Cyperus rotundus L.	Cyperaceae
	Cyperus difformis L.	Cyperaceae

C. Broad leaved weeds:

Trianthema portulacastrum L.	Aizoaceae
Euphorbia hirta L.	Euphorbiaceae
Phyllanthus niruri L.	Euphorbiaceae
Physalis minima	Solanaceae
Commelina benghalensis	Commelinaceae
Cleome viscosa	Capparidaceae
Acalypha indica	Euphorbiaceae
Corchorus acutangulus	Tiliaceae
Phyllanthus maderaspetensis	Euphorbiaceae

4.1.2 Density of Grasses

The data on the density of grasses at 30, 45 DAS and at maturity are presented in Table 7. The data in Table 7 reveals that the grassy weed population increased along with the crop growth till maturity. Significantly higher grassy weed population was observed in weedy check treatment at all the stages of observation, while the weed free (T_2) treatment recorded the lowest values. At 30 DAS, the lowest density of grasses were observed in T_5 i.e. one handweeding and T_6 i.e.two handweedings while T_5 and T_6 were at par with each other. Among the herbicides, T_8, i.e. fluchloralin @ 1.0 kg a.i. ha^{-1} recorded lower grass population (35.0 m^{-2}). The two soil solarization treatments viz., 0.05mm and 0.1mm thick transparent polyethylene sheets were at par with each other and were comparable with T_7 (benthiocarb @ 0.5 kg a.i. ha^{-1}).

Table 7. **Density of grasses (Number m^{-2}) as affected by different weed control treatments at different stages of crop growth**

	Treatments	30 DAS	45 DAS	Maturity
T_1	Control	9.77* (95.00)	10.97 (120.00)	11.20 (125.00)
T_2	Weed free	3.24 (10.00)	3.08 (9.00)	2.12 (4.00)
T_3	Soil solarization with 0.05 mm thick transparent polyethylene sheet	8.09 (65.00)	8.97 (80.00)	8.39 (70.00)
T_4	Soil solarization with 0.1 mm thick transparent polyethylene sheet	8.51 (72.00)	9.61 (92.00)	9.02 (81.00)
T_5	Hand weeding at 20 DAS	4.52 (20.00)	7.28 (54.00)	7.17 (51.00)
T_6	Hand weeding at 20 and 40 DAS	4.94 (24.00)	3.53 (12.00)	2.54 (6.00)
T_7	Benthiocarb @ 0.5 kg a.i. ha^{-1} pre emergence	8.97 (80.00)	10.02 (100.00)	9:30 (86.00)
T_8	Fluchloralin @ 1.0 kg a.i. ha^{-1} pre plant incorporation	5.95 (35.00)	7.51 (56.00)	7.10 (50.00)
T_9	Imazethapyr @ 0.1 kg a.i. ha^{-1} early post emergence	7.24 (52.00)	8.09 (65.00)	7.24 (52.00)
	SEm$\pm$	0.28	0.35	0.32
	CD (P=0.05)	0.82	1.05	0.93
	CV (%)	8.31	13.90	9.0

Figures in parantheses indicate original values.

* $\sqrt{x + 0.5}$ transformed values

At 45 DAS, the lowest number of grassy weeds were observed in weed free treatment (T_2) which was statistically at par with T_6 treatment receiving two handweedings at 20 and 40 DAS. The highest number of grassy weeds (120 m^{-2}) were recorded in weedy check (T_1) which was comparable with T_7 i.e application of benthiocarb @ 0.5 kg a.i. ha^{-1}. T_3 and T_4 treatments where soil solarization was given with 0.05mm and 0.1mm thick transparent polyethylene sheets were statistically equal.

At maturity, the lowest and highest density of grasses was noticed with weed free (T_2) and weedy check (T_1). The treatments fluchloralin @ 1.0 kg a.i. ha^{-1}(T_8), handweeding once at 20 DAS (T_5) and imazethapyr @ 0.1 kg a.i. ha^{-1} were statistically at par with each other. Significant reduction in grasses population was recorded with handweeding twice at 20 and 40 DAS (6.0 m^{-2}) i.e. the lower number of grass weeds. The treatments T_3 and T_4 were also at par with each other.

4.1.3 Density of Sedges

The data pertaining to the density of sedges at 30, 45 DAS and at maturity are furnished in Table 8.

Data on sedge population indicates that their density gradually increased from 30 DAS to maturity. At 30 DAS, the lowest sedge population was recorded with T_2 and T_6 treatments and they were at par with each other. The two soil solarization treatments T_3 and T_4 were also at par with each other where T_3 was comparable with T_6 and T_4.

Table 8. **Density of of sedges (Number m^{-2}) as affected by different weed control treatments at various stages of crop growth**

	Treatments	30 DAS	45 DAS	Maturity
T_1	Control	7.24* (52.00)	9.02 (81.00)	9.61 (92.00)
T_2	Weed free	2.73 (1.00)	3.24 (10.00)	2.54 (6.00)
T_3	Soil solarization with 0.05 mm thick transparent polyethylene sheet	4.30 (18.00)	5.95 (35.00)	5.52 (30.00)
T_4	Soil solarization with 0.1 mm thick transparent polyethylene sheet	5.14 (26.00)	7.38 (54.00)	6.36 (40.00)
T_5	Hand weeding at 20 DAS	3.53 (12.00)	5.14 (26.00)	5.52 (30.00)
T_6	Hand weeding at 20 and 40 DAS	3.80 (14.00)	4.30 (18.00)	3.53 (12.00)
T_7	Benthiocarb @ 0.5 kg a.i. ha^{-1} pre emergence	6.81 (46.00)	8.09 (65.00)	8:39 (70.00)
T_8	Fluchloralin @ 1.0 kg a.i. ha^{-1} pre plant incorporation	5.52 (30.00)	7.24 (52.00)	5.14 (26.00)
T_9	Imazethapyr @ 0.1 kg a.i. ha^{-1} early post emergence	5.70 (32.00)	6.36 (40.00)	4.30 (18.00)
	SEm$\pm$	0.37	0.34	0.28
	CD (P=0.05)	1.08	1.00	0.8
	CV (%)	14.92	10.88	10.01

Figures in parantheses indicate original values.

* $\sqrt{x + 0.5}$ transformed values

At 45 DAS, lowest sedge population was recorded with T_2 treatment (10.0 m^{-2}) followed by T_6 treatment. The treatments T_8, T_4 and T_7 were also equal at their influence on sedge population. Significant reduction in sedges population was recorded with soil solarization with 0.05 mm thick transparent polyethylene sheet (T_3) over the other solarization treatment T_4 i.e. with 0.1 mm thick transparent polyethylene sheet.

At maturity, significantly lower sedge density was recorded with T_6 treatment (12.0 m^{-2}) and it was followed by T_9 treatment (18.0 m^{-2}). The treatments T_8, T_5 and T_3 were at par with each other.

4.1.4 Density of Broad leaved weeds

The data pertaining to density of broad leaved weeds are furnished in Table 9 and depicted in Fig.3.

At 30 DAS, the lower density of broad leaved weeds was recorded with weed free (7.0 m^{-2}) which was at par with T_6, T_5 and T_9 treatments. Significant reduction in density of broad leaved weeds was also recorded with T_5 treatment over soil solarization with 0.1mm thick transparent polyethylene sheet (T_3) while treatments T_8 and T_4 wre at par with each other. Significantly higher number of broad leaved weeds was recorded with weedy control (T_1).

At 45 DAS, significantly lowest density of broad leaved weeds (5.0 m^{-2}) was recorded with T_2 treatment and it was at par with T_6 and T_9 treatments. The treatments T_3, T_4 and T_7 are comparable with each other while T_8 and T_5 were also comparable with each other.

Table 9. **Density of broad leaved weeds (Number m^{-2}) as affected by different weed control treatments at various stages of crop growth**

	Treatments	30 DAS	45 DAS	Maturity
T_1	Control	6.96* (48.00)	8.68 (75.00)	8.97 (80.00)
T_2	Weed free	2.73 (7.00)	2.34 (5.00)	1.87 (3.00)
T_3	Soil solarization with 0.05 mm thick transparent polyethylene sheet	4.63 (21.0)	6.89 (47.0)	5.7 (32.0)
T_4	Soil solarization with 0.1 mm thick transparent polyethylene sheet	5.7 (32.0)	7.1 (50.0)	6.28 (39.0)
T_5	Hand weeding at 20 DAS	3.53 (12.0)	5.7 (32.0)	4.74 (22.0)
T_6	Hand weeding at 20 and 40 DAS	3.39 (11.0)	3.4 (10.0)	2.73 (7.0)
T_7	Benthiocarb @ 0.5 kg a.i. ha^{-1} pre emergence	6.28 (39.0)	7.64 (58.0)	7:03 (49.0)
T_8	Fluchloralin @ 1.0 kg a.i. ha^{-1} pre plant incorporation	5.14 (26.0)	5.52 (30.0)	4.74 (22.0)
T_9	Imazethapyr @ 0.1 kg a.i. ha^{-1} early post emergence	3.93 (15.0)	3.24 (10.0)	3.53 (12.0)
	SEm$\pm$	0.42	0.34	0.37
	CD (P=0.05)	1.20	1.01	1.10
	CV (%)	18.09	13.24	16.34

Figures in parantheses indicate original values.

* $\sqrt{x + 0.5}$ transformed values

At maturity also lower density of broad leaved weeds was recorded with weed free(T_2) and were at par with T_6 and T_9 treatments. Among the herbicides, significantly lower density of broad leaved weeds (12.0 m^{-2}) was recorded with imazethapyr @ 0.1 kg a.i. ha^{-1} (T_9) over benthiocarb application @ 0.5 kg a.i. ha^{-1}. The highest number of broad leaved weeds were observed in weedy check (T_1).

4.1.5 **Total Density of weeds**

The data regarding the total density of weeds are presented in Table 10 and furnished in Fig.3.

The data in Table 10 indicates that different weed control treatments significantly influenced the total number of weeds m^{-2}. The total number of weeds m^{-2} gradually increased with the advanced age of the crop upto 45 DAS.

The total density of weeds at 30 DAS was significantly higher (195.0 m^{-2}) in weedy check compared to other treatments. Significantly higher reduction in total population of weeds was recorded with weed free condition which was at par with one handweeding at 20 DAS followed by handweeding twice at 20 and 40 DAS. The treatments T_8, T_9 and T_3 were equally effective with respect to the total number of weeds.

At 45 DAS, the total population of weeds was lower with T_2 treatment (24.0 m^{-2}) followed by T_6 (40.0 m^{-2}) whereas higher total weeds were observed in T_1. Treatments T_5, T_8 and T_9 were statistically equal,while T_4 and T_7 were also at par with each other.

Table 10. **Density of weeds (total number m^{-2}) as affected by different weed control treatments at various stages of crop growth**

	Treatments	30 DAS	45 DAS	Maturity
T_1	Control	13.98* (195.00)	16.62 (276.0)	17.24 (297.0)
T_2	Weed free	4.94 (24.00)	4.94 (24.0)	3.24 (10.0)
T_3	Soil solarization with 0.05 mm thick transparent polyethylene sheet	10.22 (104.00)	12.74 (162.0)	11.5 (132.0)
T_4	Soil solarization with 0.1 mm thick transparent polyethylene sheet	11.42 (130.00)	14.01 (196.0)	12.66 (160.0)
T_5	Hand weeding at 20 DAS	6.67 (44.00)	10.60 (140.00)	10.17 (103.00)
T_6	Hand weeding at 20 and 40 DAS	7.03 (49.00)	6.36 (40.00)	5.04 (25.00)
T_7	Benthiocarb @ 0.5 kg a.i. ha^{-1} pre emergence	12.86 (165.00)	14.94 (223.00)	14.33 (205.00)
T_8	Fluchloralin @ 1.0 kg a.i. ha^{-1} pre plant incorporation	9.56 (91.00)	11.76 (138.00)	9.92 (98.00)
T_9	Imazethapyr @ 0.1 kg a.i. ha^{-1} early post emergence	9.97 (99.00)	11.20 (125.00)	9.08 (82.00)
	SEm±	0.62	0.46	0.21
	CD (P=0.05)	1.81	1.36	0.63
	CV (%)	12.89	8.18	4.21

Figures in parantheses indicate original values.

