STRESS MANAGEMENT IN SUMMER GROUNDNUT (*Arachis hypogaea* L.)

By

BODARE CHANDRAKANT ARUN
Reg. No. 05/004

A Thesis submitted to the

MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI-413 722, DIST. AHMEDNAGAR
MAHARASHTRA STATE (INDIA)

In partial fulfilment of the requirements for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

AGRONOMY

DEPARTMENT OF AGRONOMY,
POST GRADUATE INSTITUTE,
MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI-413 722. DIST. AHMEDNAGAR, M.S., INDIA.

2008

STRESS MANAGEMENT IN SUMMER GROUNDNUT
(*Arachis hypogaea* L.)

By

BODARE CHANDRAKANT ARUN

Reg. No. 05/004

A Thesis submitted to the

MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI-413 722, DIST. AHMEDNAGAR
MAHARASHTRA STATE (INDIA)

In partial fulfilment of the requirements for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

AGRONOMY

Approved by

Dr. M. B. Dhonde
Research Guide &
Chairman of Advisory Committee

Dr. C. B. Gaikwad
Committee Member

Dr. A. D. Kadlag
Committee Member

Prof. A. H. Sonone
Committee Member

Dr. V. S. Wani
Committee Member

DEPARTMENT OF AGRONOMY,
POST GRADUATE INSTITUTE,
MAHATMA PHULE KRISHI VIDYAPEETH,
RAHURI-413 722. DIST. AHMEDNAGAR, M.S., INDIA.

2008

CANDIDATE'S DECLARATION

I hereby declare that this thesis or part

thereof has not been submitted by

me or other person to any other

University or Institute

for a Degree or

Diploma.

Place : MPKV, Rahuri

Dated : / / 2008 ***(C. A. Bodare)***

Dr. M. B. Dhonde
Professor,
Department of Agronomy,
Mahatma Phule Krishi Vidyapeeth,
Rahuri-413 722, Dist. Ahmednagar
Maharashtra State (India)

CERTIFICATE

This is to certify that the thesis entitled, "**STRESS MANAGEMENT IN SUMMER GROUNDNUT (*Arachis hypogaea* L.)**", submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra State in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRONOMY,** embodies the results of a *bonafide* research work carried out by **Mr. BODARE CHANDRAKANT ARUN,** under my guidance and supervision and that no part of the thesis has been submitted for any other degree, diploma or publication.

The assistance and help received during the course of this investigation have been acknowledged.

Place : MPKV, Rahuri,
Date : / /2008

(**M. B. Dhonde**)
Research Guide

Dr. R. S. Patil
Associate Dean,
Post Graduate Institute,
Mahatma Phule Krishi Vidyapeeth,
Rahuri-413 722, Dist. Ahmednagar
Maharashtra State (India)

CERTIFICATE

This is to certify that the thesis entitled, "**STRESS MANAGEMENT IN SUMMER GROUNDNUT (*Arachis hypogaea* L.)**", submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra State in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRONOMY,** embodies the results of a *bonafide* research work carried out by **Mr. BODARE CHANDRAKANT ARUN,** under the guidance and supervision of **Dr. M. B. Dhonde**, Professor, Department of Agronomy, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar, Maharashtra State and that no part of the thesis has been submitted for any other degree, diploma or publication.

Place : MPKV, Rahuri,
Date : / /2008

(**R. S. Patil**)
Associate Dean (PGI)

ACKNOWLEDGEMENTS

It is proper to atleast acknowledge the debts that cannot be repaid. However, words are too meager to express esteem indebtedness and whole hearted sense of gratitude towards my Research Guide and Chairman of Advisory Committee, Dr. M. B. Dhonde, Professor, Department of Agronomy, Mahatma Phule Krishi Vidyapeeth, Rahuri for his valuable, inspiring and versatile guidance, well versed suggestions, constant encouragement, enormous help and constructive criticism throughout the completion of this venture..

I record with sincerity my profound sense of gratitude to the members of my Advisory Committee, Dr. C. B. Gaikwad, Head, Department of Agronomy; Dr. A. D. Kadlag, Soil Chemist, AICRP on STCRC Project; Prof. A. H. Sonone, Forage Breeder, AICRP on Forage Crops and Dr. V. S. Wani, Assistant Professor, Department of Statistics, MPKV, Rahuri for their immense encouragement, helpful guidance, precious advice and co-operation in preparation of this manuscript and also throughout my studies..

I am thankful to Dr. R. S. Patil, Associate Dean, Post Graduate Institute, MPKV, Rahuri and all the academic staff of PGI for their kind co-operation throughout the course..

I wish to take this valuable opportunity to express my sincere and profound thanks to Dr. A. S. Jadhav, Dean, Faculty of Agriculture, MPKV, Rahuri for giving permission and providing necessary facilities for my research work.

I shall never forget to express word of thanks to Dr. A. D. Tumbare, Prof. A. A. Shaikh, Dr. D. W. Thawal, Dr. A. G. Wani, Prof. R. P. Andhale, Prof. J. B. Shinde and Dr. D. P. Kaledhonkar for their constant guidance, encouragement and co-operation during course of studies.

I also thanks to Mr. Mhaske (Agril. Asstt.), Mr. Langore, Mr. Tonde, Mr. Kawane and all other staff members of Department of Agronomy for assisting me in carrying out field as well as laboratory work..

I am extremely thankful to my friends Amar, Vijay, Ganesh, Rohan, Hemant, Pradip, Nitin, Ajit, Pawan, Ramesh, Kalidas, Smita and my colleagues Santosh, Datta[1], Tushar, Deva, Ashok, Ganesh and Manjushree. I extent word of thanks to my senior friends Rahul, Datta[2], Shekhar, Dhiraj, Nilesh for their motivation and timely guidance.

I am deeply obliged to all the authors past and present whose literature has been cited.

I wish to convey greatest reverence and sincere feelings of respect to my grandmother Sau. Anjubai Shankar Bhandalkar, and my parents Anna and Aai whose love inexhaustible efforts, blessings and affection made me able to build up my career. Any vocabulary will be insufficient to express my deepest sense of love to my brothers Suryakant, Dhananjay, Sonya-Monya and Yogesh, my sisters Nilam, Monika, Jayshree and my uncle and aunti Shri. Tatya and Sau. Kamal.

Once again from hundreds of miles away, few people always wants my success. I would like to acknowledge those whom I am not able to recall here and those who I might have left on unknowingly.

I am thankful to Shri. B. B. Salve, for tidy and meticulous typing of this manuscript in a decent form.

Place : Rahuri,

Date : / /2008 **(C. A. Bodare)**

CONTENTS

LIST OF TABLES

LIST OF TABLES (CONTD…)

LIST OF FIGURES

LIST OF ABBREVIATIONS

@	:	At the rate of
B.B.F.	:	Broad Bed Furrow
C.D.	:	Critical Difference
cm	:	Centimeter(s)
°C	:	Degree celcius
CPE	:	Cumulative pan evaporation
DAS	:	Days after sowing
dm^2	:	Square decimeter
et al.	:	And others (et alli)
Fig.	:	Figure
g	:	Gramme(s)
ha	:	Hectare
i.e.	:	That is (id est)
K	:	Potassium
Kg	:	Kilogram (s)
LAI	:	Leaf Area Index
N	:	Nitrogen
N.S.	:	Non-significant
P	:	Phosphorus
%	:	Per cent
q	:	Qunintal
S.E.m	:	Standard error of mean
t	:	Tonne (s)
TE	:	Transpiration efficiency
viz.	:	Namely
Wt.	:	Weight

ABSTRACT

STRESS MANAGEMENT IN SUMMER GROUNDNUT (*Arachis hypogaea* L.)

By

BODARE CHANDRAKANT ARUN

Department of Agronomy,
Post Graduate Institute,
Mahatma Phule Krishi Vidyapeeth, Rahuri-413 722 (M.S.), India.

Research Guide	:	Dr. M. B. Dhonde
Department	:	Agronomy

The present investigation on stress management in summer groundnut was carried out during summer season of 2006 at Post Graduate Institute Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra).

The experiment was laid out in Randomized Block Design with seven treatments and four replications. The treatments consists of mulching with sugarcane trash, white polythene and stress given at different critical growth stages of groundnut *viz.*, sugarcane trash mulch with stress at flowering stage, sugarcane trash mulch with stress at pegging stage, sugarcane trash mulch with stress at pod development stage, white polythene mulch with stress at flowering stage, white polythene mulch with stress at pegging stage, white polythene mulch with stress at pod development stage and control (No mulch and no stress). The soil of experimental plot was sandy clay loam, low in available nitrogen (220.5 kg ha^{-1}), high in phosphorus (23.6 kg ha^{-1}) and very high in available potassium (326.3 kg ha^{-1}) with pH 8.2.

Contd…

Whit polythene mulch with stress at pod development stage recorded significantly higher values for the growth characters of summer groundnut *viz*., plant height, plant spread, number of branches, number of leaves, leaf area, dry matter compared to use of sugarcane trash mulch with stress at pod development stage, white polythene mulch with stress at pegging stage and control.

Yield contributing characters *viz*., number of pegs, number of filled pods and number of unfilled pods were significantly influenced due to white polythene mulch with stress at pod development stage and it was significantly superior over sugarcane trash mulch with stress at pod development stage, white polythene mulch with stress at pegging stage and control.

Likewise use of white polythene mulch with stress at pod development stage recorded significantly higher hundred pod weight (73.76 g), hundred kernel weight (45.52 g), dry pod yield (28.96 q ha^{-1}), haulm yield (47.41 q ha^{-1}), kernel yield (20.83 q ha^{-1}), oil content (47.79%), oil yield (9.89 q ha^{-1}) and gross monetary returns (60296 Rs ha^{-1}) were found significantly superior over rest of the treatments.

Sugarcane trash mulch with stress at pod development stage recorded significantly highest values for net monetary returns (34097 Rs ha^{-1}) and B:C ratio (2.44) over white polythene mulch with stress at pod development stage.

From above all, it can be concluded that flowering and pegging stages of groundnut were sensitive to moisture stress and caused maximum yield reduction, while polythene mulch played important role in conserving moisture and reducing weed growth.

Total Pages : 1 to 80

1. Introduction

Groundnut (*Arachis hypogaea* L.) is the most important oilseed as well as cash crop of India and particularly of Maharashtra. Commercially and nutritionally it is very important source of oil and agriculturally it serves in improving soil fertility by fixing atmospheric nitrogen (200 kg ha^{-1}) with help of symbiotic relationship of bacteria in root nodules and also reduces fertilizer requirement of succeeding crops (Reddy, 1982).

Out of total oil production of country 70 per cent is obtained from groundnut alone. The oil content in seed varies from 45-50 per cent depending upon the varieties and agronomic management practices. Groundnut is multipurpose crop because it gives pods, oil, fodder (dry/wet) and source of N. It is a source of fat, protein, vit. A, B_1, B_2, E. Groundnut oil as such is not only used as cooking oil but also used in manufacturing of hydrogenated (*vanaspati*) oil and soap industry. Groundnut cake has high nutritive value and used as a valuable concentrated feeding stuff for cattle and other farm animals. It is also good source of organic manure. Groundnut kernels are used for the table purpose. The National Institute of Nutrition, Hyderabad recommended per capita per annum consumption of edible oil about 12 kg. However, per capita per annum consumption of edible oil in India is only 6.6 kg against 24 kg in West Germany and Britain, 21 kg in USA and 11 kg in Japan (Tandon, 1989).

Groundnut is grown all over 100 countries in the world and plays an important role in world economy. World oilseed production is about 400 million tonnes and productivity is 1374 kg ha^{-1} (Anonymous, 2006). China, India, European Union and North America are leading groundnut producing countries. India accounts 40 per cent of world area and 30 per cent of world output of groundnut. During 2005-06, the crop occupied an area of 6.74 million ha with its annual production 7.99 million tonnes and average productivity of 1187 kg ha^{-1}. Out of total production 62.74 lakh tonnes is produced in *kharif* season.

Gujarat, Andhra Pradesh, Tamilnadu, Karnataka, Rajasthan and Maharashtra are the major groundnut producing states. Gujarat ranked first in area and production whereas Maharashtra ranked fifth in area (0.43 million ha.) and production (0.41 million tonnes) during 2005-06 with its productivity of 958 kg ha^{-1} (Anonymous, 2006). The major groundnut growing districts are Dhule, Jalgaon, Akola, Nasik, Kolhapur, Satara, Pune, Ahmednagar and Parbhani.

The low yields of groundnut in Maharashtra are mainly due to the fact that about 90 per cent of crop is cultivated during *kharif* season under rainfed condition. The monsoon is erratic and uneven distributed, often having prolonged dry spells of 4 to 6 weeks duration in growing period of August to September. This period is normally coincides with flowering, pegging and pod development stages which leads to partial or complete failure of crop in many cases. Other factors responsible for low production are, improper irrigation layout, inadequate fertilizer use, improper crop management practices, varying soil and cropping conditions. It appears that yields are higher during summer season and this may be due to adequate sunlight, warm temperature, availability of timely irrigation and fairly disease and pest free conditions. Thus, the climate of summer is quite favourable than *kharif* season in the state. There are an excellent prospects for growing groundnut in summer season under irrigated condition. Therefore, an excellent strategy for enhancing yield of this crop needs to be developed for growing groundnut in summer season. However, there is very little scope to increase the area under summer groundnut due to inadequate irrigation water availability. Moisture stress at critical growth stages due to lack of water leads to failure of crop. To overcome these problems, effective use of irrigation water can be made through its judicious application at proper time with adequate quantity.

Average yields in rainfed area are very low (750 kg ha^{-1}) because erratic and uneven distribution of rainfall and biotic stress factors that discourage investment in technological inputs. The irrigation has been made possible to get the higher yields of groundnut and a substantial increase in areas of irrigated groundnut in India. But information is limited about effects of water stress at different phenophases on growth and reproductive efficiency of crop (Golakiya and Patel, 1992).

In recent years, some useful techniques like use of organic mulch, plastic mulch have been evolved to minimize water losses through evaporation. Organic mulch available easily on farm for conserving soil moisture, avoid soil erosion and helped in increasing microbial activity in soil. Application of wheat straw as mulch @ 5 t ha^{-1} resulted in increased pod yield by 23 per cent (Dayal, 1989). Use of plastic mulch resulted in increase in yield and checking weed population in groundnut (Das and Maliwal, 1989).

With the above considerations, the present investigation entitled, “Stress management in summer groundnut” was conducted on Instructional Farm of Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra) during summer 2006 with the following objectives.

1. To study the effect of different mulches along with stress management on growth, yield and quality of summer groundnut.
2. To study the economics of different treatments under study.

2. REVIEW OF LITERATURE

2.1 Effect of polymulch

2.1.1 Growth characters

Dayal (1989) conducted trial on summer groundnut at National Research Centre, Junagadh. He found that mulching with wheat straw @ 5 t ha^{-1} increased the number and weight of pods per plant by 16 and 23 per cent, respectively.

Zhang *et al*. (1996) revealed that use of polythene mulch increased the soil temperature, soil moisture and ultimately growth contributing characters viz., LAI, number of pegs and number of pod shells over control.

Choi and Chung (1997) conducted field experiments at National Crop Experiment Station, Suwon (Korea Republic) and revealed that seedling emergence with mulch was 11-15 days earlier over no mulch and plants in mulched plot bore more flower pegs, pods over plant in control plots.

Shyam Sunder (1999) used plastic film (7 µ thickness) mulch in groundnut at Mahatma Phule Krishi Vidyapeeth, Rahuri and reported significant increase in the growth contributing characters over unmulched treatments.

Kathmale *et al*. (2000) conducted field experiment at Agricultural Research Station, Sangli showed that the growth, yield contributing characters and yield of groundnut were increased significantly due to polythene mulch.

Chitodkar (2000) conducted a trial at Mahatma Phule Krishi Vidyapeeth, Rahuri on summer groundnut cv. JL-220, using clay texture soil and reported that plant height, spread, number of branches, functional leaves and leaf area were at higher magnitude due to plastic film + kaoline (8%) spray compared to application of sugarcane trash @ 5 t ha^{-1} + kaoline (8%) spray.

Kumar *et al*. (2002) conducted field experiment at ICAR Research Complex, Manipur Centre, Imphal during *rabi* season and observed that plant height, dry matter accumulation, LAI, CGR and RGR were found significantly higher in flat bed with polymulch and it was followed by BBF system with polymulch overall the treatments.

Mahalle *et al*. (2002) carried out field experiment at Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra) on medium soil during summer, using TAG-24, AK-159, JL-24 and SB-XI varieties of groundnut and reported that morphological characters viz., plant height, number of flowers and number of branches, days to flowering were significantly influenced by polythene mulch.

Ghosh *et al.* (2003) conducted field experiment from 1990-1997 at Junagadh (Gujarat) and revealed that black polythene had no beneficial effect on pod yield of groundnut but increased germination and early crop growth due to increase in soil temperature.

Shaikh *et al*. (2004) conducted trial at College of Agriculture, Pune showed that the mulching with polythene film gave the highest number of pods $plant^{-1}$ (49.25), weight of pods $plant^{-1}$ (63.48 g) and 100 kernel weight (51.55 g).

Pawar *et al.* (2008) conducted field experiment at Marathwada Agricultural University, Parbhani on groundnut and revealed that growth characters like plant height, number of branches and number of leaves significantly superior in black polythene mulch over control.

