CROP WEATHER RELATIONSHIP ON SESAME VARIETIES UNDER DIFFERENT DATES OF SOWING

THESIS

Submitted to
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola
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By

NEELESH KUMAR SAHU

AGRONOMY SECTION
COLLEGE OF AGRICULTURE, NAGPUR

Dr. PANJABRAO DESHMUKH KRISHI VIDYAPEETH,
KRISHINAGAR PO, AKOLA (MS) 444 104

Enrolment Number –KK/2472

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DECLARATION OF STUDENT

I hereby, declare that the experimental work and its interpretation of the thesis entitled, **"CROP WEATHER RELATIONSHIP ON SESAME VARIETIES UNDER DIFFERENT DATES OF SOWING"** or part thereof has neither been submitted for any other degree or diploma of any university, nor the data have been derived from any thesis/publication of any university or scientific organization. The source of materials used and all assistance received during the course of investigation have been duly acknowledged.

Place: Nagpur

Date: 31.05.2014

NeeleshSahu.

(Neelesh Kumar Sahu)

Enrolment No. KK/2472

CERTIFICATE

This is to certify that thesis entitled **"CROP WEATHER RELATIONSHIP ON SESAME VARIETIES UNDER DIFFERENT DATES OF SOWING"** submitted in partial fulfilment of the requirement for the degree of **"Master of Science in Agriculture (Agronomy)"** of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola is a record of bonafide research work carried out by **Neelesh Kumar Sahu** under my guidance and supervision.

The subject of the thesis has been approved by the Student's Advisory Committee.

Jiotode

Place: Nagpur
Date: 31/5/2014

(D. J. Jiotode)
Chairman,
Advisory Committee

Countersigned

Associate Dean,
College of Agriculture, Nagpur
Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola

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1. Chairman (Shri D. J. Jiotode) Jiotode
2. Member (Dr. V. S. Khawale) ....
3. Member (Shri P. D. Deshmukh) ....
4. Member (Dr. Mrs. Shanti Patil) ....
5. External Member (Dr. P.C. Pagar) ....

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Neelesh Sahu

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(Neelesh Kumar Sahu)

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CONTENT

(A) List of Tables

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(C) Abbreviations

%	Percent
/	Per
°C	Degrees Celsius
^{0}D	Degree days
CD	Critical difference
cm	Centimetre
DAS	Days After Sowing
dm^2	Decimeter square
et al.	Et alia (and his associates)
Fig.	Figure
g	Gram
ha	Hectare
HU	Heliothermal unit
i.e.	That is
kg	Kilogram
m	Meter
mg	Milligram
mm	Millimetre
MW	Meteorological Week
N.S.	Non-significant
No.	Number
q	Quintal
RF	Rainfall
RH	Relative humidity
S E (m) ±	Standard error of mean
Sig.	Significant
T max	Maximum temperature
T min	Minimum temperature
Viz.	Namely

(D) THESIS ABSTRACT

a)	Title of the thesis	:	"CROP WEATHER RELATIONSHIP ON SESAME VARIETIES UNDER DIFFERENT DATES OF SOWING"
b)	Full name of student	:	**Neelesh Kumar Sahu**
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j)	Signature, Name and address of forwarding authority	:	

Deshpande
Dr. R. M. Deshpande
Professor of Agronomy
College of Agriculture,
Nagpur.

ABSTRACT

The present investigation entitled **"CROP WEATHER RELATIONSHIP ON SESAME VARIETIES UNDER DIFFERENT DATES OF SOWING"** was carried out to identify suitable variety and influence of sowing dates on yield of sesame.

The field experiment was conducted during *kharif* season of 2013-2014 with sesame variety AKT-64 and Western-11 on field No. 9 of Agronomy farm, College of Agriculture, Nagpur. The experiment was laid out in Split Plot Design with ten treatment combinations with three replications consisting five levels of sowing date *i.e.* 26^{th} MW, 27^{th} MW, 28^{th} MW, 29^{th} MW and 30^{th} MW and two varieties *i.e.* AKT-64 and Western-11.

Effect of sowing dates

Various sowing dates significantly influenced the growth and yield of sesame varieties. Sowing of different sesame varieties under different dates significantly influence the plant height, number of branches plant^{-1} and various yield contributing characters such as number of capsule plant^{-1}, seed yield plant^{-1}, straw yield plant^{-1}, seed yield qha^{-1}, straw yield qha^{-1} and biological yield (qha^{-1}).

Effect of varieties

Among the two cultivars AKT-64 recorded the higher growth and yield attributing characters which results in significantly higher seed yield over the variety western-11.

Weather parameters

In case of weather parameters, temperature requirement is highest when crop sown on 27^{th} MW than rest of the sowing dates.

Relative humidity requirement of sesame is highest when crop sown on 28^{th} MW than rest of the sowing dates.

