EFFECT OF DIFFERENT TYPES OF MULCHES ON GROWTH AND YIELD OF DRIP IRRIGATED VEGETABLES

By

E. B. GILSHA BAI

THESIS

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Faculty of Agriculture Engineering & Technology
Kerala Agricultural University

Department of Land and Water Resources & Conservation Engineering
KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY
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DECLARATION

I hereby declare that this thesis entitled "**Effect of different types of mulches on growth and yield of drip irrigated vegetables**" is a bonafide record of research work done by me during the course of research and that this thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Tavanur
3-9-1997

E.B. Gilsha Bai

CERTIFICATE

Certified that this thesis entitled "**Effect of different types of mulches on growth and yield of drip irrigated vegetables**" is a record of research work done independently by Kum. E.B. Gilsha Bai under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associateship to her.

Dr. Jobi V. Paul
(Chairman, Advisory Committe)
Associate Professor
Department of LWRCE
KCAET, Tavanur

Tavanur
3-9-1997

CERTIFICATE

We, the undersigned members of the Advisory Committee of Kum. E.B. Gilsha Bai, a candidate for the degree of Master of Technology in Agricultural Engineering majoring in Soil and Water Engineering, agree that the thesis entitled "**Effect of different types of mulches on growth and yield of drip irrigated vegetables**" may be submitted by Kum. E.B. Gilsha Bai, in partial fulfilment of the requirement for the degree.

Dr. Jobi V. Paul
(Chairman, Advisory Committee)
Associate Professor
Dept. of Land and Water Resources
and Conservation Engineering
KCAET, Tavanur

Dr. K. John Thomas
Dean, KCAET
Tavanur
(Member)

Dr. P.V. Habeeburrahman
Assistant Professor
Department of SAC
KCAET, Tavanur
(Member)

Er. Jippu Jacob
Associate Professor
Department of FPM&E
KCAET, Tavanur
(Member)

External Examiner

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Gilsha Bai E.B.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

SYMBOLS AND ABBREVIATIONS

Agri.	-	Agriculture
Agric.	-	Agricultural
Am.	-	American
ASAE	-	American Society of Agricultural Engineers
Assoc.	-	Association
Bull.	-	Bulletin
cm	-	centimetre(s)
cm^2	-	square centimetre(s)
contd.	-	continued
Dept.	-	Department
Ed.	-	Edited
Engng.	-	Engineering
ET	-	Evapotranspiration
et al.	-	and others
etc.	-	et cetra
Fig.	-	Figure
FPM&E	-	Farm Power Machinery and Energy
g	-	gram(s)
ha	-	hectare(s)
Horti.	-	Horticulture
Hortic.	-	Horticultural
i.e.	-	that is
intern.	-	international
J.	-	Journal of
KCAET	-	Kelappaji College of Agricultural Engineering and Technology

Kg	-	Kilogram(s)
Lab.	-	Laboratory
lb	-	Pound
LDPE	-	Low Density Polyethylene
Ltd	-	Limited
m	-	metre(s)
mm	-	millimetre(s)
pp	-	pages
Proc.	-	Proceedings of
Publ.	-	Publication
PVC	-	Poly Vinyl Chloride
Rept.	-	Report
Rs	-	Rupees
SAC	-	Supportive and Allied Courses
Sci.	-	Science
SJC	-	Silver Jubilee Convention
Soc.	-	Society
Stn.	-	Station
t/ha	-	tonnes per hectare
Univ.	-	University
Viz.	-	namely
°	-	degree
%	-	per cent
/	-	per
'	-	minute
"	-	Second

Introduction

INTRODUCTION

Irrigation is an age-old art and science as old as civilization. The ever increasing population of the world require more food and in many areas this will mean more irrigation. While more irrigation is needed for food production, less water will be available for irrigation, because of municipal and industrial demands. At the beginning of this century, 90% of all water used in the world was for irrigation. By 1960 it was about 80%. Currently it is about 70% and by the year 2000 it is expected to be 60% (Biswas, 1993). Water used for irrigation is still increasing but at a slower rate, not as fast as municipal and industrial use. Thus, the mandate is clear, more food be grown with less water. This means more intensive agriculture and effective utilization of available irrgation water.

In recent years the water resources are dwindling at a faster rate. Thus, it becomes necessary to increase the irrigation efficiency. The inefficiency of irrigation is mainly due to evaporation,deep percolation and tail water runoff losses, which cause individual field efficiencies to be low.

Water is an important input in agriculture. In order to reduce the loss of water from the field, the water use efficiency has to be increased. The main water loss in irrigated agriculture is through evapotranspiration. Evapotranspiration or consumptive use is the quantity of water transpired by plants during their growth or retained in the plant tissue, plus the moisture evaporated from the surface of the soil and the vegetation. The relative amounts of direct evaporation from land and water surfaces depend usually on the amount of ground cover. For most crops covering the soil surface, only a very small amount of water is lost from the ground surface.

The only way to reduce the consumptive use of water in the irrigated agriculture is to reduce evaporation by mulching and micro irrigation, to reduce the irrigated area, and to grow more drought tolerant crops. In the early stages of growth when plants are small the inter-plant area is completely exposed, resulting in large scale wastage of water due to evaporation. This loss of water from the field can be reduced by covering the inter-plant area with some materials. This process of covering the soil around the base of the plant with suitable materials is known as mulching.

Dry leaf, paddy straw, paddy husk, dry grass, saw dust, coconut husk, coconut leaves, etc., are some of the materials used for mulching. Besides these, plastic films such as Low Density Poly Ethylene (LDPE) films, Ethylene Vinyl Acetate films, etc., are used as mulches to reduce evaporation.

In mulching, the soil surface, where crops are growing is covered directly by these materials, with a very thin air space between the cover and soil surface. Mulching helps in reducing evaporation by the physical presence of mulches on the soil; thus, conserving the moisture in the soil profile.

Mulching conserves the moisture in the soil without affecting crop growth and yield. It also reduces weed growth and increase the water and fertilizer use efficiency.

Mulching generally increases yield and improves product quality by modifying the microclimate of the plants. Temperature is an important environmental factor for plant growth. Soil and air temperature play an important role in the growth and development of vegetables. The temperature of the plant environment can be modified by covering the area between plants using plastic films (Takakura, 1993). In order to improve the thermal environment of the soil, film mulching is widely used both in open fields and in green houses.

Colour of plastic film used for mulching varies from transparent to black. Each has its own specific characteristics. Transparent film creates the highest soil temperature because of the penetration of solar radiation. With coloured film, the temperature in the soil is slightly lower than in transparent film-covered soil.

Opaque mulches prevent germination of annual weeds. Mulches can also provide a barrier to soil pathogens. Mulching reduces the impact of rain drops on the soil and hinders runoff and wind erosion. Thus, it reduces the removal of organic matter and plant nutrients from soil by erosion. Natural mulching materials increases infiltration of water into the soil and improves soil structure.

Irrigation being a precious input especially during summer season; its judicious use along with mulching would certainly help in the better utilization of the available water resources. Irrigation efficiency can be increased by adopting micro irrigation methods like drip irrigation also. It is one of the latest innovative methods of irrigation which enables slow and precise application of water and nutrients to plants, avoiding soil erosion and wastage of water by evaporation and deep percolation.

The modern technique of drip irrigation was developed in Israel by Simca Blass, a water engineer in 1959. Now it is very common in countries like America, Israel, Canada, Australia, South Africa and parts of Europe. About 0.4 million hectares of cultivated land in India utilizes this system of irrigation.

In drip system, the actual water requirement of the crop is determined and applied drop by drop at the root zone of the plant, there by, reducing wastage of water.

Major advantages of drip irrigation are,

1. Water saving
2. Uniform water distribution
3. Weed control
4. Land saving
5. Less labour cost
6. Higher yield

In drip irrigation, water is applied at a slower rate to keep the moisture content most favourable for plant growth. Excess of water applied reduces plant growth as it displaces the air at the root zone, required for plant growth. Small but frequent application of water enables the plant to grow

Drip irrigation system can be used for all wide-spaced crops, as in orchards, plantations, row crops and others. Water is applied continuously over a long period through a network of tubings and water delivering devices like drippers.

Water conservation is the most obvious advantage of this system. Losses are almost fully eliminated. This system of irrigation ensures uniform application of water throughout the field which results in uniform plant growth and yield. In recent years, considerable interest has been shown in drip irrigation as a means for increasing yield, and irrigation efficiency and reducing operation costs. Soil erosion is almost eliminated in steep hilly areas by the use of this method of irrigation.

However, high initial cost of the system and the attitude of the farmers to shun the progressive methods and technologies, resulted the reduced acceptance of drip irrigation in India.

Water conservation is important in the vegetable cultivation also. Tomato, brinjal, bhindi (ladies finger), cabbage, cucumber, amaranthus, etc., are some of the vegetables grown in India. Vegetable crops occupy an area of about 1.5 million hectares in India (Yawalkar, 1985). Vegetable growing yields a much higher income per hectare than any other type of farming. A vegetable grower usually grows two to three crops a year in the same land because most of the vegetable crops are of short duration.

In many areas of India, vegetable is taken as third crop in paddy fields during summer season. Irrigation is an essential practice for the same. But the same is frequently interrupted due to the scarcity of water during the season. In this contest, drip irrigation is an effective method that can be resorted to improve the vegetable production. So during summer season the aim is to utilize the available water effectively as well as to conserve whatever moisture available in the soil. Mulching becomes a relevant practice for soil moisture conservation. Hence, drip irrigation along with mulch helps to achieve both the objectives of effecient utilization of available water and conservation of soil moisture.

In India, only a few studies are seen reported, to find out the combined effect of drip irrigation and mulching on vegatable cultivation. Hence, the present project is an attempt to study the effect of drip irrigation along with plastic mulch on yield of brinjal.

The objectives of the study are:

(1) To determine the effect of types of mulches on the growth and yield of vegetable crops.

(2) To examine the influence of type of mulch on soil temperature.

(3) To examine the variation in soil moisture with type of mulch.

(4) To find out percentage water saved by the use of mulches.

(5) To determine the effect of mulches on weed control.

Review of Literature

REVIEW OF LITERATURE

Mulching is the practice of covering the soil around plants to make conditions more favourable for growth, development and efficient crop production. Both natural and artificial materials are used as mulching materials. Natural mulches such as straw, paddy husk, coir pith, saw dust, compost, etc. are in use for centuries. The advent of synthetic materials like polyethylene, PVC and ethylene vinyl assetate have altered the methods and benefits of mulching. Many scientists from all over the world have reported that muchling increased the growth of plant and the yield from it. (Gutal *et al.*, 1993, Pulikar *et al.*, 1993, Farias *et al.*, 1994, Siwek *et al.*, 1994)

2.1 Effect of mulches on growth and yield

2.1.1 Effect of natural mulch

Patra *et al.* (1993) conducted a 2-year field study in which M. arvensis plants (Japanese mint) were muchled with rice straw and citronella distillation waste, and controls were not mulched. Herb yield was increased by 17% and 31% with rice straw and citronella distillation waste, respectively, compared with the controls. The essential oil yield was also significantly increased.

A field experiment to study the effects of irrigation schedules based on cumulative pan evaporation with and without grass mulching on two varieties of Okra (Lady's finger)was conducted by Pulekar *et al.* (1993). The pooled results revealed that scheduling of irrigation at 50 mm cumulative pan evaporation with 50 mm of water in conjunction with dry grass mulching significantly increased green fruit yield in both varieties of Okra as compared to other treatments.

2.1.2 Effect of synthetic mulch

Plants give more yield when mulched with artificial materials than with natural mulches. Reports by many research workers support this.

Free and Bay (1965) reported that,grain yields of shelled corn over a 3-year period for corn hybrids, Cornell M-10 and Robson 350, were increased by 1456 and 896 lb/acre, respectively, by the use of slit translucent plastic covers on the field as mulch. They also reported that, when the plastic cover was no slit, but was sealed to the stalks to supress evaporation and to prevent the entrance of rain, yields were at or above 5600 lb/acre, and were consistently higher than yields for unmulched plots.

According to Emmert (1969) black plastic was exceptionally good for early planting of vegetables. Bhattacharya and Madhava Rao (1985) reported beneficial responses like early maturity and higher yield by using polythene mulches.

Shikhamany *et al.* (1990) found that vine yields were highest with polythene mulch followed by straw mulch and no mulch.

According to Gutal *et al.* (1992) the use of plastics in agriculture helped to increase the production per unit area for all types of crops. Based on 3- years' data they concluded that 25 micron black LDPE film had a significant effect on the growth and yield of crops, increasing yield by 55% compared to the control treatment. In an experiment conducted by Quadir (1992) seedlings of watermelon were mulched with straw, clear polyethylene film or black polyethylene film. Control plants were not mulched. Marketable fruit yield per plant was significantly improved by mulching and was highest with black polyethylene mulch. Fruit yield per hectare was also significantly improved by mulching, polyethylene being more effective than straw.

Himelrick *et al.* (1993) conduted an experiment to find out the effect of mulch type in annual hill strawberry. The control treatment was bare ground and the plastic mulch treatments were clear plastic, black, black on white, white on black. Total yields with all mulches except white on black were significantly higher than the control. Taber (1993) reported that plastic mulch and cover treatments increased total and early yield of muskmelon compared with bare soil.

Castilla (1994) studied the influence of soil mulching with polyethylene film on garlic. Single and double garlic rows mulched with polyethylene film were compared with bare soil. Yields of fresh green plants were significantly higher in the mulched treatment. The final gralic yields were similar in the single row mulched and control treatments, but significantly higher in the double row mulched treatments than control treatments.

Two experiments were carried out by Castellane *et al.* (1994) to verify the influence of polyethylene film mulches and pest control on the development and yield of tomato. In comparison to unmulched areas mulched areas showed higher total yield. An experiment was conducted by Chakraborty and Sadhu(1994) to study the effect of different mulch types and colours on the growth and yield of tomato. Polyethylene mulches, irrespective of colour were superior to rice straw mulch in improving growth and yield of tomato.

Davis (1994) compared various mulches for fresh market basil production. Sweet basil and bush basil were grown on bare ground or mulched with black polyethylene, wheat straw, hardwood bark, pine bark or mixed wood chips. Yields throught the growing season were highest with black polyethylene mulch and lowest with hardwood and pine bark mulches.

Eltez and Tuzel (1994) investigated the possibility of using perlite as a mulch material because of its high water holding capacity and it was compared with two polyethylene films to determine the effect on yield and quality of tomatoes grown in greenhouses. Experiments were conducted during Spring and Autum 1993 with black polyethylene, white polyethylene and perlite with a granule thicknes of 3 mm. Results showed that the higest total yield in spring was obtained with black polyethylene, an increase of 25% and in autum the white polyethylene performed best, producing a 37.5% increase in yield. Perlite also performed well, producing second highest yield in spring.