2.1.2 Yield and yield contributing characters

Joshi *et al.* (1987) conducted trial at Mahatma Phule Krishi Vidyapeeth, Rahuri on summer groundnut cv. SB XI and TMV-10 and observed that 12 per cent increase in pod yield of groundnut due to mulching of wheat straw @ 5 t ha^{-1}.

Rao *et al.* (1991) conducted a field trial for evaluation of broad bed furrow for summer groundnut at Northern Telangana (Andhra Pradesh) and found that groundnut varieties ICGS-11 and Kadiri-3 produced dry pod yields of 2.9 and 3.9 t ha^{-1}, respectively in flat bed system and 4.8 and 3.4 t ha^{-1} in BBF system of planting.

Khalak and Kumarswami (1992) carried out trial at GKVK, Bangalore (Karnataka) on potato cv. Khufri Jyoti with treatments no mulch, straw mulch and polythene mulch. Mulching with straw and polythene gave average yield of 18.2 and 16.7 t ha^{-1} compared with 14.2 t ha^{-1} without mulching.

Basu (1999) in multilocaton trials in India with groundnuts, the use of polythene mulch significantly increased pod yield between 11.4 to 11.7 per cent.

Shyam Sunder (1999) from the experiment conducted at Mahatma Phule Krishi Vidyapeeth, Rahuri on groundnut cv. Koyna (B-95) observed that yield contributing characters *viz.*, dry pod, haulm, protein and oil yield were significantly maximum with polythene mulch (thickness 7 μ) over unmulched treatment.

Kathmale *et al*. (2000) revealed from the field experiment that the polythene mulched groundnut produced maximum net returns (46607 Rs. ha^{-1} with B:C ratio 4.35 as compared to straw mulched (net returns 40516 Rs. ha^{-1} with B.C. ratio 4.45) and control (net returns 33169 Rs. ha^{-1} with B.C. ratio 4.29).

Kumar (2001) conducted field experiment during *rabi* season in Manipur Centre (Imphal) and Sikkim Centre (Gangtok) in view to introduce *rabi* groundnut in the states. At Manipur highest groundnut yield was found in flat bed system with polymulch (2181 kg ha^{-1}) and at Sikkim highest pod yield was recorded in BBF system with polymulch.

Gogoi *et al.* (2002) conducted an experiment to study the effect of sowing dates and mulching in summer groundnut at Assam Agricultural University, Jorahat, Assam and recorded application of paddy husk, paddy straw and transparent polythene as mulch material significantly improved the yield contributing characters and yield over no mulch treatment.

Mahalle *et al*. (2002) carried out field experiment to study the effect of polythene mulch on morphological changes and yield of summer groundnut cv. TAG 24, AK-159 and JL-24 and reported that yield increase due to polythene mulch which might be attributed to reduction of soil compaction around the pod size and better conservation of soil moisture.

Subramaniyam *et al*. (2002) conducted field trial at Vridhachalam, Andhra Pradesh on groundnut during *rabi* season and revealed that the days to

50% flowering were earlier in the polythene film mulched plots when compared to non-mulched plot. However, peg formation and pod setting percentage were higher in mulched plots.

Raskar and Bhoi (2003) conducted field experiment during summer season at Rahuri (Maharashtra) to evaluate the irrigation schedule for summer groundnut and effect of mulch. Higher pod yield was obtained in polythene mulch with kaoline spray (3%).

Ravankar *et al*. (2003) conducted field experiment on the alkaline soils of Akola (Maharashtra) to investigate the effect of polythene mulch on dry matter, crop yield and nutrient uptake of groundnut cultivars TAG-24, TG-26, AK-159, AK 1224, JL-24, AK-265, AK-267 and SB XI. Mulching produced the higher dry matter weight (27.55 q ha^{-1}), pod yield (15.30 q ha^{-1}) and nutrient uptake (78.8, 16.7 and 31.9 kg ha^{-1}, N, P, K) over no mulch.

Raskar *et al.* (2005) carried out field experiment at Dapoli (Maharashtra) and reported that the yield contributing characters, viz., number of pods, number of developed pods and number of effective pegs were significantly higher with polythene mulch as compared with other mulch (No mulch, grass mulch and straw mulch).

Pawar *et al.* (2008) conducted field experiment at Marathwada Agricultural University, Parbhani (Maharashtra) on groundnut and revealed that maximum crop yield and higher water use efficiency observed in black polythene sheet over sugarcane trash mulch, wheat straw mulch and control.

2.2 Effect of organic mulch

2.2.1 Growth characters

Gaur and Mukharjee (1979) carried out trial on groundnut at IARI, New Delhi and reported that incorporation of wheat straw @ 5 t ha^{-1} into the soil one week before sowing markedly increased the number and dry weight of nodules, pod yield by 95 per cent and haulm yield by 75 per cent.

Dayal (1989) conducted a trial on groundnut at National Research Centre, Junagadh (Gujarat). He opined that mulching with wheat straw @ 5 t ha^{-1} increased the number and weight of pods per plant by 16 and 23 per cent, respectively.

Balsubramaniyam and Palanippan (1996) conducted a research trial at Vidhyachalam (Tamilnadu) during *kharif* and *rabi* season on groundnut and found that application of organic mulch @ 12.5 t ha^{-1} significantly increased the pod yield.

Mehta *et al*. (1996) concluded that application of organic mulch, phosphorus and phosphate solubilizing micro-organisms to groundnut significantly increased the number of root nodules $plant^{-1}$ and dry weight $plant^{-1}$.

Sadhu *et al*. (1996) reported that wheat straw mulch and FYM treatments increased plant height, filled pods $plant^{-1}$ and haulm yield of groundnut.

2.2.2 Yield and yield contributing characters

Ashrif and Thornton (1965) conducted trial on groundnut at Gambia and reported that application of 5 t ha^{-1} grass mulch per hectare 4 weeks after germination increased the yield of groundnut.

Gaur and Mukharjee (1979) reported from IARI, Delhi that the application of 5 t ha^{-1} wheat straw into soil before 1 week of sowing increased the pod yield by 95 per cent and haulm yield by 75 per cent in groundnut.

Joshi *et al*. (1987) conducted trial on groundnut at Rahuri and concluded that application of 5 t ha^{-1} wheat straw as mulch significantly increased the pod yield. It also suppressed the weed growth.

Reddy (1994) conducted field experiment to evaluate the drought management practices and their influence on yield and net returns. Application of groundnut shells @ 5 t ha^{-1} increased pod yield (20.47 q ha^{-1}) and net returns (14473 Rs. ha^{-1}) as compared to control (11994 Rs. ha^{-1}).

2.3 Effect of water stress

2.3.1 Growth characters

Reddy and Rao (1968) studied the influence of progressive water stress on vegetative growth and yield of groundnut at Tirupati (Andhra Pradesh) and observed that the vegetative growth (dry matter $plant^{-1}$) was reduced progressively with water stress and flowering period was more sensitive to water deficiency.

Mandal and Ghosh (1984) from field trial of groundnut reported that 3 irrigations 35 DAS + 70 DAS + 88 DAS shown highest pod yield, stalk yield and number of branches per plant over control.

Shinde and Pawar (1984) from their studies on effect of water stress on summer groundnut, reported that the water stress given at various growth stages (seedling to flowering, flowering to pegging, pegging to pod formation and pod formation to pod maturity) had no significant effect on growth characters viz., plant height and number of branches plant^{-1}.

A field trial conducted at Rajendranagar (Andhra Pradesh) by Venkateshwar Rao *et al.* (1986) revealed that moisture stress at flowering decreased the dry matter production severely than the moisture stress at pegging and pod formation stages of groundnut.

At Hyderabad, Kumar *et al.* (1987) found that imposition of various irrigation schedules at different crop growth phases of groundnut, caused significant variation in functional leaves throughout the crop period (40, 80, 120 DAS), but the plant height and dry matter accumulation differed significantly only at 80 and 120 days.

Shrinivasan and Arjunan (1987) concluded that water stress imposed in the mid season of growth period especially at pod formation to maturity stage cause yield reduction to greater extent when compared to earlier drought in growth period of bunch groundnut cultivars.

Sharma and Shivkumar (1989) found that groundnut showed remarkable tolerance to drought stress from emergence to peg initiation and benefited from this drought stress when additional irrigations were given to later stages of growth.

Golakiya and Patel (1992) studied effect of water stress on different phenophases of groundnut. The growth parameters viz., days to 50% flowering, days to leaf opening, leaf area index, leaf area duration, etc. were curtailed due to water stress imposed at all phenophases but more so when the crop was stressed during flowering stage.

Patil and Morey (1993) conducted field experiment on vertisol at Akola (Maharashtra) on groundnut cv. SB-XI and irrigated at cumulative pan evaporation ratios of 0.50, 0.60, 0.80 upto flowering, flowering to pod development and pod development to maturity stage. Water stress upto flowering and pod formation stages decreased the pod yield.

Ved Singh *et al*. (1994) conducted field trial at Shriganganagar, to show the effect of irrigation and phosphorus application on groundnut. Maximum pod and haulm yield was recorded when 4 irrigations were applied at vegetative, flowering, pegging and pod development stages.

Shridhara *et al*. (1995) from Bangalore (Karnataka) studied groundnut with normal irrigation or subjected to water stress at 30-50, 50-70 or 70-90 DAS. The crop irrigated at CPE ratio 0.4, 0.5 or 0.8 water stress between 30 to 70 DAS reduced the dry matter accumulation, LAI and leaf area compared with stress at 70-90 DAS or no water stress. Irrigation at 0.8 CPE gave high dry matter accumulation and LAI.

Kim *et al*. (1996) reported that groundnut were water stressed at seedling, flowering and ripening growth stages. Shoot dry weight at harvest was decreased by stress at flowering stage while ripening had little effect on growth. Plants stressed at seedling stage largely recovered before harvest.

Sudhakar Babu *et al*. (1996) carried out experiment on groundnut and stated that effective soil depth played significant role in growth and dry matter yield of groundnut and moisture stress at 75 DAS was found to be more detrimental than early (25 DAS) and mid (50 DAS) stress.

Patra *et al*. (1998) conducted field trial and showed that 3 irrigations given at critical growth stages had highest pod and haulm yield than only 1 irrigation at flowering or two irrigations each at flowering and pod initiation.

Velu (1998) conducted a trial at Water Technology Centre, Tamilnadu Agril. University, Coimbatore (Tamilnadu) on effect of water stress on yield potential and revealed that production of flowers, total pegs were reduced maximum under stress at flowering stage.

Babitha and Reddy (2001) carried out field experiment at Acharya N. G. Ranga Agricultural University, Hyderabad (Andhra Pradesh) and reported that total dry matter at harvest had significant positive correlation with transpiration efficiency in simulated drought treatment. Leaflet size was significantly and negatively correlated with transpiration efficiency under drought stress condition only.

2.3.2 Yield and yield contributing characters

Singh *et al*. (1968) from the trial on groundnut conducted at Hissar, reported that application of two irrigations one each at flowering and fruiting stage was more helpful as compared to one irrigation at flowering stage in increasing the number of pods and weight of pods plant^{-1}.

Investigation were carried out at Marathwada Agril. University, Parbhani by Shinde and Pawar (1984) during summer season to find out the effect of water stress at critical growth stages of groundnut. The results revealed that the water stress at 4 IW/CPE ratio at all the growth stages (seedling, flowering, pegging and pod maturity) was detrimental for pod yield.

Mandal and Ghosh (1984) conducted experiment to find out effects of rice husk and rice straw as mulches in conserving soil moisture. It was reported that two irrigations each at 35 DAS and 70 DAS obtained higher yield than no irrigation and only one irrigation at flowering.

At Rajendranagar, Andhra Pradesh, Venkateshwar Rao *et al.* (1986) reported that the moisture stress at flowering stage of groundnut reduced the number of pods per m^2 by greater extent than stress at pod formation stage. They further mentioned that minimum reduction in pod number was due to stress at flowering followed by stress at pod formation as compared to stress at pegging and no stress condition.

Patel and Golakiya (1988) studied the effect of water stress on yield attributes of groundnut at Gujarat Agricultural University, Junagadh (Gujarat) and reported that lowest pod and haulm yields were recorded under stress during flowering stage.

Khera *et al*. (1990) conducted field experiment in Ludhiana and reported that three irrigations given at flowering, pegging and pod formation recorded higher pod yield over no irrigation, one irrigation at flowering, two irrigations each at flowering and pegging.

Padma and Subba Rao (1992) from their experiment in *kharif* groundnut at Hyderabad reported that the 100 kernel weight was significantly more in irrigated plots than control (no irrigation) plots.

Reddy and Reddy (1993) conducted field trial to formulate optimum water management practices for groundnut grown under variable water supplies and found that scheduling irrigation to supply adequate water during moisture sensitive periods of flowering and pod formation stage yet allowed moderate stress at vegetative and maturity phases produced optimum yield (28.23 q ha^{-1}) with maximum WUE (7.73 kg ha^{-1} mm^{-1}) and water economy.

Sakarvadia and Yadav (1994) reported from Junagadh that the water stress given at flowering, pegging, pod formation stages of groundnut cv. GG2 gave pod yield 1.43, 1.18, 1.07 t ha^{-1} compared with normal irrigation 2.25 t ha^{-1}.

Uke *et al.* (1995) from Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola (Maharashtra) reported that the number of pods and test weight of groundnut did not differ significantly due to various irrigation treatments. However, the number of pods per plant was maximum due to one irrigation at flowering to pegging stage while the test weight and shelling percentage was maximum due to one irrigation at 75 CPE and closely followed by one irrigation at pod formation to pod maturity.

Ramamoorthy and Basu (1996) in field experiment during summer season at Coimbatore, Tamilnadu, groundnut cv. CO-1 were not stressed and water stressed at vegetative (Ve), flowering (Fl), pegging (Pe), maturity (Ma), Ve + Fl, Fl + Pe or Pe + Ma growth stages. Water stress at Fl + Pe and at Pe + Ma decreased shelling percentage and 100 seed weight.

Chavan (1997) carried out field experiment at Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra) during *kharif* season. It was reported that highest pod yield was obtained from irrigation given at critical growth stages (flowering, pegging, pod development) than other treatments (irrigation at flowering + pegging, flowering + pod development, pegging + pod development) and highest yield reduction in stress given at flowering.

Ghatak *et al*. (1997) conducted field experiment on silty loam soil during summer and reported that yield attributes and yield were highest with frequent irrigation at 0.8 atmospheric tension (atm). When irrigated according to growth stages two irrigations at flowering and pegging gave best results with yield of 1.83 t ha^{-1} compared with 0.88 t ha^{-1} in rainfed groundnut.

Patra *et al*. (1998) conducted trial on groundnut at Kalyani, West Bengal in summer and revealed that yield increased as irrigation frequency (1-3 irrigations) increased from 1.35 t ha^{-1} when only irrigated at flowering to 2.42 t ha^{-1} when irrigated at flowering + pod initiation + pod development stages.

Velu (1998) from field experiment conducted at Coimbatore, reported that water stress at flowering had lowest shelling percentage and pod yield than the control.

Halepyati (2001) conducted field experiment at Gulberga (Karnataka) to determine the response of groundnut to Zn levels and moisture regimes; (irrigation once in 15 days (control), skipping irrigation at 30^{th} day of sowing, skipping irrigation at 60^{th} day of sowing and skipping irrigation at 75^{th} day of sowing. Irrigation once in 15 days resulted in higher pod yield but low 100 kernel weight.

Hemlatha *et al.* (2005) conducted experiment to supply response of evapotranspiration deficit imposed at specific crop growth period. The crop in fully irrigated control produced higher pod yield over other treatments (stress at flowering and pegging and pod initiation, pod filling).

2.4 Weed intensity

Eglay (1983) observed that solarization by transparent polythene sheet for 1 to 4 week significantly reduced the total weed emergence of pig weed (*Amaranthes* sp.), morning glories (*Ipomea* sp.) and various grasses by 44 to 98 per cent on silt clay loam soil at Weed Science Labroatory, Agricultural Research Station, Stoneville (U.S.).

Kushnarao and Krishnappa (1995) reported that solarization with clear transparent polythene sheet for 6 weeks in summer increased soil temperature upto 8°C and helped to reduce weed population by 80.6% on sandy loam soil at University of Agril. Sciences, GKVK, Bangalore (Karnataka).

Lalitha *et al.* (2001) conducted field experiment at GKVK, Bangalore and reported that application of transparent polythene sheet in groundnut resulted into reduction in weed count and weed dry matter even upto harvest.

Subramaniyam *et al.* (2002) reported that usefulness of polythene film mulching in arresting weed growth and maximizing pod yield of groundnut. The net returns and benefit:cost ratio were also higher with the mulching treatment.

3. MATERIAL AND METHODS

The present field experiment entitled, "Stress management in summer groundnut" was conducted on Instructional Farm of Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar during summer, 2006. The details of the material used and methods adopted during the course of investigation are given in this chapter.

3.1 Details of experimental material

3.1.1 Experimental site

The experiment was conducted at Instructional Farm of Post Graduate Research Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra).

3.1.2 Soil

The topography of the experimental field was uniform and leveled. The soil of experimental area was well drained. The initial soil samples from experimental field were collected from 0-15 cm depth at 12 spots and composite sample was prepared for determining physical and chemical properties of soil. The data in respect of physical and chemical properties of soil along with analytical methods used are given in Table 1.

The data from Table 1, revealed that the soil of the experimental field was sandy clay loam, low in available nitrogen (220.5 kg ha^{-1}), moderately high in phosphorus (23.6 kg ha^{-1}) and very high in potassium (326.3 kg ha^{-1}) with pH 8.2.