Agro-meteorological, sowing of sesame crop on 27^{th} MW was found suitable while variety AKT-64 was better than Western-11.

CHAPTER I

INTRODUCTION

1.1 Background information

Oilseeds are the backbone of agricultural economy of India from the time immemorial. The oilseed crops are major source of oil and fats which forms valuable ingredients in human diet. Our country is facing acute shortage of edible oil mainly because of heavy demand due to the population pressure raised as standard of living and increasing requirement of oil consuming industries. This demand is partly met from soybean, sunflower and palm oil. Under such situation, it needs to build up self sufficiency in oil production to meet the increasing demand of consumer and industries. In general, per hectare yield of oilseed crop including sesame are less than those obtained elsewhere in the world, which further aggravate the problem.

Sesame [*Sesamum indicum* Linn. (Pedaliaceae)] adorned as "queen of oilseed crop" by virtue of the excellent quality of oil produces and its use in domestic purpose. It is one of the most important ancient edible crops grown in India next to groundnut and rapeseed-mustard. This crop is probably the most oilseeds known and grown by man. Archaeological evidence indicated that sesame seeds were found in Harappa, the oldest archaeological site in the region, in addition to the largest sesame acreage and diverse forms of sesame are seen in India. Some species are also found in Africa. India is now considered as the basic centre of origin (Rathore, 2005).

Sesame is presumed to have originated in Africa and later spread to West Asia to India, China and Japan. The important countries producing sesame are India, China, Japan, Sudan, Mexico, Turkey, Burma and Pakistan. In India, the major sesame growing states are Uttar Pradesh, Rajasthan, Madhya Pradesh, Andhra Pradesh, Maharashtra, Gujarat, Tamil Nadu and Orissa.

Sesame is mainly distributed between 25^0 S and 25^0 N latitude, however, it can be grown well up to 40^0 N latitude in China, Russia, USA and subtropics and 35^0 S in South America. It is a crop of both tropics and subtropics. India ranks third in acreage with approximately quarter of total production (Rathore, 2005). The highest production is observed in China with higher productivity. Nearly, 85 countries in the world cultivate sesame contributing 34 in Asia, 25 in Africa, 18 in Central and South America and 8 in Europe.

India ranks first in area (45%) of sesame in the world. The total area of sesame in India during 2012-13 is 17.03 lakh hectares and total production is 7.48 lakh tones. In Maharashtra state, area under sesame crop during 2010-2011 was 560 ha with production of 199 tones and productivity of 355 kg ha^{-1}. In Vidarbha region, Nagpur and Amravati revenue divisions are the most important sesame growing areas. Vidarbha region was having 117 ha area with production of 40 tones and with an average productivity of 368 kg ha^{-1} during 2010-2011 (Anonymous, 2012).

The important districts growing this crop in Maharashtra are Jalgaon, Nashik, Dhule, Pune and Solapur. Now a day this crop is cultivated in summer season under irrigated conditions. Sesame yield is better in summer season under irrigated condition due to favorable weather parameters such as photoperiod temperature and humidity etc. Narayanan and Reddy (1982) at Hyderabad concluded that poor yield of sesame was due to less daily sunshine hours in cloudy weather during rainy season (average of 4-6 hours) as compared to average of 12.5 hours in summer.

In India, sesame seeds are used for oil extraction (78%), edible purpose (20%) and seed purpose (2%). Out of that 70% sesame seeds are used for edible purpose as salad and cooking oil and remaining 30% for toilet soap and manufacture of maragarine (Rathore , 2005). Sesame is also known as benniseed, qinqelly, sesame, sisim, til and hawari. The sesame seeds are rich source of edible oil, food, nutrition health care and biomedicine. Its oil content generally varies from 48 to 52 per cent and contains 6355 kcal kg^{-1} energy in seeds (Kumar and Goel, 1994). The seeds are also rich source of proteins (20–28 %), sugars (14-16%), minerals (5-7%) and nutrients like calcium (1.31%) and phosphorus (Dinosa and Gupta, 1993). Sesame is regarded fatty acids composition of its oil and its resistance to oxidation and rancidity even when stores at ambient air temperature. Due to the presence of potent antioxidant, sesame seeds are called as "The seeds of immortality" with the growing health consciousness and sesame has recently emerged valuable crop.

1.2 Importance of the study

Sesame though cultivated in small scale, it is of immense importance in industry and commerce. It is used as a component for the manufacture of soap and paints. It is also used in pyrethrin insecticidal industry. The roots and seeds are used in the preparation of the tonic for the hair. They enrich the blood and are useful in the snake bites, bleeding piles etc. Sesame oil is useful for dry cough, asthma disease of lungs, burning sensation disease of the ear and eyes. Recently omega-6 fatty acid desaturase also got from Sesame which is helpful for heart patients (Jin *et al.* 2001).