* $\sqrt{x+0.5}$ transformed values

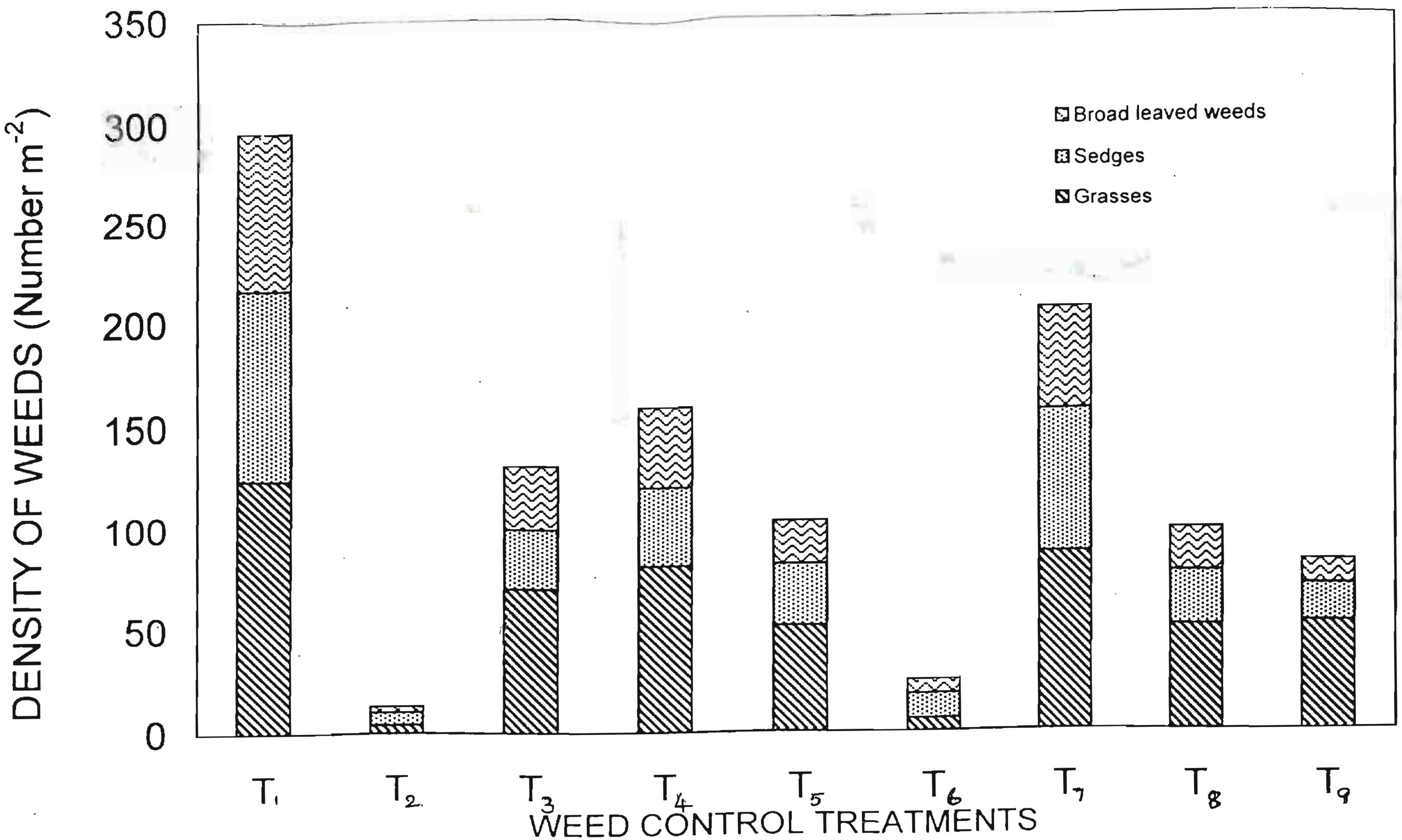


Fig.3 Density of weeds (Total number m^{-2}) as influenced by different weed control treatments at maturity

At maturity, the total weed population was lower with weed free condition followed by handweeding twice at 20 and 40 DAS (T_6). Treatments T_8 and T_5 were at par with each other while T_5 and T_3 were also statistically at par with each other. There was a significant reduction in the total population of weeds with treatment T_3 (soil solarization with 0.05 mm thick transparent polyethylene sheet) over the soil solarization with 0.1 mm thick transparent polyethylene sheet (T_4). Among the herbicides, pre-emergence application of benthiocarb @ 0.5 kg a.i. ha^{-1} (T_7) was found to be poor in reducing the weed number (205.0 m^{-2}) compared to the rest of the herbicides.

4.1.6 **Total Drymatter of weeds**

The data pertaining to total drymatter of weeds are presented in Table 11and Fig.4. The data in Table 11 reveals that the drymatter production of weeds increased with the age of the crop growth upto 45 DAS and afterwards there was a gradual decline upto maturity.

At 30 DAS, the total drymatter accumulation by weeds was higher in weedy check (T_1),whereas significantly lower drymatter accumulation of weeds was recorded with T_6 and T_5 treatments which were at par with each other There was a significant difference in drymatter accumulation of weeds with the two soil solarization treatments (T_3 and T_4) which were superior over the control (T_1).

At 45 DAS, there was a significant influence of soil solarization with different thickness of transparent polyethylene sheets on the total drymatter accumulation of weeds. Soil solarization with the finer transparent polyethylene

Table 11. **Total drymatter accumulation of weeds (g m^{-2}) and weed control efficiency (%) as affected by different weed control treatments at various stages of crop growth**

	Treatments	30 DAS	45 DAS	Maturity	Weed control efficiency(%)
T_1	Control	41.9	56.7	62.5	--
T_2	Weed free	19.5	14.6	11.6	98.0
T_3	Soil solarization with 0.05 mm thick transparent polyethylene sheet	24.2	37.0	37.8	65.0
T_4	Soil solarization with 0.1 mm thick transparent polyethylene sheet	27.0	40.1	38.6	61.0
T_5	Hand weeding at 20 DAS	21.6	37.2	38.8	60.0
T_6	Hand weeding at 20 and 40 DAS	22.8	19.0	32.2	93.0
T_7	Benthiocarb @ 0.5 kg a.i. ha^{-1} pre emergence	22.9	45.6	39.8	56.0
T_8	Fluchloralin @ 1.0 kg a.i. ha^{-1} pre plant incorporation	26.3	34.8	37.0	68.0
T_9	Imazethapyr @ 0.1 kg a.i. ha^{-1} early post emergence	25.6	31.3	36.1	72.0
	SEm$\pm$	0.9	0.86	1.22	0.9
	CD (P=0.05)	2.8	2.60	2.56	2.7
	CV (%)	13.88	13.32	9.83	5.7

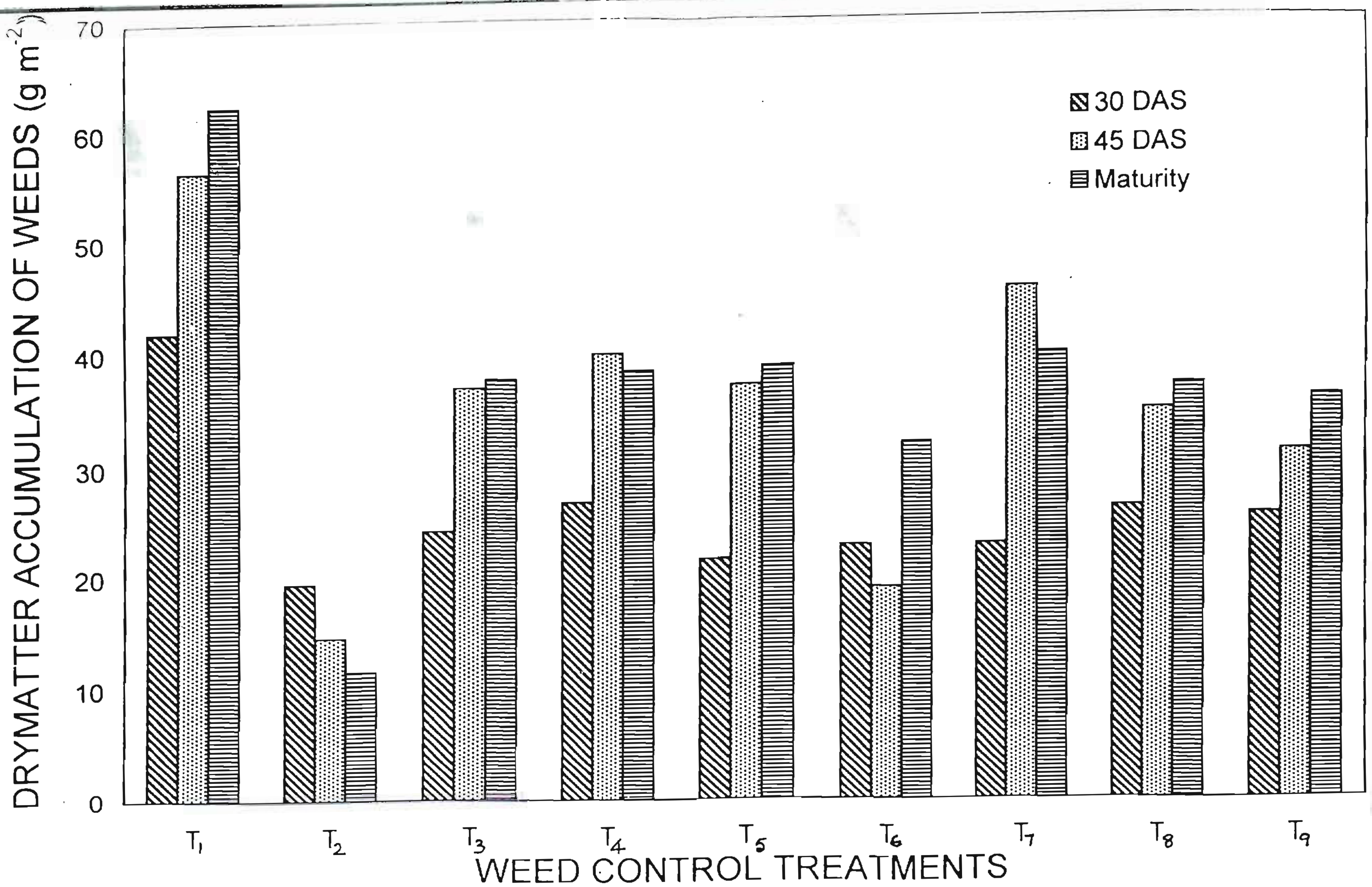


Fig.4 Total drymatter accumulation of weeds (gm^{-2}) as affected by different weed control treatments at various stages of crop growth

sheet (T_3) was superior over thicker transparent polyethylene sheet treatment (T_4). Lowest accumulation (18.92 g m^{-2}) of drymatter of weeds was recorded with T_6 treatment followed by T_9 (31.27 gm^{-2}).

At maturity, the drymatter accumulation of weeds was significantly higher in weedy check followed by benthiocarb application @ 0.5 kg a.i. ha^{-1} (39.8 g m^{-2}) over the rest of the treatments, while the treatments T_3, T_4, T_5 and T_8 were at par with each other. Lowest weed drymatter accumulation (11.5 g m^{-2}) was recorded with T_2 treatment followed by T_6 treatment (32.21 g m^{-2}).

4.1.7 **Weed Control Efficiency**

Weed control efficiences computed for different treatments are presented in Table 11 and Fig.6.

A perusal of data in Table 11 shows that the highest and lowest weed control efficiencies i.e. 93.0 per cent and 56 per cent were recorded with handweeding twice at 20 and 40 DAS (T_6) and benthiocarb application @ 0.5 kg a.i. ha^{-1} (T_7), respectively. Among the herbicide treatments, the maximum weed control efficiency was observed with imazethapyr @ 0.1 kg a.i. ha^{-1} (72.0%) followed by fluchloralin @ 1.0 kg a.i. ha^{-1} (68.0%).

T_3 and T_4 treatments recorded weed control efficiency of 65.0 per cent and 61.0 per cent, respectively and were superior over handweeding once at 20 DAS (T_5).

4.2 OBSERVATIONS ON BLACKGRAM

4.2.1 Germination Count

Data regarding germination count recorded at seven DAS are presented in Table 12.

A glance at the data on Table 12 indicates that the variations in germination count due to different treatments were found to be non significant.

4.2.2 Crop Stand

Data regarding crop stand (Number m^{-2}) recorded at 15 DAS and at maturity are presented in Table 12.

The data on crop stand reveals that at 15 DAS and at maturity there was no significant difference in the crop stand due to the weed contorl treatments.

4.2.3 Plant height

The data pertaining to plant height at maturity are presented in Table 13

A look at the data reveals that, plant height varied significantly at maturity due to different treatments tried. At maturity,the mean plant height was maximum (42 cm) in weed free (T_2) and was significantly higher over all other treatments. Among the other weed control treatments, more taller plants (38.5 cm) were observed with handweeding twice at 20 and 40 DAS (T_6) which was at par with T_9 (early post-emergence application of imazethapyr @ 0.1 kg a.i. ha^{-1}). The treatments T_8 and T_5 were at par with each other (33.0 and 31.5 cms). The least plant height was observed in weedy check treatment.