Table 1. Physical and chemical properties of soil under investigation and methods used.

Sr. No.	Characteristics	Composition	Method adopted
A)	**Physical properties**		
1	Coarse sand (%)	13.11	International pipette method (Piper, 1966)
2	Fine sand (%)	39.61	-do-
3	Clay (%)	23.49	-do-
4	Silt (%)	23.18	-do-
5	Textural class	Sandy clay loam	Triangular diagram (Piper, 1966)
B)	**Chemical properties**		
1	Available N (kg ha^{-1})	220.5	Modified Alkaline permanganate method (Saharawat and Burford, 1982)
2	Available P (kg ha^{-1})	23.6	Olsen's method (1954)
3	Available K (kg ha^{-1})	326.3	Flame photometer method (Hanway and Heidal, 1967)
4	Organic carbon (%)	0.58	Walkley and Black method (Nelson and Sommer, 1982)
5	Soil pH (1:2.5)	8.2	Potentiometric (Jackson, 1973)
6	Electrical conductivity (dSm^{-1})	0.36	Conductometric (Jackson, 1973)

3.1.3 Geographical and climatic conditions

3.1.3.1 General

Geographically the Central Campus of Mahatma Phule Krishi Vidyapeeth, Rahuri is situated 33 km away from Ahmednagar on Ahmednagar-Manmad State Highway No. 14. It lies between 19°48′ N and 19°47′ N latitude and 74°32′ E and 76°19′ E longitude and at an altitude of 657 meters above mean sea level.

This area falls under semi-arid tropics with an annual rainfall ranging from 307 to 619 mm. The average rainfall is 520 mm. The rainfall is erratic and ill distributed in 15 to 45 rainy days in different years. Out of the total annual rainfall, 80 per cent rainfall receives from South-West monsoon from June to September, while rest from North-East monsoon during October and November and practically negligible rains receives during summer. Hence, assured irrigation facilities are needed for growing of crops like groundnut in summer.

The mean annual maximum and minimum temperature ranges from 33 to 43°C and 3 to 18°C, respectively. The mean relative humidity during morning and evening hours was 59 and 35 per cent, respectively.

3.1.3.2 Nature of season during the experimental period

The climatic conditions prevailed during the period of present investigation are presented in Table 2. It was observed that maximum and minimum temperature ranged from 26.1°C to 40.3°C and from 7.2°C to 23.1°C, respectively during the crop growth period. The relative humidity during morning and evening ranged from 45 to 95 per cent and 16 to 66 per cent, respectively.

Table 2. Weekly weather data during the crop growth period.

Month	Met. Week	Temperature (°C)		Relative humidity (%)		Rain-fall (mm)	Mean evapo-ration (mm/day)
		Max.	Min.	Morn.	Even.		
1	2	4	5	6	7	8	9
December, 2005	49	29.5	13.1	75	34	-	3.6
	50	27.7	8.6	78	28	-	2.7
	51	27.6	7.8	76	26	-	2.4
	52	30.8	9.9	78	26	-	6.4
January, 2006	01	28.1	9.7	81	34	-	2.5
	02	29.1	10.1	78	30	-	2.5
	03	31.6	12.9	75	34	-	2.9
	04	26.9	7.2	71	22	-	3.5
February, 2006	05	30.0	10.2	64	22	-	3.5
	06	30.2	10.0	67	19	-	3.6
	07	32.2	13.1	65	23	-	3.8
	08	36.5	15.0	58	20	-	4.4
March, 2006	09	29.5	18.2	64	27	-	4.2
	10	31.9	14.5	68	21	-	4.5
	11	26.1	16.3	65	33	-	4.2
April, 2006	12	30.9	17.2	52	21	-	5.6
	13	36.1	16.4	48	18	-	5.9
	14	37.2	16.1	49	18	-	6.4
	15	38.2	18.9	55	17	-	6.8
May, 2006	16	36.2	21.1	49	22	-	6.5
	17	37.6	20.0	56	20	-	7.2
	18	39.7	23.1	45	18	-	6.6
	19	40.3	23.0	47	16	-	8.7
June, 2006	20	39.3	20.3	58	23	15.8	9.6
	21	36.4	23.1	64	32	4.8	7.9
	22	33.3	22.8	92	63	34.6	7.3
	23	34.8	21.6	92	39	7.8	5.8
July, 2006	24	36.4	22.5	90	38	11.2	7.4
	25	33.8	22.3	95	56	118.5	5.0
	26	30.9	23.3	93	66	5.4	4.3

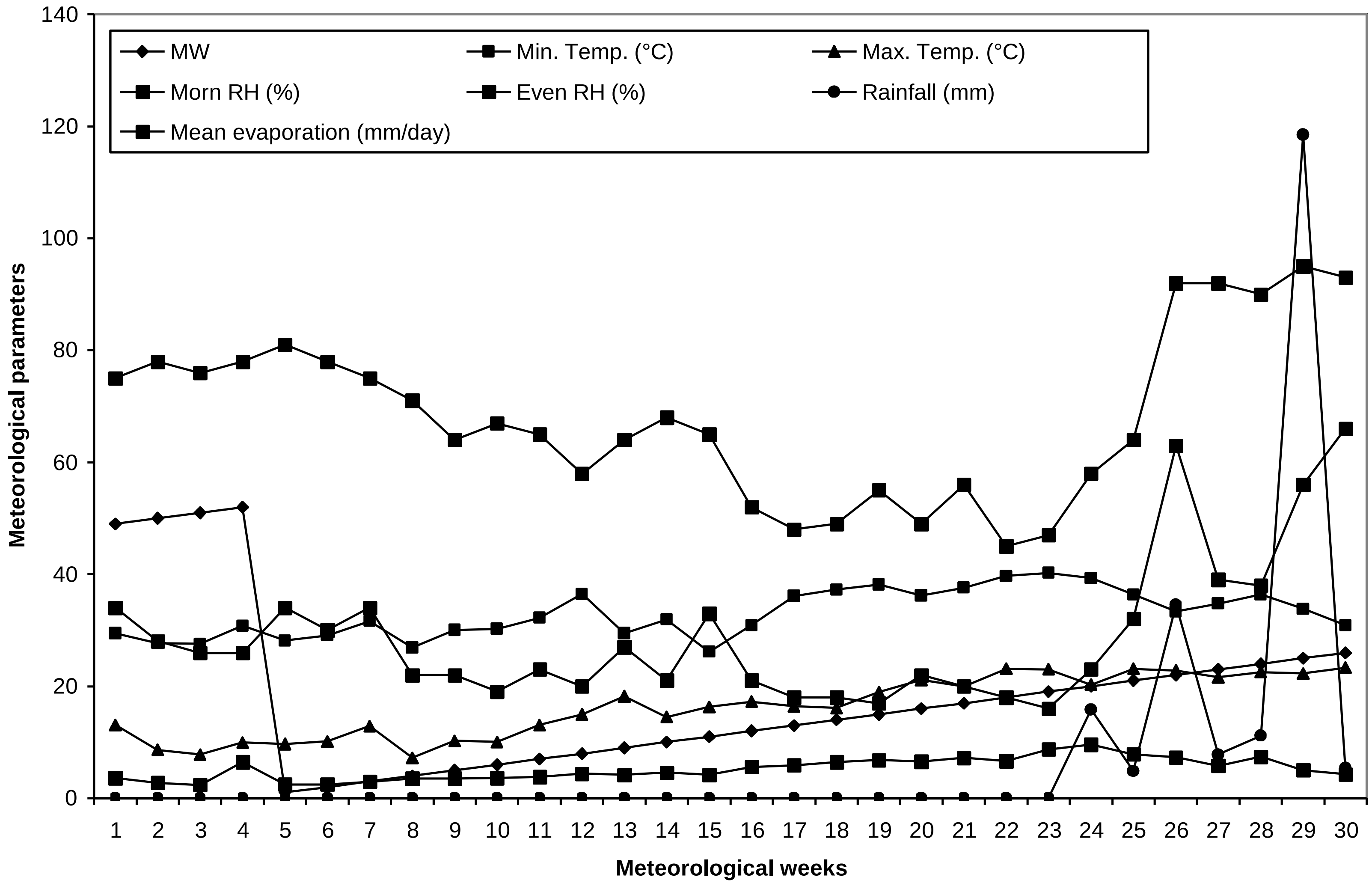


Fig. 1. Weekly weather data during the crop growth period

PDF

The mean evaporation was maximum (9.6 mm) in 20th MW and the minimum was (4.2 mm) in 9th and 11th MW.

3.1.4 Cropping history of experimental field

The cropping history of the experimental field for previous two years are presented in Table 3.

Table 3. Cropping history of experimental field

Sr. No.	Year	Crops grown in previous two years		
		Kharif	**Rabi**	**Summer**
1	2003-04	Soybean	Wheat	Groundnut
2	2004-05	Cotton	Chickpea	Fallow
3	2005-06	Soybean	Fallow	-

The present investigation was carried out on plot preceded by soybean during *kharif*.

3.1.5 Details of the experimental methods

The field experiment was laid out in randomized block design with four replications and seven treatments. The gross plot size was 4.2 x 3.6 m^2, while net plot size 3.6 x 2.8 m^2. The plan of field layout used for experimentation is depicted in Fig. 2. The details of treatments alongwith their symbol used are given in Table 4.

Table 4. Treatment details with their symbols

Sr. No.	Treatment details	Symbol
1	Sugarcane trash mulch with stress at flowering stage	M_1
2	Sugarcane trash mulch with stress at pegging stage	M_2
3	Sugarcane trash mulch with stress at pod development stage	M_3
4	White polythene mulch with stress at flowering stage	M_4
5	White polythene mulch with stress at pegging stage	M_5
6	White polythene mulch with stress at pod development stage	M_6
7	Control	M_7

3.1.6 Field operations

The details of cultural operations carried out in experimental plot are presented in Table 5.

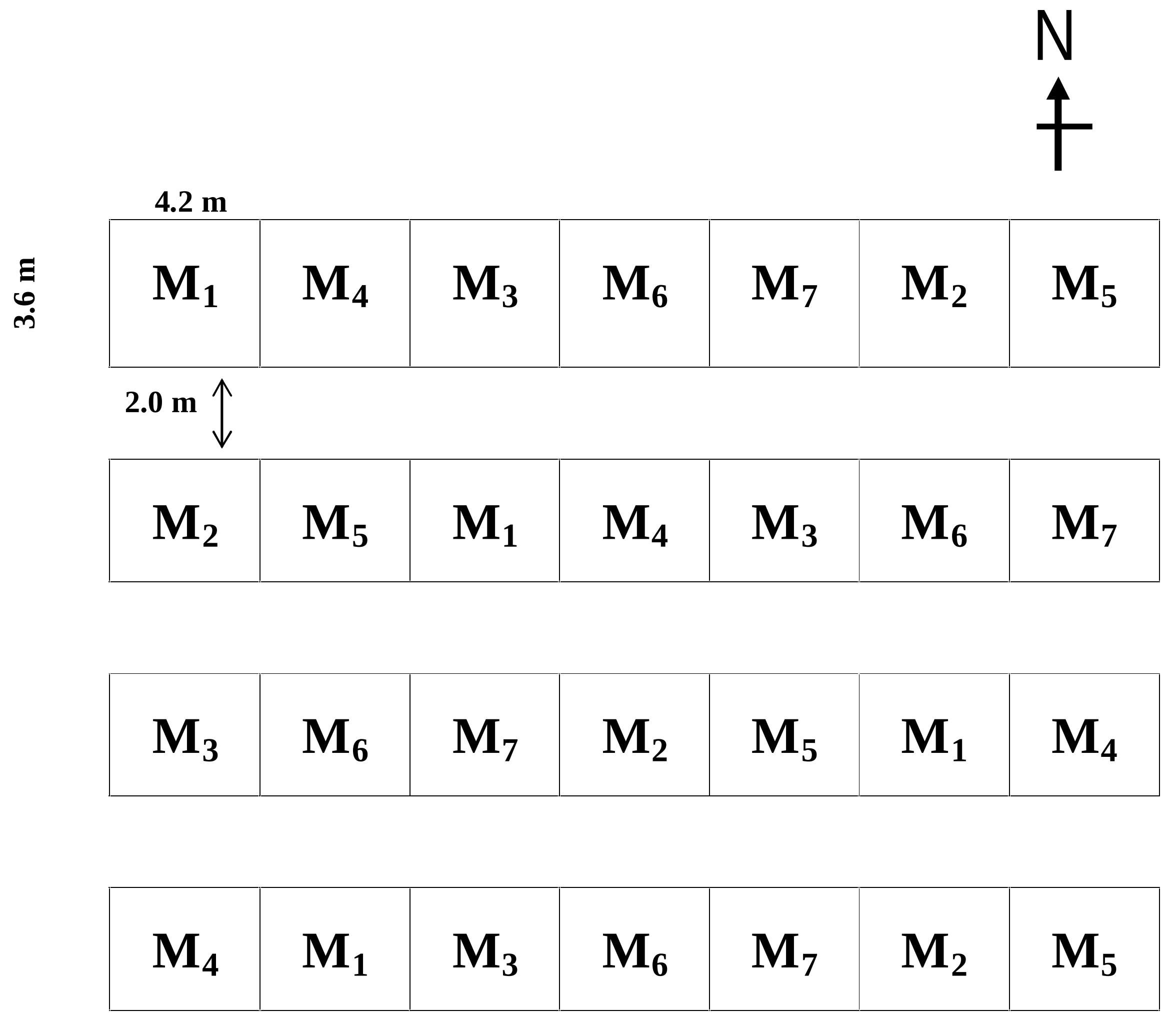
3.1.7 Preparation of planting layout

The flat beds were prepared as per the size of gross plot. White polythene paper sheet was placed over the beds before sowing and sugarcane trash mulch was applied @ 5 t ha^{-1} in between crop rows 15 days after sowing.

3.1.8 Seed and sowing

3.1.8.1 Seed

Spanish bunch type TAG-24 variety of groundnut was selected for experimental purpose. Seed of TAG-24 was brought from the All India Co-ordinated Project on Groundnut, Mahatma Phule Krishi Vidyapeeth, Rahuri.



Design	:	Randomized block design		
Replications	:	Four		
Treatments	:	Seven		
Spacing	:	30 x 10 cm		
Plot size	:	Gross plot size	:	4.2 x 3.6 m^2
		Net plot size	:	3.6 x 2.8 m^2
Mulches	:	a. Sugarcane trash		
		b. White polythene sheet		

FIG. 2. PLAN OF LAYOUT

Table 5. Cultural operations carried out in experimental plot

Sr. No.	Particulars of operation	Frequency	Date
A	**Pre-sowing operations**		
1	Ploughing	1	24/1/2006
2	Discing	1	5/2/2006
3	Harrowing	1	9/2/2006
4	Collection of stubbles	1	10/2/2006
5	Pre-sowing irrigation	1	13/2/2006
6	Preparation of layout	1	20/2/2006
B	**Sowing and application of fertilizers**		
1	Application of fertilizers	1	22/2/2006
2	Application of plastic mulch	1	22/2/2006
3	Sowing by dibbling	1	23/2/2006
C	**Post sowing operations**		
1	Light irrigation after sowing	1	24/2/2006
2	Gap filling	1	4/3/2006
3	Application of sugarcane trash mulch	-	10/3/2006
4	Hand weeding	2	20/3/2006 8/4/2006
5	Irrigation		
a)	Common to all treatments	2	5/3/2006 15/3/2206
b)	i) Sugarcane trash mulch with stress at flowering ii) White polythene mulch with stress at flowering	-	25/3/2006 5/4/2006
c)	i) Sugarcane trash mulch with stress at pegging ii) White polythene mulch with stress at pegging	-	16/4/2006 27/4/2006
d)	i) Sugarcane trash mulch with stress at pod development ii) White polythene mulch with stress at pod development	-	6/5/2006 17/5/2006
D	**Plant protection** (Malathion spray)	-	23/4/2006
E	**Harvesting and drying**	-	30/6/2006 11/7/2006

3.1.8.2 Seed treatment

The groundnut kernels were treated with thiram @ 2.5 g kg^{-1} of seed before sowing.

3.1.8.3 Sowing

Sowing was done on 23rd February, 2006. Only one kernel was dibbled per hill with spacing of 30 cm x 10 cm.

3.1.8.4 Fertilizer application

Well decomposed FYM applied before the sowing @ 10 tonnes ha^{-1}. The crop was fertilized with recommended dose of 25 kg N and 50 kg P_2O_5 ha^{-1}. The entire recommended dose of fertilizer was applied as basal for all the treatments before dibbling. Nitrogen was supplied through urea, while phosphorus was provided through single super phosphate.

3.1.8.5 Plant protection measures

One spray of malathion @ 1.5 ml lit^{-1} of water was given to control aphid, jassids at 60th day of crop growth.

3.1.8.6 Weeding and intercultivation

The groundnut crop was kept weed free by hand weeding on 25 DAS and 45 days after dibbling.

3.1.8.7 Harvesting and drying

The groundnut crop was uprooted after its maturity and air dried for 10-12 days after harvest.

3.2 Biometric observations

The various biometric observations were recorded on five randomly selected plants from each plot. The bamboo pegs were fixed with labels near observation plants for their easy location. The growth observations were recorded at 30, 60, 90 days after sowing and at harvest. These biometric observations, their frequencies, etc. recorded during the period of investigation are presented in Table 6.