Per capita per annum consumption of oil in India is very less (3 kg), while in other countries, the average consumption is 25kg. Diet survey conducted amongst the low income groups by the National Nutrition Monitoring Bureau (NNMB) revealed that average consumption of oil per head is very low. As per recommendation of scientific council of India our need is 11 kg $head^{-1}$.

Yield potential of this crop can be exploited by the use of agronomic techniques. Among them standardized agronomic practices required for realizing yield potential of *kharif* sesame, sowing time and varieties play pivotal role.

In order to bring out country as a whole to a level on which other countries are standing as far as agricultural production is concerned, it is very essential to emphasize on such aspects. Some of the basic principles of factors contributing towards the increasing in per hectare yield of crops such as suitable cultivar with required heritable potentially, proper sowing time and prevalence of congenial weather conditions.

The importance of last factor besides the first two can in the least be underestimated. It is true that prevalence of congenial weathers conditions is the only factor which neutralizes the good heritable potentiality of a variety under systematic agronomic practices low will be obtained if it is grown at improper time.

Recent studies confirm that varieties differ extensively in the physiological processes determining the yield. It has been also shown that the total yield per plant and per unit area is determined by the number of capsules and seed weight per plant. These physiological factors also influenced by environmental factors.

Sesame is a photo and thermo- insensitive and short day plant. The sesame oil has greater stability and quality under varying climatic condition.

1.3 Objectives of the study

With this background, to identify suitable variety and influencing sowing date on yield of sesame, the present investigation has been under taken with the following objectives.

1. To quantify the influence of temperature and relative humidity on the growth and development of sesame varieties.
2. To find out the most optimum meteorological week for sowing of sesame.

1.4 Hypothesis

A field trial conducted at Oilseed Research Institute, Faisalabad during 1984-1987 with sesame cv. P-37-40 sown on 15^{th} to 30^{th} June, 15^{th} to 30^{th} July and 15^{th} to 30^{th} August. The crop sown during July exhibited maximum seed yield (1247 kg ha^{-1}) (Khan *et al.*, 1991).

In view of this, it was felt necessary to assess the crop weather relationship on sesame varieties under different dates of sowing.

1.5 Scope and limitations

The sowing season of crop varies considerably from one part of a country to another owing to difference in climate, soil, variety grown and also the basis of irrigation *i.e.* whether the crop is raised as rainfed or under irrigated condition. It is cultivated mostly under rainfed condition. In area of marginal and sub marginal soils.

Time of sowing and the age of crop are important factor that materially influenced the yield and quality of the produce.

Now a day, attention also paid on global warming and due to global warming, climatic changes are often observed in India. That's why growth, yield, and oil percentage in sesame is greatly affected. To overcome this problem, there is necessity to study the response of the different varieties of sesame to different sowing time

Research has however, been both limited and unevenly distributed geographically. Very little information on sowing time of sesame is available. There is a great scope for increasing the yield of sesame crop substantially by resorting to optimum sowing time is "non cash" input, it is essential to find out the suitable time of sowing to a particular variety of sesame.

CHAPTER II

REVIEW OF LITERATUERE

2.1 Effect of varieties

Narayanan and reddy (1982) showed that SP-1181 produced the higher yield than T-30, TPI-1, Gouri and TMV-3 varieties of sesame.

Narayan and Narayanan (1987) proved that TMV-3 produced maximum yield due to more branches and number of seed per capsule than Patan-64, Modhavi, Gouri, NP-6 and T-12 varieties of sesame.

Patel *et al.* (1988) observed significant difference in grain yield of sesame due to varieties. The highest grain yield (918 kg ha^{-1}) was obtained from sesame variety G. Till-1, but it remained statistically at par with variety Mrug-1. Significantly lowest grain yield (372 kg ha^{-1}) was obtained from variety Patan-64.

Chimanshette and Dhoble (1992) revealed that sesame variety JLT-7 produced highest yield (373 kg ha^{-1}) than T-65 variety.

Ghungarde *et al.* (1992) observed that sesame variety JLT-7 produced significantly higher grain yield than Punjab-1.

Itnal *et al.* (1993) revealed that Til-1 and TMV-3 genotype produced maximum yield than the local varieties.

Sesame varieties TMV-4 and TMV-6 produced more yield (674 kg ha^{-1}) than VS-350 (634 kg ha^{-1}) (Anonymous, 1995).

The AKT-101 variety of sesame produced higher yield (941 kg ha^{-1}) over L-38 (741 kg ha^{-1}) with higher monetary return of Rs. 14990 ha^{-1} and B:C ratio of 4.9 (Anonymous, 1997).