Table 12. **Germination count (plants m^{-2}) at 7 DAS and crop stand (plant m^{-2}) as infuenced by different weed control treatments at 15 DAS and at maturity**

	Treatments	Germination count 7 DAS	Crop stand	
			15 DAS	Maturity
T_1	Control	32.5	32.8	31.0
T_2	Weed free	32.8	32.8	32.5
T_3	Soil solarization with 0.05 mm thick transparent polyethylene sheet	32.0	32.5	32.0
T_4	Soil solarization with 0.1 mm thick transparent polyethylene sheet	32.5	32.5	32.0
T_5	Hand weeding at 20 DAS	32.8	32.8	32.5
T_6	Hand weeding at 20 and 40 DAS	32.8	32.8	32.5
T_7	Benthiocarb @ 0.5 kg a.i. ha^{-1} pre emergence	31.0	32.0	31.5
T_8	Fluchloralin @ 1.0 kg a.i. ha^{-1} pre plant incorporation	31.8	32.3	32.0
T_9	Imazethapyr @ 0.1 kg a.i. ha^{-1} early post emergence	32.3	32.5	32.0
	SEm$\pm$	1.34	1.86	1.43
	CD (P=0.05)	NS	NS	NS
	CV (%)	8.33	11.5	9.0

4.2.4 Number of Branches per plant

The data recorded on number of branches per plant are presented in Table 13.

Data on number of branches per plant tells us that significantly higher number of branches per plant (5.9) were found in weed free treatment (T_2) whereas 3.2 branches per plant, the lowest were found in weedy check (T_1). Soil solarization with 0.05 mm thick transparent polyethylene sheet (T_3) and 0.1 mm thick transparent polyethylene sheet (T_4) and benthiocarb @ 0.5 kg a.i. ha^{-1} (T_7) were statistically at par with each other with respect to number of branches per plant. Fluchloralin @ 1.0 kg a.i. ha^{-1} (T_8) @ 0.1 kg a.i. ha^{-1} were also equally effective at their influence on this parameter.

4.2.5 Crop Drymatter accumulation

Data on drymatter accumulation (gm^{-2}) of blackgram at different stages of crop growth are presented in Table 14 and Fig.5.

The crop drymatter accumulation increased with advanced crop growth in all the treatments. At all the stages of crop growth, maximum and minimum drymatter accumulation was observed with weed free (T_2) and control (T_1) respectively.

At 30 DAS, handweeding twice at 20 and 40 DAS (T_6) was at par with early post-emergence application of imazethapyr @ 0.1 kg a.i. ha^{-1} (T_9). Likewise benthiocarb @ 0.5 kg a.i. ha^{-1} and soil solarization with 0.1 mm thick transparent polyethylene sheet were also statistically at par. The remaining treatments differed significantly with each other.

Table 13 . **Plant height (cm) and number of branches per plant at maturity as affected by weed control treatments**

	Treatments	Plant height (cm)	Number of branches per plant
T_1	Control	28.0	3.2
T_2	Weed free	42.0	5.9
T_3	Soil solarization with 0.05 mm thick transparent polyethylene sheet	33.0	4.6
T_4	Soil solarization with 0.1 mm thick transparent polyethylene sheet	31.5	4.6
T_5	Hand weeding at 20 DAS	33.5	4.8
T_6	Hand weeding at 20 and 40 DAS	38.5	5.4
T_7	Benthiocarb @ 0.5 kg a.i. ha^{-1} pre emergence	32.0	4.3
T_8	Fluchloralin @ 1.0 kg a.i. ha^{-1} pre plant incorporation	35.0	5.4
T_9	Imazethapyr @ 0.1 kg a.i. ha^{-1} early post emergence	37.2	5.4
	SEm$\pm$	0.74	0.12
	CD (P=0.05)	2.22	0.35
	CV (%)	12.97	9.24

Table 14. **Drymatter accumulation of crop (gm^{-2}) as influenced by different weed control treatments at various growth stages**

	Treatments	30 DAS	60 DAS	Maturity
T_1	Control	28.3	136.2	156.2
T_2	Weed free	68.4	300.5	321.6
T_3	Soil solarization with 0.05 mm thick transparent polyethylene sheet	38.7	210.2	229.2
T_4	Soil solarization with 0.1 mm thick transparent polyethylene sheet	32.6	189.7	200.5
T_5	Hand weeding at 20 DAS	50.8	220.7	245.6
T_6	Hand weeding at 20 and 40 DAS	60.9	290.5	300.5
T_7	Benthiocarb @ 0.5 kg a.i. ha^{-1} pre emergence	30.5	220.6	234.6
T_8	Fluchloralin @ 1.0 kg a.i. ha^{-1} pre plant incorporation	54.0	265.4	275.3
T_9	Imazethapyr @ 0.1 kg a.i. ha^{-1} early post emergence	54.3	282.5	295.7
	SEm$\pm$	0.64	5.81	2.36
	CD (P=0.05)	2.00	16.97	6.89
	CV (%)	17.56	9.89	13.76

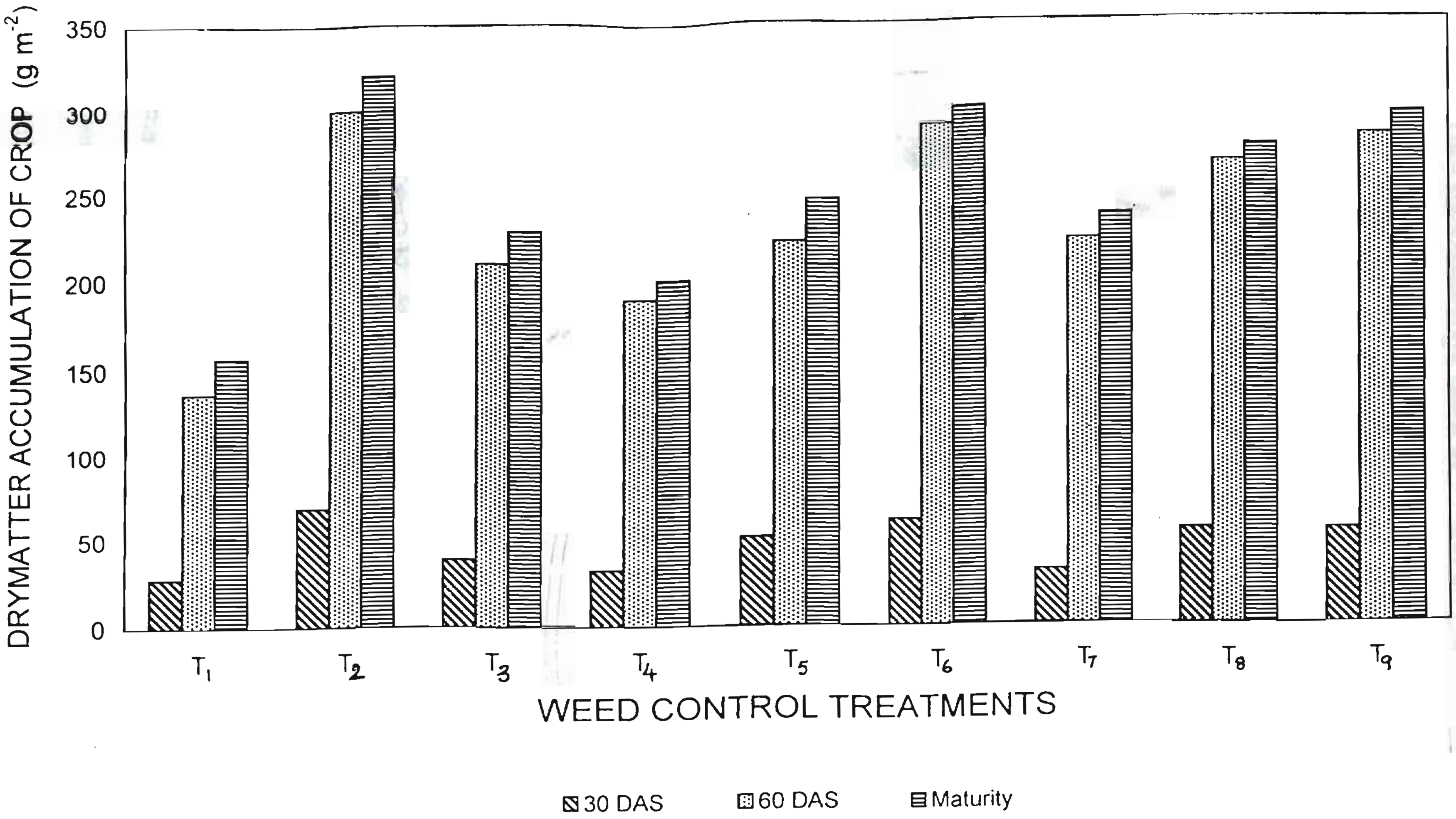


Fig.5 Drymatter accumulation of crop (gm^{-2}) as affected by different weed control treatments at various stages of crop growth

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At 60 DAS handweedings twice at 20 and 40 DAS (T_6) was at par with T_9 i.e. imazethapyr @ 0.1 kg a.i. ha^{-1}. The treatments T_3 and T_4, the two solarization treatments were at par with each other while solarization with 0.05 mm thick transparent polyethylene sheet was comparable with handweeding once i.e. 20 DAS. T_9 and T_6 were equal at their influence on drymatter accumulation.

At maturity also T_3, T_4 treatments and T_6, T_9 treatments were statistically at par, while the remaining treatments differed significantly with each other with respect to drymatter accumulation (g m^{-2}).

4.3 YIELD ATTRIBUTES AND YIELD

4.3.1 Number of Pods per plant

The data pertaining to number of pods per plant were furnished in Table 15.

The data in Table 15 reveals that maximum (16.80) and minimum (8.5) number of pods per plant were recorded with T_2 and T_1 respectively (Table 15). The herbicide treatments imazethapyr @ 0.1 kg a.i. ha^{-1} (T_9) was at par with two handweedings at 20 and 40 DAS (T_6) treatment. There was a non significant influence of thickness of transparent polyethylene sheet on number of pods per plant and the two treatments T_3 and T_4 were at par with each other. All the other treatments differed significantly among themselves with regard to number of pods per plant.

Table 15. **Yield attributes as affected by different weed control treaments in blackgram**

	Treatments	Number of pods per plant	Number of seeds per pod	1000-seed weight (g)	Seed yield per plant (g)
T_1	Control	8.5	5.8	38.6	1.7
T_2	Weed free	16.8	6.3	39.4	4.0
T_3	Soil solarization with 0.05 mm thick transparent polyethylene sheet	11.4	6.2	38.7	2.5
T_4	Soil solarization with 0.1 mm thick transparent polyethylene sheet	11.1	6.1	38.7	2.4
T_5	Hand weeding at 20 DAS	12.8	6.2	38.9	2.8
T_6	Hand weeding at 20 and 40 DAS	15.6	6.3	39.0	3.7
T_7	Benthiocarb @ 0.5 kg a.i. ha^{-1} pre emergence	9.7	6.0	38.8	2.2
T_8	Fluchloralin @ 1.0 kg a.i. ha^{-1} pre plant incorporation	14.1	6.3	38.8	3.2
T_9	Imazethapyr @ 0.1 kg a.i. ha^{-1} early post emergence	15.4	6.3	39.2	3.6
	SEm$\pm$	0.45	0.06	0.23	0.07
	CD (P=0.05)	1.01	0.2	NS	0.22
	CV (%)	7.09	2.15	1.2	10.36

4.3.2 **Test Weight**

The data on test weight (1000 seed) were furnished on Table 15. A glance at the data in Table 15 reveals that the differences in 1000 seed weight due to different weed control treatments were found to be non significant.

4.3.3 **Seed Yield per plant**

The data on seed yield per plant was furnished on Table 16. The seed yield per plant of blackgram was significantly affected by the different weed control treatments.

Maximum seed yield per plant (4.0 g) was observed with weed free treatment (T_2) significantly higher seed yield per plant was recorded with handweeding twice at 20 and 40 DAS (3.66) was at par with T_9 (imazethapyr @ 0.1 kg a.i. ha^{-1}). The treatment T_4 (2.4 g) was comparable with T_3 (2.5 g). Significantly lower seed yield per plant (2.16 g) was obtained with benthiocarb @ 0.5 kg a.i. ha^{-1} (T_7) compared to the other two herbicide treatments T_8 and T_9.

4.3.4 **Seed Yield**

The data on seed yield are furnished on Table 16 and depicted in Fig.7.

A perusal of the data reveals that the yield of blackgram was significantly affected by different weed control treatments.