In field trials conducted by Farghali (1994) aubergine plants grown on a clay soil were mulched with black or white polyethylene sheets applied before planting. Compared with unmulched controls, mulching resulted in earlier flowering and fruiting, increased plant height and greater number of branches. Average early yield and total yield was more in mulched plots compared to control plots. The white mulch resulted in slightly higher yields than the black one.

Studies by Farias *et al.* (1994) on cucumber showed that fruit number and yield were higher for mulched plots. Mulching reduced the number of days to flowering and first harvest. The effect of transparent plastic tunnels, transparent plastic film mulch, black plastic mulch, sugarcane trash mulch and no mulch on microclimatic factors, vegetative growth and cumulative yield of tomato was studied by Firake *et al.* (1994). Earliest flowering and fruiting were observed with sugarcane trash mulch. The average plant heights in the treated plots were 14.8% greater than those with no mulch. Maximum cumulative yield was observed in the transparent plastic tunnels followed by sugarcane trash mulch.

The effcts of mulches of black plastic, saw dust, straw or coarse sand on the growth and yield of 'Annona Squamosa' (custard apple) were investigated by Mandal and Chattopadhyay (1994). The highest shoot growth was observed for the straw mulch treatment. The yield was also higher for straw mulch treatment followed by black plastic mulch.

Siwek *et al.* (1994) studied the effct of mulching on changes in microclimate and on the growth and yield of sweet pepper grown in plastic tunnels. White or black polyethylene mulches were applied. The black polyethylene mulch resulted in a 10.3% increase and the white polyethylene resulted in only a 6.1% increase in the yield over the bare tunnel soil. Fruits were larger with either mulch than with no mulch.

Siwek and Libik (1994) investigated the effect of black and milk - white polyethylene sheeting and black polypropylene unwoven fabric used for mulching, on the microclimatic conditions and the growth and yield of aubergine. The use of black polyethylene and polypropylene mulch increased the marketable yield by 12.5% and 5.9% respectively, compared with bare soil. In contrast the milk- white polyethylene mulch reduced the yield by 8%. In all treatments the non-marketable yield was small and fruit was of good quality.

An experiment was conducted by Srinivas and Hegde (1994) to find out the effect of different mulches and cover crops on water relation, yield and wateruse of Robusta banana. Two mulches (rice straw and black polythene), four cover crops and a control (no mulch and cover crops) were the treatments.

Polythene as well as straw mulch significantly increased the plant height and grith. Fruit yield of banana was higher under polythene mulched than under cover-cropped banana and banana without cover crop and mulch. The yield increase with polythene mulch was 19% and with straw mulch 11%.

The effect of mulching with transparent or black plastic film on the vegetative growth and soil temperature was investigated in the greenhouse production of sweet pepper by Cebula (1995). The vegetative growth of plants were more intensive in mulched stands. The transparent film gave slightly better results than the black one. During the entire period of fruiting the highest percentage of fruit set was recorded in plants mulched with transparent plasic film, and the lowest with the unmulched control. Yields were 38.6% and 19% higher with transparent and black mulches, respectively, compared with the control. Mulching also favourably affected the marketable quality of fruits and the earliness.

Rubeiz and Freiwal (1995) conducted a study to find out the effect of row cover and black plastic mulch on tomato production. Tomato plants were grown under floating row covers, black polyethylene mulch, mulch plus row cover, and no protection (control). Early and total yields were highest with mulching and lowest with row covers. The largest fruits were produced with black mulch.

Lourduraj *et al.* (1996) conducted field experiments for four years on bhindi (Lady's finger) and for two years on tomato at Tamil Nadu Agricultural University, Coimbatore. Results revealed the beneficial effects of mulching. In the case of tomato, mulching with black LDPE recorded yield of 12.735 Kg/ha, thus registering 28.4% yield enhancement over unmulched control. In bhindi, mulching with black LDPE resulted in 50% yield increase compared with the control.

The above studies reveal that mulching, natural or synthetic, enhances the plant growth increases the yield from the plants.

2.2 Moisture retention under the mulch

In recent years the water resources are dwindling at a faster rate which warrants for judicious utilization of water. Water applied to crops is lost through evaporation from soil surface and transpiration through foliage. Moisture conservation and utilization are important in summer season to increase the efficiency of irrigation water. The essence of water conservation lies in minimizing evaporation rather than reducing the transpiration. The evaporation from soil surface depends on the type of cover on it. By providing a protective barrier on the soil surface, a mulch reduces water evaporation resulting in increased soil moisture levels. Proper conservation of soil moisture especially through mulches would ensure better growth and development of plants. Although mulches have been used for a variety of purposes, moisture conservation is considered to be the most outstanding effect.

Carolus and Downes (1958), Lippert *et al.* (1964) and Harries (1965) reported that mulching was an effective method of preventing water evaporation from the upper soil layer. Emmert (1969) reported that, even without irrigation, if the weather was not too dry, good tomatoes could be produced with the aid of plastic, owing to the conservation of moisture by mulch.

In a study conducted by Ashworth and Harrison (1983), clear polyethylene plots retained the least soil moisture compared to other plastic and natural mulches. The low soil moisture levels under the clear polyethylene were due to the high soil temperatures increasing evaporation. According to Bojadzieva and Cekleev (1984), in protected cultivation, mulches were used to control evaporation.

Sweeney *et al.* (1987), Bhella (1988) and Clough *et al.* (1990) had studied the moisture conserving property of polyethylene mulches. Gutal *et al.* (1992) conducted a study to find out the mulching effects on the yield of tomato crop. The results obtained showed that polyethylene mulch films had significant effect on the growth of tomato by conserving 28% soil moisture compared to the control treatment.

Patra *et al.* (1993) reported that mulched soils contained approximately 2 to 4% more moisture at ploughing depth than unmulched soils. According to Uthaiah *et al.* (1993) both natural and synthetic mulches had helped in conserving soil moisture in the root zone of coconut and hence enhanced the growth. Soil moisture played an important role in the growth and productivity of plant system. Among natural mulches, coir pith helped in retaining moisture for a long time. Plant height, leaf production and number of leaflets were least when plastic sheet was used as mulch.

In a study conducted by Chakraborty and Sadhu (1994) greater soil moisture conservation was observed with polyethylene mulches. The ability of rice straw mulch or water-hyacinth mulch to conserve soil moisture was appreciably lower than that of the polyethylene mulch. Gupta and Acharya (1994) conducted an experiment on strawberry using different mulches and reported that water-use efficiency in terms of fruit yield per centimeter of water used was maximum under the black polyethylene.

Srinivas and Hegde (1994) conducted a study to find out the effect of mulches and cover crops on `Robusta' banana. The treatments consisted of two mulches, rice straw and black polyethylene, and four cover crops along with a control (no mulch and cover crops). Water use of banana was lowest under the polyethylene mulch, followed by straw mulch, and was highest when banana was raised with cover crops. The evapotranspiration under polyethylene mulch decreased by 8% and 14% compared with that under straw mulch and no mulch. Water-use efficiency was highest under pollyethylene mulch, largely due to higher yield and reduced evapotranspiration.

From the above studies it is found that mulching reduces the evaporation and thus increases the soil moisture content in the crop root zone.

2.3 Effect of mulch type on soil temperature

Temperature is an important environmental factor for plant growth. The temperature of the plant environment can be modified by covering the area. Thermal conditions in the root zone can also be changed by plastic mulching.

Soil temperature beneath the transparent mulch is higher than that of the plots without mulch (Hopen, 1965; Waggoner *et al.*, 1960; Knavel and Mohr, 1967), which enables the advancing of seeding or planting time.

Ashworth and Harrison (1983) conducted an experiment to determine the effect of six synthetic and two organic mulches on weed control, water conservation, soil temperature and soil-air oxygen concentration. They found that each mulch created its own unique soil temperature regime. Soil temperatures under clear polyethylene were significantly higher than under all other mulches. In contrast, the two organic mulches maintained soil temperatures significantly cooler than all other treatments from noon until evening. All synthetic mulches maintained day time temperatures significantly higher than the control.

Ochigbo and Harris (1989) reported that the use of plastic cover produced marked increase in the growth and yield of bush tomatoes. Early yield was also increased by the use of cover. According to them these effects were attributable to higher temperature under the polyethylene. Himelrick *et al.* (1993) studied the effect of mulch type on annual hill strawberry and reported that highest soil temperature occured under the clear plastic mulch and the lowest on bare ground.

Castilla *et al*. (1994) conducted a study to find out the effect of mulching with clear polyethylene film on garlic. Soil temperatures were significantly higher in the mulched treatments than in control, increasing growth and development of the plants. Castellane *et al*. (1994) from their experiment on tomato reported that in comparison to unmulched areas, plastic mulched areas showed higher soil temperature.

Chakraborty and Sadhu (1994) reported that polyethylene mulches increased the soil temperature by 2 to 3°C above the control. Whereas plots mulched with natural materials such as straw or water-hyacinth were not different from the control. Gupta and Acharya (1994) conducted an experiment on strawberry and reported that the use of black polyethylene mulch was superior to that of transparent polyethylene. The beneficial effects of transparent polyethylene due to rise in soil temperature during the initial growth stage was counteracted during the fruiting stage due to higher soil temperature. Where as black polyethylene raised the soil temperature 2 to 3°C during night over unmulched soil and did not alter the day temperature.

According to Larios *et al*. (1994) all the polyethylene mulches increased the soil temperature compared with the control. They also reported that clear film significantly increased soil temperature compared with black and white film. Mandal and Chattopadhyay (1994) investigated the effect of mulches on the growth and yield of `Annona Squamosa' and found that mulching increased the soil temperature and yield compared with the control.

Siwek *et al*. (1994) conducted an experiment to study the effect of white and black polyethylene mulches on sweet pepper. Temperature measurements taken at 8.00 hr showed, the soil under black mulch was, on average, 0.5°C warmer, while that under white polyethyene was 0.5°C cooler than the bare soil. Changes in microclimate affected the plant growth. Mulching resulted in an increase in total and marketable yield. The highest marketable yield was found in black mulched units, which might be attributed to the higher soil temperature. Siwek and Libik (1994) studied the changes in microclimate of mulched egg plant and reported higher temperature and yield from plastic mulched plots.

The effect of mulching sweet pepper with transparent or black plastic film on soil temperature and some features of vegetative growth of plants was investigated by Cebula (1995).

Compared with the unmulched control, the temperature of the soil was, on average, 2°C higher under transparent and black plastic mulch at depths of 4 cm and 12 cm. The transparent film ensured higher soil temperatures during the day, while the loss of heat energy at night was to a greater degree prevented by the black mulch.

The above literatures give a clear indication that there is an increase in soil temperature and improvement in microclimate of the plants by the use of plastic mulch.

2.4 Effect of mulching on weed control

Weed menace in cropped fields is increasing at an alarming rate in spite of the concerted efforts to get rid of it. Apart from manual weeding, weeds can also be controlled by using chemicals. But this cause serious pollution of the eco-system. Soil solarization and plastic mulching are effective methods for weed control and are recommended by many researchers. This involves heating the soil surface by using plastic sheets placed on moist soil to trap the solar radiation. The basic phenomenon which helps in weed control is the lethally high soil temperature built up the soil beneath the sheet.

Clarkson and Frazier (1957) reported that polyethylene mulching materials were effective for weed control. Ashworth and Harrison (1983) conducted a study to determine the effect of organic and synthetic mulches on weed control, water conservation and soil temperature. They found that the opaque synthetic mulches like black polyethylene remained intact throughout the summer and thus provided the most effective weed control. The worst weed problems were associated with straw and clear polyethylene. Benoit (1994) had also reported the weed control and soil conditioning effect of black plastic mulch.

The results of the study conducted by Chakraborthy and Sadhu (1994) were similar to that obtained by Ashworth and Harrison (1983). Weeds did not grow at all in the plots mulched with black polyethylene. Clear polyethylene allowed considerable weed growth, and the fresh and dry weights of weeds under clear polyethylene mulch were as high as those obtained with rice-straw mulch. According to Davis (1994) all mulches organic or synthetic, provided acceptable weed control.

Gupta and Acharya (1994) found that black polyethylene suppressed weed growth whereas transparent polyethylene encouraged excessive weed growth. Shrivastava *et al.* (1994)

conducted an experiment on tomato and found that a combination of drip with black plastic mulch could control the weeds as high as 98%. In a similar study (Anonymous, 1989) it was reported that black plastic mulch and sugar cane trash mulch could reduce the weed growth to the tune of 91% and 87% respectively.

According to Srinivas and Hegde (1994) mulches not only helped in moisture conservation but reduced weed competition and increased the water and fertilizer use efficiency.

From the above studies it is seen that mulching reduces the weed growth considerably which in turn reduces the cost of cultivation.

2.5 Effect of different colours of plastic mulches

The colour of film used for mulching varies, from transparent to black. Each has its own specific characteristics. Several scientists have studied the effect of mulch colour on the growth and yield of crops, soil temperature, weed control etc.

Decoteau *et al.* (1988) conducted a study to find out mulch colour effects on reflected light and tomato plant growth. Differences in the growth of tomato grown with white and black coloured polyethylene mulch were evaluated in a greenhouse. The surface colour of plastic mulch could change the quantity of light and the spectral balance reaching the plants, with resulting effects on growth and fruit production. The surface colour of the mulch affected root-zone temperatures also. Soil temperature 2.5 cm below the black mulch surface averaged almost 1°C higher than soil temperatures below the white mulch surface.

In their work with tomatoes Decoteau *et al.* (1989) found that plants grown over red mulch had the highest early marketable yields and produced the least amount of foliage, while plants grown over white or silver coloured mulch had lower early marketable yields but produced more foliage.

Brown *et al.* (1992) conducted a study to determine the effect of plastic mulch colour on the yield and earliness of tomato. The various treatments were six coloured plastic mulches, a clear plastic mulch and an unmulched control. Early marketable yields were significantly higher from plants grown over aluminium, red or black mulch than from those grown over white mulch. Total marketable yields were higher from plants grown over green or aluminium coloured mulch than from plants grown over black or white mulch. Reflective mulches had no advantage over unmulched or clear plastic mulch in either earliness or total yield.

In an experiment conducted by Quadir (1992) seedlings of watermelon were mulched with straw, clear polyethylene and black polyethylene. Controls were not mulched. Marketable fruit yield/plant was highest with black polyethylene.

Albregts and Chandler (1993) investigated the effect of polyethylene mulch colour on the fruiting response of strawberry. The mulch colours used were black, white, blue, brown, green, orange, red, and yellow. The early yield was increased in all three seasons by using yellow mulch and during two seasons by white mulch, compared with black mulch. The total yield was reduced with some coloured mulches during two of the seasons. The soil temperature in the beds was highest throughout the season with the blue mulch and lowest with the white and yellow mulches.