Kadam (2001) studied the performance of two cultivars L-38 and AKT-101. AKT-101 was found to be good in respect of growth parameters, yield contributing characters, utilization of applied fertilizers, oil content and yield.

Korhale (2010) conducted an experiment on varietal performance of sesame with cultivars Phule Til-1 and AKT-101. He observed that AKT-101 showed better growth and yield attributing characters with oil content over Phule Til-1 variety.

Patil (2012) conducted an experiment on response of sesame with cultivars Phule Til-1, AKT-101, JLT-7 and Padma under summer condition. He observed that AKT-101 showed better growth and yield attributing characters.

2.2 Effect of sowing time

An experiment on sowing date of sesame L-38 was conducted at Department of Agronomy, Dr. PDKV Akola, Oilseed Research unit at Amravati and found that the highest yield was obtained when sowing done at 2nd week of February (324 kg ha^{-1}) which was significantly higher than late sowing (3rd and 4th week of February) as well as early sowing (1st week of February) (Anonymous, 1988).

Khan *et al.* (1991) conducted field trial at Oilseed Research Institute, Faisalabad during 1984-1987 with sesame cv. P-37-40 sown on 15th to 30th June, 15th to 30th July and 15th to 30th August. The crop sown during July exhibited maximum seed yield (1247 kg ha^{-1}).

Jadhav *et al.* (1993) stated that sowing during second week of February was found to be optimum sowing time for the summer sesame (L-38) cultivar with yield potential of 5.48 q ha^{-1}. Sowing during last week of February reduced the grain yield by 39.8 qha^{-1} and 40.8 per cent as compared to sowing during 1st and 2nd week of February, respectively.

Chakraborty *et al.* (1994) found that the duration of the different phenophases would be increased when the sesame cultivar T-85 crop was sown in February or in early March. Growing degree days and photothermal unit requirement for emergence to branching did not follow a definite pattern. Requirement increased linearly for flower initiation to 100 per cent flowering and capsule initiation to capsule maturity when the crop was sown in February. The heliothermal unit requirement increased for different phenophases up to 23rd February sowing. It did not follow any definite pattern for late sown crop.

The yield interaction was greater when sesame was sown during April 1st week compare to early sowing of March 1st week. Hence, it can be recommended that sowing of summer irrigated sesame can be undertaken during 1st week of March for higher yield (Anonymous, 1995).

Nirval *et al.* (1995) conducted field trial in *kharif* (monsoon) 1988-1992 at Parbhani. Sesame cultivars T-85 and JLT-7 were sown at the onset of monsoon and 10, 20 and 30 days later. Seed yield was 351 kg ha^{-1} in cv. T-85 and 459 kg ha^{-1} in JLT-7, it decreased with delay in sowing after monsoon.

Bennett *et al.* (1996) carried out an experiment at Katherine (Northern territory Australia) during 1995-97 on effect of sowing time on yield of sesame. Sowing of sesame on 6th February produced the highest seed yield of 1387 kg ha^{-1}.

Gupta *et al.* (1998) conducted field experiment at Hissar (Haryana) on sesame cv. HT-1, HT-24 and HT-35 which were sown on 1st, 10th July (normal date), 20th and 30th July. Oil and fatty acid content did not differ significantly between cultivars. Total oil percent was 47.9, 49.6, 48.1 and 45.3 percent with the four sowing date as listed. Content of linoleic acid decreases with oleic and stearic acid increased as sowing was delayed, palmatic acid content decreases at the last sowing date.

El Serogy (1998) conducted a field experiment in Mallawi, Egypt during 1995 and 1996 to study the effect of sowing dates (mid April and late May), taller plants, lower stem height to the first capsule and higher fruiting zone, number of capsule per plant, seed weight per plant, 1000 seed weight, seed yield per feddan and oil percentage were obtained with early sowing (mid April).

Sharma *et al.* (1998) conducted a field experiment during rainy season of 1994-95 and 1995-96 at Powarkheda (Madhya Pradesh). Sesame cv. TKG-21 was sown in early and late July, mid August and early September. Sesame yield was decreases with delay in sowing in 1994-95. Net monetary returns and B:C ratio were greatest with sowing in July than at later sowing dates.

Jain *et al.* (1999) conducted a field trial under rainfed condition in 1994-97 at Jalgaon, Nagpur (Maharashtra) and Shillongani (Assam). Sesame was sown at normal date, 10 and 20 day later on flat beds and furrows. Delayed sowing decreased the yield at all sites.

Leda *et al.* (1999) conducted trial in 1997-98 by sowing sesame on 8 dates between 20th April and 27th July. Yield increased with delay in sowing from 20th April to 4th May then decreased with further delay. Yield on the main stem showed a similar pattern to total yield but yield on the side branches increased slightly with delay in sowing from 20th April to 18th May and 1st June then decreased slowly with further delay in sowing.