3.2.1 Pre-harvest observations

3.2.1.1 Initial plant count

The initial plant count was recorded by counting the number of plants from each plot on 20 day of crop growth.

3.2.1.2 Plant height (cm)

Plant height was measured from the ground level to the base of terminal leaf bud on main stem on 30, 60, 90 days after sowing and at harvest.

3.2.1.3 Number of branches plant^{-1}

The number of branches per plant was counted from the selected five plants and the value was averaged out.

3.2.1.4 Plant spread (cm)

The plant spread was recorded by measuring the horizontal space occupied by plant between tips of two extreme leaves.

3.2.1.5 Number of functional leaves plant^{-1}

Fully developed unfolded compound leaves plant^{-1} were recorded at 30, 60, 90 days of crop growth and at harvest.

Table 6. Details of biometric observations.

Sr. No.	Particulars	Frequency	Days after sowing	Sample size
I	**Pre-harvest studies**			
1	Initial plant count	1	20	All plants from net plot
2	Plant height (cm)	4	30, 60, 90 and at harvest	5 plants from net plot
3	Plant spread (cm)	4	30, 60, 90 and at harvest	5 plants from net plot
4	Number of branches $plant^{-1}$	4	30, 60, 90 and at harvest	5 plants from net plot
5	Number of functional leaves $plant^{-1}$	4	30, 60, 90 and at harvest	5 plants from net plot
6	Leaf area $plant^{-1}$ (dm^2)	4	30, 60, 90 and at harvest	5 plants from net plot
7	Dry matter $plant^{-1}$ (g)	4	30, 60, 90 and at harvest	5 plants from net plot
8	Number of pegs $plant^{-1}$	3	60, 90 and at harvest	5 plants from net plot
9	Final plant count	1	At harvest	All plants from net plot
II	**Post harvest studies**			
1	Number of filled pods $plant^{-1}$	1	At harvest	5 plants from net plot
2	Number of unfilled pods $plant^{-1}$	1	At harvest	5 plants from net plot
3	Hundred pod weight (g)	1	At harvest	5 plants from net plot
4	Hundred kernel weight (g)	1	At harvest	5 plants from net plot
5	Shelling (%)	1	At harvest	5 plants from net plot

Table 6 (Contd..)

Sr. No.	Particulars	Frequency	Days after sowing	Sample size
6	Sound mature kernel (%)	1	At harvest	5 plants from net plot
7	Dry pod yield (q ha^{-1})	1	At harvest	Sample from net plot
8	Dry haulm yield (q ha^{-1})	1	At harvest	Sample from net plot
9	Dry kernel yield (q ha^{-1})	1	At harvest	Sample from net plot
10	Oil content (%)	1	At harvest	Sample from net plot
11	Oil yield (q ha^{-1})	1	At harvest	Sample from net plot
III	**Weed intensity (per m^2 area)**	-	15 days interval	-
IV	**Soil moisture (%)**	-	15 days interval	-
V	**Chemical Analysis**			
1	Particle size	1	Before sowing	-
2	pH (1:2.5)	1	Before sowing	-
3	EC (dSm^{-2})	1	Before sowing	-
4	Available nitrogen (kg ha^{-1})	2	Before sowing and after harvest	-
5	Available phosphorus (kg ha^{-1})	2	Before sowing and after harvest	-
6	Available potassium (kg ha^{-1})	2	Before sowing and after harvest	-

3.2.1.6 Leaf area plant^{-1} (dm^2)

Leaf area plant^{-1} was recorded at 30, 60, 90 days of crop growth and at harvest with automatic leaf area meter (Model Laser Area Meter CI-203).

3.2.1.7 Dry matter plant^{-1} (g)

From selected plants, plant parts were separated and they first air dried and then dried in an oven at 65°C till constant weight was observed. From weight of these plants, average dry matter plant was recorded at 30, 60, 90 days of crop growth and at harvest.

3.2.1.8 Number of pegs plant^{-1}

Number of pegs plant-1 was counted from the sampled plant and the values were averaged out. The observations were recorded at 60, 90 days of crop growth and at harvest.

3.2.1.9 Final plant count

Final plant count from the net plot was recorded at the time of harvesting.

3.2.1.10 Weed intensity

Number of weeds observed per m^2 area was recorded from each plot at 15 days interval during crop growth.

3.2.1.11 Soil moisture status (%)

Gravimetric method used to determine the soil moisture. Soil from different treatments at 30 cm depth collected during morning hours of the day. Moisture percentage was calculated at 15 days interval during crop growth period by following formula.

$$\text{Soil moisture content} = \frac{\text{Weight of moist soil} - \text{Weight of dry soil}}{\text{Weight of dry soil}} \times 100$$

3.2.1.12 Irrigation

One pre-sowing irrigation was given while preparing layout and one light irrigation was given after dibbling of seeds. Subsequent irrigations were given at 10-12 days interval by keeping in view that stress to be given at critical growth stages of the crop to the particular treatment. Moisture stress was given in each phenophase viz., flowering (35-55 DAS), pegging (55-75 DAS) and pod development (75-95 DAS) during the crop growth by escaping irrigation during phenophase.

3.2.2 Post harvest studies

3.2.2.1 Number of filled pods plant^{-1}

Number of filled pods plant^{-1} was counted at the time of harvest.

3.2.2.2 Number of unfilled pods plant^{-1}

The number of unfilled pods plant^{-1} was counted at the time of harvest.

3.2.2.3 Hundred pod weight (g)

From the sample of dry pods taken from each net plot produce, the hundred pods were counted, sun dried and weight was recorded.

3.2.2.4 Hundred kernel weight (g)

Randomly selected sample of hundred kernels from each net plot was obtained by shelling the pods and it's weight was recorded.

3.2.2.5 Shelling percentage

A half kg sample of dry pods was taken from each net plot and they were shelled out. The shelling percentage was calculated by using following formula.

$$\text{Shelling percentage} = \frac{\text{Weight of kernels (kg)}}{\text{Weight of pods (kg)}} \times 100$$

3.2.2.6 Sound mature kernel percentage (SMK)

From the net plot, randomly kernels were taken out. Fully matured kernels were counted and SMK (%) was calculated as follows :

$$\text{SMK (\%)} = \frac{\text{Number of fully matured wrinkle free kernels}}{\text{Total number of kernels}} \times 100$$

3.2.2.7 Dry pod yield (q ha^{-1})

After maturity, the plants from each net plot were uprooted and pods were separated from the plants. Soil and other material were also removed. Then weight of sun dried pods was taken.

3.2.2.8 Dry haulm yield (q ha^{-1})

After removing the pods from plants the haulm was sun dried till constant weight was obtained. The haulm yield from each plot was recorded.

3.2.2.9 Dry kernel yield (q ha^{-1})

Kernel yield was calculated from representative sample from net plot.

3.2.2.10 Oil content (%)

Representative sample of kernels from each net plot produce was taken for estimation of oil content by Nuclear Magnetic Resonance (NMR) spectrometry (Jambunathan *et al.*, 1985).

3.2.2.11 Oil yield (q ha^{-1})

The oil yield was calculated as follows :

Oil yield (q ha^{-1}) = Yield of kernel (q ha^{-1}) x Oil content in percentage

3.3 Economic studies

The total cost of cultivation was worked out by considering the prevailing market prices during period of experimentation as Cost A.

Gross monetary returns were calculated by using the market prices of main produce and by produce.

Net monetary returns were calculated by subtracting the value of cost of cultivation i.e. cost A from gross monetary returns.

Benefit cost ratio was calculated by using the following formula.

$$\text{B:C ratio} = \frac{\text{Gross monetary returns}}{\text{Cost A}}$$

3.4 Statistical analysis and interpretation of data

The data thus recorded were statistically analysed by using techniques of analysis of variance (Fisher, 1950) and test of significance was carried out as given by Panse and Sukhatme (1985). In the tabular data in the text C.D. values have been given for comparison only in cases where 'F' test was significant, figures for S.E.m± are given. The data are also presented with suitable graphically illustration at appropriate places.

4. results and discussion

A field experiment entitled, “Stress management in summer groundnut” was conducted during summer season of 2006 at Post Graduate Institute Research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri. The details of the investigation are presented and discussed in this chapter under suitable headings.

4.1 Pre-harvest studies

4.1.1 Plant count

4.1.1.1 Plant count at 20 days after sowing

Data regarding mean plant count at 20 days after sowing per net plot as observed in different treatments under study are presented in Table 7. The mean initial plant count was 3.22 lakhs ha^{-1}. The different treatments did not affect significantly plant population at 20 days after sowing.

4.1.1.2 Plant count at harvest

The data regarding mean plant count at harvest was found 3.07 lakh ha^{-1}. The different treatments did not affect significantly the plant count at harvest.

Table 7. Initial and final plant count (lakh ha^{-1}) as influenced by different treatments.

Symbol	Treatments	Initial plant population	Final plant population
M_1	Sugarcane trash mulch with stress at flowering stage	3.19	3.03
M_2	Sugarcane trash mulch with stress at pegging stage	3.20	3.05
M_3	Sugarcane trash mulch with stress at pod development stage	3.25	3.08
M_4	White polythene mulch with stress at flowering stage	3.23	3.10
M_5	White polythene mulch with stress at pegging stage	3.23	3.08
M_6	White polythene mulch with stress at pod development stage	3.27	3.12
M_7	Control	3.20	3.03
	S.E. ±	0.25	0.19
	C.D. at 5%	N.S.	N.S.
	General mean	3.22	3.07

4.1.2 Plant height (cm)

The data regarding plant height of groundnut as influenced periodically by different treatments are presented in Table 8 and graphically depicted in Fig. 3.

The mean plant height increased with advancement of age of the crop. The mean maximum plant height was recorded at harvest (30.10 cm).

At 30 days after sowing, the different treatments did not differ significantly. However, white polythene mulch treatment with stress at pod development stage showed maximum plant height (6.48 cm) and the minimum plant height was observed in white polythene mulch with stress at pegging stage (5.28 cm).

At 60 days after sowing maximum plant height was recorded in treatment white polythene mulch with stress at pod development stage (18.60 cm) and it was significantly superior over all the treatments except sugarcane trash mulch with stress at pod development stage (17.75 cm).

At 90 days after sowing maximum plant height was observed by white polythene mulch with stress at pod development stage (29.52 cm) and it was significantly superior to all the treatments except sugarcane trash mulch with stress at pod development stage (27.97 cm). The minimum plant height was recorded in control plot (25.00 cm).

At harvest white polythene mulch with stress at pod development stage produced the maximum plant height (31.77 cm) and it was found superior over all the treatments except white polythene mulch with stress at pegging stage (31.54 cm) and sugarcane trash mulch with stress at pod development stage (30.82 cm).

Table 8. Plant height (cm) as influenced periodically by different treatments.

Symbol	Treatments	Days after sowing			
		30	60	90	At harvest
M_1	Sugarcane trash mulch with stress at flowering stage	5.33	15.43	25.25	28.63
M_2	Sugarcane trash mulch with stress at pegging stage	5.43	16.00	26.85	29.76
M_3	Sugarcane trash mulch with stress at pod development stage	5.66	17.75	27.97	30.82
M_4	White polythene mulch with stress at flowering stage	5.53	15.65	25.75	30.06
M_5	White polythene mulch with stress at pegging stage	5.28	16.99	27.39	31.54
M_6	White polythene mulch with stress at pod development stage	6.48	18.60	29.52	31.77
M_7	Control	5.51	16.71	25.00	28.10
	S.E. ±	0.27	0.47	0.63	0.57
	C.D. at 5%	N.S.	1.39	1.88	1.70
	General mean	5.60	16.75	26.59	30.10

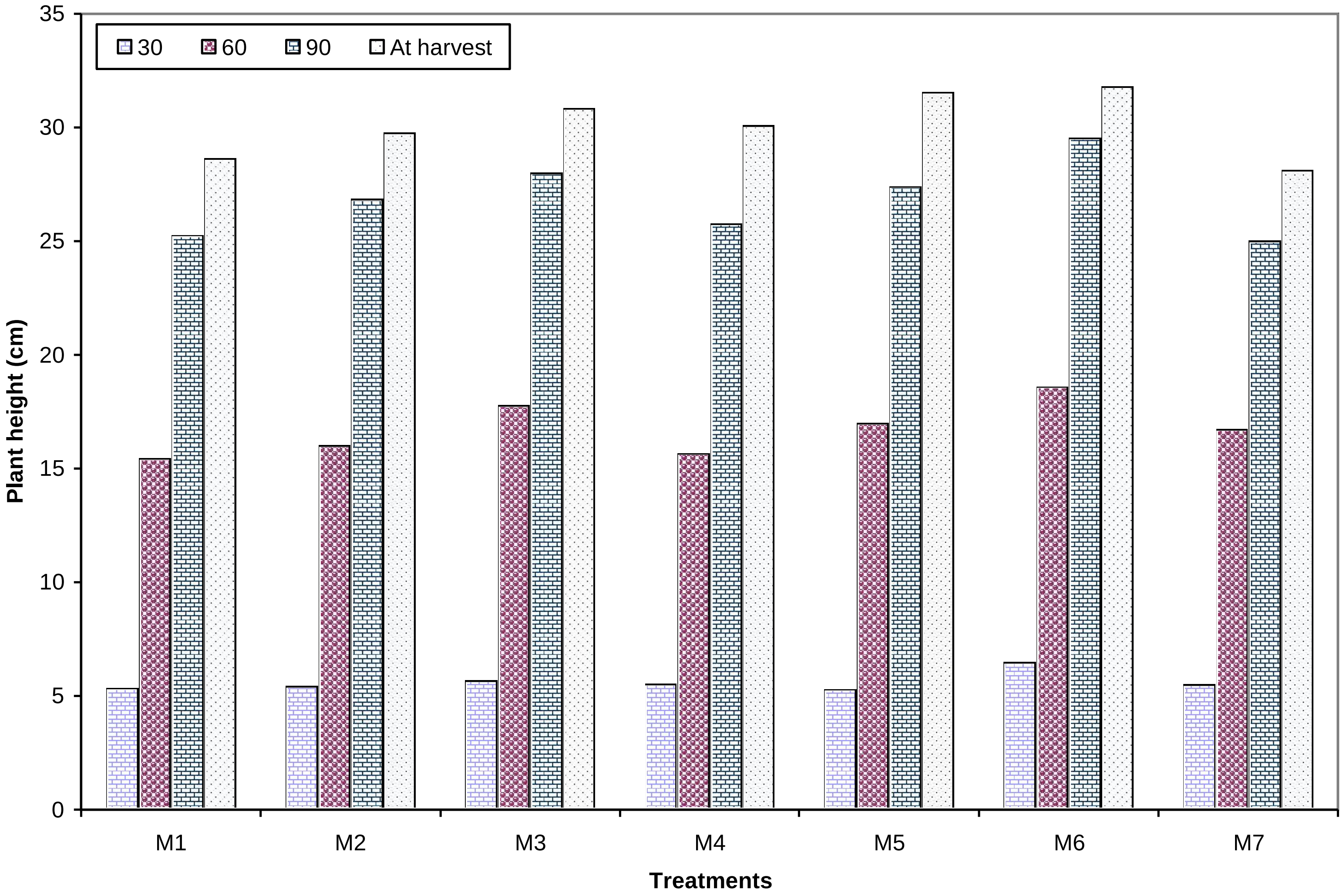


Fig. 3. Plant height (cm) as influenced periodically by different treatments

The application of mulches helped in conservation of soil moisture, resulting in enhancement of early crop growth. These results are in agreement to those reported by Zhang *et al.* (1996) and Mahalle *et al.* (2002).

The plant height was reduced due to stress at different growth stages of crop as reported by Chavan (1997).

4.1.3 Plant spread (cm)

The data regarding mean plant spread of groundnut as influenced periodically by different treatments are presented in Table 9 and graphically depicted in Fig. 4. The mean maximum plant spread was recorded at 90 DAS (26.18 cm).

At 30 days after sowing, the different treatments did not affect significantly. The maximum plant spread recorded in white polythene mulch with stress at pod development stage (9.37 cm).

At 60 days of sowing white polythene mulch with stress at pod development stage (24.23 cm) produced maximum spread and it was found superior over all the treatments except sugarcane trash mulch with stress at pod development stage (24.03 cm) and white polythene mulch with stress at pegging stage (23.55 cm).

At 90 days after sowing maximum plant spread was recorded in white polythene mulch with stress at pod development stage (27.55 cm) and it is significantly superior over all the treatments except sugarcane trash mulch with stress at pod development stage (27.40 cm).

Table 9. Plant spread (cm) as influenced periodically by different treatments.