Chakraborty and Sadhu (1994) conducted an experiment to study the effect of different mulch types and colours on the growth and yield of tomato, weed growth, soil temperature etc. Among the mulch colours, black and red polyethylene increased plant height by 23.8 and 30.9% respectively compared with the control. Black colour advanced the flowering period by 10 days and red colour by 11 days. Early flowring, greater number of fruits/plant and larger fruit size with red and black polyethylene resulted in 77.0 and 73.3 % higher yield, respectively, compared with the control. Black polyethylene completely suppresed the weed growth. Other colours, viz. blue, white etc. also checked the weed growth, whereas clear polyethylene and natural mulching materials were markedly less efficient. Black polyethylene was found most economical.

In field trials conducted by Farghale (1994) aubergine plants grown on a clay soil were mulched with black and white polyethylene sheets and the controls were not mulched. He reported that white mulch resulted in slightly higher total yield than the black one. In an experiment conducted by Farias *et al.* (1994) cucumber seeds were sown in beds and covered with clear, white or black plastic mulch. Controls were not mulched. Beds received micro irrigation. The highest number of fruits and yield were obtained with clear plastic mulch. White or black mulch also significantly increased yield.

Gabriel *et al.* (1994) conducted a 2-year experiment to evaluate the effect of mulch colur on early and total yield of fresh market tomatoes. Treatments consisted of no mulch, clear polyethylene, black polyethylene, and white/black polyethylene mulch films. Mulch colour affected early and total yield in both years. Among the mulches clear polyethylene showed the highest soil temperature and white/ black film the lowest. The highest early and total yields were obtained from plants grown with clear or black polyethylene. In both seasons, early or total yields were not improved with white/black mulch.

An experiment by Gupta and Acharya (1994) on strawberry showed that the use of black polyethylene mulch was superior to that of transparent polyethylene. Water-use efficiency in terms of fruit yield per centimetre of water used is maximum under the black polyethylene. Larios *et al.* (1994) found that clear polyethylene gave more marketable yield from cucumber than white and black mulches.

Rosano *et al.* (1994) conducted a field trial in which tomatoes were grown on plots covered with a photodegradable black film mulch, a photodegradable transparent film mulch, a conventional black film mulch, a conventional transparent film mulch, or on bare soil. Conventional and photodegradable black film mulches were considered more suitable than transparent ones. The effect of white and black polyethylene mulches on the microclimate in plastic tunnels and on the growth and yield of green pepper was investigated by Siwek *et al.* (1994). Marketable yield from treatments with white mulch was exceeded by the yield from unmulched plots by 6.1%. The highest marketable yield was found in black mulched units, which was 10.3% more than the yield from bare soil plots.

The efect of mulching with transparent or black plastic film on soil temperature and some features of the vegetative growth of plants was investigated by Cebula (1995) in the greenhouse production of sweet pepper. The transparent film assured higher soil temperatures during the day, while the loss of heat energy at night was to a greater degree prevented by the black mulch. In the case of vegetative growth, slightly better results were noted with the transparent film than with the black one.

2.6 Effect of drip irrigation on growth and yield

Drip irrigation is one of the latest methods of irrigation which enables slow and precise application of water and nutrients to precise locations, eliminating soil erosion and wastage of water by evaporation and deep percolation.

The first experiment on drip irrigation began in Germany in 1869, where clay pipes were used as a combination of irrigation and drainage systems. Present drip irrigation technology owes to Simca Blass, who developed and used this technology in 1963 in Israel. With the success stories of this system waving around, a number of inventors and companies began to develop and study drip irrigation system. Goldberg (1971) described drip irrigation as a multi-disciplinary agricultural practice and has enormous potentials and possibilities.

Field experiments with drip irrigation in tomatoes in Israel have shown yield per ha 65% greater than that obtained by furrow and sprinkler irrigation. Abrol and Dikshit (1971) compared drip method with conventional basin method of irrigation in India for onions and okra. They found significant increase in yield and water-use efficiency in the drip method which was ascribed to increased availability of soil moisture at low tension and reduced surface evaporation.

Cole (1971) reported that drip irrigation resulted in considerable increase in water- use efficiency over furrow and sprinkler irrigation. Grobellar (1971) reported that drip irrigated Apple orchards produced 81.8% more total yield than when it was flood irrigated during the previous season. In case of drip irrigated grapes for vine production a yield increase of 190% was obtained.

Sivanappan *et al.* (1975) conducted experiments with vegetables and cash crops and observed that water used in drip method was only 1/2 to 1/5 of the controlled surface methods and at the same time yield was increased to 10 to 40% in many crops. They also reported in 1976 on the response of banana to drip irrigation and compared it to the check basin method. No significant differences in yield of banana was observed under the two methods. Quantity of water used in drip irrigated plots was only one fourth of the check basin method.

Goldberg *et al.* (1976) explained drip irrigation as a new agro-technical approach for growing crops under controlled conditions of soil moisture, fertilization, salinity and pest control. It has significant response on crop yield and timing of harvest. Sivanappan *et al.* (1976) introduced drip irrigation as a novel method to save water. Irrigation experiments on vegetable crops indicated a considerable saving in water use and an increase in yield as compared to surface methods.

Gupta and Tyagi (1985) studied the effect of trickle irrigation and surface irrigation on the water use and salt accumulation. When compared with surface irrigation system, trickle irrigation results in 35% higher water-use efficiency and 32% lower salt accumulation. Bui and Kinoshita (1985) and Batchelor *et al.* (1990) showed that drip irrigation can be adopted for the irrigation of sugarcane that it is technically the most practical method of ensuring freedom of the crop from drought and maximizing the yield.

The above studies give a clear indication that drip irrigation is advantageous for plant growth and it conserves considerable amount of water also.

2.7 Combined effect of drip irrigation and mulching

Drip irrigation as well as mulching can increase the growth and yield of crops. Many scientists have studied the effect of drip irrigation and mulching on different crops separately. But very few workers have studied the combined effect of drip and mulch on the yield of crops.

Shajari *et al.* (1990) conducted research on water saving on sandy soil in drip irrigation. Aimed at economising on irrigation water experiment was conducted on sandy loam soil. The experiment concluded that in dry agricultural areas plastic mulch could be a good tool in keeping moisture in drip irrigated plant rows to an optimal level before seeding is resumed. The problems due to reduced rate of application can be compensated by high frequency irrigation.

An investigation on the evaluation of differwnt types of mulches and irrigation methods on the growth of pre-bearing coconut plants was carried out by Uthaiah *et al.* (1993). Different mulches used were coir pith, paddy husk, black polythene sheet, and jalashakti, and different irrigation methods were earthen pitcher, drip irrigation, and pot watering. The data on plant height, number of leaves produced per year, and frond characters as influenced by different mulches and quantity of water did not differ significantly. Increase in plant height and production of leaf was more in plants under drip irrigation and coir pith mulch. Among the different mulches, coir pith was found to be better than other mulches in terms of vegetative growth. Better growth of plants under mulch and irrigation could be attributed to higher soil moisture content.

Shrivastava *et al.* (1994) studied the effect of drip, mulches, and irrigation levels on tomato yield. The treatments comprised of various combinations of two irrigation methods - drip and surface flood - with and without two mulches of either black plastic or sugarcane trash. The study revealed that drip plus sugarcane trash mulch scheduled at 0.4 pan evaporation (PE) levels was the best combination, which gave the highest fruit yield, with 44% water saving. In areas of high weed intensity drip at 0.4 PE along with plastic mulch could be adopted. This treatment resulted in 95% deduction in weed infestation, 53% higher yield and 44% saving in irrigation water when compared with the surface flood without mulch treatment.

In the study conducted at Plasticulture Development Centre, Tavanur (Anonymous, 1997), to find out the effect of drip irrigation along with plastic mulching on bhindi, the maximum yield was obtained from flood irrigated plots with black polyethylene mulch. Black mulched drip irrigated treatment with 0.8V volume of water gave next higher yield.

From the studies cited above it is seen that drip irrigation as well as mulching can reduce cost of crop production and increase productivity. So it is necessary to study the combined effect of drip irrigation and mulching on crop production. Only a few studies are seen reported in India, to find out the effect of drip irrigation along with mulching on vegetable production. Hence, this study was under taken.

Materials and Methods

MATERIALS AND METHODS

The materials used and methodology adopted for conducting experiment, data collection and analysis are presented in this chapter. A field experiment to find out the effect of different colours of plastic mulches and different levels of drip irrigation on the growth and yield of brinjal was conducted during February, 1996 to June, 1996.

3.1 Location

The experiment was conducted in the Instructional farm, Kelappaji College of Agricultural Engineering and Technology (KCAET), Tavanur. It is situated at 10° 53' 30" north latitude and 76° east longitude.

3.2 Climate

Agroclimatically, the area falls within the border line of Northen zone and Central zone of Kerala. Most part of the rainfall received in this region is from south-west monsoon. The average annual rainfall varies from 2500 mm to 2900 mm.

3.3 Season and weather conditions

The experiment was conducted during the summer season of 1996. Rainfall occured and recorded at the Instructional

Farm of KCAET, Tavanur, for the period of investigation are presented in Appendix-I.

3.4 Soil

The relative proportion of sand, silt and clay determines the soil texture. The surface soil is sandy loam in texture comprising of 10 per cent gravel, 65 per cent sand and 12.5 per cent clay.

3.5 Experimental Procedure

The procedure employed for conducting the field experiment to estimate the effect of plastic mulch colour and drip irrigation on vegetable production is described here. In the experiment two types of irrigation methods were used viz. surface irrigation and drip irrigation. Three levels of irrigation water were applied in the drip treatments. Two colours of plastic mulches were used. The controls were not mulched. In each plots 4 brinjal (Solanum melongena) plants were planted in a line with 60 cm spacing between the plants.

3.5.1 Land Preparation

The field was prepared for planting by ploughing with a tractor drawn cultivator.

3.5.2 Layout of the experiment

The experiment was laid out with 3 replications and 12 treatments as follows.

T1 - Drip irrigation with V volume of water applied.

T2 - Drip irrigation with 0.8V volume of water applied.

T3 - Drip irrigation with 0.6V volume of water applied.

T4 - Control with surface method and V volume of water.

T5 - Drip irrigation with V volume of water + black plastic mulch

T6 - Drip irrigation with 0.8V volume of water + black plastic mulch

T7 - Drip irrigation with 0.6V volume of water + black plastic mulch

T8 - Control with surface method with V volume of water + black plastic mulch.

T9 - Drip irrigation with V volume of water + transparent plastic mulch

T10 - Drip irrigation with 0.8V volume of water + transparent plastic mulch.

T11 - Drip irrigation with 0.6V volume of water + transparent plastic mulch.

T12 - Control with surface method with V volume of water + transparent plastic mulch.

The experimental layout is shown in fig.1

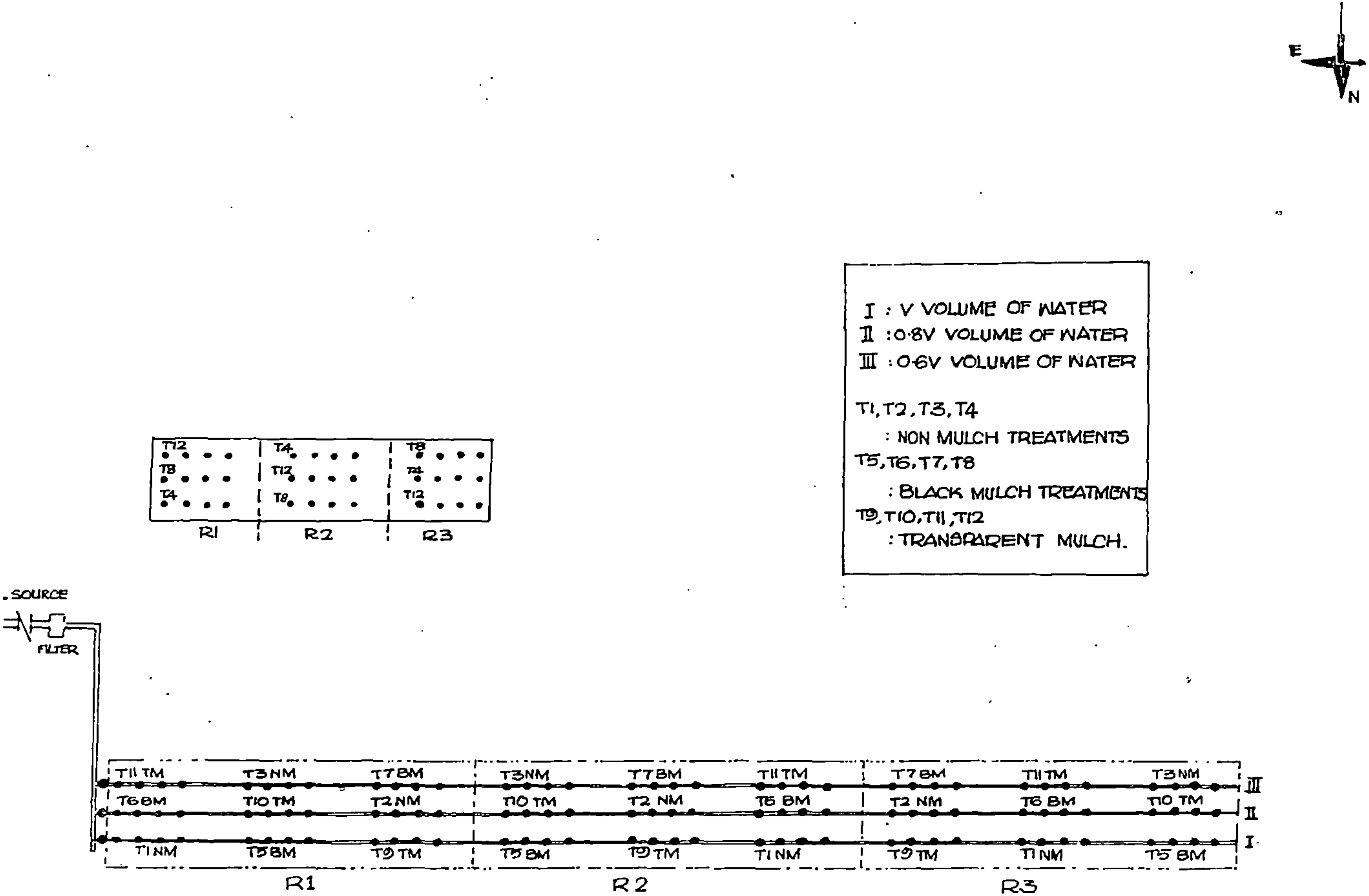

Fig.1 Layout of the experiment

Plate 1. Experimental set-up

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3.5.3 Drip system installation

Field was prepared and drip system was installed in the field. There were three laterals in the drip system, so that each lateral was used for applying different level of irrigation.