Highest seed yield (1332 kg ha^{-1}) was recorded in weed free (T_2) treatment, while the lowest seed yield (564 kg ha^{-1}) was recorded in weedy check (T_1) Two handweedings at 20 and 40 DAS (T_6) resulted in 1222 kg seed yield

Table 16. **Seed yield (kg ha^{-1}) and haulm yield (kg ha^{-1}) as influenced by different weed control treatments**

	Treatments	Seed Yield (kg ha^{-1})	Haulm Yield (kg ha^{-1})
T_1	Control	564	1094
T_2	Weed free	1332	2083
T_3	Soil solarization with 0.05 mm thick transparent polyethylene sheet	834	1425
T_4	Soil solarization with 0.1 mm thick transparent polyethylene sheet	802	1420
T_5	Hand weeding at 20 DAS	940	1600
T_6	Hand weeding at 20 and 40 DAS	1222	1993
T_7	Benthiocarb @ 0.5 kg a.i. ha^{-1} pre emergence	720	1337
T_8	Fluchloralin @ 1.0 kg a.i. ha^{-1} pre plant incorporation	1076	1755
T_9	Imazethapyr @ 0.1 kg a.i. ha^{-1} early post emergence	1210	1902
	SEm$\pm$	33.5	30.6
	CD (P=0.05)	97.8	89.3
	CV (%)	12.96	13.77

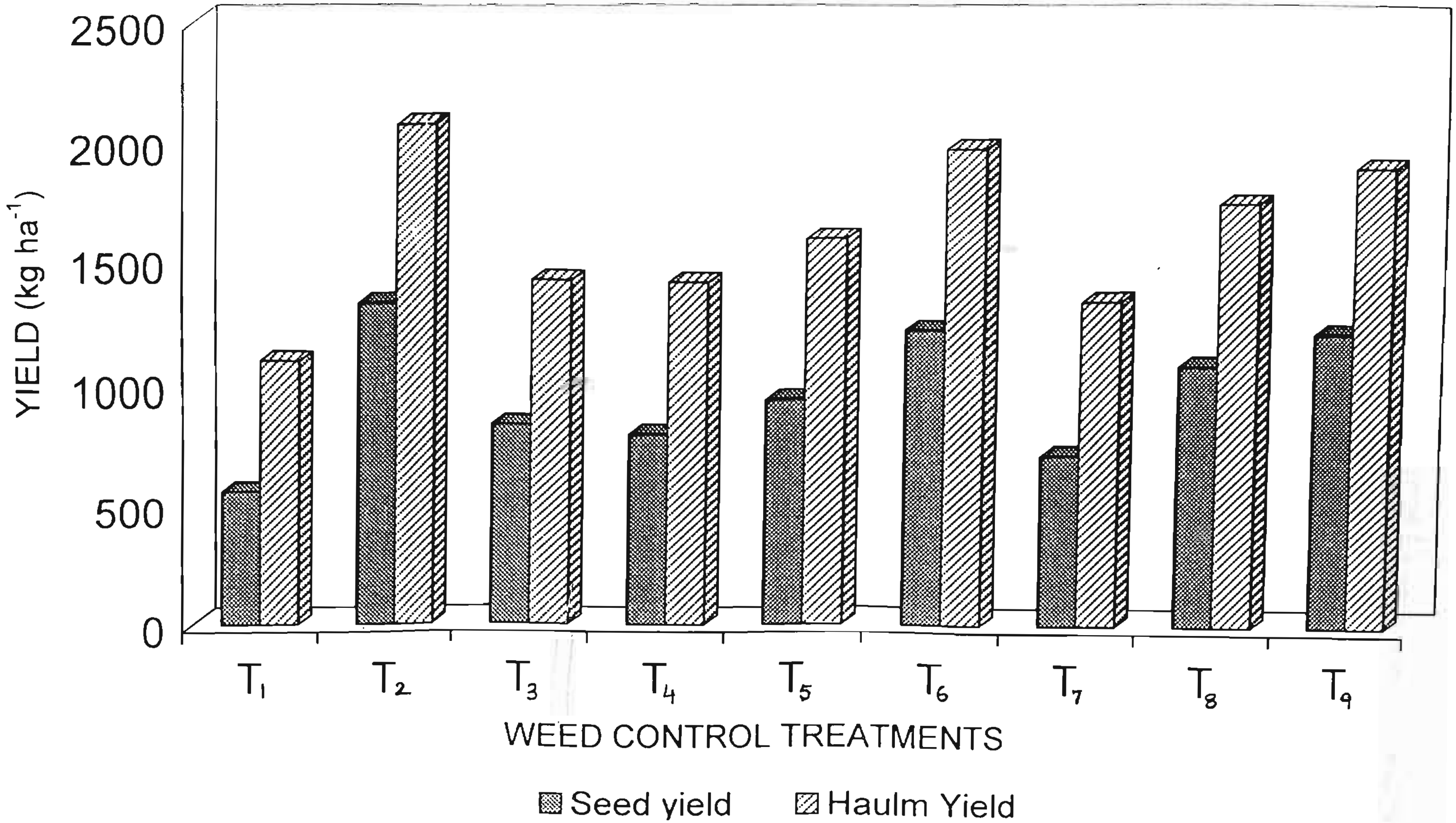

Fig.7 Seed yield (kg ha^{-1}) and haulm yield (kg ha^{-1}) as influenced by different weed control treatments

per hectare which was statistically at par with imazethapyr @ 0.1 kg a.i. ha^{-1} giving 1210 kg seed ha^{-1}. Significantly higher seed yield was recorded with T_8 i.e. fluchloralin @ 1.0 kg a.i. ha^{-1} (1076 kg ha^{-1}) over T_7 treatment. The two soil solarization treatments significantly influenced seed yield over control but were statistically at par with each other. The remaining treatments tried differed significantly with each other in respect of seed yield.

4.3.5 Haulm Yield

The data on haulm yield are presented in Table 16 and Fig.7 and a glance at Table 18 clarifies that the haulm yield was significantly influenced by different weed control treatments. Lowest haulm yield (1094 kg ha^{-1}) was observed with control (T_1). Highest haulm yield (1993 kg ha^{-1}) was recorded with handweeding twice at 20 and 40 DAS and it was at par with imazethapyr application (1902 kg ha^{-1}). The treatments T_4 and T_3 are at par with each other. A non significant increase in haulm yield was observed due to different in thicknesses of transparent polyethylene sheets used in T_3 and T_4 treatments.

4.3.6 Harvest index and Weed index

The data pertaining to weed index was furnished in Table 17 and the data indicates that the lowest weed index (8.27%) was obtained with handweeding twice and significantly superior over the rest of the treatments except T_9 where imazethapyr was applied @ 0.1 kg a.i. ha^{-1}. Among the herbicides, imazethapyr @ 0.1 kg a.i. ha^{-1} as early post-emergence application (T_9) recorded lower weed index of 9.0 per cent compared to all other herbicides T_3 and T_4 recorded weed indices of 37.2 per cent and 39.6 per cent,respectively and were statistically equivalent (Table 17).

Table 17. **Harvest index (%) and weed index (%) as affected by different weed control treatments**

	Treatments	Harvest index (%)	Weed index (%)
T_1	Control	35.0	57.5
T_2	Weed free	39.0	--
T_3	Soil solarization with 0.05 mm thick transparent polyethylene sheet	36.0	37.2
T_4	Soil solarization with 0.1 mm thick transparent polyethylene sheet	37.0	39.6
T_5	Hand weeding at 20 DAS	37.0	29.3
T_6	Hand weeding at 20 and 40 DAS	38.0	8.3
T_7	Benthiocarb @ 0.5 kg a.i. ha^{-1} pre emergence	37.0	45.9
T_8	Fluchloralin @ 1.0 kg a.i. ha^{-1} pre plant incorporation	38.0	19.0
T_9	Imazethapyr @ 0.1 kg a.i. ha^{-1} early post emergence	39.0	9.0
	SEm±	1.0	1.1
	CD (P=0.05)	NS	3.2
	CV (%)	9.5	8.2

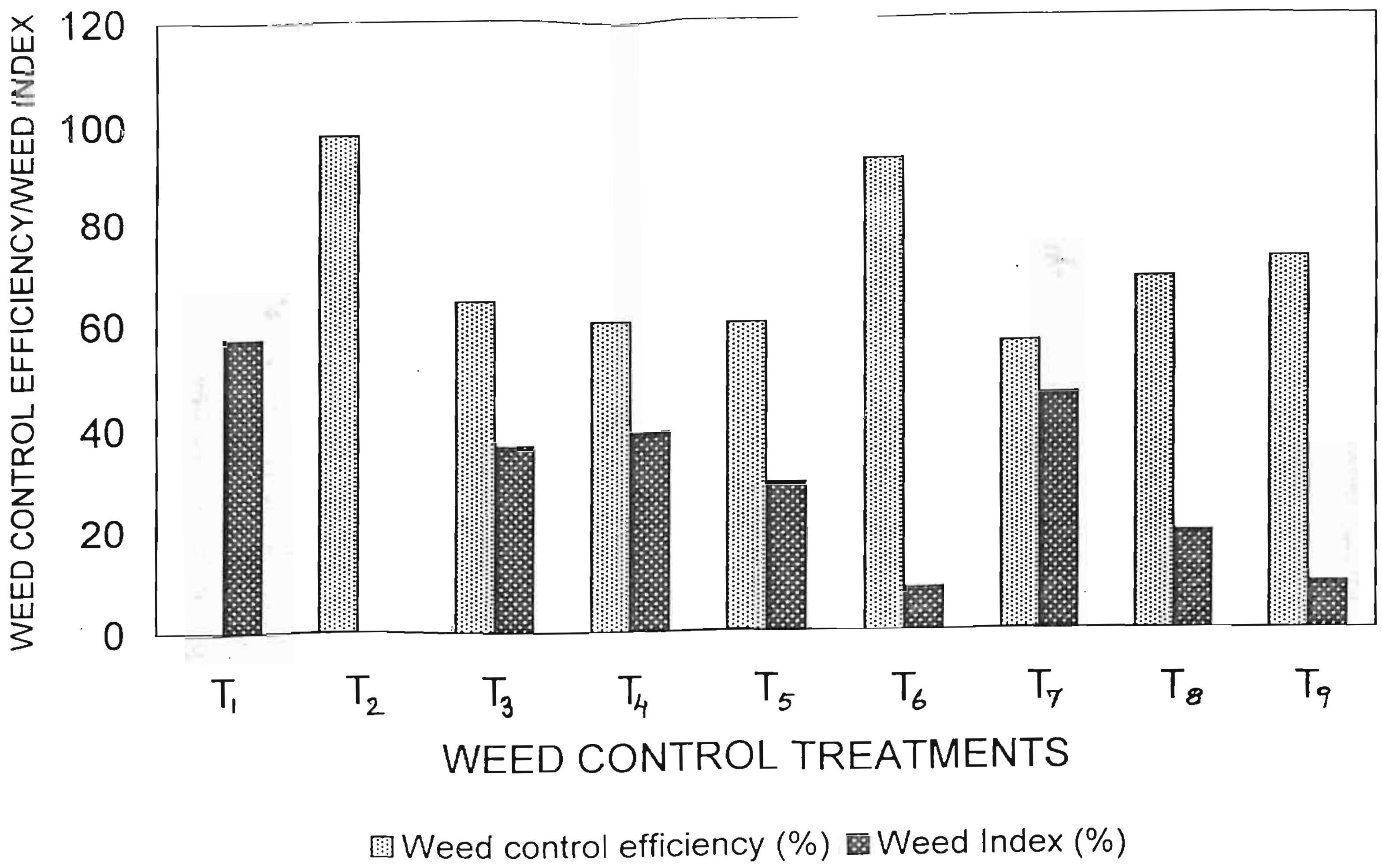

Fig. 6 Weed control efficiency (%) and weed index (%) as affected by different weed control treatments

Significantly highest weed index (57.5%) was obtained in weedy check followed by benthiocarb application @ 0.5 kg a.i. ha^{-1} as pre-emergence (45.9%) Fig.6. No significant difference of weed control treatments on harvest index.

4.4 SOIL TEMPERATURE

Data regarding soil temperature are furnished in Table 18 and Fig.8.

Higher soil temperatures were recorded with soil solarization treatments. i.e. soil solarization with 0.05 and 0.1 mm thick TPS. Increase in soil temperature was recorded in solarized soil in all the observations taken at weekly intervals.

Among the soil solarization treatments, T_3 recorded higher soil temperature i.e. 10-12^{0}C over the control whereas T_4 treatment which recorded 5-8^{0}C increase at all stages of observations.

4.5 ECONOMICS

The data on economics of different weed control treatments are presented in Table 19.

From the data in Table 19 and Fig.9, it is evident that pre plant incorporation of fluchloralin @ 1.0 kg a.i. ha^{-1} (T_7) recorded the highest benefit cost ratio (8.46) followed by benthiocarb @ 0.5 kg a.i. ha^{-1} (8.37) and imazethapyr @ 0.1 kg a.i. ha^{-1} (6.37). The net returns per rupee invested were negative (-0.74 and -0.77) with T_3 and T_4 respectively.

Additional net income over unweeded control was maximum (Rs.10,997) with pre-plant incorporation of fluchloralin @ 1.0 kg a.i.ha^{-1} (T_7) and negative with the two soil solarization treatments T_3 and T_4.