Symbol	Treatments	Days after sowing			
		30	60	90	At harvest
M_1	Sugarcane trash mulch with stress at flowering stage	8.03	21.60	25.35	23.09
M_2	Sugarcane trash mulch with stress at pegging stage	8.76	22.57	25.77	23.81
M_3	Sugarcane trash mulch with stress at pod development stage	8.90	24.03	27.40	23.89
M_4	White polythene mulch with stress at flowering stage	8.28	21.90	24.41	24.33
M_5	White polythene mulch with stress at pegging stage	9.13	23.55	26.30	24.21
M_6	White polythene mulch with stress at pod development stage	9.37	24.23	27.55	25.23
M_7	Control	8.52	22.76	26.29	24.35
	S.E. ±	0.43	0.52	0.30	0.42
	C.D. at 5%	N.S.	1.55	0.90	1.26
	General mean	8.71	22.95	26.18	24.24

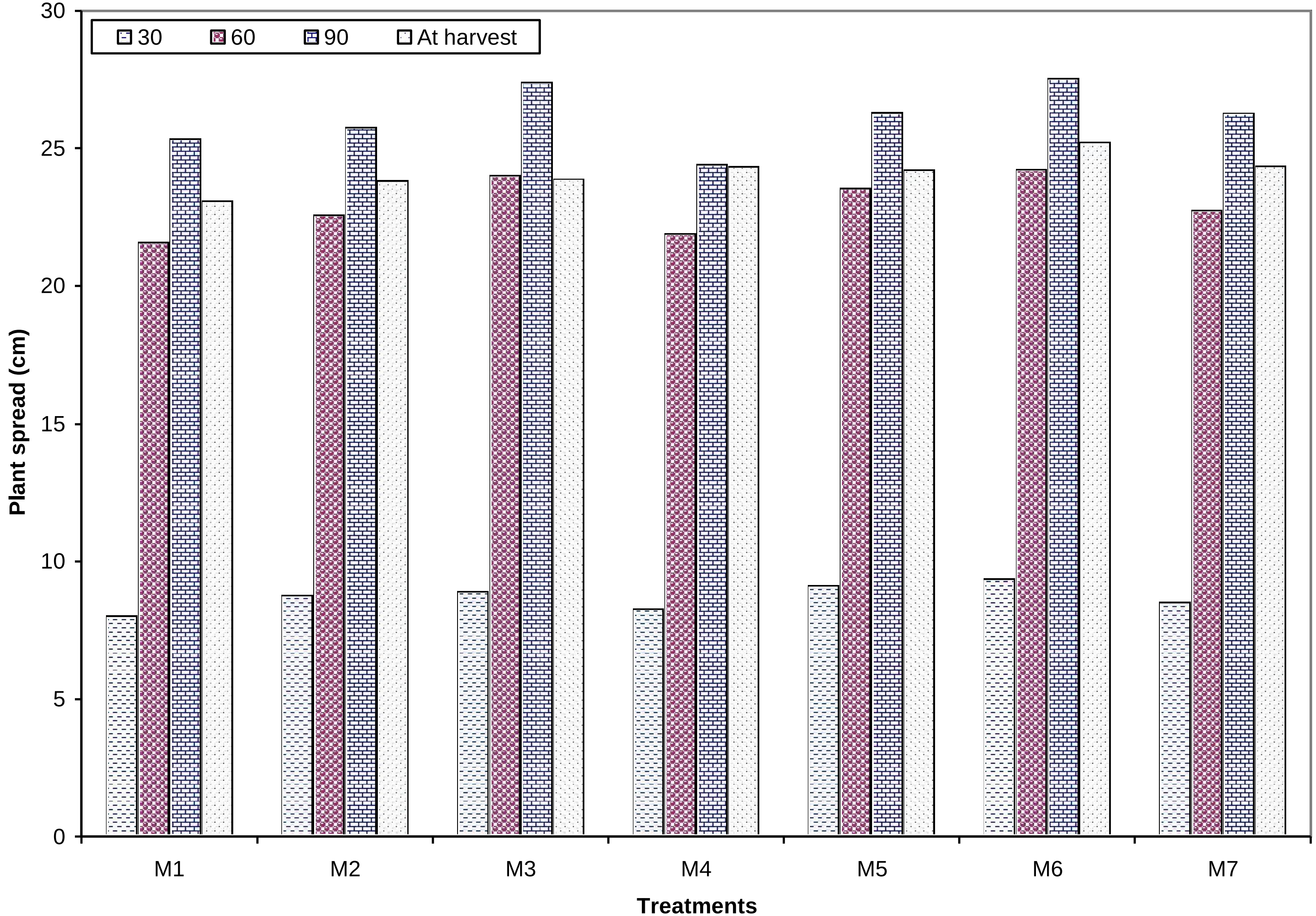


Fig. 4. Plant spread (cm) as influenced periodically by different treatments

At harvest maximum plant spread was recorded with white polythene mulch with stress at pod development stage (25.23 cm) and it was found significantly superior over most of the treatments except control (24.35 cm), white polythene mulch with stress at flowering stage (24.33 cm) and white polythene mulch with stress at pegging stage (24.21 cm).

The application of poly mulch significantly increased plant spread as reported by Shyam Sundar (1999). Application of mulches enhanced the microbial and root activities in rhizosphere due to increase in soil temperature and better soil moisture condition during crop growth. These results are in conformity with results obtained by Balasubramaniyam and Pallaniappan (1996).

4.1.4 Number of branches plant^{-1}

The data regarding mean number of branches plant^{-1} as influenced by different treatments are presented in Table 10 and depicted graphically in Fig. 5. The mean maximum number of branches plant^{-1} was recorded at 90 DAS (5.34).

At 30 days after sowing the different treatments did not differ significantly. White polythene mulch with stress at pegging stage recorded maximum number of branches (2.75).

At 60 days after sowing maximum number of branches per plant was recorded in white polythene mulch at pod development stage (4.73) and it was significantly superior to all the treatments except control (4.58) and sugarcane trash mulch with stress at pod development stage (4.37).

At 90 days after sowing maximum number of branches per plant recorded in white polythene mulch with stress at pod development stage (5.94) and it was significantly superior over all the treatments.

Table 10. Number of branches plant^{-1} as influenced periodically by different treatments.

Symbol	Treatments	Days after sowing			
		30	60	90	At harvest
M_1	Sugarcane trash mulch with stress at flowering stage	2.61	3.88	5.03	5.03
M_2	Sugarcane trash mulch with stress at pegging stage	2.66	4.11	5.10	5.10
M_3	Sugarcane trash mulch with stress at pod development stage	2.69	4.37	5.53	5.53
M_4	White polythene mulch with stress at flowering stage	2.67	3.93	5.16	5.16
M_5	White polythene mulch with stress at pegging stage	2.75	4.27	5.40	5.40
M_6	White polythene mulch with stress at pod development stage	2.64	4.73	5.94	5.94
M_7	Control	2.61	4.58	5.21	5.21
	S.E. ±	0.20	0.16	0.11	0.11
	C.D. at 5%	N.S.	0.41	0.34	0.34
	General mean	2.66	4.26	5.34	5.34

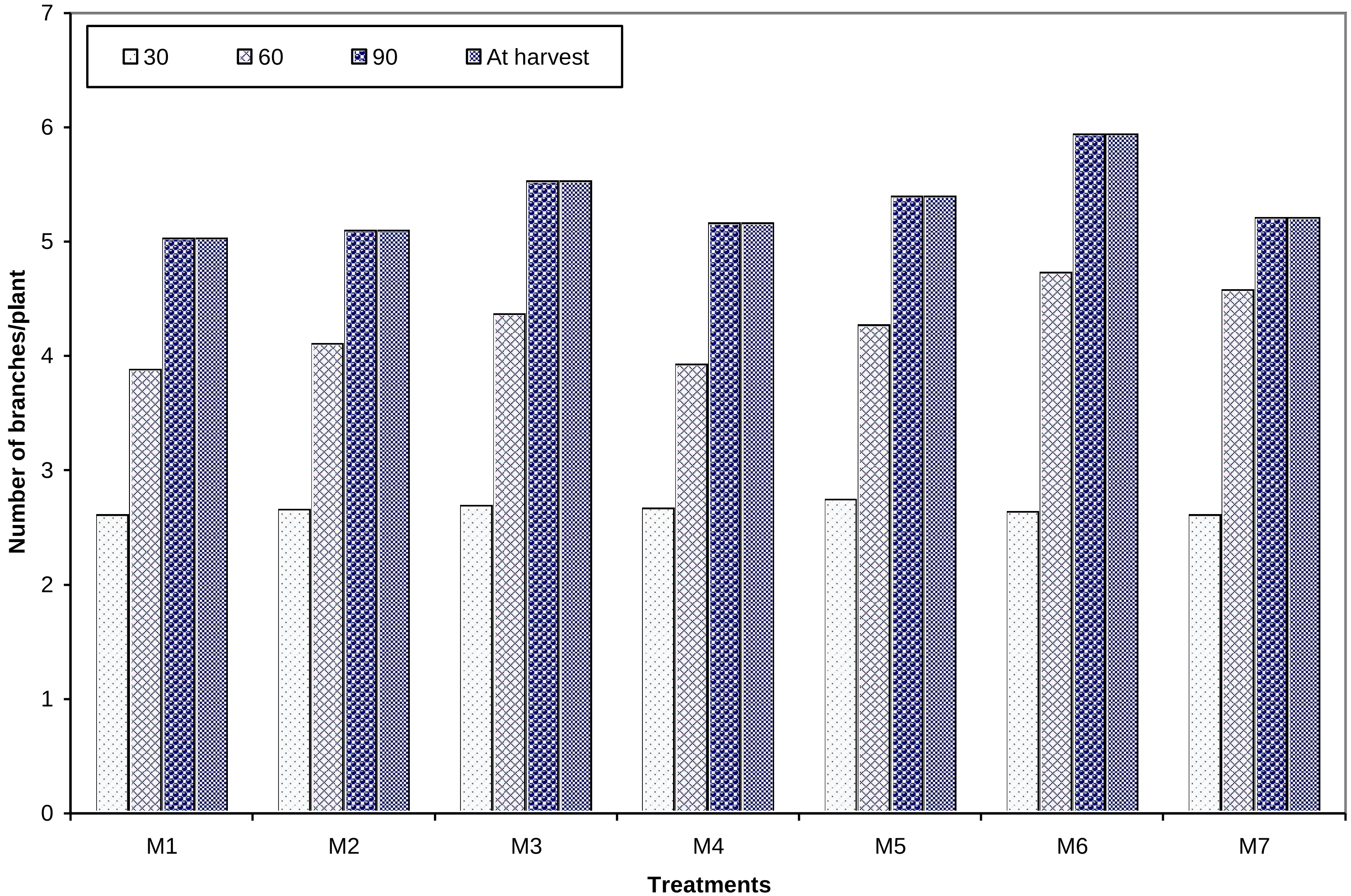


Fig. 5. Number of branches per plant as influenced periodically by different treatments

There is no any reduction in number of branches at harvest.

The mulching helped in suppressing weeds to the extent of 50 per cent which might have diverted available nutrient and enlighten to main crop and ultimately plastic mulch produced maximum branches per plant over no mulch (Rao *et al.*, 1991) and Kumar *et al.* (2002) also reported similar results.

4.1.5 Number of functional leaves plant^{-1}

The data regarding number of functional leaves plant^{-1} as influenced periodically by different treatments are presented in Table 11. The mean maximum number of leaves per plant recorded at 90 days after sowing (74.67).

At 30 days after sowing the different treatments did not affect significantly. The maximum number of leaves plant^{-1} was recorded in white polythene mulch with stress at pod development stage (5.62).

At 60 days after sowing maximum number of leaves plant^{-1} was recorded in white polythene mulch with stress at pod development stage (29.68) and it was significantly superior over rest of the treatments.

At 90 days after sowing maximum number of functional leaves plant^{-1} was recorded in white polythene mulch with stress at pod development stage (76.93) and it was significantly superior over most of the treatments except white polythene mulch with stress at pegging stage (76.18) and sugarcane trash mulch with stress at pod development stage (75.97).

Table 11. Number of functional leaves plant^{-1} as influenced periodically by different treatments.

Symbol	Treatments	Days after sowing			
		30	60	90	At harvest
M_1	Sugarcane trash mulch with stress at flowering stage	4.63	27.73	73.81	69.86
M_2	Sugarcane trash mulch with stress at pegging stage	4.82	28.10	73.95	70.43
M_3	Sugarcane trash mulch with stress at pod development stage	4.83	28.79	75.97	71.77
M_4	White polythene mulch with stress at flowering stage	5.23	27.99	74.72	71.29
M_5	White polythene mulch with stress at pegging stage	5.41	28.01	76.18	72.77
M_6	White polythene mulch with stress at pod development stage	5.62	29.68	76.93	72.59
M_7	Control	4.66	27.18	71.15	68.25
	S.E. ±	0.26	0.28	0.70	0.94
	C.D. at 5%	N.S.	0.83	2.08	2.80
	General mean	5.03	28.21	74.67	70.99

At harvest maximum number of functional leaves plant^{-1} was recorded with white polythene mulch with stress at pegging stage (72.77) and it was significantly superior over rest of the treatments.

Chavan (1997) conducted that availability of sufficient moisture enhances the expansion of plant tissues thereby resulting in good vegetative growth. Moisture stress at flowering and pegging resulted into sharp decline in vegetative growth. The increase in height increases number of leaves and thereby leaf area which is site of photosynthetic activity, this leads to increase in dry matter.

4.1.6 Leaf area plant^{-1} (dm^2)

The data regarding leaf area plant^{-1} (dm^2) of groundnut as influenced periodically by different treatments are presented in Table 12. The data revealed that leaf area increased with advancement in age of crop upto 90 days and it was maximum at 90 DAS (20.08 dm^2).

At 30 days after sowing the different treatments did not affect significantly. The treatment of white polythene mulch with stress at pod development stage recorded maximum leaf area per plant (2.69 dm^2).

At 60th days after sowing the treatment white polythene mulch with stress at pod development stage recorded maximum leaf area per plant (17.33 dm^2) and it was significantly superior over all the treatments except white polythene mulch with stress at pegging stage (16.25 dm^2).

At 90 days after sowing maximum leaf area per plant was recorded in white polythene trash mulch with stress at pod development stage (23.93 dm^2) and it was significantly superior over all the treatments.

Table 12. Leaf area plant^{-1} (dm^2) as influenced periodically by different treatments.

Symbol	Treatments	Days after sowing			
		30	60	90	At harvest
M_1	Sugarcane trash mulch with stress at flowering stage	2.18	14.03	18.22	16.43
M_2	Sugarcane trash mulch with stress at pegging stage	2.40	14.95	19.75	17.58
M_3	Sugarcane trash mulch with stress at pod development stage	2.55	15.05	20.25	18.10
M_4	White polythene mulch with stress at flowering stage	2.61	15.09	18.59	16.61
M_5	White polythene mulch with stress at pegging stage	2.62	16.25	21.94	19.48
M_6	White polythene mulch with stress at pod development stage	2.69	17.33	23.93	21.17
M_7	Control	2.39	13.09	17.88	15.69
	S.E. ±	0.096	0.52	0.59	0.54
	C.D. at 5%	N.S.	1.55	1.76	1.61
	General mean	2.49	15.11	20.08	17.87

At harvest maximum leaf area was recorded in white polythene mulch with stress at pod development stage (21.17 dm^2) and it was significantly superior over all the treatments.

Application of polymulch significantly increased leaf area over unmulched treatments. This might be due to slight rise in temperature in rhizosphere which activated the micro-organisms and probably enhanced uptake of micro and macronutrients and this ultimately resulted in increase in growth contributing character like leaf area. Similar results were obtained by Zhang *et al*. (1996).

Leaflet size was significantly and negatively correlated with transpiration efficiency (TE) under drought stress condition as reported by Babitha and Reddy (2001).

4.1.7 Dry matter plant^{-1} (g)

The data regarding dry matter plant^{-1} as influenced periodically by different treatments recorded in Table 13 and depicted in Fig. 6 and observed that maximum mean dry matter plant^{-1} was recorded at 90 DAS (16.03 g).

At 30 days after sowing maximum dry matter plant^{-1} was recorded in white polythene mulch with stress at pod development stage (2.17 g) and it was significantly superior over most of the treatments except white polythene mulch with stress at flowering stage (2.10 g) and white polythene mulch with stress at pegging stage (2.13 g).

At 60 and 90 days after sowing white polythene mulch with stress at pod development stage recorded maximum dry matter per plant (13.69 g, 18.62 g, respectively) and it was significantly superior over all the treatments.

Table 13. Dry matter plant^{-1} (g) as influenced periodically by different treatments.