3.5.4 Mulch spreading and planting

Two colours of plastic sheets - black and transparent were used for mulching. Position of each treatment plot and position of plants in each plot were marked as per the layout. Fertilizers, compost and chemical fertilizers were applied in the soil around the position of the plant. Recommendations in the `package of practice' were followed to find out the quantities of fertilizers required. Nitrogen was applied as urea, phosphorus as super phosphate and potassium as muriate of potash. Fertilizers were fully applied as basal dose, because spreading of the mulch material prevented the split application.

For planting the seedlings, small holes were made in the polyethylene sheets as per the spacing required after spreading the mulch sheets in respective plots. Seedlings of 40 days of age were transplanted into the field from the nursery. The ends of the sheets were covered by soil to prevent evaporation and blowing off by wind.

3.5.5 Irrigation

Water requirement of the crop was calculated using modified Penman formula and shown in Appendix-II. From ET_0 ET_{crop} for each month was calculated by multiplying it with crop coefficient (K_c) for various stages.

$$ET_{crop} = ET_0 * K_c$$

From this ET_{crop} values daily water requirement per plant `V' was calculated. In drip treatments three levels of irrigation were used, viz. V, 0.8V and 0.6V. In the drip system, there were three laterals and each lateral was used for applying each level of irrigation. Level of irrigation, that is, volume of irrigation water applied was regulated by adjusting the time of operation. A tap connector was fixed at the head end of each laterals. Irrigation was started at the same time in all the three laterals. Irrigation was given daily.

3.5.6 Plant protection

To prevent shoot and fruit borers in plant, pesticide `Ekalux' was sprayed in all plots once in three weeks.

3.6 Experimental Observations

Observations on moisture content, soil temperature, plant height, plant spread, weight of weeds and yield were taken. Details are given below.

3.6.1 Moisture content

Soil moisture content at 5 cm depth in the root zone was determined in every plots before and after each irrigation by gravimetric method.

Soil moisture depleted from the root zone in an interval of successive irrigations is the difference between moisture content after one irrigation and just before next irrigation. Percentage water saving by the use of plastic mulches was calculated from the soil moisture depletion. Percentage water saving is the ratio of difference in moisture depletion from nonmulched and mulched plots of same method and level of irrigation to moisture depletion from the nonmulched plot.

3.6.2 Soil temperature

Soil temperature was measured at soil surface and 5 cm below the surfacce in the root zone. The measurement was taken in between 2 pm and 3 pm, because at that time soil attains maximum temperature of that day. Ordinary mercury thermometer was used for measuring temperature.

3.6.3 Biometric observations

Biometric observations viz. plant height and plant spread were taken weekly. A square shaped wooden frame was made to measure the plant spread. Holding the square frame over the plant, by visual observation plant spread was determined. Flowering date of each plant in the different treatments was also recorded.

3.6.4 Wet weight of weeds

Weeds were removed manually from all unmulched plots once in three weeks. Weights of the removed weeds were noted.

3.6.5 Harvesting

Harvesting was started 37 days after transplanting. Harvesting was done weekly from all the plots. Weight of fruits harvested from each plot was recorded.

3.7 Analysis of the data observed

Statistical analysis of the data obtained was done using the computer package named MSTATC. Analysis of variance was done to find out the significant difference in the observations with respect to treatments. The level of significance used was $P = 0.05$. Critical differences were also calculated for all the observations. The results are presented in the next chapter.

Results and Discussion

RESULTS AND DISCUSSION

Results obtained from the experiment "Effect of different types of mulches on growth and yield of drip irrigated vegetables" are presented and discussed in this chapter after analysing the observations taken during the course of work.

4.1 Effect of mulch colour on soil temperature

Soil temperature measurements were taken between 2 pm and 3 pm. Temperature measured during this time was considered as the maximum soil temperature of that day. Measurement of maximum soil temperature at soil surface and 5 cm below the soil surface were taken. Surface soil temperature was always higher than soil temperature measured 5 cm below the surface in all plots.

Variation in soil temperature at surface and 5 cm below the surface with various treatments is shown in fig.2. Effect of mulching and irrigation levels on the surface soil temperature and soil temperature at 5 cm depth is shown in tables 1 and 2 respectively. Treatments with black mulch as well as transparent mulch increased the soil temperature compared to the nonmulched treatments. Transparent mulch treatments irrespective of irrigation method and level of irrigation showed very high temperature between 2 pm and 3 pm.

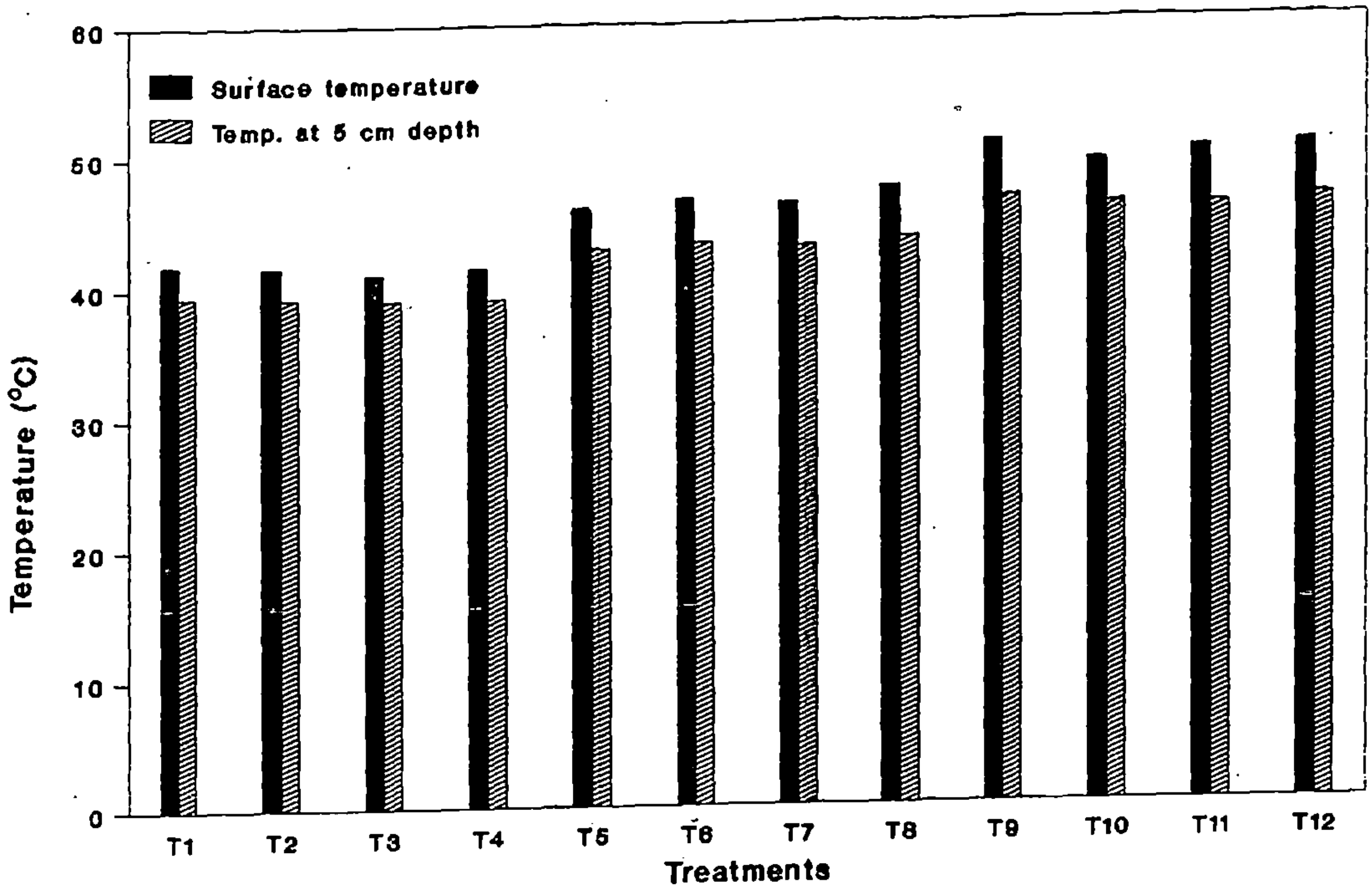

Fig.2 Variation of soil temperature with treatments

Table 1. Average soil temperature (°C) at the surface

Treatments	week 1	week 2	week 3	week 4	week 5	week 6	week 7	week 8	week 9	week10	week11	week12	week13
T1-Drip (V Vol.)	42.83	42.67	45.33	39.67	43.00	41.67	41.33	41.17	42.00	41.33	41.33	41.00	39.00
T2-Drip(0.8V Vol.)	41.33	42.83	44.33	39.33	44.00	42.00	41.00	40.50	41.67	42.33	40.67	41.00	38.83
T3-Drip(0.6V Vol.)	41.33	43.00	43.33	39.67	42.67	41.00	41.67	40.83	41.00	41.33	40.00	40.00	37.17
T4-Surface(V Vol.)	41.50	42.83	43.50	39.83	43.33	40.67	42.00	40.50	41.67	40.33	41.00	40.33	41.00
T5-Drip (V Vol.) + BP	46.17	45.00	46.67	45.00	49.00	46.33	46.67	44.50	45.67	46.00	47.67	45.00	43.17
T6-Drip(0.8V Vol.)+BP	46.16	45.83	47.83	45.67	50.00	47.67	47.33	46.00	45.00	47.33	47.33	44.67	45.33
T7-Drip(0.6V VOl.)+BP	46.17	45.83	49.67	44.67	49.00	46.67	45.33	43.83	46.00	47.67	47.33	45.33	43.00
T8-Surface(V Vol.)+BP	48.16	44.83	50.17	46.00	50.00	48.67	48.00	43.50	49.33	47.33	47.33	45.67	46.67
T9 -Drip(V Vol.) +TP	52.33	51.50	54.00	47.67	54.67	51.33	50.67	49.67	51.33	50.67	49.33	48.33	47.33
T10-Drip(0.8V Vol.)+TP	51.00	48.67	51.00	47.00	50.33	49.33	48.00	50.17	48.33	47.67	50.33	48.67	49.00
T11-Drip(0.6V Vol.)+TP	51.33	49.16	51.67	48.67	51.33	50.33	49.83	51.50	50.33	50.00	49.67	46.67	49.37
T12-Surface(V Vol.)+TP	51.33	52.83	50.67	49.00	54.67	51.00	51.00	49.83	48.00	49.67	50.00	47.00	48.83
S.E.m +	0.9552	0.9552	1.122	0.6205	1.272	1.087	1.061	0.6478	1.096	1.250	0.968	1.222	1.111
C.D. at 5%	2.801	2.801	3.290	1.820	3.731	3.188	3.110	1.900	3.215	3.666	2.839	3.585	3.258
Air temperature (C)	38	38	39.5	36	38	35	36.5	36	37	36	35	35.5	35

Table 2. Average soil temperature (°C) at 5 cm below the surface

Treatments	week 1	week 2	week 3	week 4	week 5	week 6	week 7	week 8	week 9	week10	week11	week12	week13
T1-Drip (V Vol.)	39.83	40.00	40.67	37.50	40.33	39.00	39.00	39.67	39.33	40.00	39.50	39.33	38.10
T2-Drip(0.8V Vol.)	39.17	40.83	40.33	37.50	40.33	38.33	39.33.	38.83	39.00	39.67	39.67	39.67	37.33
T3-Drip(0.6V Vol.)	39.17	40.17	39.83	37.17	40.33	38.50	39.33	39.67	38.67	39.33	39.00	39.00	36.63
T4-Surface(V Vol.)	39.33	39.33	40.33	37.67	39.33	38.33	40.33	39.50	39.00	38.33	39.67	39.00	38.17
T5-Drip (V Vol.) + BP	42.17	42.67	44.33	41.33	45.33	42.67	44.00	41.83	42.00	42.67	44.33	42.00	40.83
T6-Drip(0.8V Vol.)+BP	41.50	43.33	45.67	41.16	46.33	44.16	43.66	42.67	41.50	43.50	44.33	42.33	41.83
T7-Drip(0.6V VOl.)+BP	42.33	43.33	46.33	40.83	45.00	43.00	43.00	41.67	42.50	43.83	43.33	42.17	40.67
T8-Surface(V Vol.)+BP	42.67	42.67	44.67	42.00	47.00	44.17	44.33	41.67	43.50	43.67	44.00	42.00	42.83
T9 -Drip(V Vol.) +TP	47.00	46.67	49.33	44.83	49.33	46.50	46.83	47.00	46.17	47.67	45.67	43.00	44.00
T10-Drip(0.8V Vol.)+TP	46.33	46.00	48.33	42.50	48.33	45.67	45.00	47.67	44.33	44.00	47.00	45.67	45.17
T11-Drip(0.6V Vol.)+TP	47.00	45.67	48.33	43.67	46.33	44.67	44.50	49.33	46.00	46.17	45.00	43.33	44.83
T12-Surface(V Vol.)+TP	46.17	48.50	47.00	44.67	50.50	47.00	46.83	47.33	43.67	47.00	45.33	44.14	45.65
S.E.m +	0.6445	0.656	0.9941	0.5771	0.9545	0.9445	0.8771	0.5357	0.918	1.14	1.036	1.017	0.6885
C.D. at 5%	1.89	1.924	2.916	1.692	2.799	2.77	2.572	1.571	2.692	3.344	3.038	2.981	2.019
Air temperature (C)	38	38	39.5	36	38	35.5	36.5	36	37	36	35	35.5	35

Transparent mulch transmits almost all the light and heat energy into the soil. This might be the reason for higher soil temperature beneath the transparent sheet.

Soil temperature at the surface and at 5 cm below the soil surface were higher than the control by 3 to 4°C in the black mulch treatments. But these temperatures were less than the temperatures observed in the transparent mulch treatments. Black mulch does not transmit all the light and solar energy into the soil. It also prevents the loss of heat energy from the soil. Thus it increased the soil temperature slightly, compared to the non-mulched treatments. This slight increase in soil temperature in the root zone was advantageous to the crop.

4.2 Effect of mulch on moisture conservation

Presence of a cover over the soil in the inter-plant area reduced the evaporation from the soil surface. Thus mulch increased the moisture level in the crop root zone. Only the amount of water that was absorbed by the plant was removed from the crop root zone. Effect of mulching on soil moisture is shown in table 3. The moisture depleted from the non-mulched drip irrigated plots was observed more compared to the mulched treatments. There was only slight difference in the moisture depletion with various irrigation levels.