Nath *et al.* (2000) conducted field experiment during summer season of 1993-94 on sesame to study the capsule production efficiency of main stem and branches of sesame cultivars at different sowing dates in alluvial soil of tropical humid region in West Bengal (India). The highest capsule production by main stem and first, second and third primary branches in acrosentric order was observed for the crop sown on 19th February. The number of capsule on main stem was reduced by 70.51 and 34.98 per cent when crop was sown on 21th March and 28th April, respectively.

Rajib Nath and Chakraborthy (2000) adopted three sesame cultivars (Kanke-1, Rama and B-67) and were sown on 10th and 19th February, 1st, 11th and 21th March and 7th, 18th and 28th April, 1993 and 1994 in West Bengal, India. The maximum number of capsule per plant was produced when crop was sown on 19th February and Kanke-1 had the highest capsule volume index among these three cultivars.

Bahale *et al.* (2001) conducted field trial during 1995-98 to determine the appropriate sowing time, suitable method of layout and management of excess water in vertisols to sustain and maximize the productivity of rainfed sesame in Northern Maharashtra and showed the optimum sowing date (OST) i.e. 26th MW produced significantly higher seed yield and gave significantly more gross monetary returns with the highest benefit : cost ratio (4.52) than the rest of the delayed sowing times.

Lee Sungwoo *et al.* (2001) conducted field experiment to study the effect of delayed sowing on the growth of sesame in Korea Republic during 1999 and 2000. They reported that the sowing dates delayed by 5, 15, 26, 36 and 46 days when compared to 15th May standard sowing date, the number of capsule per plant and length of stem bearing capsules were greatly decreased, while plant height and stem diameter were not significantly affected by delayed sowing dates.

Muthusankaranarayanan *et al.* (2001) studied the influence of various dates of sowing and nitrogen management for irrigated sesame at the Agricultural College and Research Institute farm (TNAU), Killikulam during 1995, 1997 and 1998. The results of the study indicated that sowing from 16th February to March was the ideal time for summer irrigated sesame. Application of nitrogen at 40 kg ha^{-1} in two equal splits (basal + on 30 DAS) was found to be the economical nitrogen management schedule for summer irrigated sesame.

Patra (2001) conducted experiment with ten sesame cultivars (Vinayak, Usha, Kanak, OTM-10, OTM-11, Wma, Kalika, Krishna, B-67 and Balangir Local) and were sown on two different dates (25th June and 15th July) during 1996-98 in Orissa. It was found that a cultivar B-67 was tallest while OTM-11 and OTM-10 were the shortest among cultivars. A higher capsule per plant was obtained with the 25th June sowing compared to the 15th July sowing. Kalika produced the highest seed and oil yield followed by Kanak and B-67.

Badran (2002) conducted an experiment in Alexandria (Egypt) during summer, 2000 and 2001 to study the effect of sowing dates on the performance of sesame cultivars Giza-25 and Giza-32 and groundnut cultivar Giza-5 in an intercropping system for sesame the relative yield was 34.54 per cent higher when Giza-32 was used instead of Giza-25. The simultaneous planting of the crop on 15th April recorded 36.27 per cent higher relative yield as compared to the simultaneous planting of both the crop on 15th May.

Kim Dongkwan *et al.* (2002) carried out a study in Korea Republic to determine the difference in the growth, grain yield and seed quality of sesame plant in response to different sowing dates (9th May and 8th June). Sesamum plant which were sown on 9th May had more effective branch numbers and capsules number per plant than those sown on 8th June. Although sesame plants sown on 9th May had lower ripened grain percentage at the upper and middle part of the capsule setting and the seed yield was similar to those sown on 8th June.

Yogendra Kumar *et al.* (2002) conducted a field experiment during *kharif* season of 1997-98 at Agriculture Research Station, Durgapur (Jaipur) to assess the impact of advance sowing on groundnut (*Arachis hypogea* L.). The crop sown on 1st June recorded significantly higher productivity in term of pod, kernel, and haulm yield (30.81, 20.38 and 48.78 q ha^{-1}) over 16th June and 1st July sowing respectively.

Abdel Rahman *et al.* (2003) conducted a field trial on the sandy soil of Assiut, Egypt in 2001 and 2002 to investigate the effects of sowing dates (10^{th} May, 25^{th} May and 10 June), Nitrogen fertilizer rate (60, 80 and 100 kg/fed) and plant population (70000, 35000 and 23333 plant / fed) on the performance of sesame cv. Giza 32. Plant sown on 10^{th} may recorded the maximum height (178.99 cm). The height and the number of branches per plant were highest in plant sown on 25^{th} May. The highest seed and oil yield (6.20 ard/fed and 366.39 kg/fed) were obtained at 80 kg/fed, in plant sown on 10^{th} May and grown at 70000 plant population.