Table 18. **Influence of soil solarization treatments on soil temperature (°C) at 5cm depth of soil at weekly intervals.**

Treatments	Soil Temperature (°C)			
	1	2	3	4
Control	34.0	33.6	31.7	31.5
Soil solarization with 0.05mm thick TPS	46.7	43.7	43.2	41.0
Soil solarization with 0.1mm thick TPS	39.5	38.1	37.8	36.7

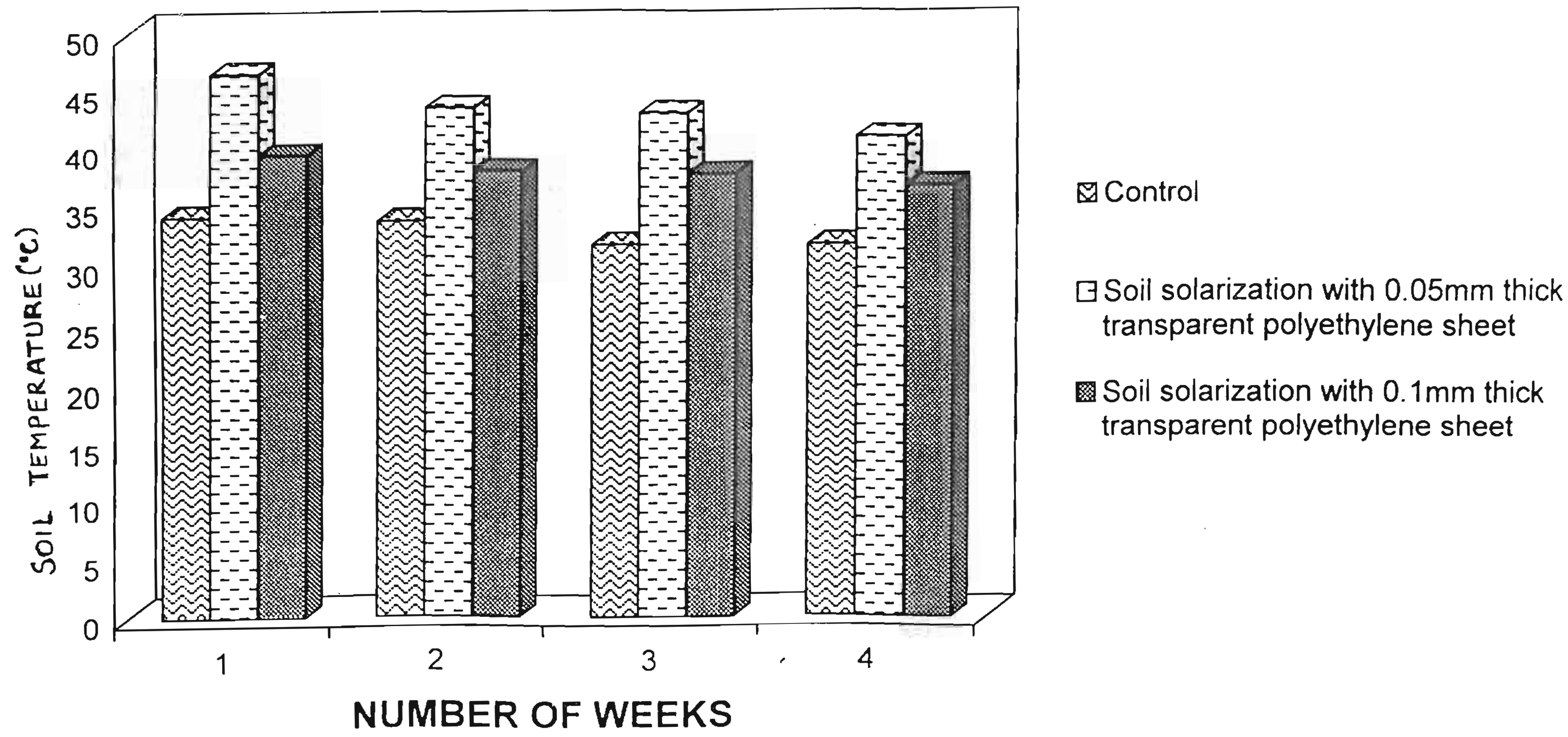

Fig.8 Influence of soil solarization treatments on soil temperature (°C) at 5cm depth of soil at weekly intervals

Table 19. **Economics of different weed control treatments**

	Treatments	Seed yield (kg ha^{-1})	Additional yield (kg ha^{-1}) over T_1	Value of additional yield (Rs.) over T_1	Additional cost (Rs.) incurred over T_1	Net income(Rs.) over T_1	BCR
T_1	Control	564	--	--	--	--	--
T_2	Weed free	1332	768	14976.00	6675.00	8301.00	1.24
T_3	Soil solarization with 0.05 mm thick transparent polyethylene sheet	834	270	5265.00	20254.00	-14989.00	-0.74
T_4	Soil solarization with 0.1 mm thick transparent polyethylene sheet	802	238	4641.00	20254.00	-15613.00	-0.77
T_5	Hand weeding at 20 DAS	940	376	7332.00	1335.00	5997.00	4.49
T_6	Hand weeding at 20 and 40 DAS	1222	658	12831.00	2225.00	10606.00	4.76
T_7	Benthiocarb @ 0.5 kg a.i. ha^{-1} pre emergence	720	156	3042.00	324.65	2717.35	8.37
T_8	Fluchloralin @ 1.0 kg a.i. ha^{-1} pre plant incorporation	1076	516	9984.00	1054.65	8929.35	8.46
T_9	Imazethapyr @ 0.1 kg a.i. ha^{-1} early post emergence	1210	646	12597.00	1600.00	10997.00	6.87

Cost of inputs:

Benthiocarb - Rs. 260 per litre
Imazethapyr - Rs.1600 per litre
Fluchloralin - Rs. 470 per litre

15 labourers ha^{-1} at weekly interval for weed free treatment
30 labourers ha^{-1} at 20 DAS
20 labourers ha^{-1} at 40 DAS
Spraying charges Rs. 64.65 ha^{-1}

Cost of outputs:

Cost of blackgram - Rs. 1950 $quintal^{-1}$
Cost of polyethylene sheet (100 m^2) (per three seasons) - Rs. 607.62

For 1 season cost of polyethylene sheet (100 m^2) - Rs.202.54

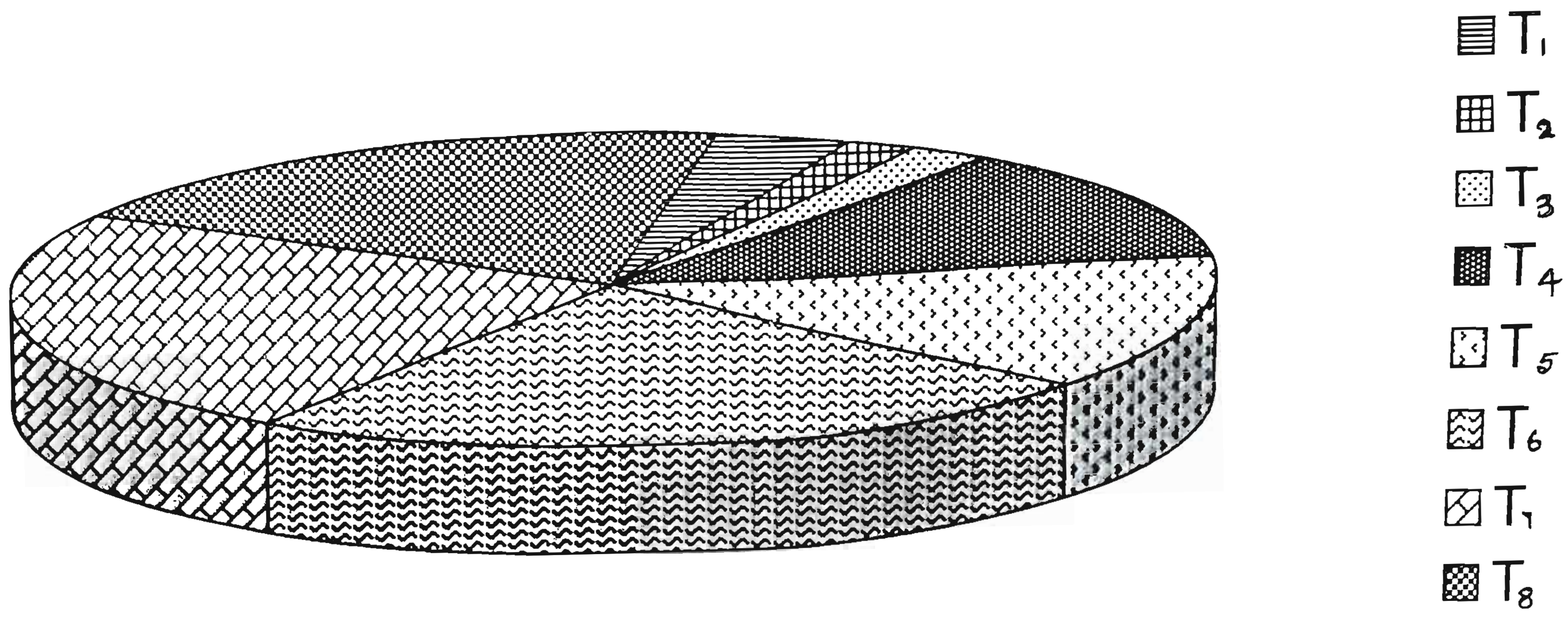

Fig.9 Benefit cost ratio as affected by different weed control treatments

Discussion

CHAPTER - V

DISCUSSION

Pulses occupy a unique position not only in Indian agriculture, but also in Indian dietaries. Blackgram being one of the important pulse crops in Andhra Pradesh is cultivated both in *kharif* and *rabi* seasons. Yields of blackgram are low and it falls within the range of 600-650 kg ha^{-1}. Lower yields of blackgram may be due to several reasons. One of the factors being severe weed competition accounting for yield losses upto 50 to 60% (Vats, and Sawhney 1981; Singh and Singh, 1988). Different methods of weed control were suggested in blackgram for enhancing the yields (Pandey, 1989 and Gogoi *et al.*, 1991).

Keeping these aspects in view, an experiment was laid at Agricultural College Farm, Bapatla during *kharif* season of 2000 to study the "Relative efficiency of solarization and herbicides for weed control in *kharif* blackgram".

The experiment consisted of nine treatments i.e. unweeded check (T_1), weed free (T_2), soil solarization with 0.05 mm thick transparent polyethylene sheet (T_3), soil solarization with 0.1 mm thick transparent polyethylene sheet (T_4), handweeding at 20 DAS (T_5), handweedings twice at 20 and 40 DAS (T_6), benthiocarb @ 0.5 kg a.i. ha^{-1} as pre-emergence application (T_7), fluchloralin @ 1.0 kg a.i. ha^{-1} as pre-plant incorporation (T_8) and imazethapyr @ 0.1 kg a.i. ha^{-1} as early post-emergence application (T_9) in a randomised block design replicated four times.

During the course of presenting the results of the investigation, many significant variations in the treatment evaluation were obtained under the influence of different treatments. Variations found significant or those assuming uniform trend are discussed in this chapter. It has been attempted to establish "effect and cause relationship" based on the results of the present investigation duly supported by available evidences and relevant literature.

The entire discussion has been described under the heads given below.

5.1 Weather conditions and soil.

5.2 Effect of weed control treatments on weed dynamics.

5.3 Effect of weed control treatments on crop growth and yield.

5.4 Effect of soil solarization on soil temperature.

5.5 Economics.

5.1 WEATHER CONDITIONS AND SOIL

The experiment was conducted on a clay soil which is medium in available nitrogen (282.2 kg ha^{-1}) and phosphorus (41.0 kg ha^{-1}) and high in potash (561 kg ha^{-1}). The experimental soil was slightly alkaline in reaction.

Blackgram, LBG-20 of 75 days duration released by Regional Agricultural Research Station, Lam Farm, Guntur, was tested to know the effect of weed control treatments on it's growth and yield.

During the period of experimentation 934.7 mm rainfall was received in 35 rainy days. The relative humidity ranged between 60 per cent and 85 per cent. The number of sunshine hours during the soil solarization period of 30 days on an average was 5.6 hrs. per day (Fig.1b).

5.2 EFFECT OF TREATMENTS ON WEED DYNAMICS

In general, the density of grasses, sedges and broad leaved weeds increased upto 45 DAS and decreased thereafter. The decreasing trend after 45 DAS might be due to the smothering effect of the crop as well as drying of the matured weeds, which completed their life cycle before harvesting of the crop.

Weeds continued to emerge upto 40 days after sowing. Profuse weed growth during the early period of crop growth might be due to the optimum conditions for germination of weed seeds.

Different weed control treatments significantly reduced the grassy weed population at all the stages (Table 7). Population of grasses increased upto 45 DAS and thereafter decreased gradually at maturity. Handweeding twice (20 and 40 DAS) resulted in minimising monocot weeds besides weed free situation at all the stages where the crop could be able to cover the entire ground and suppressed the monocot weed growth. Fluchloralin @ 1.0 kg a.i. ha^{-1} (ppi) suppressed the grasses population by 72 per cent at maturity when compared to benthiocarb application @ 0.5 kg a.i. ha^{-1}. Fluchloralin is absorbed by the roots of sedges and broad leaved weeds more readily than the grasses (Gupta, 1993). It affects seed germination and other physiological growth processes. These findings are in confirmation with Chin and Pandey (1991) and De *et al.* (1994).

Soil solarization treatments significantly reduced the weed count at all stages of crop growth compared to unweeded check. The reduction in grasses population at 45 DAS was 15 per cent more due to 0.05 mm transparent polyethylene than 0.1 mm transparent polyethylene sheet. Rise in soil temperature to higher levels by 0.05 mm thick transparent polyethylene sheet might have caused the death or damage to the weed seeds present in the soil to a greater extent, thus reducing their emergence and dry weights to the minimum. Kumar *et al.* (1993) and Habeeburrahaman (1992) also observed the superiority of thin transparent polyethylene sheet over the thick one with respect to weed control.