Table 3. Average soil moisture depletion (%)

Treatments	week 1	week 2	week 3	week 4	week 5	week 6	week 7	week 8	week 9	week10
T1-Drip (V Vol.)	10.62	12.93	11.34	11.15	11.46	11.15	10.47	9.41	10.84	11.06
T2-Drip(0.8V Vol.)	9.33	10.64	10.20	8.99	9.68	8.96	9.41	8.40	8.65	9.28
T3-Drip(0.6V Vol.)	9.33	9.61	9.37	9.43	9.05	9.28	9.11	8.05	8.87	9.05
T4-Surface(V Vol.)	17.14	17.51	18.44	13.00	16.11	18.16	17.88	18.29	17.87	17.94
T5-Drip (V Vol.) + BP	6.42	6.44	7.05	7.32	6.18	6.58	7.11	6.48	7.05	6.92
T6-Drip(0.8V Vol.)+BP	6.43	6.11	6.48	5.56	5.64	7.32	6.76	6.74	6.35	6.21
T7-Drip(0.6V Vol.)+BP	6.09	6.08	6.77	5.32	5.20	5.70	5.88	5.86	5.83	5.71
T8-Surface(V Vol.)+BP	12.63	12.66	11.94	10.57	11.79	11.23	9.55	9.77	9.92	10.17
T9 -Drip(V Vol.) +TP	7.42	6.78	6.55	6.58	6.87	7.22	6.08	6.32	6.50	6.89
T10-Drip(0.8V Vol.)+TP	6.82	6.23	6.44	6.19	5.79	6.98	5.99	6.33	6.40	6.13
T11-Drip(0.6V Vol.)+TP	5.86	5.54	6.11	6.47	5.51	6.40	6.10	6.12	6.01	5.76
T12-Surface(V Vol.)+TP	12.83	12.27	12.36	10.27	10.83	9.77	9.92	11.71	10.91	10.42
S.E.m +	0.5495	0.6517	0.6829	0.6369	0.6403	0.6807	0.719	0.7757	0.5961	0.584
C.D. at 5%	1.612	1.911	2.003	1.868	1.878	1.996	2.109	2.275	1.748	1.713

But non-mulched and mulched treatments showed significant difference in the moisture depletion.

Black mulched and transparent mulched plots did not show significant variation in moisture depletion. Even though the soil moisture in the root zone was more, treatments with transparent mulch resulted in low yield and plant growth. The adverse effects of high temperature was more pronounced in the transparent mulched treatments. Average soil moisture depleted was minimum in the T7 (0.6V volume drip + black mulch) treatment (fig.3). Increased soil moisture in the root zone of the plant under the black mulch favourably attributed to the plant growth and yield.

Water saving (per cent) by the use of black plastic mulch was about 32 to 35%. Transparent mulch also saved 30 to 34% water compared to non-mulched treatments. Mulching increases the moisture level in the root zone. This increase in moisture level is achieved by preventing the loss of water due to eveporation and might have resulted in the corresponding water saving. This saved water can be used for irrigating more area.

4.3 Effect of mulching and drip irrigation on growth

Plant height and spread were measured weekly to study the effect of mulching and drip irrigation on the vegetative

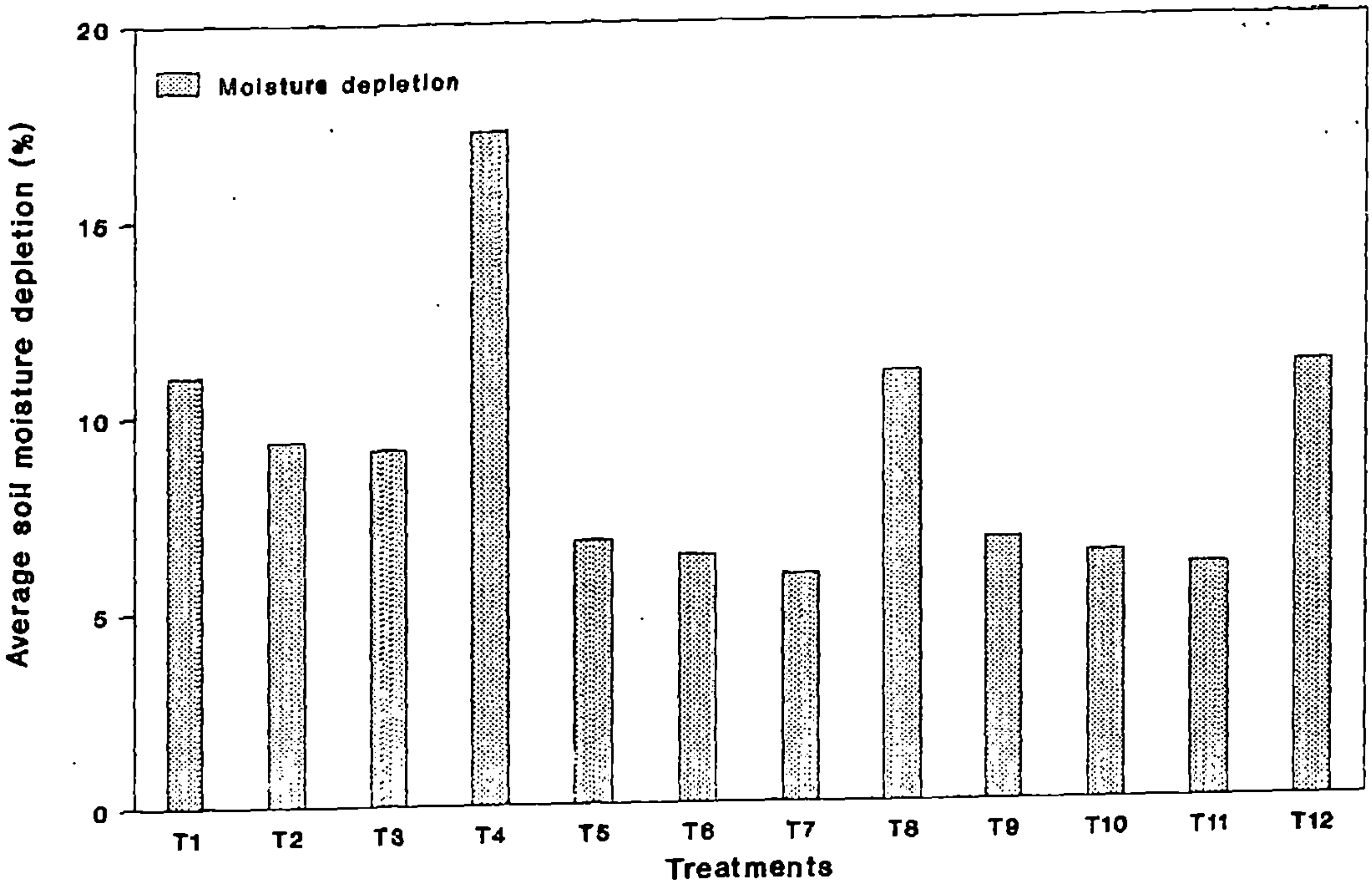

Fig.3 Variation of soil moisture depletion with treatments

growth of the plants. Average values of plant height is shown in table 4. Treatments with black mulch showed higher plant heights when compared to other treatments in first few weeks. But finally maximum average height of the plant (44.16 cm) was observed in the non-mulched drip irrigated treatment with 0.8V volume of water. During the last few weeks of observation, black mulched and non-mulched treatments did not show any significant difference in the plant height.

The variation of final plant heights with treatments are shown in fig.4. Average height of the plants in the case of transparent mulch treatments were significantly lower than the control treatment. Minimum plant height (32.25 cm) was observed in the treatment T9 (V volume drip + transparent mulch). High soil temperature developed beneath the transparent mulch may be the reason for reduced plant height in the treatments with transparent mulch.

Method of irrigation and level of irrigation water did not show much effect on the plant height.

Plant spread was another observation taken to study the effect of mulch colour and level of irrigation on growth of vegetables. Variation of final plant spread with various treatments is shown in fig.5. Drip irrigated transparent mulch treatments irrespective of irrigation level showed very low values of plant spread. Surface irrigated transparent

Plate 2. Plot with black mulch

Plate 3. Plot with transparent mulch

Table 4. Week wise plant height (cm)

Treatments	week 1	week 2	week 3	week 4	week 5	week 6	week 7	week 8	week 9	week 10
T1-Drip (V Vol.)	9.50	11.09	14.42	17.50	22.92	29.58	37.08	39.26	40.83	41.17
T2-Drip(0.8V Vol.)	11.17	13.75	16.75	20.08	25.75	31.33	40.92	42.75	44.08	44.16
T3-Drip(0.6V Vol.)	9.92	11.08	14.17	16.50	20.50	24.17	35.19	38.25	42.17	42.42
T4-Surface(V Vol.)	9.42	10.25	12.50	16.75	22.75	29.17	37.83	39.50	42.33	42.51
T5-Drip (V Vol.) + BP	8.50	9.25	11.25	14.00	18.33	22.25	31.83	38.74	41.25	42.50
T6-Drip(0.8V Vol.)+BP	10.75	12.67	15.83	18.25	23.50	27.58	34.33	37.50	40.83	41.55
T7-Drip(0.6V Vol.)+BP	11.25	13.42	16.42	18.58	22.58	27.17	36.17	40.08	42.50	43.00
T8-Surface(V Vol.)+BP	12.42	14.75	18.08	21.33	25.58	30.92	38.33	40.25	41.50	42.00
T9 -Drip(V Vol.) +TP	10.50	12.08	14.83	16.00	18.00	19.75	24.92	27.67	31.92	32.25
T10-Drip(0.8V Vol.)+TP	9.75	10.83	13.75	15.42	18.75	21.25	27.25	31.42	33.83	34.10
T11-Drip(0.6V Vol.)+TP	9.17	10.42	13.39	15.08	16.83	18.92	22.33	27.42	31.78	32.50
T12-Surface(V Vol.)+TP	11.17	12.75	16.25	18.58	22.74	27.08	34.08	35.41	36.00	36.25
S.E.m +	0.866	1.344	1.756	1.810	2.044	2.604	3.417	2.926	3.015	2.896
C.D. at 5%	2.540	3.943	5.151	5.307	5.994	7.637	10.02	8.583	8.843	8.494