Kalita *et al.* (2003) carried out an experiment at Jorhat during the winter season of 1997-98 under rainfed, medium land situation to find out the effect of sowing date on the seed yield of linseed (*Linum usitatissimum* L.). The crop sown on 10^{th} November recorded significantly higher seed yield 6.67 q ha^{-1} than 21^{th} November, 5.54 q ha^{-1} in 1997-98 and 4.78 q ha^{-1} in 1998-99.

Radha Kumari *et al.* (2004) conducted field experiment on sesame to study the effect of four dates of sowing (15^{th} September, 1^{st} October, 15^{th} October and 1^{st} November) during rabi 1999-2000 at S. V. Agriculture College Tirupati. The highest seed yield of 2.02 q ha^{-1} was obtained with 1^{st} October sowing and decreased gradually thereafter.

Thanki *et al.* (2004) conducted a field experiment on sesame in Gujarat during summer 1999-2000. It found that sowing on 17^{th} February gave the highest plant height (104cm), the number of capsules and branches per plant and test weight.

Asghar Ali *et al.* (2005) conducted an experiment in Faisalabad, Pakistan, in 2003, to determine the effect of different sowing dates and row spacing on the growth and yield of sesame cv. 92006. Four sowing dates (8, 15, 22 and 29 July) and 3 row spacing (30, 45 and 60 cm) were used. Effect of sowing dates was highly significant and maximum seed yield was produced when the crop was sown on 8 and 15 July due to higher number of capsule per plant and more seed per capsule.

Shim Kong *et al.* (2006) conducted a field experiment to identify the effect of sowing dates on flowering and maturity of 20 genotypes, found that days to flowering, days to maturity, days from flowering to maturity and number of capsule per plant showed significant differences by years, sowing dates and cultivars. Plant height, number of capsule per plant and seed weight per plant decreased significantly as sowing dates were delayed. Number of capsule and seed weight per plant showed highest value with 10th May sowing under different sowing dates, sesame cultivars with earlier flowering habit were much less affected by day length compare to those with later flowering habit. It may be concluded that early maturing sesame varieties have higher potential adoptability to various sesame cropping system in view of their less sensitivity to day length changes under different sowing dates.

Abdel Rahman *et al.* (2007) conducted an experiment during *kharif* 2002-2003 at the Experimental Farm, Faculty of Agriculture, Nile Valley University, Darmali (Northern Sudan). The objective of the investigation was to evaluate some promising sesame genotypes under different sowing dates (mid June, early July and mid July). Result showed that sowing dates significantly affected number of plant m^{-2}, number of branches, number of capsule per plant, 1000 seed weight and seed yield. The highest seed yield was recorded for early July sowing by Shuhak genotype.

Awasthi *et al.* (2007) conducted a field experiment during winter (*rabi*) 2001-2002 and 2003-2004 at Kanpur to evaluate the effect of sowing dates (15th and 30th October) of Indian mustard and found that mustard showed better performance when sown on 15th October.

Olowe (2007) carried out an experiment to evaluate the optimum sowing dates for two varieties (Yandev-55 and E-8) of sesame during late rainy season in 1998-1999 in south west Nigeria. Both the varieties were sown in early July, mid July, late July, mid August and late August on late season crops in both the years Yandev-55 and E-8 produced maximum grain yield when sown in early July and late July respectively.

Sarkar *et al.* (2007) carried out an experiment at agronomy field laboratory, Bangladesh Agricultural University, during the period from February to June, 1999 to investigate the effect of sowing dates and time of harvesting on the yield and yield contributing characters of sesame seed. The experiment considered three sowing dates viz; 26th February, 10th March and 22th March and showed that the highest plant height, number of branches plant^{-1}, capsule yield plant^{-1}, seed yield (kg ha^{-1}) and straw yield (kg ha^{-1}) were obtained from the crop shown on 26th February.

Chakraborthy *et al.* (2010) conducted an experiment on dates of sowing (22nd February, 7th March and 22nd March) and varieties (BT-894-3, Rama and BT- 893-1) in three successive years (2004, 2005 and 2006) at BCKV, West Bengal to find out temperature and humidity profile within sesame canopy and their impact on various growth processes. Results revealed that different dates of sowing exposed the crop to different range of temperature and RH (above and below the crop). From polymeric chain reaction (PCR) analysis it is evident that temperature and RH on all data points significantly affected the biometric parameters. This crop could not be sown after 7th March under West Bengal condition, both the flowering and capsule setting would be adversely affected by higher temperature below the sesame canopy.

Nafe *et al.* (2010) conducted a field experiment to evaluate the effect of the day length and genotype on yield and yield component for two seasons (1986 -1987). Eighteen genotypes (local to exotic) of sesame crop were planted in January, May and September sowing dates. The results revealed that May sowing was favored yield and yield component while January and September sowing dates were resulted in reduction in yield.