Symbol	Treatments	Days after sowing			
		30	60	90	At harvest
M_1	Sugarcane trash mulch with stress at flowering stage	1.88	9.15	14.22	13.38
M_2	Sugarcane trash mulch with stress at pegging stage	1.93	11.21	16.39	15.17
M_3	Sugarcane trash mulch with stress at pod development stage	1.97	12.35	16.92	15.76
M_4	White polythene mulch with stress at flowering stage	2.10	10.35	15.41	13.74
M_5	White polythene mulch with stress at pegging stage	2.13	12.11	17.30	16.12
M_6	White polythene mulch with stress at pod development stage	2.17	13.69	18.62	17.77
M_7	Control	1.82	8.18	13.42	12.20
	S.E. ±	0.04	0.40	0.36	0.35
	C.D. at 5%	0.11	1.20	1.07	1.05
	General mean	2.00	11.00	16.03	14.87

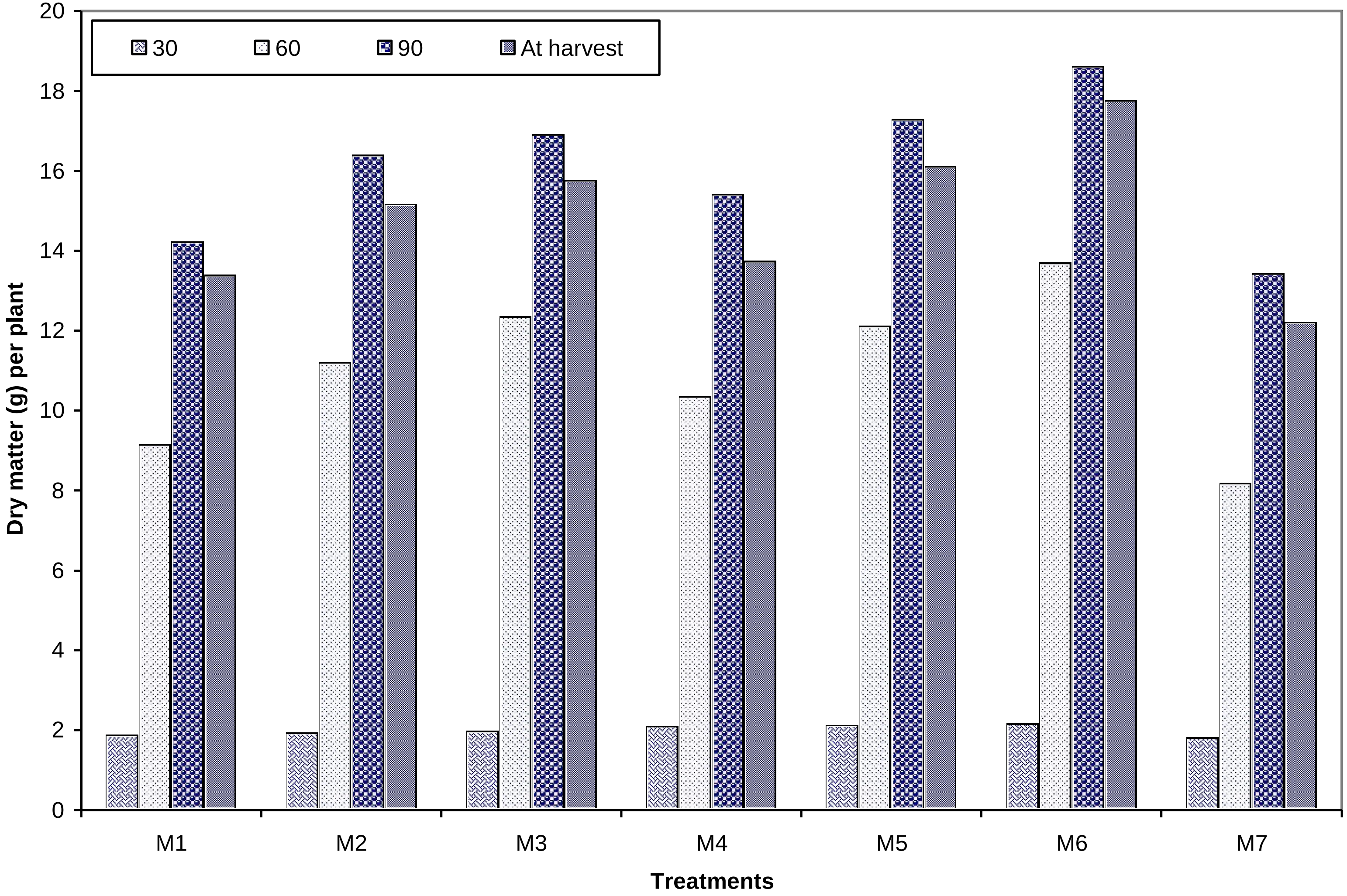


Fig. 6. Dry matter per plant (g) as influenced periodically by different treatments

PDF

At harvest maximum white polythene mulch with stress at pod development stage recorded the maximum dry matter per plant (17.77 g) and it was significantly superior over all the treatments.

This total increase in dry matter per plant was due to conducive environment for microflora and microfauna increased uptake of nutrient (Mehta *et al.*, 1996). The nutrient uptake is beneficial to increase plant height, number of leaves, number of branches per plant and thereby dry matter accumulation per plant. Kumar *et al.* (2002) and Ravankar (2003) also reported similar results. Increase in number of leaves per plant and leaf area (dm^2) enhances photosynthetic activity and thereby increase in dry matter as reported by Chavan (1997).

4.1.8 Number of pegs plant^{-1}

The data regarding number of pegs plant^{-1} as influenced periodically by different treatments are presented in Table 14.

At 60 days after sowing maximum number of pegs plant^{-1} produced in white polythene mulch with stress at pod development stage (24.75) and it was significantly superior over all the treatments except sugarcane trash mulch with stress at pod development stage (24.16).

At 90 days after sowing maximum number of pegs plant^{-1} were recorded in white polythene mulch with stress at pod development stage (12.48) and it was significantly superior over all the treatments except sugarcane trash mulch with stress at pod development stage (12.04).

Table 14. Number of pegs plant^{-1} as influenced periodically by different treatments.

Symbol	Treatments	Days after sowing		
		60	90	At harvest
M_1	Sugarcane trash mulch with stress at flowering stage	19.14	8.45	4.36
M_2	Sugarcane trash mulch with stress at pegging stage	21.90	9.15	4.92
M_3	Sugarcane trash mulch with stress at pod development stage	24.16	12.04	6.11
M_4	White polythene mulch with stress at flowering stage	20.74	8.66	5.60
M_5	White polythene mulch with stress at pegging stage	22.99	11.89	6.10
M_6	White polythene mulch with stress at pod development stage	24.75	12.48	6.20
M_7	Control	18.63	7.32	5.61
	S.E. ±	0.53	0.48	0.45
	C.D. at 5%	1.58	1.44	1.35
	General mean	21.76	9.99	5.55

At harvest, the number of pegs were reduced down, however, it was observed that white polythene mulch with stress at pod development stage recorded maximum number of pegs per plant (6.20).

Number of pegs per plant was increased due to optimum soil moisture conserved by plastic mulch (Choi and Chung, 1997) Similar results were reported by Zhang *et al*. (1996), Raskar *et al*. (2005) and Hemalatha *et al.* (2006).

4.2 Post harvest studies

Data pertaining to yield contributing characters viz., number of filled pods, unfilled pods plant^{-1} at harvest are presented in Table 15.

4.2.1 Number of filled pods plant^{-1}

Data pertaining to number of filled pods at harvest as influenced by different treatments are presented in Table 15. The mean number of filled pods plant^{-1} (18.97) was recorded at harvest.

The treatment of white polythene mulch with stress at pod development stage gave maximum filled pods plant^{-1} (23.66) and it was significantly superior over all the treatments.

4.2.2 Number of unfilled pods plant^{-1}

The data pertaining to number of unfilled pods per plant as affected by different treatments are presented in Table 15. The mean number of unfilled pods plant^{-1} (3.98) was recorded at harvest.

Table 15. Number of filled and unfilled pods plant^{-1} as influenced by different treatments.

Symbol	Treatments	Number of filled pods	Number of unfilled pods
M_1	Sugarcane trash mulch with stress at flowering stage	16.47	3.77
M_2	Sugarcane trash mulch with stress at pegging stage	18.26	4.02
M_3	Sugarcane trash mulch with stress at pod development stage	21.29	4.06
M_4	White polythene mulch with stress at flowering stage	17.45	3.88
M_5	White polythene mulch with stress at pegging stage	21.10	4.05
M_6	White polythene mulch with stress at pod development stage	23.66	4.06
M_7	Control	14.56	4.03
	S.E. ±	0.62	0.16
	C.D. at 5%	1.84	N.S.
	General mean	18.97	3.98

The different treatments did not affect significantly however maximum number of unfilled pods $plant^{-1}$ was recorded in white polythene mulch with stress at pod development stage (4.06).

4.2.3 Hundred pod weight (g), hundred kernel weight (g), shelling (%) and sound mature kernel (%)

The data regarding 100 pod weight (g), 100 kernel weight (g), shelling (%) and sound mature kernel (%) at harvest as influenced by different treatments are presented in Table 16.

The mean values of 100 pod weight, 100 kernel weight, shelling (%) and sound mature kernel (%) are 69.13 g, 38.67 g, 70.86 and 89.63 per cent, respectively.

4.2.3.1 Hundred pod weight (g)

Maximum 100 pod weight was recorded in white polythene mulch with stress at pod development stage (73.76 g) and it was significantly superior over all other treatments except sugarcane trash mulch with stress at pod development stage (71.99 g) and white polythene mulch with stress at pegging stage (71.79 g).

Maximum hundred pod weight recorded with polythene mulch. This might be due to better soil moisture condition in root zone of crop during peg formation and pod development stages. Similar results were reported by Chitodkar (2000), Kathmale *et al.* (2000), Subramaniyam *et al.* (2002) and Shaikh *et al.* (2004).

Table 16. Hundred pod weight (g), hundred kernel weight (g), shelling (%) and sound mature kernel (%) as influenced by different treatments.

Symbol	Treatments	Hundred pod weight	Hundred kernel weight	Shelling	Sound mature kernel
M_1	Sugarcane trash mulch with stress at flowering stage	64.99	35.36	68.41	88.63
M_2	Sugarcane trash mulch with stress at pegging stage	66.85	37.42	70.40	89.21
M_3	Sugarcane trash mulch with stress at pod development stage	71.99	42.30	71.43	90.42
M_4	White polythene mulch with stress at flowering stage	68.74	36.01	69.21	89.31
M_5	White polythene mulch with stress at pegging stage	71.79	39.91	73.70	89.56
M_6	White polythene mulch with stress at pod development stage	73.76	45.32	75.11	91.02
M_7	Control	65.75	34.32	67.70	89.23
	S.E. ±	0.96	1.16	1.43	0.11
	C.D. at 5%	2.85	3.46	4.25	0.34
	General mean	69.13	38.67	70.86	89.63

4.2.3.2 Hundred kernel weight (g)

Data revealed that white polythene mulch with stress at pod development stage recorded highest hundred kernel weight (45.32 g) and it was significantly superior over all other treatments except sugarcane trash mulch with stress at pod development stage (42.30 g).

This might be due to better soil moisture conservation by mulches. These results are in conformity with those obtained by Chitodkar (2000), Gogoi (2002), Shaikh *et al.* (2004). Polymulch reduce the weed growth which ultimately reduce the crop competition and results into favourable growth (Subramaniyam *et al.*, 2002).

4.2.3.3 Shelling percentage

Table 16 revealed that treatment white polythene mulch with stress at pod development stage recorded highest shelling percentage (75.11) and it was significantly superior over all the treatments except white polythene mulch with stress at pegging stage (73.70) and sugarcane trash mulch with stress at pod development stage (71.43).

This results are similar with those recorded by Shyam Sundar (1999) and Chitodkar (2000). Polymulch reduce the weed competition and enhances favourable environment for crop growth which results into increase in shelling percentage (Subramaniyam *et al.*, 2002).

4.2.3.4 Sound mature kernel percentage

Table 16 showed that highest sound mature kernel percentage were recorded in white polythene mulch with stress at pod development stage (91.02).

4.2.4 Dry pod yield

The data regarding the dry pod yield of groundnut as influenced by different treatments are presented in Table 17 and depicted in Fig. 7. Mean dry pod yield recorded was 25.59 q ha^{-1}.

Maximum dry pod yield was recorded in white polythene mulch with stress at pod development stage (28.96 q ha^{-1}) and it was found significantly superior over all other treatments and minimum yield was obtained from control (22.94 q ha^{-1}).

Maximum dry pod yield obtained with polymulch due to sufficient moisture conservation through mulch which might be available at critical growth stage. Similar results were obtained by Shyam Sundar (1999), Kathmale *et al.* (2000), Mahalle *et al*. (2002), Shaikh *et al*. (2004) and Pawar *et al.* (2008).

The water stress given at flowering and pegging stages reduced the pod yield. The increase in pod yield may be attributed by favourable effect of irrigation applied at critical growth stages as reported by Chavan (1997) and Golakiya and Patel (1992).

4.2.5 Dry haulm yield

The data regarding dry haulm yield (q ha^{-1}) of groundnut as influenced by different treatments are presented in Table 17 and graphically depicted in Fig. 7. Mean dry haulm yield recorded was 42.14 q ha^{-1}.

Treatment of white polythene mulch with stress at pod development stage recorded highest dry haulm yield (47.41 q ha^{-1}) and it was significantly superior over all of the treatments.

Table 17. Dry pod yield (q ha^{-1}), dry haulm yield (q ha^{-1}) and dry kernel yield (q ha^{-1}) as influenced by different treatments.

Symbol	Treatments	Dry pod yield	Dry haulm yield	Dry kernel yield
M_1	Sugarcane trash mulch with stress at flowering stage	23.56	38.89	16.49
M_2	Sugarcane trash mulch with stress at pegging stage	25.81	42.20	18.40
M_3	Sugarcane trash mulch with stress at pod development stage	27.10	44.72	19.46
M_4	White polythene mulch with stress at flowering stage	24.38	40.17	17.60
M_5	White polythene mulch with stress at pegging stage	26.41	43.57	18.99
M_6	White polythene mulch with stress at pod development stage	28.96	47.41	20.83
M_7	Control	22.94	38.04	16.74
	S.E. ±	0.41	0.73	0.32
	C.D. at 5%	1.23	2.18	0.97
	General mean	25.59	42.14	18.61

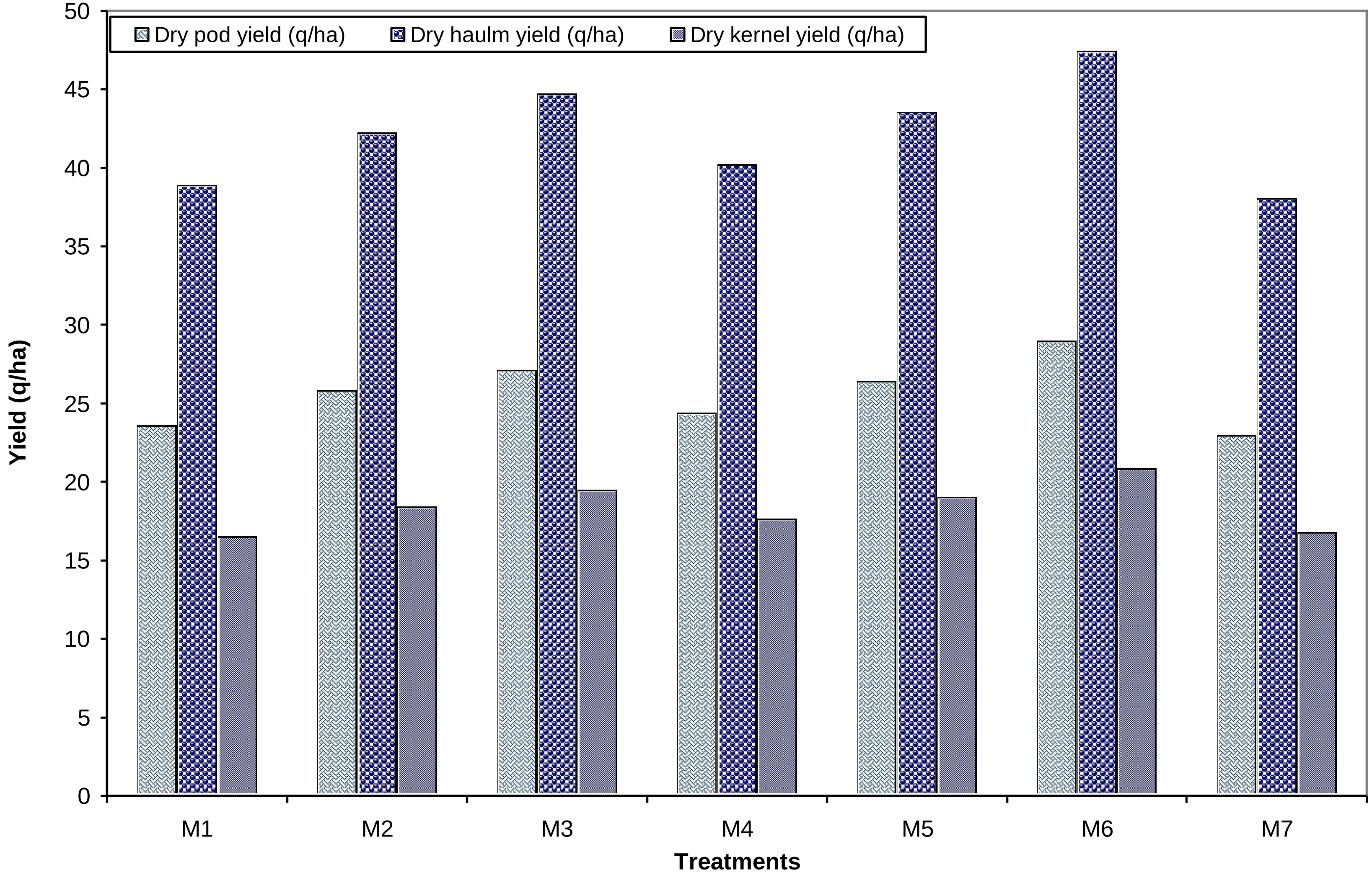


Fig. 7. Dry pod yield (q/ha), dry haulm yield (q/ha) and dry kernel yield (q/ha) as influenced by different treatments

This can be attributed to availability of sufficient moisture which was conducive for availability of nutrients as reported by Shyam Sundar (1999), Shaikh *et al.* (2004) and Pawar *et al.* (2008). Shoot dry weight at harvest was decreased mostly by stress at the flowering stage while stress during ripeing had little effect (Kim *et al.*, 1996).

4.2.6 Dry kernel yield

The data regarding dry kernel yield (q ha^{-1}) as influenced by different treatments are presented in Table 17 and graphically depicted in Fig. 7. Mean dry kernel yield recorded was 18.61 q ha^{-1}.

Maximum dry kernel yield was recorded with white polythene mulch with stress at pod development stage (20.83 q ha^{-1}) and it was significantly superior over all of the treatments.