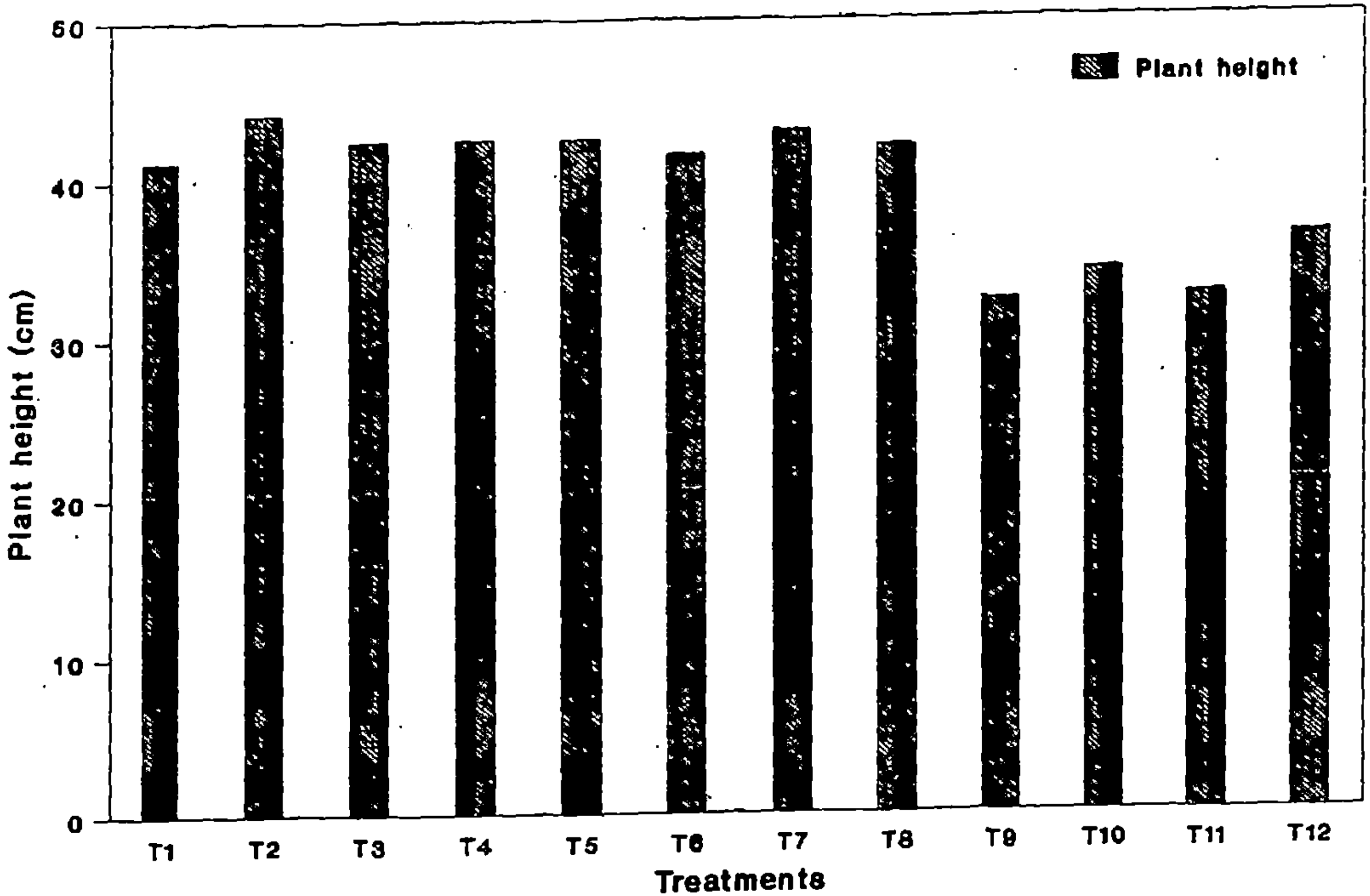

Fig.4 Variation of final plant height with treatments

Plate 4. Non-mulched plot

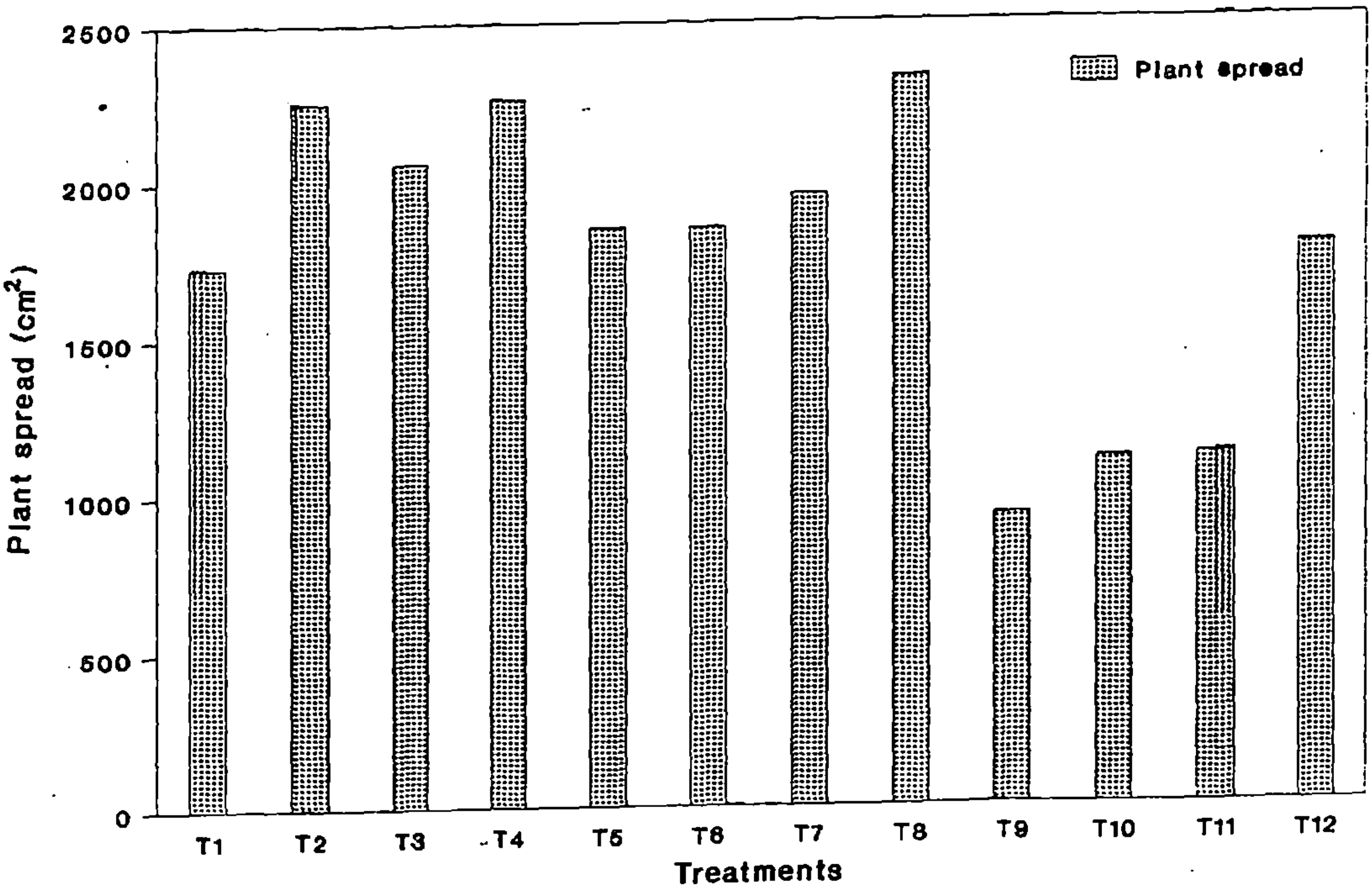

Fig.5 Variation of final plant spread with treatments

mulch treatment gave slightly higher value than drip irrigated treatments. Here also the reason for low plant spread in the treatments with transparent mulch may be the high soil temperature developed beneath it.

Effect of mulching and drip irrigation on plant spread is shown in table 5. In non-mulched treatments, no significant variation was observed in plant spread with the method or level of irrigation. Among black mulched treatments surface irrigated treatment gave more plant spread than drip irrigated treatments. This revealed that surface irrigation resulted in better plant spread in both black and trasnsparent mulched treatments. Exess water applied through surface irrigation may be the reason for this better plant spread.

4.4 Effect of mulching on weed control

Significant reduction in weeds was observed in the treatments with mulches (table 6). Weeding was done from all non-mulched plots, both in surface irrigated and drip irrigated, once in three weeks. Practically there was no need of weeding from the plastic mulched plots. Absence of light under the black mulch and high soil temperature and low intensity of solar radiation under the transparent mulch gave an unfavourable condition for germination and growth of weeds.

Table 5. Week wise plant spread (sq.cm.)

Treatments	week 1	week 2	week 3	week 4	week 5	week 6	week 7	week 8	week 9	week 10
T1-Drip (V Vol.)	105.95	126.60	231.44	368.10	727.14	1258.97	1650.29	1675.51	1712.06	1731.94
T2-Drip(0.8V Vol.)	125.97	208.92	296.68	453.62	947.84	1638.04	1896.14	2067.41	2210.29	2250.31
T3-Drip(0.6V Vol.)	80.08	168.23	215.13	330.62	700.74	1064.05	1673.24	1873.84	2056.51	2059.34
T4-Surface(V Vol.)	110.28	190.17	306.38	388.37	870.27	1443.10	1957.52	2130.28	2256.41	2260.53
T5-Drip (V Vol.) + BP	75.27	101.31	149.15	279.19	582.24	987.34	1443.10	1715.30	1822.15	1850.45
T6-Drip(0.8V Vol.)+BP	106.37	145.77	244.66	361.48	731.23	1137.15	1713.85	1768.77	1808.61	1850.50
T7-Drip(0.6V Vol.)+BP	82.47	109.03	178.54	306.38	675.93	1231.91	1661.74	1876.74	1922.33	1950.65
T8-Surface(V Vol.)+BP	120.83	248.99	376.91	456.70	1029.49	1849.22	2293.26	2310.08	2315.42	2320.30
T9 -Drip(V Vol.) +TP	80.67	110.14	152.09	212.92	452.38	771.64	896.4	905.48	920.55	925.0
T10-Drip(0.8V Vol.)+TP	75.48	109.28	166.62	252.60	432.61	774.34	1025.31	1057.11	1092.38	1102.36
T11-Drip(0.6V Vol.)+TP	85.62	115.46	167.37	217.33	422.64	712.07	907.01	1003.92	1091.92	1110.50
T12-Surface(V Vol.)+TP	125.43	172.95	352.66	406.01	671.51	1326.68	1724.26	1752.39	1770.67	1781.35
S.E.m +	15.18	34.60	50.75	55.01	118.8	230.3	227.10	228.6	236.4	235.4
C.D. at 5%	44.51	101.50	148.80	161.40	348.60	675.5	666.00	670.4	693.3	690.4

Table 6. Influence of plastic mulching on weed control

Treatments	Wet wt. of removed weed (g)
T1-Drip (V Vol.)	4033.33
T2-Drip(0.8V Vol.)	4000.00
T3-Drip(0.6V Vol.)	3685.00
T4-Surface(V Vol.)	5216.67
T5-Drip (V Vol.) + BP	0.0
T6-Drip(0.8V Vol.)+BP	0.0
T7-Drip(0.6V VOl.)+BP	0.0
T8-Surface(V Vol.)+BP	0.0
T9 -Drip(V Vol.) +TP	0.0
T10-Drip(0.8V Vol.)+TP	0.0
T11-Drip(0.6V Vol.)+TP	0.0
T12-Surface(V Vol.)+TP	0.0
S.E.m +	64.24
C.D. at 5%	188.40

Plate 5. Effect of mulchinig on weed growth

Wet weight of removed weeds was maximum in the non-mulched surface irrigated treatment (5216 g). In drip irrigated non-mulch treatments, weeds were comparatively less. The reason may be reduced wetted area in drip irrigated plots.

4.5 Effect of mulching on flowering of the plants

Effect of different mulches on the flowering of plants is shown in table 7. Plants in the mulched plots took less no of days to flower after transplanting. Minimum number of days to flower was observed in the surface irrigated black mulch (T8) treatment. T3 (0.6V drip + nonmulch) treatment took maximum number of days to flower. Early flowering is one of the major advantages of mulching. Improved micro climate of the plants may be the reason for this.

4.6 Effect of synthetic mulch and drip irrigation on yield

The yield from each plant was collected. It was observed that all the treatments with black mulch gave better yield compared to other treatments. The average yield obtained from various treatments are shown in table 8. The yield obtained was maximum in the black mulched drip irrigated plants with 0.8V volume of water i.e. T6 treatment. Yield from this treatment was 76.49% higher than T4 i.e. the non-mulched

Table 7. Influence of plastic mulching on the number of days to flower in brinjal

Treatments	No. of days to flower
T1-Drip (V Vol.)	37
T2-Drip(0.8V Vol.)	34
T3-Drip(0.6V Vol.)	42
T4-Surface(V Vol.)	37
T5-Drip (V Vol.) + BP	32
T6-Drip(0.8V Vol.)+BP	30
T7-Drip(0.6V VOl.)+BP	30
T8-Surface(V Vol.)+BP	26
T9 -Drip(V Vol.) +TP	29
T10-Drip(0.8V Vol.)+TP	34
T11-Drip(0.6V Vol.)+TP	30
T12-Surface(V Vol.)+TP	31
S.E.m +	1.863
C.D. at 5%	5.463

Table 8. Average yield of brinjal from the various treatments

Treatments	Total yield (tones/ha)
T1-Drip (V Vol.)	6.873
T2-Drip(0.8V Vol.)	11.647
T3-Drip(0.6V Vol.)	7.353
T4-Surface(V Vol.)	7.923
T5-Drip (V Vol.) + BP	11.717
T6-Drip(0.8V Vol.)+BP	13.983
T7-Drip(0.6V VOl.)+BP	12.773
T8-Surface(V Vol.)+BP	13.727
T9 -Drip(V Vol.) +TP	4.06
T10-Drip(0.8V Vol.)+TP	4.893
T11-Drip(0.6V Vol.)+TP	3.937
T12-Surface(V Vol.)+TP	9.207
S.E.m +	2.426
C.D. at 5%	7.117

surface irrigated control treatment. Other black mulched treatments viz. black mulch plus drip irrigation with V volume of water (T5), black mulch plus drip irrigation with 0.6V volume of water (T7), black mulch plus surface irrigation with V volume of water (T8) also gave significantly higher yield when compared to the control. Yield from these treatments were 47.89%, 61.21% and 73.26% higher than the control, respectively. Results obtained from the experiment conducted by Gutal *et al.* (1992) supports this result. They found that black LDPE film increased the yield by 55% compared to the control treatment. Increased yield from the black mulched treatments may be due to the increased soil moisture content in the root zone, slightly increased soil temperature under the black plastic sheet, less weed growth and early flowering and maturity of the fruits.

The percentage increase or decrease in yield from all treatments compared with the control is shown in fig.6.

All transparent mulch treatments except T12 (transparent mulch + surface irrigation) treatment gave lesser yield than the control. The reduction in yield in T9, i.e. transparent mulch plus drip irrigation with V volume of water, T10, i.e., transparent mulch plus drip irrigation with 0.8V volume of water, and T11 i.e., transparent mulch plus drip irrigation with 0.6V volume of water were 48.76%, 38.24% and 50.31%, respectively. This reduction in yield may be due to the

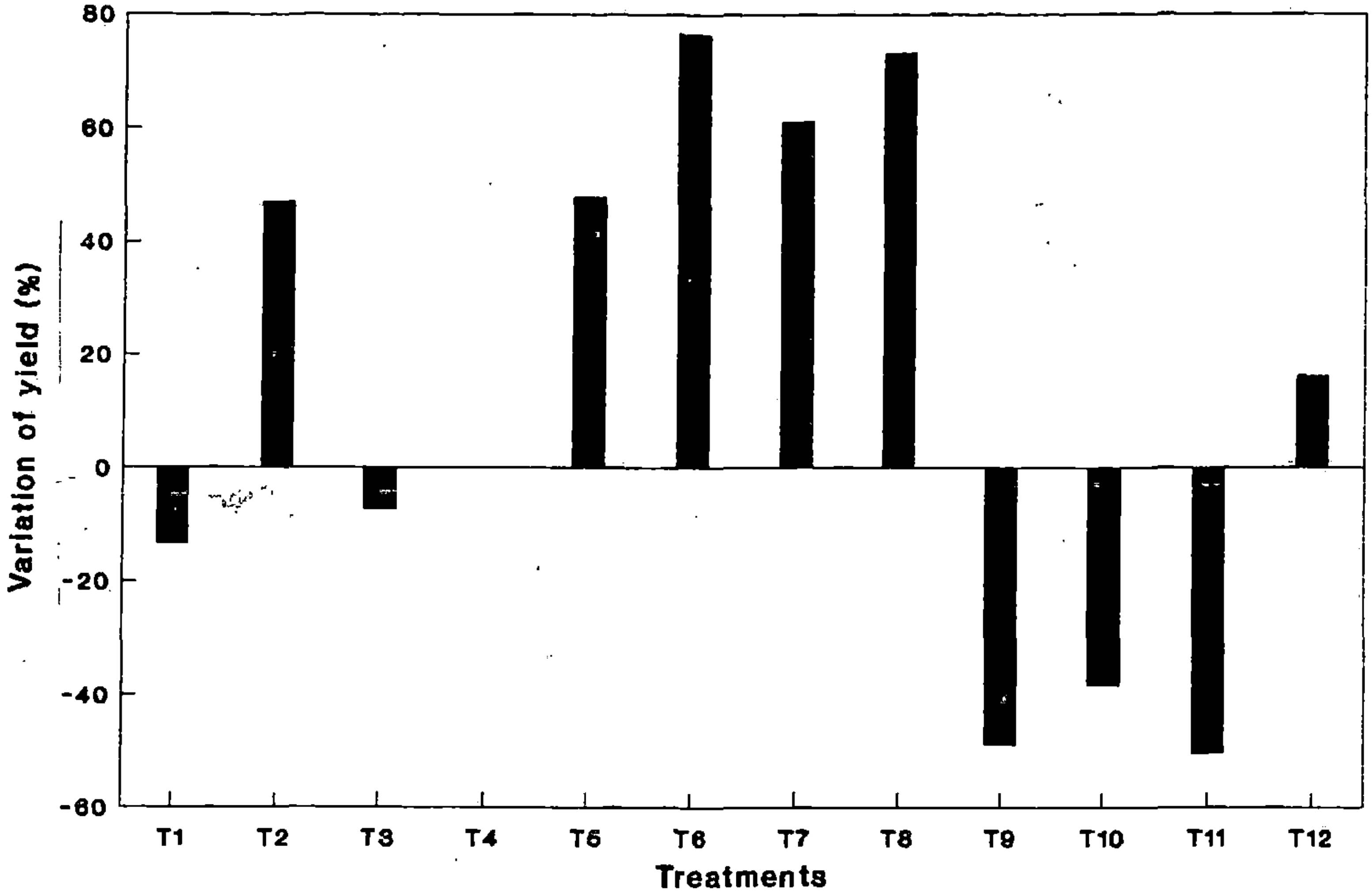

Fig.6 Percentage variation of yield with treatments

adverse effect of higher soil temperature developed under the transparent film in the root zone of the plants. Minimum yield was obtained from the transparent mulch plus drip irrigation with 0.6V volume of water treatment.