Rammohan and Sivagamy (2012) conducted a field experiment during summer season of 2006 to fix optimum time of sowing and spacing for realizing higher seed yield in sesame. Consisting two sowing dates *i.e.* second fortnight of February and first fortnight of March and revealed that performance of sesame variety KS-95010 was superior when sown early during the second fortnight of February under irrigated condition in the Cauvery delta zone.

Ogbonna and Umar-shaba *et al.* (2012) conducted a two years study at the Teaching and Research farm of the department of Crop Science, University of Nigeria, Nsukka to determine the effect of time of planting on growth and yield of sesame. The study determined the optimum time of sowing of sesame in the derived Savanna agroecology of south eastern Nigeria and identified high yielding sesame cultivar for the zone. Three sowing dates (22nd July, 22nd August and 22nd September) were tested in 2009 while in 2010; the planting dates were 22nd June, 22nd July and 22nd August. Four sesame accessions (Zuru, NCRI-BEN 01M, 43-9-1 and NCRI-BEN 03L) were also evaluated in both years. Based on the results, time of sowing headed significant effect on growth and yield of sesame. Plant height, number of leaves, stem girth and number of branches per plant decreased with delay in time of sowing. Early sowing in the season significantly increased grain for all accessions. Grain yield decreased by 42 per cent and 91 per cent when sowing delayed from July to August and September, respectively, in 2009 season. In 2010 season, grain yield decreased by 16 per cent and 32 per cent as sowing was delayed from June to July and August, respectively. Among the climatic factor rainfall appeared to contribute more to change in performance across sowing dates.

CHAPTER III

MATERIAL AND METHODS

A field experiment was conducted to study the "Crop weather relationship on sesame varieties under different dates of sowing" during 2013-14 at Agronomy farm, College of Agriculture, Nagpur.

3.1 Basic resource information

3.1.1 Experimental site

The experimental site was selected on the merit in respect of suitability of land for sesame cultivation with uniform fertility and topography. With this consideration, the experiment was laid out on Plot No.9 of the Agronomy farm, College of Agriculture, Nagpur, during *kharif* season 2013-14.

3.1.2 Soil characteristics

The experimental field was fairly uniform and levelled. Soil of experimental plot was medium black. Soil samples were collected from randomly selected spots at a depth of 0-30 cm from the experimental area, mixed well and a composite sample of one kg was then prepared and analyzed for various physio-chemical properties of the soil. The details of analysis done, methods adopted and values obtained are presented in Table-1, showing mechanical and chemical composition of the soil.

From the data presented in Table-1, it would be observed that soil of the experimental site was loamy clay in texture, medium in available nitrogen, phosphorus and sulphur and rich in available potash. Organic carbon content was medium and soil reaction was slightly alkaline.

Table 1: Physical and chemical composition of the soil

Sr.No.	Particulars	Value	Method followed
A.	Mechanical composition		
1.	Coarse sand (%)	14.20	Standard International pipette method (Piper, 1966)
2.	Fine sand (%)	7.50	
3.	Silt (%)	20.18	
4	Clay (%)	58.12	
B.	**Chemical composition**		
1.	Available N (kg ha^{-1})	295.60	Alkaline potassium permanganate method (Subbaiah and Asija, 1956)
2.	Available P_2O_5 (kg ha^{-1})	25.20	Olsen's method (Jackson, 1967)
3.	Available K_2O (kg ha^{-1})	406.05	Flame emission spectrophotometer (Jackson, 1967).
4.	Available S (mg ha^{-1})	7.50	Turbidimetric method (Jackson, 1967).
5.	Organic carbon (%)	6.30	Walkey and Black method (Jackson, 1967)
C.	**Soil reaction**		
1.	pH	7.6	By glass electrode pH meter (Jackson, 1967)

3.1.3 Cropping history of the experimental site

The cropping history of the experimental field during last three years is given in Table 2.

Table 2: Cropping history of the experimental site

Year	Season		
	Kharif	*Rabi*	*Summer*
2010-2011	Cotton	----	-----
2011-2012	Soybean	Mustard	----
2012-2013	Pigeon pea	----	----

3.2 Weather and climatic conditions

Nagpur is located at North latitude of 20° 10' and East longitude of 79° 10' having an elevation of 310.5 m above MSL and has subtropical climate. The climate is hot and slightly humid. The weekly weather data in respect of temperature, rainfall, humidity and evaporation recorded at Meteorological Observatory, Agronomy farm, College of Agriculture, Nagpur, during June 2013 to October 2013 are presented in Table-3 and graphically depicted in Fig.1.