At 45 DAS, significant reduction (54.2 per cent) in sedge population was recorded in soil solarization treatment with 0.05 mm thick transparent polyethylene sheet (T_3) over the other soil solarization treatment (T_4) i.e. with 0.1 mm thick polyethylene sheet (Table 8). Significantly better control of sedges by soil solarization was also obtained by Subhash Kumar and Yadeuraju (1997), Reddy and Khan (2000). During soil solarization period. eventhough weed seeds germinate, because of high temperature of the soil and absence of the air, they dessicate. Similar results were reported by Yaduraju (1993) and Sivakumar *et al.* (2001).

At 30 DAS, the lower density of broad leaved weeds was recorded with weed free (7.0 m^{-2}) which was at par with T_6, T_5 and T_9 treatments. At 45 DAS, significantly lowest density of broad leaved weeds (5.0 m^{-2}) was recorded with T_2 treatment and it was at par with T_6 and T_4 treatments.

At maturity, lower density of broad leaved weeds (3.0 m^{-2}) was recorded with weed free treatment and was at par with T_6 and T_9

treatments (12.0 m^{-2}). The superiority of imazethapyr in controlling broad leaved weeds over the other herbicides might be due to its selective and effective control. This herbicide is readily absorbed through xylem and phloem to the growing points where it accumulates (Zimdahl, 1999). Susceptible weeds may germinate and emerge, however normal growth stops at the cotyledon stage. Susceptible weeds either cannot metabolize the herbicide or metabolize it too slowly for detoxification. The reduction in the population of dicot weeds in weed free situation may be due to time to time weedings which influenced the better development of plant canopy thereby suppressing the weed growth. Significant reduction in weed population with fluchloralin and imazethapyr was also observed in blackgram which results in 122 per cent lower weed density over benthiocarb. These results are confirmed by Kumar and Singh (1992), Soni and Singh (1988) and Chin and Pandey, (1991).

The total density of weeds at 30 DAS was significantly higher (195.0 m^{-2}) in weedy check compared to other treatments. The treatments T_8, T_9 and T_3 were equally effective with respect to the total number of weeds.

AT 45 DAS the total weed population was lower with weed free condition (24 m^{-2}) followed by handweeding twice at 20 and 40 DAS (T_6) over the herbicides (Table 10). This may be due to the better spread of the crop canopy over the ground thereby restricting light interception by weeds. Moreover the competition for moisture, nutrients offered to the weeds by the crop is greater due to its better development of the canopy and the root system. The effective reduction in weed density by two handweedings at 20 and 40 DAS in blackgram was also reported by Gogoi *et al.* (1991) and Saraswat and Mishra (1993).

At maturity, the total population of weeds was lower in weed free condition (10.0 m^{-2}) followed by handweeding twice at 20 and 40 DAS (T_6) (Table 10). These was a significant reduction in the total population of weeds with treatment T_3 over T_4. Among the herbicide treatments, imazethapyr @ 0.1 kg a.i. ha^{-1} significantly reduced total weed density, by 16.32 per cent over fluchloralin due to its excellent control of dicot weeds and sedge species *Cyperus rotundus* and *Cyperus difformis*. The efficiency of imazethapyr in controlling sedge population in addition to other weeds was also reported in groundnut by Selvamani and Sankaran (1989) and in soybean by Wang *et al.* (1984).

Drymatter accumulation by weeds (Table 11) gradually increased upto 45 DAS and thereafter, it declined. This could be due to the vigorous and competitive growth by blackgram suppressing the weed growth as well as the reduced weed densities at later stages of observations. The higher the drymatter production of weeds during crop growth, the greater would be the competition between crop and weeds. At 45 DAS the drymatter accumulation was significantly higher in weedy check followed by benthiocarb application @ 0.5 kg a.i. ha^{-1} (Table 11 and Fig. 4) over the rest of the treatments. Lowest weed dry matter accumulation (11.6 g m^{-2}) was recorded with

T_2 treatment followed by T_6 treatment (32.2 g m^{-2}). The reduced weed drymatter production in these treatments may be attributed to the reduced weed population observed in these treatments. Soil solarization either with 0.05 mm thick or 0.1 mm thick transparent polyethylene sheets resulted in significantly lower drymatter accumulation than the weedy check. (65.3 and 62.0 per cent lower drymatter than weedy check in 0.05 and 0.1 mm thick TPS respectively). This might be due to the reduced weed density in soil solarization treatments. Reduced weed dryweight with application of imazethapyr in soybean was reported earlier by Billore *et al.* (1998) and Selvamani and Sankaran (1984) in groundnut, while reduction in weed drymatter with fluchloralin application was also reported by Sharma and Rajkhowa (1988) and Yadav and Shrivastava (1998).

Weed control efficiency (WCE) denotes the relative efficiency of weed control practices compared to no weeding treatment. The highest and lowest weed control efficiencies i.e. 98.0 per cent and 56 per cent were recorded with weed free (T_2) and benthiocarb application @ 0.5 kg a.i. ha^{-1} (T_7) respectively. Weed free (T_2) and handweeding twice at 20 and 40 DAS (T_6) proved to be superior to the other weed control treatments because of the complete removal of weeds at the early stages and suppression of weed growth by crop at later stages (Gogoi *et al.*, 1991). The weed control efficiency with soil solarization treatments T_3 and T_4 were 65.0 per cent and 61.0 per cent, respectively. Soil solarization with transparent polyethylene sheets offered better and weed free environment for blackgram crop giving it an opportunity to grow under less competetive situation. This weed free enviornment in early stages of crop growth resulted in lower weed densities which is reflected in lower weed drymatter accumulation. These results are in confirmity with the findings of Patel *et al.* (1980) in tobacco and Katan (1984) in cotton.

5.3 EFFECT OF WEED CONTROL TREATMENTS ON CROP GROWTH AND YIELD

There was a non significant influence of different weed control treatments on germination count at seven DAS and also on crop stand at 15 DAS and at maturity.

5.3.1 Growth Parameters

At maturity the mean plant height was maximum (Table 15) in weed free (T_2) and was significantly higher over all other treatment followed by handweeding twice (T_6). T_2. T_6 and T_9 treatments recorded 50, 37.5 and 32.8 per cent increase in plant height,respectively over weedy check. Manual weeding in T_2 treatment and T_6 treatments during the critical period of weed competition giving weed free environment resulted in significantly taller plants. Early post-emergence application of imazethapyr (T_9) also was found effective in reducing the total weed density (Table 10) among the herbicides tried. This reduced total number of weeds also resulted in weed free environment making blackgram plants to utilize the natural resources efficiently thereby the increased height of the plant. Similar results were reported by Balyan and Bhan (1984). The reduced plant height in unweeded control might be due to profused weed growth thereby suppressing the plant growth (Srinivasarao ., 1993).

Number of branches per plant at maturity varied significantly due to methods of weed control (Table 13). Significantly higher number of branches per plant were recorded with weed free conditions followed by handweeding twice at 20 and 40 DAS. Minerals and moisture are readily and sufficiently available for crop plants in weed free conditions. Plant growth is influenced by the rapidity of cell division, cell elongation and enlargement. The available essential plant nutrients and soil moisture encourage these processes further (Venkateswarlu, 1999). When there was no competition for space, the plant growth was further encouraged in giving more number of branches per plant. These results are in conformity with Balyan and Bhan (1984) and Rajendra Singh and Chaudhary (1992).

The crop drymatter accumulation gradually increased with crop growth in all the treatments (Table 14). Drymatter production varied significantly due to different weed control treatments at all the stages of growth. At 30 DAS, handweeding twice at 20 and 40 DAS (T_6) was at par with early post-emergence application of imazethapyr @ 0.1 kg a.i. ha^{-1}. Likewise benthiocarb @ 0.5 kg a.i. ha^{-1} and soil solarization with 0.1mm thick transparent polyethylene sheet were also statistically at par. The remaining treatments differed siginificantly with each other. Maximum amount of drymatter accumulation (321.6 g m^{-2}) was recorded with weed free condition which was 105.9 per cent greater over the control (T_1). Significantly higher drymatter accumulation was recorded with T_9 and T_6 treatments at 60 DAS and maturity (Fig.5) over rest of the treatments except T_2 treatment. Total drymatter production is directly related to increase in plant height, number of branches per plant. Relatively less weed population (Table 10) and weed drymatter production (Table 11) were observed with these treatments due to effective weed control which might have helped to provide better growth environment in favour of crop and resulted in more drymatter production. Similar results were also reported by Venkateswarlu (1986), De *et al.* (1994) and Jain *et al.* (1997).

5.3.2 **Yield Attributes**

Methods of weed control significantly influenced the number of pods per plant (Table 1). Maximum number of pods per plant were recorded with weed free situation (16.0) followed by handweeding twice at 20 and 40 DAS (15.6) which was 97.6 per cent and 83.5 per cent more, respectively over control. Higher pod number per plant due to handweeding was also reported by Masood Ali (1984) and Singh *et al.* (1992). The higher plant height (Table 13) and good branching as reflected in higher drymatter production (Table 14) with these treatments (T_2, T_6 and T_9) might have helped in better partitioning of drymatter for reproductive growth thereby increasing the pod number per plant. The increase in pod number per plant is about two times in weed free situation compared to that in weedy situation.

Higher number of pods per plant in blackgram due to application of fluchloralin was reported by Singh *et al.* (1992), Yadav and Shrivastava (1998) and Jain *et al.* (1997). Maximum number of matured pods per plant through application of imazethapyr in groundnut was recorded by Selvamani and Sankaran (1989) and Chin and Pandey (1991). The two soil solarization treatments T_3 and T_4 resulted an increase of 34.2 per cent and 31.0 per cent respectively with respect to number of pods per plant. Biradar and Hosamani (1997) reported 62 per cent increase in number of pods per plant compared to weedy check in groundnut crop.

Weed control treatments did not significantly influence the thousand seed weight in blackgram. Test weight being a genetic character is not generally influenced by management practices (Reddy, 1999). Seed yield per plant recorded was signifcantly higher with T_6 and T_9 treatments besides weed free situation. Increased plant height , more number of branches per plant and higher drymatter accumulation per unit area in these treatments might be the reason for the improved yield attributes. Soil solarization treatments significantly influenced the seed yield per plant compared to no weeding. These results are in agreement with Golombek *et al.* (1995).

Maximum yield attributing traits were recorded in cultural pratices i.e. weed free (T_2) handweeding twice at 20 and 40 DAS and lowest in control. Pods per plant, seeds per pod, weight of seed per plant recorded were higher in weed free situation followed by two handweedings (T_6) and imazethapyr treatment (T_9). These results are in conformity with Jain *et al.* (1997).

5.3.3 **Crop Yield**

Crop yield is an ultimate result of all growth and yield attributing characters. Those treatments whichever significantly increased the growth and yield attributing characters also increased the crop yield.

All the weed management treatments adopted in this investigation had increased yield over no weeding treatment. (Table 16 and Fig. 7). As usual better growing conditions in the weed free treatment had resulted in much higher seed yields (1332 kg ha^{-1}).

Higher seed yield of 1222 kg ha^{-1} was obtained with handweeding twice at 20 and 40 DAS which was at par with early post-emergence treatment of imazethapyr @ 0.1 kg a.i. ha^{-1} (1210 kg ha^{-1}), compared to that with no weeding treatment (564 kg ha^{-1}). This accounted for a yield reduction of 57.5 per cent in unweeded plots because of severe weed competition as evidenced by maximum weed density and weed drymatter accumulation which resulted in reduced crop growth and yield attributes. The per cent yield reduction in this study also falls in the range of yield reductions reported in other experiments too (Govindra singh *et al.*, 1982. Kumar and Singh, 1985).

Soil solarization treatments T_3 and T_4 recorded 834 kg ha^{-1} and 802 kg ha^{-1} of blackgram yield, respectively and were at par with each other. 47.8 per cent and 42.1 per cent increase in seed yield over unweeded check was obtained with the two soil solarization treatments T_3 and T_4, respectively.

The increase in seed yield due to early post-emergence application of imazethapyr (T_9) was 114.5 per cent . over the unweeded check, whereas 90.7 per cent increase in yield was obtained with pre-plant incorporation of fluchloralin @ 1.0 kg a.i. ha^{-1} (T_8). This increase in yield may be attributed to lower dry matter accumulation by weeds, decrease in their population or because of the non-inhibitory beneficial effects of herbicides on soil microbial, soil respiratory and enzymatic activities which control transformation of nutrients. (Chin and Pandey, 1991 and Schnurer, 1985).

5.3.4 Haulm Yield

Significantly higher haulm yield was recorded with handweeding twice at 20 and 40 DAS (1993 kg ha^{-1}). Among the herbicides, imazethapyr @ 0.1 kg a.i. ha^{-1} recorded significantly greater haulm yield compared to other weed control treatments (1902 kg ha^{-1}) which was closely followed by fluchloralin application @ 1.0 kg a.i. ha^{-1}. These results are in agreement with Billore *et al.* (1998).