Similar trend was observed as that of pod yield, haulm yield and similar results were also reported by Shyam Sundar (1999), Chitodkar (2000) and Shaikh *et al.* (2004).

Water stress given at flowering and pegging stages reduced the pod yield as reported by Chavan (1997) and Golakiya and Patel (1992).

4.2.7 Oil content (%)

Data pertaining to the mean oil content of groundnut kernel as influenced by different treatments are presented in Table 18. The mean oil content was 47.12 per cent.

Highest oil content was recorded in treatment of white polythene mulch with stress at pod development stage (47.79%) and was significantly superior over rest of the treatments. However, it was at par with sugarcane trash mulch with stress at pod development stage (47.31%).

Table 18. Oil content (%) and oil yield (q ha^{-1}) as influenced by different treatments.

Symbol	Treatments	Oil content	Oil yield
M_1	Sugarcane trash mulch with stress at flowering stage	46.52	7.85
M_2	Sugarcane trash mulch with stress at pegging stage	46.85	8.60
M_3	Sugarcane trash mulch with stress at pod development stage	47.31	9.22
M_4	White polythene mulch with stress at flowering stage	46.65	8.15
M_5	White polythene mulch with stress at pegging stage	47.22	8.87
M_6	White polythene mulch with stress at pod development stage	47.79	9.89
M_7	Control	47.71	7.78
	S.E. ±	0.15	0.15
	C.D. at 5%	0.46	0.45
	General mean	47.12	8.63

4.2.8 Oil yield (q ha^{-1})

Data regarding the mean oil yield of groundnut kernel as influenced by different treatments are presented in Table 18. The mean oil yield was 8.63 q ha^{-1}.

Data revealed that the treatment of white polythene mulch with stress at pod development stage (9.89 q ha^{-1}) recorded maximum oil yield (q/ha) and was significantly superior over rest of the treatments.

4.3 Weed intensity (per m^2 area)

The data regarding weed intensity (per m^2 area) is presented in the Table 19.

The differences in mean weed intensity at 15 days interval were found statistically significant. The weed intensity observed more in control plots as there were no mulching. White polythene mulch is better than sugarcane trash mulch in order to control the weeds. These mulches also helps in conservation of soil moisture.

These results are in conformity with the results of Lalitha *et al*. (2001) and Subramaniyam *et al*. (2002).

4.4 Soil moisture status (%)

The data regarding soil moisture (%) content in soil as influenced by different treatments are presented in Table 20.

Table 19. Weed intensity (per m^2 area) at 15 days interval as influenced by different treatments.

Symbol	Treatments	Days after sowing							
		15	30	45	60	75	90	105	120
M_1	Sugarcane trash mulch with stress at flowering stage	11.91	3.93	9.60	15.44	11.40	15.33	9.70	13.86
M_2	Sugarcane trash mulch with stress at pegging stage	11.30	4.17	11.06	15.04	11.12	15.50	9.05	14.32
M_3	Sugarcane trash mulch with stress at pod development stage	11.56	4.22	10.93	15.58	10.93	14.79	9.35	14.50
M_4	White polythene mulch with stress at flowering stage	9.46	3.43	6.71	8.52	7.42	9.42	6.55	9.32
M_5	White polythene mulch with stress at pegging stage	9.24	3.16	6.23	7.47	7.16	9.01	6.90	9.70
M_6	White polythene mulch with stress at pod development stage	9.05	2.80	6.49	8.11	7.70	9.22	6.43	9.81
M_7	Control	13.85	4.98	15.54	22.41	14.40	19.95	13.26	17.04
	S.E. ±	0.27	0.24	0.37	0.28	0.46	0.49	0.35	0.43
	C.D. at 5%	0.82	0.72	1.10	0.83	1.38	1.45	1.06	1.30
	General mean	10.91	3.81	9.50	13.22	10.02	13.31	8.74	12.65

Table 20. Soil moisture status (%) at 15 days interval as influenced by different treatments.

Symbol	Treatments	Days after sowing							
		15	30	45	60	75	90	105	120
M_1	Sugarcane trash mulch with stress at flowering stage	37.76	29.30	25.56	34.05	37.59	34.10	32.32	32.68
M_2	Sugarcane trash mulch with stress at pegging stage	37.35	33.56	37.20	28.61	38.72	34.00	31.82	32.19
M_3	Sugarcane trash mulch with stress at pod development stage	36.79	32.77	36.73	34.60	28.69	24.27	31.87	32.36
M_4	White polythene mulch with stress at flowering stage	38.42	30.95	27.04	36.40	38.09	35.71	32.73	35.10
M_5	White polythene mulch with stress at pegging stage	37.60	35.52	38.08	29.89	38.92	36.14	32.50	34.21
M_6	White polythene mulch with stress at pod development stage	39.25	34.86	37.89	36.49	30.97	25.29	32.21	33.01
M_7	Control	34.39	27.02	32.10	25.94	35.87	30.71	28.17	27.90
	S.E. ±	0.44	0.46	0.34	0.34	0.35	0.41	0.36	0.40
	C.D. at 5%	1.30	1.39	1.03	1.02	1.06	1.24	1.07	1.20
	General mean	37.36	32.01	33.51	32.28	35.54	31.64	31.68	32.50

The differences in mean moisture content was statistically significant. The moisture per cent was significantly higher in polythene mulch than sugarcane trash mulch and control. Sometimes moisture per cent get reduced its due to stress to particular growth stage of crop but at 105 DAS, and 120 DAS, there is no reduction in moisture, it is because frequent rainfall during last days of crop growth period that may affect the stressed condition.

Mulches improved soil moisture by reducing evaporation, runoff suppressing weed growth, increased germination and early crop growth due to increase in soil temperature.

Higher moisture conservation can be achieved by using transparent plastic mulch as reported by Mahalle *et al*. (2002), Ghosh *et al*. (2003) and Pawar *et al.* (2008).

4.5 Economic studies

The data regarding cost of cultivation, gross monetary returns, net monetary returns and benefit cost ratio of groundnut as influenced by different treatments are presented in Table 21 and graphically depicted in Fig. 8.

Table 20 revealed that the mean gross monetary returns, net monetary returns and benefit cost ratio were 53480, 28966 Rs. ha^{-1} and 2.18, respectively.

4.5.1 Cost of cultivation

The data regarding cost of cultivation show that treatment with white polythene mulch has more cost of cultivation (26291 Rs. ha^{-1}) than treatment of sugarcane mulching (23589 Rs. ha^{-1}). Whereas unmulched has lowest cost of cultivation (21956 Rs. ha^{-1}).

Table 21. Economic studies

Symbol	Treatments	Cost of cultivation (Rs. ha^{-1})	Gross monetary returns (Rs. ha^{-1})	Net monetary returns (Rs. ha^{-1})	B:C ratio
M_1	Sugarcane trash mulch with stress at flowering stage	23589	49058	25469	2.08
M_2	Sugarcane trash mulch with stress at pegging stage	23589	53735	30146	2.28
M_3	Sugarcane trash mulch with stress at pod development stage	23589	57686	34097	2.44
M_4	White polythene mulch with stress at flowering stage	26291	50764	24473	1.93
M_5	White polythene mulch with stress at pegging stage	26291	55043	28752	2.09
M_6	White polythene mulch with stress at pod development stage	26291	60296	34005	2.29
M_7	Control	21956	47777	25821	2.17
	S.E. ±	-	838	838	0.03
	C.D. at 5%	-	2489	2488	0.10
	General mean	-	53480	28966	2.18

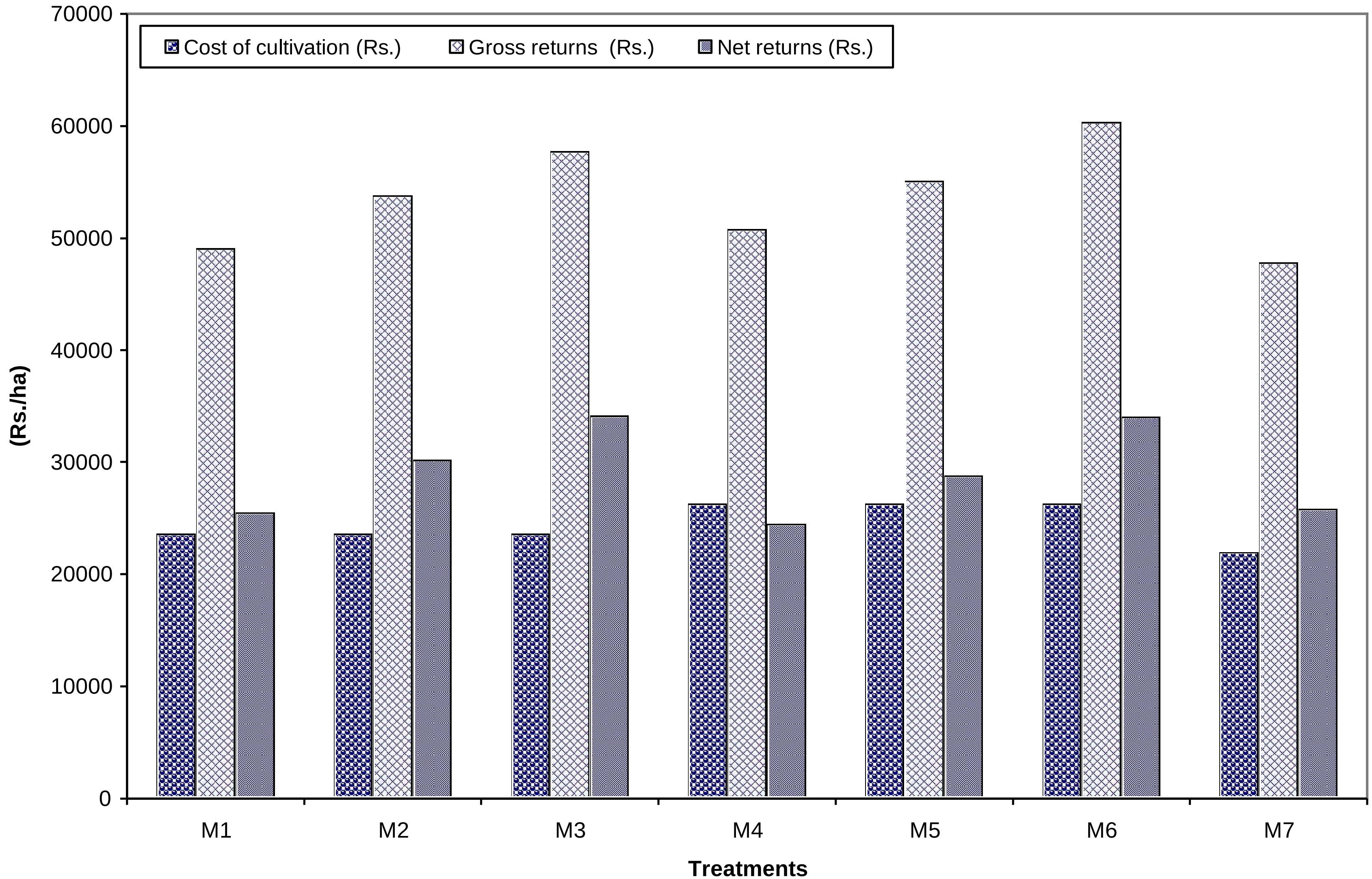


Fig. 8. Economical studies

4.5.2 Gross monetary returns

Table 21 shows that the treatment of white polythene mulch with stress at pod development stage was recorded highest (60296 Rs. ha^{-1}) and significantly superior to rest of treatments followed by sugarcane trash mulch with stress at pod development stage (57686 Rs. ha^{-1}). Maximum gross monetary returns obtained with polymulch similar results reported by Chitodkar (2000), Shyam Sundar (1999), Kathmale *et al.* (2000) and Raskar and Bhoi (2003).

4.5.3 Net monetary returns

Table 21 shows that the treatment of sugarcane trash mulch with stress at pod development stage (34097 Rs. ha^{-1}) recorded highest net monetary returns and was significantly superior to most of the treatments. However, it was at par with white polythene mulch with stress at pod development stage (34005 Rs. ha^{-1}). Net monetary returns are recorded more in sugarcane trash mulch treatment due to low cost of sugarcane trash.

4.5.4 Benefit cost ratio

The data regarding benefit cost ratio revealed that sugarcane trash mulch with stress at pod development stage (2.44) was significantly higher than the rest of the treatments.

4.6 Available N, P, K (kg ha^{-1}) in soil after harvest of crop

The data pertaining to available N, P, K (kg ha^{-1}) presented in Table 22. The mean values of available N, P, K (kg ha^{-1}) are 231.31 kg ha^{-1}, 28.32 kg ha^{-1}, 318.26 kg ha^{-1}, respectively and it revealed that increase in availability of N, P, K (kg ha^{-1}) in soil after harvest.

Table 22. Available nitrogen, phosphorus and potassium (kg ha^{-1}) in soil after harvest of crop as influenced by different treatments.

Symbol	Treatments	N	P	K
M_1	Sugarcane trash mulch with stress at flowering stage	231.91	28.47	318.24
M_2	Sugarcane trash mulch with stress at pegging stage	231.50	28.37	318.52
M_3	Sugarcane trash mulch with stress at pod development stage	231.47	28.35	318.27
M_4	White polythene mulch with stress at flowering stage	231.21	28.18	318.20
M_5	White polythene mulch with stress at pegging stage	231.21	28.28	318.23
M_6	White polythene mulch with stress at pod development stage	231.67	28.37	318.16
M_7	Control	231.23	28.20	318.19
	S.E. ±	0.41	0.11	0.11
	C.D. at 5%	1.22	0.34	0.33
	General mean	231.31	28.32	318.26

5. summary and conclusions

Efficient and economic utilization of available water is key factor in successful crop production during summer. However, it is very necessary to protect crop from water stress at critical growth stages and avoid irrecoverable yield loss. The use of different mulches like sugarcane trash and white polythene sheet is beneficial for conserving water by reducing evaporation losses and weed competition to crop.

In view of this present investigation entitled, “Stress management in summer groundnut” was carried out during summer 2006 at the Instructional Farm, Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra).

The field trial was laid out in randomized block design with seven treatments and four replications. Treatment detailed viz., sugarcane trash mulch with stress at flowering stage (M_1), sugarcane trash mulch with stress at pegging stage (M_2), sugarcane trash mulch with stress at pod development stage (M_3), white polythene mulch with stress at flowering stage (M_4), white polythene mulch with stress at pegging stage (M_5), white polythene mulch with stress at pod development stage (M_6) and control (M_7, No stress and no mulching). The soil of experimental plot was sandy clay loam with low in available nitrogen (220.5 kg ha^{-1}), high in phosphorus (23.6 kg ha^{-1}), and very high in available potassium (326.3 kg ha^{-1}) with pH of 8.2.

The sowing was done by dibbling on 23rd February, 2006 with spacing 30 cm x 10 cm. The gross and net plot size were 4.2 x 3.6 m^2 and 3.6 x 2.8 m^2, respectively. White polythene (7 μ thickness) mulch sheets were used for respective treatments before sowing and sugarcane trash mulch @ 5 t ha^{-1} was applied 15 DAS. Irrigation was given at 10-12 days interval with view of stress given at critical growth stage of the crop to respective treatment. General climatic conditions during crop growth were favourable except rainfall occurred frequently during last month of crop growth period that may affect stressed condition.

Besides this all preharvest and postharvest observations were recorded at proper interval. Weed intensity and available moisture in soil measured at 15 days interval. Some important findings come out from present investigation are summarized below.

The growth attributes viz., plant height, plant spread, number of bunches $plant^{-1}$, number of functional leaves, leaf area $plant^{-1}$, dry matter $plant^{-1}$ and number of pegs $plant^{-1}$ was significantly influenced due to the treatment of white polythene mulch with stress at pod development stage.

The yield contributing characters viz., number of filled pods, number of unfilled pods, hundred pod weight (g), 100 kernel weight (g), shelling percentage, sound mature kernel percentage, dry pod yield (q ha^{-1}), dry kernel yield (q ha^{-1}), oil content and oil yield (q ha^{-1}) were significantly influenced by the treatment of white polythene mulch with stress at pod development stage and it was significantly superior over most of the treatments followed by sugarcane trash mulch with stress at pod development stage.

The maximum dry pod yield (28.96 q ha^{-1}), haulm yield (47.41 q ha^{-1}) and dry kernel yield (20.83 q ha^{-1}) were recorded with treatment of white polythene mulch with stress at pod development stage. The second best treatment was found to be sugarcane trash mulch with stress at pod development stage with dry pod yield (27.10 q ha^{-1}), dry haulm yield (44.72 q ha^{-1}) and dry kernel yield (19.46 q ha^{-1}). The lowest yield potential among mulch treatments recorded by sugarcane trash mulch with stress at flowering stage viz., dry pod yield (23.56 q ha^{-1}), dry haulm yield (38.89 q ha^{-1}) and dry kernel yield (16.49 q ha^{-1}).

The maximum gross income was obtained from white polythene mulch with stress at pod development stage (60296 Rs. ha^{-1}). However, highest net income obtained from treatment of sugarcane trash mulch with stress at pod development stage (34097 Rs. ha^{-1}) and also recorded highest benefit cost ratio (2.44). Maximum net returns and better benefit cost ratio was obtained due to less cost of sugarcane trash mulch.

Conclusions

Based on findings emerged out of this investigation the following conclusions could be drawn.