Yield from non-mulched drip treatment with 0.8V volume of water was slightly higher than the control treatment. Other non-mulched drip irrigated treatments (T1 & T3) gave lesser yield than control treatment (T4). But yield from these treatments were significantly higher than transparent mulch treatments. Treatment T2, i.e., drip irrigated non-mulched treatment with 0.8V volume of water, showed an increase in the yield by 47% when compared with the control. Treatments T1 and T3 showed a decrease in yield by 13.25% and 7.19%. In the black mulched and transparent mulched treatments surface irrigation increased the yield than drip irrigation.

Among the different transparent mulched treatments, only T12, i.e., transparent mulch plus surface irrigation treatment gave more yield than the control. This indicates that surface irrigation gave more yield than drip irrigation method, but in water scarce areas we can increase irrigation potential and thereby yield by the use of drip irrigation. Use of mulches, especially black polyethylene mulch further enhance the yield and profit. Among the black mulched treatments drip irrigated treatment with 0.8 V volume of water gave slightly better yield than T8 (black mulch + surface irrigation) treatment.

In both type of mulch treatments drip irrigation with 0.8V volume of water applied, gave more yield compared to other levels of irrigation. In the non-mulched treatments also higher yield was obtained from the drip irrigated plots with 0.8V volume of water. So in drip method this level of irrigation is better than other levels of irrigation. Since water application is frequent and losses are less in drip method plants require only 0.8V volume of water by this method of irrigation.

4.7 Relation between soil temperature and yield

Variation of soil temperature, both at surface and 5cm below the surface with various treatments is shown in fig.7. It also shows the variation of yield with treatments. Temperatures observed in the treatments with black mulch were 3 to 4°C more than the non-mulched treatments. Maximum temperature in the treatments with transparent mulch was 6 to 7°C more than that of the non-mulched treatments. Yield from the black mulched treatments was considerably higher than the non-mulched and transparent mulched treatments. Treatments with transparent mulch gave very low yield. This showed that slight increase in soil temperature by the use of black plastic mulch was beneficial to the plants, and high

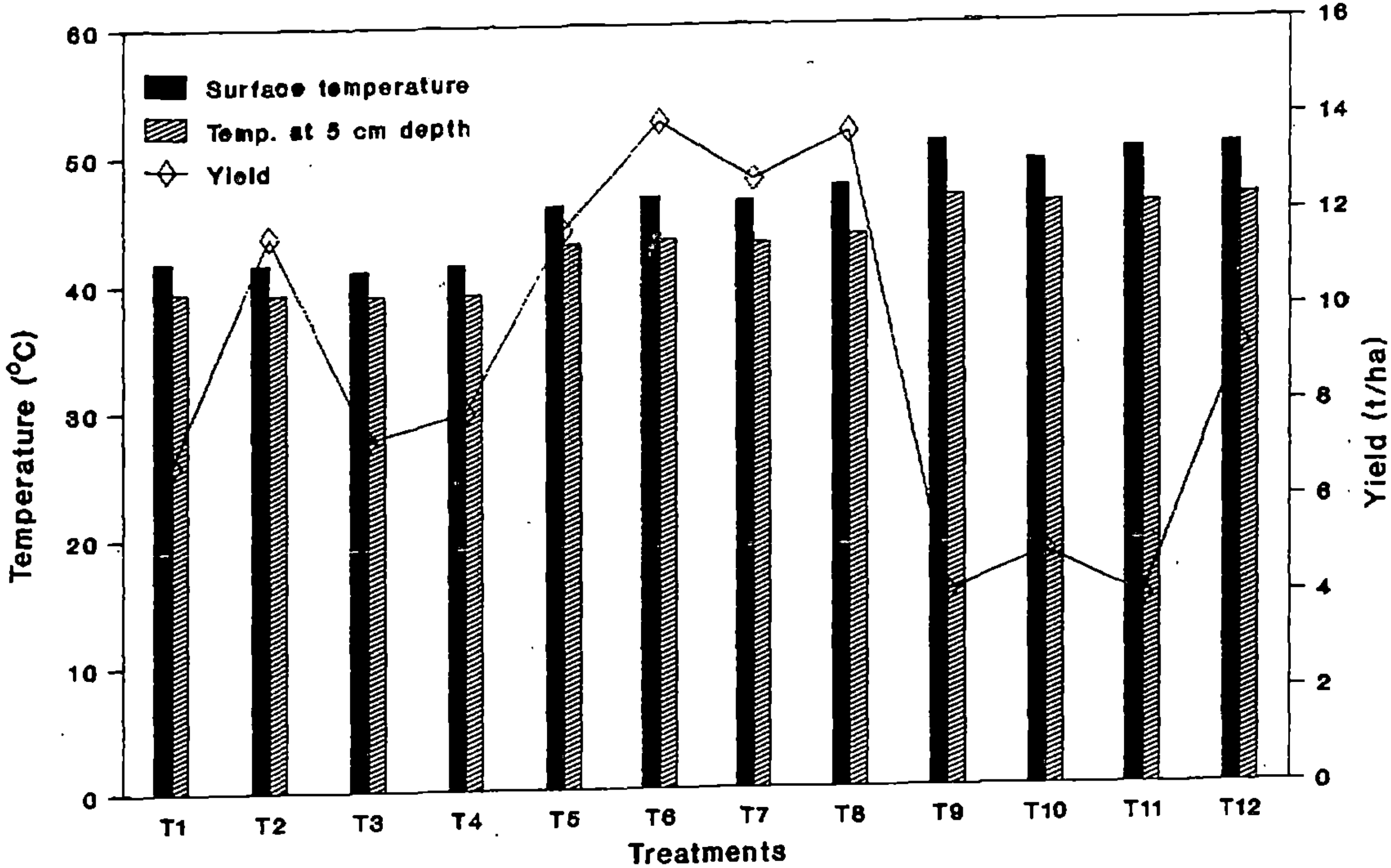

Fig.7 Variation of yield and soil temperature with treatments

soil temperature under the transparent mulch adversely affected the plant. So yield increase was noticed with increase in soil temperature upto a level of about 46°C at soil surface and then decrease in yield was noticed with increase in soil temperature.

4.8 Relation between moisture depleted and yield

Moisture depleted and yield from various treatments are shown in fig.8. Mulched treatments, both black and transparent, showed less moisture depletion when compared to the non-mulched treatments. Compared to non-mulched and transparent mulched treatments, black mulched treatments gave more yield. From the figure it is clear that there is no direct relation between yield and moisture depleted from the soil.

4.9 Relation between plant height and yield

Variation in plant height and yield with various treatments is shown in fig.9. From the figure it is clear that yield does not depend on plant height. There was no particular relation between plant height and yield.

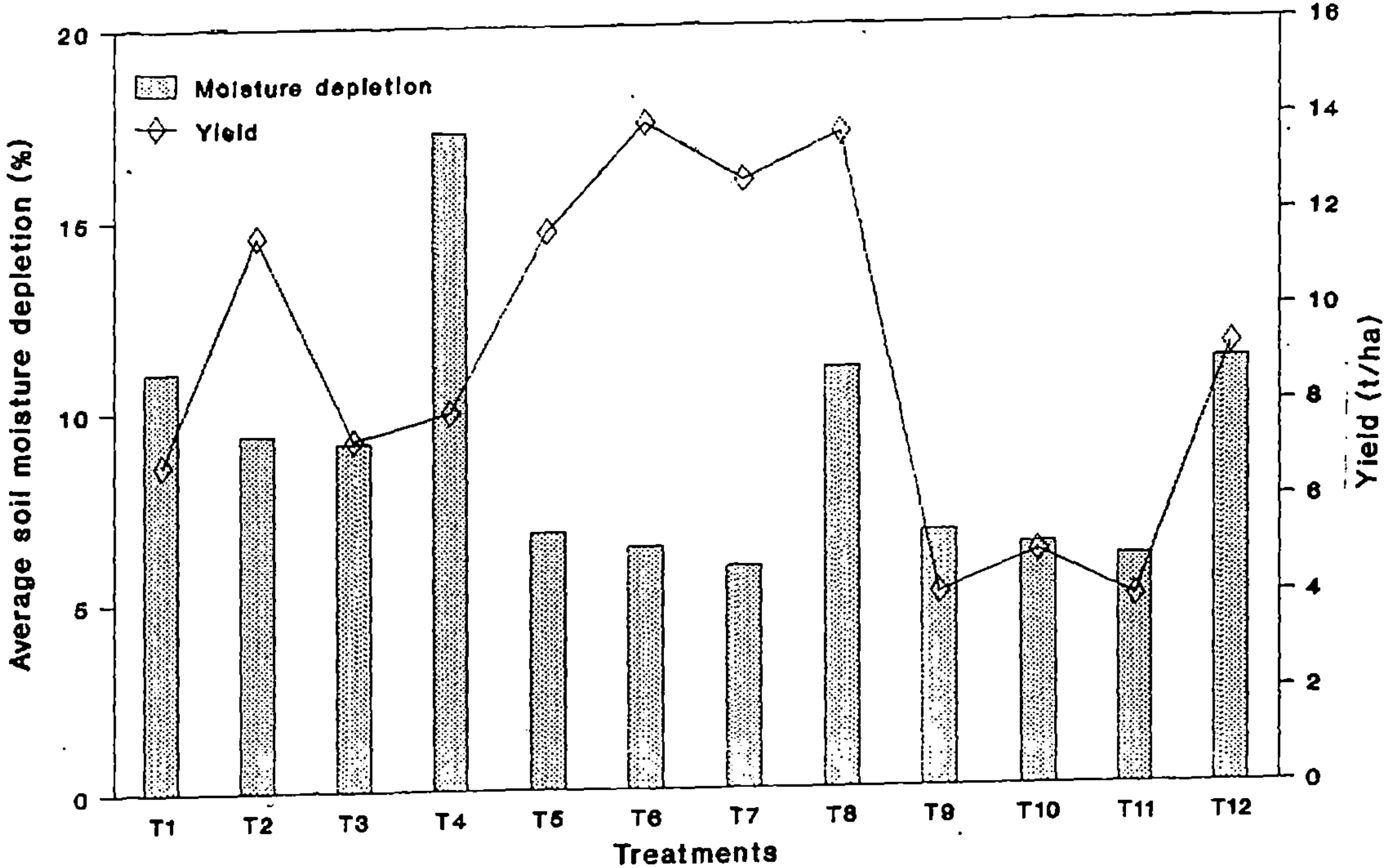

Fig.8 Variation of yield and moisture depletion with treatments

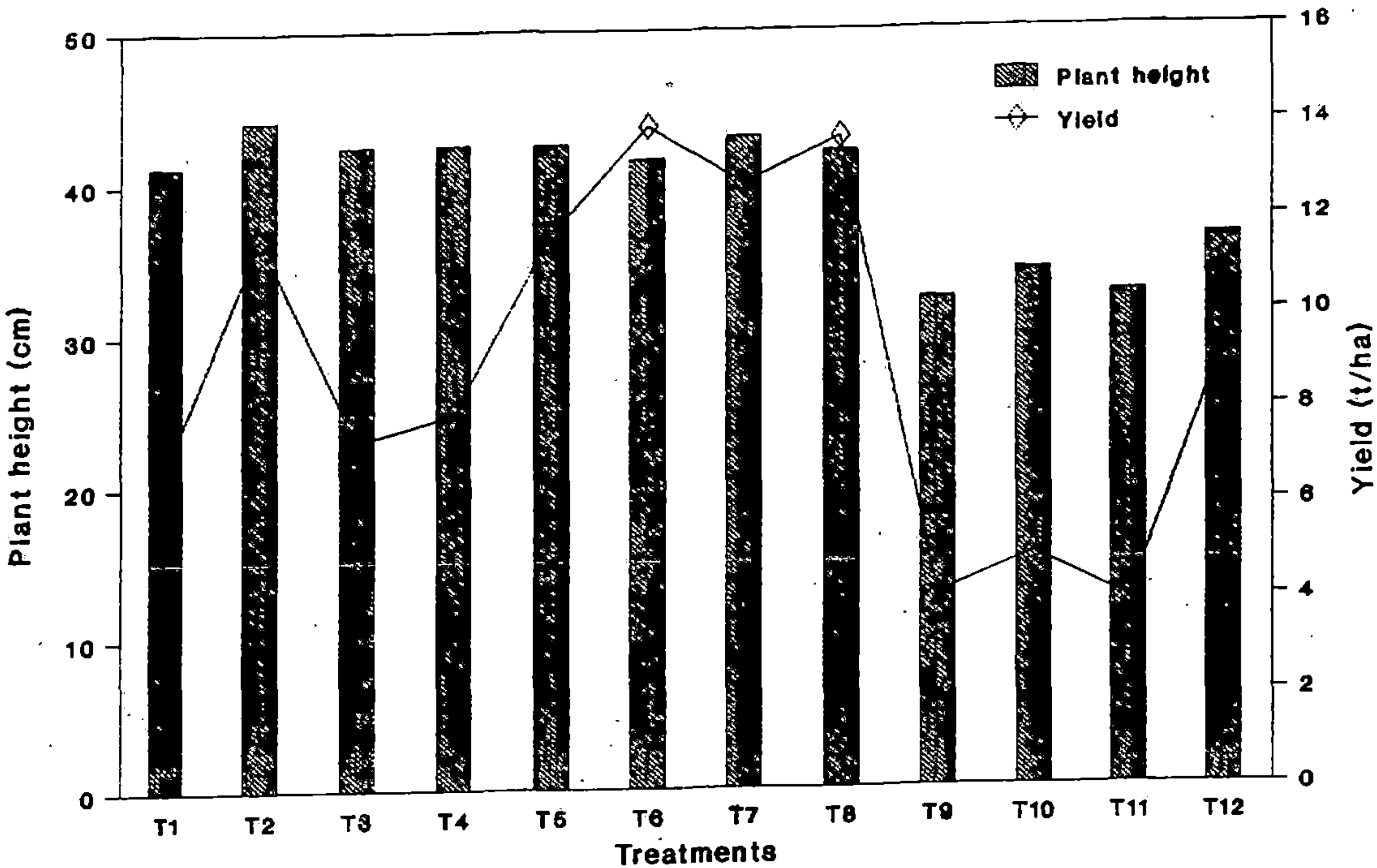

Fig.9 Variation of yield and plant height with treatments

4.10 Relation between plant spread and yield

The variation in plant spread and yield with various treatments is shown in fig.10. Non-mulched plots showed more plant spread compared to mulched plots. But black mulched surface irrigated plot gave maximum plant spread (2320.30 cm). There was no significant difference in the plant spread between the non-mulched and black mulched treatments. In the transparent mulched and non-mulched plots yield increase was noticed with increase in plant spread. In the black mulched plots such trend was not noticed. Among the nonmulched treatments T2 showed maximum spread (2250.31 cm) and maximum yield.