The greater haulm yield in T_6 treatment was due to better control of weeds in these plots which inturn influenced the drymatter acumulation of crop at maturity.

The differences in the harvest index due to weed management treatments were not significant (Appanna, 1994).

Weed index is the measure of crop yield reduction due to weed competition in comparision to weed free situation and has negative correlation with each other (Reddy, 1999).

Among the herbicides, the lowest weed index (9.02%) was obtained with imazethapyr at 0.1 kg a.i. ha^{-1} (T_9) followed by pre-plant incorporation of fluchloralin @ 1.0 kg a.i. ha^{-1} (19.09%). The lower weed indices obtained in these treatments indicates lower per cent seed yield reduction due to minimum weed competition. The maximum weed index (45.9%) was obtained with benthiocarb @ 0.5 kg a.i. ha^{-1}. This may be attributed to the severe weed competition offered by the weeds to the crop plants in these plots which inturn significantly and negatively influenced the yield and yield attributes. No weeding treatment (T_1) recorded a weed index of 57.5 per cent. This was due to severe weed competition by uncontrolled weed growth, which resulted in maximum crop yield reduction. The results are in corroboration with the findings of Govindra Singh *et al.* (1982) and Kumar and Singh (1985).

5.4 **SOIL TEMPERATURE** (°C)

Soil temperatures during the soil solarization period of 30 days were higher in soil solarization treatments T_3 and T_4 compared to control (Table 18).

Significantly higher soil temperatures were recorded with soil solarization with 0.05 mm thick transparent polyethylene sheet (47.5°C) in the first week over the other soil solarization treatment (T_4). These results are in confirmation with several research workers. (Chauhan *et al.*, 1988, Ajay Arora, 1998). The supremacy of transparent polyethylene in raising soil temperature to higher magnitudes could be due to its maximum transmittance of the incoming shortwave radiation. It was also seen that thinner transparent polyethylene is comparatively more effective than thicker transparent polyethylene owing to its higher radiation transmittance. These findings agree with that of Lodha (1989), Emani (1991), Habeeburrahaman and Hosmani (1996) and Subhash Kumar and Yaduraju (1997).

5.5 ECONOMICS

From the economics computed (Table 19), maximum net additional income of Rs. 10,997 was obtained with early post-emergence application of imazethapyr @ 0.1 kg a.i. ha^{-1} (T_9) among the herbicides over no weeding (T_1). The additional net income was negative with the two soil solarization treatments T_3 and T_4 (Rs. -14,989 and Rs. -15,613). This is due to higher initial cost incurred on the transparent polyethylene sheet.

The maximum benefit cost ratio of 8.46 was obtained with fluchloralin @ 1.0 kg a.i. ha^{-1} (T_8) compared to that of other herbicide treatments. This is due to more seed yield and lower cost of fluchloralin (Rs. 470 per litre) compared to that of other herbicide treatments. Though handweeding (T_6) and imazethapyr treatment (T_9) gave maximum additional yield and net income over all the other treatments, it gave the benefit cost ratio of 4.76 and 6.87. The lower benefit cost ratio in this treatment is mainly due to higher cost involved in manual weeding Rs. 2225 per two weedings and higher cost of imazethapyr herbicide Rs.1600 per litre.

Thus, the higher cost involved in manual weeding was not compensated by the additional grain yield obtained in handweeding resulting in lower BCR.

From the foregoing discussion, the following conclusions are drawn.

The weed flora of grasses, sedges and broad leaved weeds was effectively suppressed by handweeding twice at 20 and 40 DAS (T_6) followed by imazethapyr @ 0.1 kg a.i. ha^{-1} (T_9) and fluchloralin @ 1.0 kg a.i. ha^{-1} (T_8). The weed drymatter was effectively reduced by early post-emergence application of imazethapyr and pre-plant incorporation of fluchloralin @ 1.0 kg a.i. ha^{-1} (T_8) besides handweeding twice at 20 and 40 DAS. The soil solarization treatments T_3 and T_4 significantly suppressed the weed density and weed drymatter over control.

The highest weed control efficiency was recorded with weed free treatment followed by handweeding twice at 20 and 40 DAS (T_9). Among the herbicide treatments, higher weed control efficiency was recorded with application of imazethapyr (T_9) followed by fluchloralin (T_8) but the highest weed index was recorded with benthiocarb @ 0.5 kg a.i. ha^{-1} (T_7) because of its inefficacy in suppressing the total weed density and weed drymatter.

Higher blackgram drymatter production, number of branches per plant, number of pods per plant, seeds per pod and seed yield was obtained with handweeding twice at 20 and 40 DAS (T_6) and were on par with imazethapyr @ 0.1 kg a.i. ha^{-1} (T_9). Hence handweeding at 20 and 40 DAS seems to be essential, as blackgram is more sensitive to weed interference during first 40 DAS.

Summary

CHAPTER - VI

SUMMARY

A field experiment entitled "Relative efficiency of solarization and herbicides for weed control in *kharif* blackgram" was conducted at the Agricultural College Farm, Bapatla ,on a clay soil during *kharif* season 2000-01 with the objectives: (i) to study the efficiency of soil solarization and herbicides on weed dynamics in blackgram (ii) to study the impact of various weed control treatments on growth and yield of blackgram crop (iii) to find out a suitable method of weed control in blackgram during *kharif* season.

The treatments consisted of control (T_1), weed free (T_2), soil solarization with 0.05 mm thick transparent polyethylene sheet (T_3), soil solarization with 0.1 mm thick transparent polyethylene sheet (T_4), handweeding once at 20 DAS (T_5), two handweedings at 20 and 40 DAS (T_6), pre-emergence application of benthiocarb @ 0.5 kg a.i. ha^{-1} (T_7), pre-plant incorporation of fluchloralin @ 1.0 kg a.i. ha^{-1} (T_8) and early post-emergence application of imazethapyr @ 0.1 kg a.i. ha^{-1} (T_9). These nine treatments were arranged in randomised block design with four replications. The test variety used was LBG-20.

In general, the weather parameters during the experiment were favourable for blackgram crop growth. During the crop period the mean maximum and mean minimum temperatures were 33.1°C and 25.1°C

respectively. The maximum temperatures ranged from 28.6°C to 38.7°C and minimum temperatures ranged from 21.4°C to 27.3°C. The mean relative humidity varied between 60.6 per cent 84.4 per cent. Number of sunshine hours per day during the experimental period ranged from 0.5 to 7.0. During the period of experimentation, a total rainfall of 934.7 mm was received in 35 rainy days.

The weed flora observed in this study belong to three different groups viz., grasses (*Cyanodon dactylon, Digitaria sanguinalis ,Eragrostis minor etc.*); sedges (*Cyperus rotundus, Cyperus difformis*) and broad leaved weeds (*Trianthema portulacastrum, Euphorbia hirta, Phyllanthus niruri* etc.). In general, the density and drymatter production of all the groups of weeds were significantly reduced by handweeding twice at 20 and 40 days after sowing (DAS) and early post-emergence application of imazethapyr (T_9). The next best treatment was fluchloralin at 1.0 kg a.i. ha^{-1} as pre-plant incorporation (T_7).

The maximum weed control efficiency (98.0%) was recorded with weed free treatment (T_2). Among the herbicide treatments, the maximum weed control efficiency (72.0%) was recorded with imazethapyr @ 0.1 kg a.i. ha^{-1} (T_9) closely followed by fluchloralin @ 1.0 kg a.i./ha^{-1} (T_8). The maximum (45.9%) and minimum (8.3%) weed indices were recorded with benthiocarb and handweeding twice (T_6), respectively.

Among the soil solarization treatments, soil solarization with 0.05mm thick transparent polyethylene sheet (T_3) recorded higher soil temperature

Literature Cited

Note: The literature is cited as per the "Thesis Guidelines" prescribed by Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad-30.

LITERATURE CITED

Abd - Elrazik A A Fahmy FG Amein A M and El-Amein A I 1990 Effect of solarization on seedling diseases of onion and population densities of fungi in soil. The Sixth Congress of Phytopathology, Cairo.

Abu - Irmaileh B E 1991 Weed control in squash and tomato fields by soil solarization in the Jordan valley. Weed Research 31(3) : 125-133.

Agri India Green Pages 1999 Agricultural Statistics of India. Agri Information Services Private Limited, Pune 1: 379-382.

Al - Raddad A AL - Momany Abu-Gharbieh W and Saleh H 1990 Effect of soil solarization on endomycorrhizal fungus *Giamus mossea* and *Fusarium*. First International Conference on Solarization 19-25 February Amman, Jordan.

Ajay Arora 1998 Soil solarization : Effects on soil moisture, soil temperature and chemical properties of the soil. Crop Research 16(1) : 41-49.

Ajay Arora and Yaduraju N T 1996 Soil solarization : Its role in weed management. Indian Farming 46(2) : 13-16.

All India Co-ordinated Pulse Improvement Project 1985 Consolidated report of *kharif* pulses. Directorate of Pulses Research, Kanpur.

All India Co-ordinated Research Project on Weed Control, Sriniketan Centre 1988 Third Annual Report (1988) Viswa Bharati - Sriniketan pp. 185-190.

Appanna 1994 Weed Management in rice-fallow blackgram (*Vigna mungo* L. Hepper). M.Sc. (Ag.) Thesis, Acharya N.G.Ranga Agricultural University, Hyderabad.

Ashton F M and Crafts A S 1981 Mode of action of herbicides. Wiley Interscience Publications New York pp. 221.

Balyan R S and Bhan V M 1984 Promising herbicides for weed control in chickpea. Indian Journal of Weed Science 16(2) : 69-75.

Bharati K Madhulety T V and Narayanan A 1998 Effect of benthiocarb on yield and yield attributes on blackgram (*Vigna mungo* L. Hepper) genotypes. The Andhra Agricultural Journal 45 (3&4): 191-193.

Billore Joshi and Ramesh 1997 Comparative performance of weedicides in soybean Pestology 21(11) : 43-45.

Billore Ramesh and Joshi 1998 Comparative efficacy of herbicides in soybean (*Glycine max*). Pestology 22(7) : 60-61.

Biradar I B and Hosamani M M 1997 Effect of soil solarization on weed control and its effects on yield of groundnut (*Arachis hypogeae L.*) Karnataka Journal of Agricultural Sciences 10(4) : 966-970.

Bisen C R, Tomar S S and Bajpai R P 1981 Chemical weed control in urd (*Vigna mungo*). In Abstracts of papers annual conference of Indian Society of Weed Science held at Bangalore, November 25, 1981 pp.26.

*Cartia G 1987 Results of soil solarization in Sicily. Defesa Delle Piante 10(1) : 189-194.

Canevari M Colbert D Chavarria R and Verdegaal P 1989 Efficacy and yield comparision of herbicides in seedlings alfalfa in the Central valley of California in Proceedings of the Western Society of Weed Science 42 : 70-74.

Chauhan Y S Nene Y L Johansen C Haware M P Saxena N P Sardar Singh Sharma S B Sahrawat K L Burforad J R Rupela O P Kumar rao J V D K and Sitanantham S 1988 Effect of soil solarization on pigeonpea and chickpea Research Bulletin No.11 ICRISAT, Patancheru, Hyderabad, India.

Chen Y and Katan J 1980 Effect of solar heating of soils by transparent polyethylene mulching on their chemical properties. Soil Science 130 : 271-277.

Chin D V and Jitendra Pandey 1991 Effect of pre and post emergence herbicides on weeds and yield of blackgram (*Phaseolus mungo*). Indian Journal of Agronomy 36 : 276-277.

Das S K Saha D and Bhattacharya S P 1990 Chemical weed control in blackgram through AC-263,499. Environment and Ecology 8(4) : 1307-1308.

De G C Chakraborty T and Modak R 1994 Effect of integrated weed management in blackgram in the lateritic belt of West Bengal. Indian Agriculturist 38(4) : 257-262.

De G C Chakraborty T Modak R and Das S 1995 Efficiency and economics of integrated weed management in chickpea and blackgram. Indian Agriculturist 39(3) : 213-217.

Economics and Statistical Bulletin 1999 Directorate of Statistics and Economics Government of Andhra Pradesh pp. 17-18.

*Elmore C L 1983 Solarization for weed control in vegetable crops In Abstracts. Meeting of the Weed Science Society of America pp.22.

Emani E 1991 Soil solarization and mulching for weed management in cowpea (*Vigna unguiculata L*). Thesis submitted to UAS, Dharwad.

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

Gogoi A K Kalita H Pathak A K and Deka J 1991 Weed management in blackgram (*Phaseolus mungo*). Indian Journal of Agronomy 36: 601-602.

Gogoi A K Kalita H Pathak A K and Deka J 1992 Crop-weed competition in rainfed blackgram (*Vigna mungo* L. Walp). Indian Journal of Weed Science 24 : 81-82.

Golombek S D Talwar H S and Johansen C 1995 Effect of transparent polyethylene mulch during the reproductive stages of groundnut. International Arachis Newsletter 15 : 68-69.