1. Growth, yield and quality of summer groundnut favourably influenced due to use of white polythene mulch over the sugarcane trash mulch and control.

2. The groundnut crop utilizes the moisture provided at critical growth stages more efficiently with white polythene mulch than sugarcane trash mulch.

3. Flowering and pegging stages of crop very sensitive to moisture stress and causes maximum yield reduction.

4. The use of white polythene mulch was effective in producing maximum gross returns while maximum net profit and better B:C ratio obtained with sugarcane trash mulch.

5. White polythene mulch was effective in checking weed growth and thereby reducing weed competition to crop.

The above conclusions were based on data of one season and hence need confirmation to draw definite conclusions and arrive at recommendations.

6. LITERATURE CITED

Anonymous. 2006. Agril. Statistics at Glance, 2006.

Ashrif, M. I. and Thornton, L. 1965. Effect of grass mulch on groundnuts in Gambia. Exptl. Agric., 1(2):145-152.

Babitha, M. and Reddy, P. V. 2001. Physiological traits related to water use efficiency in groundnut under stress and non-stress conditions. J. Res. ANGRAU, 29(1):9-15.

Balasubramanniyan, P. and Pallaniappan, B. S. P. 1996. Influence of organic and inorganic manuring and split application of nitrogen, potash on root nodulation and pod yield in groundnut. Madras agric. J., 83(3):198-200.

Basu, M. S. 1999. Polythene mulch groundnut trials and demonstrations at multilocations. Food Legume Newsletter, 30(3-5).

Chavan, V. S. 1997. Effects of irrigation schedules as per critical growth stages and planting layout on growth, yield and quality of kharif groundnut (*Arachis hypogaea* L.) var. Phule Pragati. M. Sc. (Agri.) Thesis submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra).

Chitodkar, S. S. 2000. Response of summer groundnut to irrigation regimes, mulches and antitransparant. M. Sc. (Agri.) Thesis submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra).

Choi, B. H. and Chung, K. Y. 1997. Effect of polythene mulching on flowering and yield of groundnut in Korea. Intern. Arachis Newsletter No. 17: 49-51.

Das, A. and Maliwal, G. L. 1989. Effect of mulching on yield of rainfed cotton in Bhel zone of Gujarat. G.A.U. Res. J., 21(2):112-117.

Dayal. 1989. Response of summer groundnut to mulching under varying irrigation regime. Groundnut news., 2(1):5.

Eglay, G. H. 1983. Weed seed and seedling reduction by soil solarization with transparent polythene sheet. Weed Sci., 31(4):404-409.

Fisher, 1950. Statistical methods for research workers. 13th edition. Oliver and Boyd, Edinburgh.

Gaur, A. C. and Mukherjee, D. 1979. Note on effect of straw on the yield of groundnut and the following wheat. Indian J. agric. Sci., 49(12):984-987.

Ghatak, S.; Sounda, G.; Maitra, S.; Roy, D. K.; Panda, P. K. and Soren, B. K. 1997. Effect of irrigation and potassium on yield attributes and yield of summer groundnut. Indian Agriculturist, 41(3):203-207.

Ghosh, P. K.; Devi Dayal, Bandopadhyay, K. K. and Manna, M. C. 2003. Organic vis-à-vis polythene mulch to boost up productivity of irrigated post-rainy season of groundnut. J. Food Agric. Env., 1(3/4):213-214.

Gogoi, P. K.; Dutta, R.; Deka, N. C. and Zalil, A. 2002. Effect of sowing dates and mulching on summer groundnut (*Arachis hypogea*) under rainfed condition. Bioweed, 13(1/2):33-37.

Golakiya, B. A. and Patel, M. S. 1992. Growth dynamics and reproductive efficiency of groundnut under water stress at different phenophases. Indian J. Agric. Res., 26(4):179-180.

Halepyati, A. S. 2001. Effect of moisture regimes and zinc levels on growth and yield of summer groundnut. Karnataka J. Agric. Sci., 14(2):451-453.

Hanway, J. and Heidal, H. S. 1967. Soil analysis method used in Iowa State College Soil Testing. Iowa agric. Univ., 57:1-37.

Hemalatha, S.; Praveen Rao, V. and Reddy, B. N. 2005. Functional approach to predict effects of water deficit in groundnut (*Arachis hypogaea*). J. Oilseed Res., 23(2):194-198.

Jackson, M. L. 1973. Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi, PP. 370-389

Jambunathan, R., Madhusudan, R. S. and Subhadra, P. B. 1985. Analysis of oil content of groundnut by Nuclear Magnetic Resonance Spectrometry. J. Sci. and Agril., 36:162-166.

Joshi, A. C.; Patil, J. R. and Umrani, N. K. 1987. Use of mulch and antitranspirant on groundnut under stressed and non-stressed conditions. J. Maharashtra agric. Univ., 12(2):247-249.

Kathmale, D. K.; Kamble, M. S.; Khadtare, S. V. and Patil, R. C. 2000. Polythene film mulch technology for yield maximization in summer groundnut (*Arachis hypogaea*). Indian J. Agron., 45(3):608-612.

Khalak, A. and Kumarswami, A. S. 1992. Nutrient uptake and tuber yield as influenced by irrigation and mulching scare water alfisols. J. Indian Potato Assoc., 19(1-2):35-39.

Khera, K. L.; Aujla, T. S. and Sandhu, B. S. 1990. Irrigation schedule for groundnut (*Arachis hypogaea*) planted on different dates. Indian J. agric. Sci., 60(12):842-844.

Kim, C. G.; Koh, M. H.; Seo, J. H. and Kim, D. H. 1996. Effect of drought stress on growth and yield of groundnut. J. Agric. Sci. Upland and Industrial Crops, 38(2):143-148.

KrishnaRao, V. and Krishnappa, K. 1995. Soil solarization for control of soil borne pathogen complexes with special reference to *Meloidogyne incognita* and *Fusarium oxysporum*. Indian Phytopath., 48(3):300-303.

Kumar, P. R.; Reddy, M. R.; Reddy, B. B. and Swamy, K. B. 1987. Effect of irrigation scheduling on growth, oil, protein content and nitrogen uptake of groundnut. Madras agric. J., 74(4-5):248-251.

Kumar, S. 2001. Production potential of rabi groundnut as influenced by polythene mulch in Northeastern India. Intern. Arachis Newsletter, 21:53-54.

Kumar, S., Shivani and Singh, J. 2002. Growth analysis of rainfed groundnut in Manipur valley under polymulch condition. J. Oilseed Res., 19(2): 181-184.

Lalitha, B. S.; NagrajRao, K. H. and Anand, T. N. 2001. Effect of solarization on weed dynamics and yield of groundnut-tomato sequence. Mysore J. agric. Sci., 35:226-231.

Mahalle, A. M.; Satpute, G. N. and Mahurkar, D. G. 2002. Effect of polymulch on morphological parameters and yield of groundnut. J. Soil and Crops, 12(2):167-169.

Mandal, B. K. and Ghosh, T. K. 1984. Efficacy of mulches in the reduction of irrigation requirement of groundnut. Indian J. agric. Sci., 54(5):446-449.

Mehta, A. C.; Malvia, D. D.; Kaneria, B. B. and Khanpara, V. D. 1996. Response of groundnut (*Arachis hypogaea* L.) to farm yard manure, phosphate and phosphate solubilizing micro-organisms. Indian J. Agron., 41(1):172-174.

Nelson, D. W. and Sommer, L. E. 1982. Total carbon and organic matter. In : A. L. Page (Ed.), Method of Soil Analysis, Part 2, Agron 9:539-579. Am. Soc. Agron. Inc. Soil Sci. Soc. Am. Madison, Wisconsin, USA.

Olsen, R. A. 1954. Estimation of available phosphorus in soil by extraction with sodium bicarbonate. USDA Cir. 339.

Padma, V. and Subba Rao, I. V. 1992. Influence of irrigation on composition and quality of groundnut genotypes. J. Oilseed Res., 9(1):159-163.

Panse, V. G. and Sukhatme, P. V. 1985. Statistical Methods for Agricultural Workers. 4^{th} Edn., ICAR, New Delhi, PP. 145-155.

Patel, M. S. and Golakiya, B. A. 1988. Effect of water stress on yield attributes and yield of groundnut (*Arachis hypogaea*). Indian J. agric. Sci., 58(9): 701-703.

Patil, S. M. and Morey, D. K. 1993. Growth and yield of summer groundnut influenced by antitranspirants and water management practices. J. Soil and Crops, 3(1):18-22.

Patra, A. K.; Tripathy, S. K.; Saumi, R. C.; Pand, P. K. and Nanda, M. K. 1998. Effect of sowing date, irrigation and spacing on nutrient content and uptake by groundnut (*Arachis hypogaea*). Indian J. Agron., 43(3): 459-463.

Pawar, S. N., Kalbande, S. R. and Jadhav, S. B. 2008. Effect of moisture conservation technique on growth and yield of summer groundnut. Intern. J. agric. Sci., 4(1):119-123.

Piper, C. S. 1966. Soil and plant analysis. Hans Publishers, Bombay, PP. 19-136.

Ramamoorthy, K. and Basu, R. N. 1996. Studies on the effect of moisture stress at different growth phases on seed vigour viability and storability in peanut. J. Agron. and Crop Sci., 177(1):33-37.

Rao, V. P., Gangakishan, A. and Reddy, M. D. 1991. Evaluation of broad bed furrows for summer groundnut in rice fallows of Northern Telanganas, Andhra Pradesh, India. Intern. Arachis Newsletter No. 10:12-13.

Raskar, B. S. and Bhoi, P. G. 2003. Response of summer groundnut (*Arachis hypogaea*) to irrigation regimes and mulching. Indian J. Agron., 48(3):210-213.

Raskar, S. K.; Shinde, P. P. and Jadhav, A. S. 2005. Response of groundnut (*Arachis hypogaea*) to micro-irrigation and mulches under lateratic soils of Konkan (Maharashtra). J. Oilseed Res., 22(2):355-356.

Ravankar, H. N.; Topre, R. K.; Deshmukh, M. S. and Deshmukh, P. W. 2003. Effect of polyethylene mulch on dry matter yield and uptake of nutrients by summer groundnut. Legume Res., 26(1):73-74.

Reddy, A. J. and Rao, I. M. 1968. Preliminary studies on effect of progressive water stress on growth and yield of groundnut (*Arachis hypogaea* L.). The Andhra agric. J., 15(5):123-127.

Reddy, P. S. 1982. Production technology for groundnut. Indian Fmg., 32(8):27-32.

Reddy, R. C. and Reddy, R. 1993. Scheduling of irrigation for peanuts with variable amounts of available water. Agric. Water Manage., 23(1-9).

Reddy, T. Yellamanda. 1994. Management practices for amelioration of moisture stress in groundnut (*Arachis hypogaea*) in arid tropics. Indian J. Agron., 39(3):489-490.

Sadhu, A. C.; Malvia, D. D. and Mathukia, R. K. 1996. Effect of irrigation, mulching and fertility levels on mustard (*Brassicai juncea*) and their residual effect on succeeding groundnut (*Arachis hypogaea*) crop. GAU Res. J., 21(2):1-7.

Saharawat, K. L. and Burford, J. B. 1982. Modification of the alkaline permanganate method for assessing the availability of soil nitrogen in upland soils. Soil Sci. J., 133(1):53-57.

Sakarvadia, H. L. and Yadav, B. S. 1994. Effect of water stress at different growth phases of groundnut on yield and nutrient absorption. J. Indian soc. Soil sci., 42(1):147-149.

Shaikh, A. A.; Nimbalkar, C.A. and Jawale, S. M. 2004. Effects of irrigation scheduling and mulches on yield and yield contributing characters of summer groundnut. J. Maharashtra agric. Univ., 29(2):163-166.

Sharma, P. S. and Shivkumar, M. V. K. 1989. Response of groundnut to drought stress in different growth phases. Agric. Water Manage., 19:301-310.

Shinde, G. G. and Pawar, K. R. 1984. Effects of water stress at critical growth stages on growth and yield of groundnut in summer season. J. Maharashta agric. Univ., 9(1):26-28.

Shridhara, C. J.; Thimmegowda, S. and Krishnamurthy, N. 1995. Effect of moisture stress and irrigation levels at different growth stages on leaf area, leaf area index, dry matter accumulation of groundnut. Indian Agriculturist, 39(3):187-192.

Shrinivasan, P. S. and Arjunan, A. 1987. Effect of water stress on yield of pods in groundnut varieties. Madras agric. J., 74(12):544-546.

Shyam, Sundar. 1999. Effect of plastic film mulch, level of fertilizer and foliar sprays on growth and yield of summer groundnut cv. Koyana (B-95). M. Sc. (Agri.) Thesis, submitted to Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra).

Singh, G. B.; Sandhu, R. S.; Singh, A. and Arrora, S. K. 1968. A note on effect of irrigation and fertilizer levels on yield and quality of groundnut in Hissar. Proc. Symp. on Water Management. Indian Soc. Agron. and ICAR, 162.

Subramaniyam, K.; Kalaiselven, P. and Arutmozi, N. 2002. Effect of polythene film mulching on flowering and pod yield of groundnut. Legume Res., 25(3):225-226.

Sudhakar Babu, S. N.; Reddy Subba G.; Pandey, A. K.; Maruthi, V. and Venkateswaralu, B. 1996. Growth nodulation and yield responses of groundnut to moisture stress under varying soil depths. J. Oilseed Res., 13(2):248-250.

Tandon, H. L. 1989. Fertilizer recommendations for oilseed crop. A guide book. Fertilizer development and consultation organization, New Delhi (India), PP. 204-205.

Uke, P. C.; Ingle, V. N.; Ingole, P. G.; Malvi, S. D. and Penshne, Y. P. 1995. Effect of advanced sowing dates and protective irrigation on growth, yield and quality of kharif groundnut variety JL-24. PKV Res. J., 19(2):169-170.

Ved Singh; Sharma, S. K.; Verma, B. L. and Siag, R. K. 1994. Effect of irrigation schedule and phosphorus fertilization on yield, water use and phosphorus uptake by groundnut (*Arachis hypogaea*) in north-west Rajasthan. Indian J. Agron., 39(1):58-61.

Velu, G. 1998. Effect of water stress on yield potential of groundnut (*Arachis hypogaea*). Indian J. agric. Sci., 68(5):284-286.

Venkateshwar Rao, P.; Subba Rao, I. V. and Reddy, P. R. 1986. Influence of moisture stress at different stages on growth and productivity of groundnut (*Arachis hypogaea* L.). The Andhra agric. J., 33(1):48-52.

*Zhang, W., Want, L. and Wang, H. 1996. Achieving groundnut yield. Proc. Intern. Workshop on groundnut, Loxie, 25-29 Aug, 1995. PP. 256-258.

*** Originals not seen.**

7. APPENDIX

Appendix-I. Cost of cultivation

Sr. No.	Treatment	For sugarcane mulched treatments (M_1, M_2, M_3)			For Polythene mulched treatments (M_4, M_5, M_6)			Control (No mulched) (M_7)		
	Particulars	**Quantity**	**Rate (Rs.)**	**Value**	**Quantity**	**Rate**	**Value**	**Quantity**	**Rate**	**Value**
1	Machine charges	-	-	6000	-	-	6000	-	-	6000
2	Labour charges	164	50	8200	168	50	8400	174	50	8700
3	Mulching material									
	1. Sugarcane trash (tones)	5 tons	0.50	2500	-	-	-	-	-	-
	2. White polythene mulch	-	-	-	55 kg	90	4950	-	-	-
4	Seeds (kg ha^{-1})	100	30	3000	100	30	3000	100	30	3000
5	Fertilizers (kg)									
	1. Urea	54	5	270	54	5	270	54	5	270
	2. SSP	312.5	3.5	1094	312.5	3.5	1094	312.5	3.5	1094
6	Irrigations	9	200	1800	9	200	1800	11	200	2200
7	Plant protection			250			250			250
8	Working capital			23114			25764			21514
9	Interest on working capital			463			515			430
10	Land revenue			12			12			12
11	Cost A			23589			26291			21956

8. vita

BODARE CHANDRAKANT ARUN

A candidate for the degree
of
MASTER OF SCIENCE (AGRICULTURE)
in
AGRONOMY
2008

Title of thesis	:	"Stress management in summer groundnut (*Arachis hypogaea* L.)"
Major field	:	Agronomy
BIOGRAPHICAL INFORMATION		
Personal	:	Born at Khandala, Tal. Khandala, Dist. Satara (M.S.) on 8th January, 1984. Son of Shri. Arun Yashwant Bodare and Sau. Sanjana Arun Bodare having two brothers Suryakant and Dhananjay.
Educational	:	Ø Attended primary school at Z. P. School, Morve, Tal. Khandala, Dist. Satara Ø Passed S.S.C. from Maloji Raje Vidyalaya, Lonand in 1999 and H.S.C. Examination from Maloji Raje Jr. College, Lonand, Tal. Khandala, Dist. Satara in 2001. Ø Received Bachelor of Science (Agriculture) degree from College of Agriculture, Pune (Mahatma Phule Krishi Vidyapeeth, Rahuri) in first class.
Others	:	Ø Passed NCC 'C' certificate with B grading in 2001 Ø Represented University in Agri-Quiz Contest on *Doordarshan-Sahyadri*. Ø Selected as Agriculture Officer (Group-B) through Agriculture MPSC in 2008.
Address		Ø A/P. Morve, Tal. Khandala, Dist. Satara bodareca@rediffmail.com