4.11 Cost Analysis

Cost of cultivation and benefit cost ratio for various treatments was worked out. Details are shown in Appendix-III.

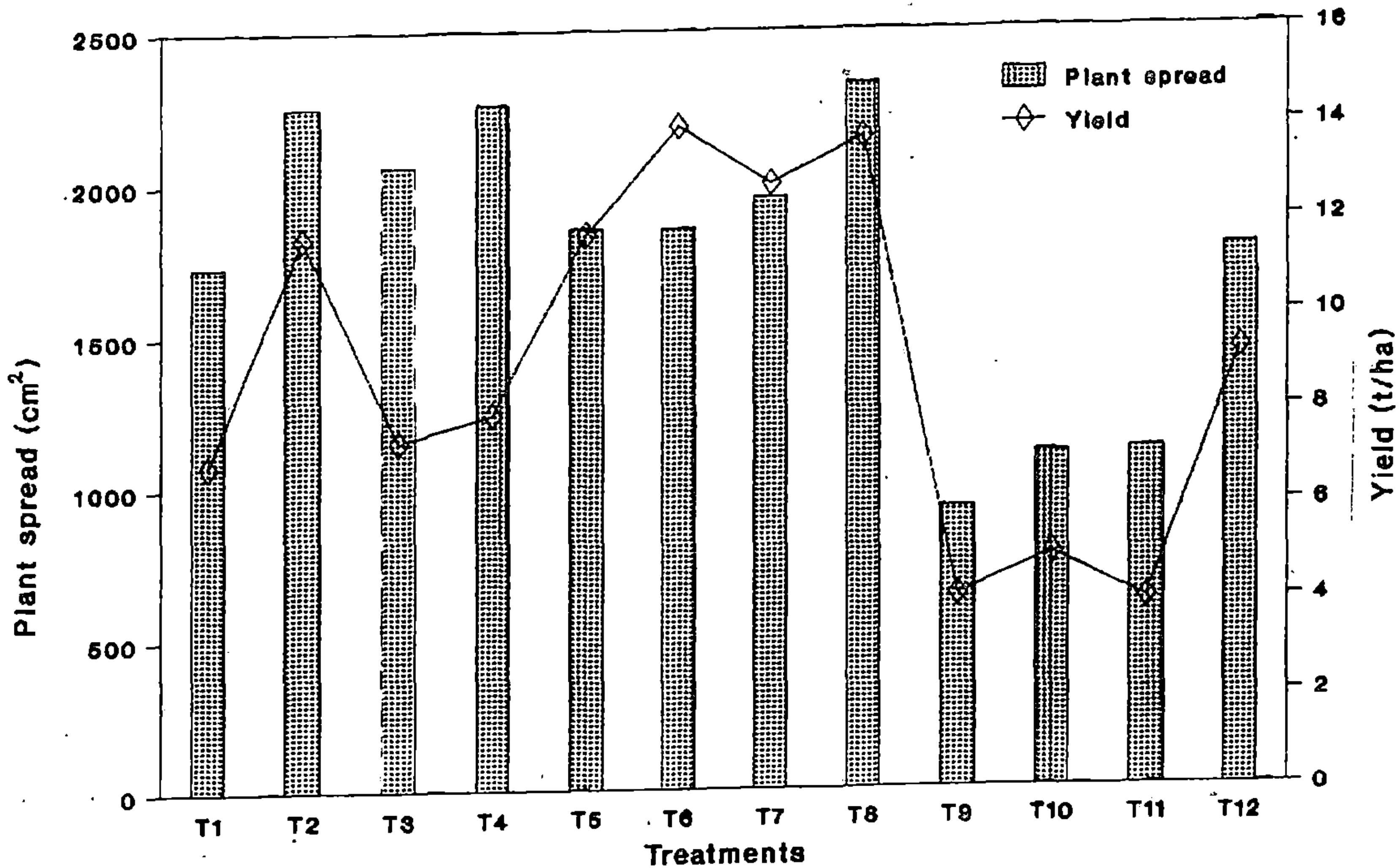

Fig.10 Variation of yield and plant spread with treatments

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Summary

SUMMARY AND CONCLUSION

Water is a very precious input in agricultcure and it needs judicious utilization. Loss of water from field can be reduced by using micro irrigation methods and mulching the inter-plant area. Drip irrigation is one of the micro irrigation methods which enables slow and precise application of water to precise locations, reducing soil erosion and wastage of water through evaporation and deep percolation. Mulching is the process of covering the soil around the plants to create more favourable conditions for their growth and production. It could be done either with natural organic wastes or with synthetic materials like plastics. It exerts a decisive effect on earliness, yield and quality of the crop. In India only few studies are seen to be conducted to find out the combined effect of drip irrigation and mulching on vegetable cultivation. Hence, an attempt was made to study the effect of drip irrigation along with two colours of plastic mulch on growth and yield of summer season brinjal crop.

The experiment was conducted in the Instructional farm of KCAET, Tavanur, during the summer season of 1996. In the experiment two types of irrigation methods, surface and drip, and two colours of plastic mulches, black and transparent, were used. In drip treatments three levels of irrigation water were applied.

Black and transparent mulches were spread in the respective plots and seedlings were planted after making holes in the sheets. Fertilizers were applied as basal dose, before spreading the plastic sheets. Using climatological data water requirement per plant `V' was calculated by Penman method. Three levels of irrigation water applied through drip system were V, 0.8V and 0.6V. Non-mulched treatment with surface irrigation was the control.

Observations on moisture content, soil temperature, plant height, plant spread, number of days to flower, weight of weeds and yield were taken. Soil moisture depleted from the root zone within the successive irrigation was also determined. Prcentage moisture conserved by the use of mulches was calculated from the moisture depleted.

From the analyses of the different observations obtained the following conclusions were arrived at.

1. Use of plastic mulches increased the soil temperature. Transparent mulch created high soil temperature compared to black mulch.

2. Presence of mulch over the soil reduced evaporation fully from the soil and thus increased the moisture level in the crop root zone.

3. Water saving by the use of plastic mulch is about 30 to 35%

4. Maximum plant height was observed in the non-mulched drip irrigated treatment with 0.8V volume of water. Black mulched and non-mulched treatments did not show significant difference in the plant height.

5. Maximum plant spread was observed in the surface irrigated black mulch treatment. Surface irrigated treatments gave more plant spread than drip irrigated treatments.

6. Significant reduction in weeds was observed in the plots with mulches. Weeds were maximum in the non-mulched surface irrigated treatment.

7. Plants in the mulched plots flowered earlier compared to non-mulched treatments. Hence earlier maturity of the fruits was also observed in the mulched treatments.

8. Black mulch increases the yield. Maximum yield was observed in the treatment with black mulch and drip

irrigation with 0.8V volume of water. Reduced weed growth, increased moisture content in the root zone, increased soil temperature, early flowering etc. were noticed in treatments with black mulch.

9. Transparent mulch reduced the yield of brinjal due to high soil temperature developed beneath the mulch.

10. Yield of brinjal increased with soil temperature upto an optimal level of about 46°C at soil surface and then decreased with increase in soil temperature.

11. In drip method 0.8V volume of irrigation water was the best.

12. Drip irrigation along with mulching in summer vegetable can reduce the cost of cultivation through efficient water management. Also the area of cultivation can be increased with the available water in the water scarce areas.

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Appendices

Appendix I

Rainfall occured during the experimental period

Date	Rainfall (cm)
28 - 3 - 1996	6.2
7 - 4 - 1996	4.9
10 - 4 - 1996	0.6
13 - 4 - 1996	0.1
17 - 4 - 1996	0.9
18 - 4 - 1996	0.6
1 - 5 - 1996	4.9
20 - 5 - 1996	0.8
24 - 5 - 1996	0.6
27 - 5 - 1996	0.3

Appendix II

II-a Month-wise Details of Climatological Parameters for 25 years from 1971 to 1995

Average of 25 years

Month	Relative humidity(%)	Temperature (C)	Mean Sun shine hr/day	Wind speed at 2m ht (km/day)	75% dependable rainfall(mm)
	Mean	Mean			
January	69.8	26.82	9.128	120.72	0.00
february	72.3	27.72	9.443	108.24	0.00
March	73.18	28.47	9.790	104.4	0.00
April	73.50	29.63	8.547	102.96	25.45
May	77.12	29.17	7.448	96.96	62.25
June	87.3	26.78	8.195	80.64	721.60

II-b Computation of evapotranspiration by Penman method

Month	Saturation Vapour pressure in m bar (ea)	Mean actual vapour pressure in m bar (ed)	(ea-ed)	Wind related functin f(u)	(1-w)	w	Radiation (Ra)	Possible Sun shine hrs (N)
1	2	3	4	5	6	7	8	9
January	35.33	24.66	10.67	0.596	0.2403	0.7597	12.952	11.526
February	37.21	26.90	10.31	0.562	0.2313	0.7687	14.015	11.75
March	38.88	28.45	10.43	0.552	0.2262	0.7738	15.177	12.00
April	41.56	30.55	11.01	0.548	0.2203	0.7797	15.700	12.35
May	40.50	31.23	9.27	0.532	0.2226	0.7774	15.623	12.65
June	35.25	30.77	4.48	0.488	0.2407	0.7593	15.423	12.775

(contd.)

Appendix II-b contd.

n/N	Rns	f(t)	f(ed)	f(n/N)	Rnl	Rns-Rnl (Rn)	Unad-justed ETo	Adjus-sted ETo
10	11	12	13	14	15	16	17	18
0.792	6.275	16.065	0.122	0.813	1.593	4.682	5.085	5.510
0.804	6.853	16.244	0.112	0.824	1.500	5.354	5.456	6.000
0.816	7.490	16.394	0.105	0.834	1.436	6.054	5.986	6.585
0.692	7.018	16.627	0.097	0.723	1.166	5.852	5.892	6.480
0.589	6.380	16.534	0.094	0.630	0.979	5.401	5.296	5.764
0.250	4.338	16.057	0.096	0.325	0.501	3.837	3.430	3.540

Appendix III

Computation of Benefit cost ratio

Items	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12
1 Fixed cost	102050	102050	102050	0.0	122050	122050	122050	20000	122050	122050	122050	20000
(a) Life (seasons)	15	15	15	0.0	15	15	15	3	15	15	15	3
(b) Depreciation	6803	6803	6803	0.0	13470	13470	13470	6667	13470	13470	13470	6667
(c) Interest	12246	12243	12246	0.0	14646	14646	14646	2400	14646	14646	14646	2400
(d) Repair and maintenance	5103	5103	5103	0.0	6103	6103	6103	1000	6103	6103	6103	1000
(e) Total(b+c+d)	24152	24152	24152	0.0	34219	34219	34219	10067	34219	34219	34219	10067
2 Cost of cultivation	26000	26000	26000	29000	15000	15000	15000	15000	15000	15000	15000	15000
3 Seasonal total cost (2+e)	50152	50152	50152	29000	49219	49219	49219	25067	49219	49219	49219	25067
4 Water applied (mm)	550	440	330	550	550	440	330	550	550	440	330	550
5 Yield of produce (t/ha)	6.87	11.65	7.35	7.92	11.72	13.98	12.77	13.73	4.06	4.89	3.94	9.21
6 Selling price (Rs/t)	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000	4000
7 Income from produce	27450	46600	29400	31680	46880	55920	51080	54920	16240	19560	15760	36840
8 Net seasonal income	-22672	-3552	-20752	2680	-2339	6701	1861	29853	-32979	-29669	-33459	11773
9 Additional area cultivated due to saving of water	–	0.25	0.66	–	–	0.25	0.66	–	–	0.25	0.66	–
10 Additional expenditure due to additional area	–	12538	33435	–	–	12305	32813	–	–	12305	32813	–
11 Additional income due to additional area	27480	58250	19404	–	–	13980	33713	–	–	4890	10402	–
12 Additional net income	–	-888	-14031	–	–	1675	900	–	–	-7415	-22411	–
13 Gross cost of production	50152	62690	83587	29000	49219	61524	82032	25067	49219	61524	82032	25067
14 Gross income	27480	58250	48804	31680	46880	69900	84793	54920	16240	24450	26162	36840
15 Gross Benefit Cost ratio	0.55	0.93	0.58	1.09	0.95	1.14	1.03	2.19	0.33	0.40	0.32	1.47
16 Water use efficiency (5/4) (Kg/ha-mm)	12.49	26.48	22.27	14.40	21.31	31.77	38.70	24.96	7.38	11.11	11.94	16.75

EFFECT OF DIFFERENT TYPES OF MULCHES ON GROWTH AND YIELD OF DRIP IRRIGATED VEGETABLES

By .
E. B. GILSHA BAI

ABSTRACT OF THE THESIS

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KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY
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ABSTRACT

The present project was to study the effect of drip irrigation along with two colours of plastic mulching on the growth and yield of summer season vegetable. Two types of irrigation methods, drip and surface, and two colours of plastic mulches, black and transparent, were used in the experiment. Three levels of irrigation water, V, 0.8V and 0.6V volume, were applied in drip treatments.

Mulches increased the soil temperature. High soil temperature was developed under transparent mulch compared to black mulch. Black mulch increased the soil temperature in the root zone by 3 to 4°C compared to non-mulched plots. This increase in soil temperature under the black mulch was advantageous to the crop.

Presence of mulch sheet over the soil reduced the evaporation from the soil. Hence, moisture depleted from the non-mulched plots were more than mulched plots. Water saving obtained by the use of plastic mulch was about 30 to 35% in the different treatments.

Black mulched and non-mulched treatments did not show significant difference in the plant height. Maximum plant height was observed in the non-mulched drip irrigated

treatment with 0.8V volume of water. Maximum plant spread was observed in the surface irrigated black mulch treatment. Surface irrigated treatments gave more plant spread than drip irrigated treatments.

Use of mulch sheets reduced the weed growth in the field. Practically, there was no need of weeding from the plastic mulched plots. Earlier flowering and maturity of fruits were observed in the mulched plots.

All treatments with black mulch increased the yield compared to the control. Treatment with black mulch and drip irrigation with 0.8V volume of water gave 76.5% more yield than the control. Most of the treatments with transparent mulch reduced the yield. This reduction in yield was due to the high soil temperature developed under the transparent mulch. Yield was increased with the soil temperature upto an optimal level of about 46°C and then decreased with the increase in soil temperature.

In drip method 0.8V volume of irrigation water level was the best. It gave highest yield and growth in mulched as well as non-mulched treatments. Drip irrigation along with mulching in summer vegetable can reduce the cost of cultivation through efficient water management. Also the area of cultivation can be increased with the available water in the water scarce areas.