Govindra Singh Bhagwat Singh and Dheer Singh 1982 Studies on weed control in urd bean. In Abstracts of papers, annual conference of Indian Society of Weed Science held at Hissar, December 27-30, 1982 pp.22

Gupta O P 1993 Modern Weed Management. Agro Botanical Publishers, Bikaner, India pp. 78.

Habeeburrahaman P V 1992 Investigation on soil solarization for weed control. Ph.D Thesis, UAS, Dharwad.

Habeeburrahaman P V and Hosmani M M 1996 Effect of soil solarization in summer on weed growth and yield of succeeding rainy season sorghum (*Sorghum bicolor*). Indian Journal of Agronomy 41 : 54-57.

Harti M C 1991 Influence of soil solarization on weed management in cowpea (*Vigna unguiculata L.*). Thesis Submitted to UAS, Dharwad

Hooda I S Singh B R and Pahuja S S 1993 Studies on methods of weed control in blackgram. In Proceedings of International Symposium, Indian Society of Weed Science, held at Hissar, November 18-20, 1993, pp.268-269.

Indu Mehta and Bonlia 1980 Comparative efficacy of different herbicides for control of weeds in Urd. In Abstracts of papers, annual conference of Indian Society of Weed Science held at Bhubaneswar, July 21-23, 1980 pp. 86.

Jackson M L 1973 Soil chemical analysis. Prentice Hall of India Private Limited, New Delhi.

Jaglan R K and Pahuja S S 1988 Effect of weed control and crop geometry on yield and yield attributing characters of blackgram (*Vigna mungo L.* Hepper) cultivars. In Abstracts of papers, biennial conference of Indian Society of Weed Science held at Jorhat, March 8-9, 1988 pp. 37.

Jain K K and Jain S C 1987 Impact of different weed free media on the growth and yield parameters of blackgram (*Vigna mungo L* Hepper) in semi-arid tropical conditions. Indian Journal of Weed Science 19 : 20-24.

Jain V K Chauhan Y S and Vivek Chitnis 1997 Effect of cultural and chemical methods of weed management on weeds and yield of blackgram. (*Phaseolus mungo*). Indian Journal of Agronomy 42 (4) : 661-664.

Jammejai Sharma 1993 Evaluation of herbicides in peas (*Pisum sativum*) in Mid-hills of Himachal Pradesh. Indian Journal of Weed Science 25 (3 & 4) : 36-39.

Jayakumar R Siddeswaran K Balasubramanian N Kempuchetty N and Subramanian S 1985 Effect of herbicides on nutrient uptake in blackgram and associated weeds. Madras Agricultural Journal 72 447-450.

*Johnson D H and Talbert R E 1989 Yellow nutsedge control in soybeans. Arkansas Farm Research 34 (4) : 7.

Kant Dahiya D R and Hooda I S 1989 Effect of weed control methods on growth yield and yield attributes of urdbean. Haryana Journal of Agronomy 5 : 18-23.

Katan J 1981 Solar pasteurization of soils for disease control. Status prospects. Plant Disease 64 (5) : 450-454.

Katan J Rotem L Finkel Y and Daniel J 1980 Solar heating for the control of pink rot and other soil borne diseases in onions. Phytoparasitica 8 (1) : 39-50.

Katan J 1984 Solar disinfestation of soil. Ecology and management of soil borne plant pathogens. Proceedings of section 5 of IV International Congress of Plant Pathology. The American Phytopathological Society, Australia. pp. 274-278.

Kumar and Singh 1985 Efficacy of herbicides for weed control in urdbean (*Vigna mungo*). In Abstracts of papers, annual conference of Indian Society of Weed Science, held at Anand, April 4-5 pp. 55.

Kumar B Yaduraj N T and Prasad D 1993 Effect of soil solarization on weeds and nematodes under tropical Indian conditions. Weed Research 33 : 423-429.

Lodha S Mahendra Singh and Sharma B M 1991 Solarization brings down soil borne pathogen in arid lands. Indian Farming 40(10): 12-13.

Malik N and Townley-Smith L 1990 Performance of imazethapyr on pulse crops. Weed Technology 4 (4) : 791-798.

Masood Ali 1984 Integrated Weed Management in blackgram. Indian Journal of Weed Science 16 : 156-160.

*Meylemans B Sangakkarra U R Damme-P-Van and Van-Damme-P 1994 46th International Symposium on crop protection : Part IV. Gent. Belgium 3 May 1994. Mededelingen 59 : 3b. 1351-1360.

Misra M and Mishra A 1995 Effect of fertilizer, weed control and row spacing on summer blackgram (*Phaseolus mungo*). Indian Journal of Agronomy 40 (3) : 434-438.

Mishra O P and Singh G 1993 Weed management in urdbean (*Vigna mungo L.* Hepper). In Proceedings of International Symposium, Indian Society of Weed Science held at Hissar, November 18-20, 1993 Volume III : 154-155.

Mohamed Ali A and Durai R 1987 Control of *Trianthema portulacastrum* L. in blackgram. Indian Journal of Weed Science 19 52-56.

*Olsen S R Codec C L Watnbe F S and Dean D A 1954 Estimation of available phosphorus in soils by extraction with sodium carbonate. USDA Circular no. 939.

Pandey 1989 Evaluation of imazethapyr in urdbean (*Phaseolus mungo L.*). Indian Journal of Weed Science 21: 75-77.

Panse V G and Sukhatme P V 1978 Statistical methods for agricultural workers. Indian Council of Agricultural Research, New Delhi pp. 152.

*Parker C and Fryer J D 1975 Weed control problems causing major reduction in world food supplies. FAO Plant Protection Bulletin 23 : 83-95.

Parveen Kumar Saraf C S Subhash Chander and Sanjay Rawal 1999 Performance of greengram and blackgram as influenced by weed management and sulphur fertilization. Annals of Agricultural Research 20(1) : 69-72.

Patel D J Patel H R Patel S K and Makwana M G 1980 Soil solarization through clear polyethylene tarping for management of knot disease in tobacco nursery. Proceedings in IX International Congress on the Use of Plastics in Agriculture 26th February - 2nd March 1990, New Delhi, India P.E. 111-119.

Piper C S 1966 Soil and plant analysis. Interscience Publishers, New York pp. 152.

*Powles S B Charman N and Poole F 1988 Solar heating (solarization) of the soil surface : Effect on weed control and yield of *Phaseolus vulgaris*. Plant Protection Quarterly 3 (1) : 31-35.

Raghavani B R Goyal S N Patel J C and Malvia D D 1987 Weed management in blackgram. Indian Journal of Weed Science 19 : 227-229.

Rajendra Singh and Chaudhary G R 1992 Effect of weed control and phosphorus on yield and yield attributes of greengram (*Phaseolus radiatus*). Indian Journal of Agronomy 37 (2) : 373-374.

Rajvir Singh Chandel A S and Singh R 1991 Weed management in urdbean (*Vigna mungo L.*). Indian Journal of Weed Science 23 : 98-100.

Ramamoorthy K and Ali A M 1988 Competition and control of *Echinocloa colonum* (L) Link. in upland bunded rice and pulse system. Indian Journal of Weed Science 20 (2) : 63-67.

Ramanathan S P and Chandrashekharan B 1998 Weed management in blackgram (*Phaseolus mungo)*. Indian Journal of Agronomy 43 (2) : 318-320.

Rao R S N and Rao K N 1988 Control of cuscuta with herbicides in blackgram (*Vigna mungo* (L.) Hepper). In Abstracts of papers, biennial conference of Indian Society of Weed Science held at Jorhat, March 8-9 1988 pp. 37.

Rao V S 1983 Principles of Weed Science. Oxford and IBH Publishing Company Private Limited pp. 56.

Reddy S R 1999 Principles of Agronomy. Kalyani publishers New Delhi pp. 366.

Reddy Y T N and Khan M 2000 Weed control in sapota orchards through use of soil covers. Indian Journal of Weed Science 32 : 103-104.

Richards L A 1954 Diagnosis and improvement of saline and alkaline soils. USDA Hand Book No. 60.

Rubin B and Benjamin A 1983 Solar heating of the soil : Effect on weed control and soil incorporated herbicides Weed Science 31(6) : 819-825.

Saraswat V N and Mishra J S 1993 Weed management in pulse crops. In Proceedings of International Symposium, Indian Society of Weed Science held at Hissar, November 18-20 1993 Volume III : 137-140.

Schnurer J Clarholm M and Rosswall T 1985 Microbial biomass and activity in an agricultural soil with different organic matter contents. Soil Biology and Biochemistry 17 : 611-628.

*Schuh J F and Harvey R G 1986 Woolly cupgrass control in soybeans In Proceedings, North Central Weed Conference 41 : 45-46.

Selvamani S and Sankaran S 1989 A comparative study of different herbicides for weed control in irrigated groundnut. Indian Journal of Weed Science 21 (1 & 2) : 37-40.

Sharma K K and Rajkhowa D J 1988 Performance of herbicides for weed control in blackgram. Pesticides 22 : 39.

Singh R V Paramar M C and Singh P P 1992 Response of blackgram (*Phaseolus mungo*) to weed control and fertilizers. Indian Journal of Agronomy 37 : 192-193.

Singh V K and Singh R P 1988 Chemical weed control in blackgram (*Vigna mungo* L.). Indian Journal of Weed Science 20 : 81-82.

Sivakumar C Balasubramanian N Krishnarajan J Mathan K K and Srinivasan P S 2001 Soil solarization on weed management in maize. Madras Agricultural Journal 88 : 697-699.

Soni K C and Harbans Singh 1988 Weed management in urdbean (*Vigna mungo* L.. Hepper). Indian Journal of Weed Science 20 : 33-37.

Srinivasa Rao K A S S 1993 Studies on weed control in soybean (*Glycine max* (L.) Merill). M.Sc. (Ag.) Thesis, Acharya N.G.Ranga Agricultural University, Hyderabad.

Subbiah and Asija G L 1956 Rapid procedure for estimation of available nitrogen in soils. Current Science 25 : 259-260.

Subhash Kumar and Yaduraju N T 1997 Soil solarization. A novel technique of pest management. Intensive Agriculture 31 : 26-27.

Sudha T Nanjappa H V Ramachandrappa B K and Mudalagiriyappa 1997 Soil solarization for weed control in finger millet and paddy nursery beds. Mysore Journal of Agricultural Science 31 : 331-335.

Sudha T Nanjappa H V Shashikant and Udikeri S 1999 Soil solarization for weed control in chilli and capsicum nursery. Crop Research 17 (3) : 356-362.

The Hindu Survey of Indian Agriculture 2000. pp. 42.

Vats O P and Sawhney J S 1981 Crop weed competition studies in blackgram (*Vigna mungo*). In Abstracts of papers, annual conference of Indian Society of Weed Science held at Bangalore, November 25 1981 pp. 28.

Venkateswarlu B 1999 Nutrient management and land configurations for sustainable groundnut production. Ph.D Thesis, Gujarat Agricultural University, Junagadh, Gujarat.

Venkateswarlu V 1986 Effects of methods of weed control and levels of phosphorus on growth and yield of blackgram. M.Sc. (Ag.) Thesis, Andhra Pradesh Agricultural University, Hyderabad.

Venkateswarlu V Rao V V Rao A S and Koteswara Rao D S 1988 Effect of methods of weed control and phosphorus levels in blackgram (*Vigna mungo*). Indian Journal of Weed Science 20 74-77.

Vijaya Bhaskar K and Nanjappa H V 1997 Effect of soil solarization on dry matter production of weeds in sunflower (*Helianthus annuus* L.). Mysore Journal of Agricultural Science 31 : 12-16.

Walkely A and Black C D 1934 Estimation of organic carbon by chromic acid titration method. Soil Science 37 : 29-38.

*Wany T Colbert D R Dobson J B Goddard G F and Hartberg T J 1984 A new grass and broadleaf herbicide for use in soybean and other legumes. Proceedings of North Central Weed Control Conference, Canada 39 : 28.

Yadav R P and Shrivastava U K 1998 Integrated weed management in blackgram. Indian Journal of Agronomy 43 (1) : 106-109.

Yaduraju N T and Ahuja K N 1990 Weed control through soil solarization. Indian Journal of Agronomy 35 (4) : 440-442.

Yaduraju N T 1993 The role of soil solarization in weed management. Proceedings of ISWS, International Symposium, Hissar, India pp. 18-20.

Yellamanda Reddy J and Sankara Reddi G H 1992 Principles of Agronomy, Kalyani publishers, Ludhiana pp. 373.

Zimdahl R C 1999 Fundamentals of Weed Science, Academic Press, London pp. 321.

* Originals not seen

Appendix

APPENDIX

CALENDER OF OPERATIONS

Date	Details of Operation
20-05-2000	Layout of the experiment
21-05-2000	Irrigation and covering T_3 and T_4 plots with polyethylene sheets
27-07-2000	Sowing and spraying of herbicides
18-08-2000	Handweeding in T_5 and T_6
02-09-2000	Spraying monocrotophos at 2 ml/L.
07-09-2000	Handweeding in T_6
11-10-2000	Harvesting of blackgram
16-10-2000	Threshing of blackgram