Table 3: Weekly meteorological data from June, 2013 to October, 2013 recorded at Agronomy Farm, College of Agriculture, Nagpur

Date		MW	Temp °C		R.H. %		Total Rainfall (mm)	No. of Rainy days	Evapo-ration (mm)
			Max.	Min.	Mor.	Eve.			
25-01	July, 13	26	29.5	25.2	82	70	253.6	3	2.3
02-08		27	29.5	24.4	85	71	71.4	3	1.8
09-15		28	29.3	24.5	89	79	127.4	5	2.0
16-22		29	29.2	24.6	83	79	117.2	4	2.2
23-29		30	28.2	24.5	88	81	38.4	4	1.6
30-05	August,13	31	26.9	23.6	90	85	276.6	5	2.4
06-12		32	28.7	24.3	86	77	54.2	4	2.1
13-19		33	30.8	24.7	89	69	67	5	2.0
20-26		34	26.9	22.9	94	88	71.6	5	1.7
27-02	September,13	35	30.3	23.9	80	63	1.2	-	2.3
03-09		36	32.3	24.2	76	58	-	-	3.4
10-16		37	33.8	24.4	76	59	1.8	-	2.7
17-23		38	29.5	23.8	90	78	100.6	5	2.4
24-30		39	32.0	24.0	76	58	-	-	3.3
01-07	October, 13	40	29.5	23.9	91	76	181.4	4	2.1
08-14		41	30.6	22.8	82	66	40.6	3	3.0
15-21		42	31.9	20.4	75	45	-	-	3.5
22-28		43	29.5	21.8	79	63	-	-	3.2

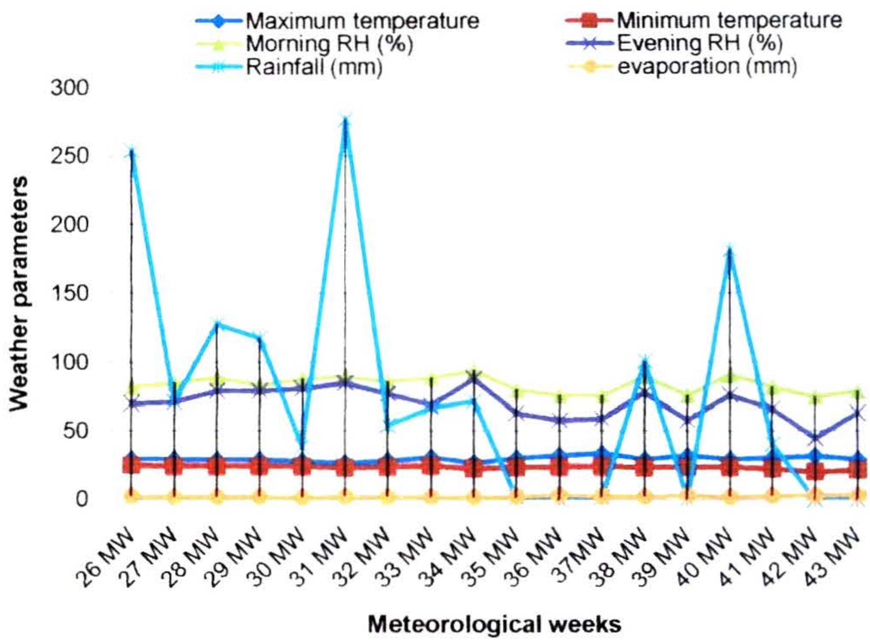

Fig 1: Weekly weather parameters during crop period

The total rainfall during crop growth period i.e. June 2013 to October, 2013 was 1403 mm received in 50 rainy days.

Table 4: Monthly meteorological data for June 2013 – October 2013 in comparison with last ten years average, recorded at Agronomy Farm, College of Agriculture, Nagpur

Month	Temperature ^0C				Rainfall (mm)		Rainy days		Relative Humidity (%)	
	Maximum		Minimum							
	N	A	N	A	N	A	N	A	N	A
June	39.4	33.9	27.1	26.1	233.6	417.1	6	10	56	66
July	31.6	29.0	24.1	24.5	370.5	405.8	16	19	79	82
August.	31.8	28.5	23.7	23.1	259.0	416.6	16.	17	78	84
September	31.5	31.9	23.5	24.1	145.5	102.4	12	5	77	71
October	32.5	31.5	21.1	22.4	49.53	222.0	2	7	58	73

N = Normal (10 years average), A= Actual monthly average

Graphical depicted in Fig. 2, 3, 4, 5 and 6.

3.3 Experimental details

The experiment was laid out in Split Plot Design with two factors *i.e.* sowing date as main plot treatment and two varieties as sub plot treatment, thus making ten treatment combinations, replicated thrice.

3.3.1 Experimental design and treatments

The present investigation, "Crop weather relationship on sesame varieties under different dates of sowing" was laid out in Split plot Design with ten treatment combinations and three replications. The

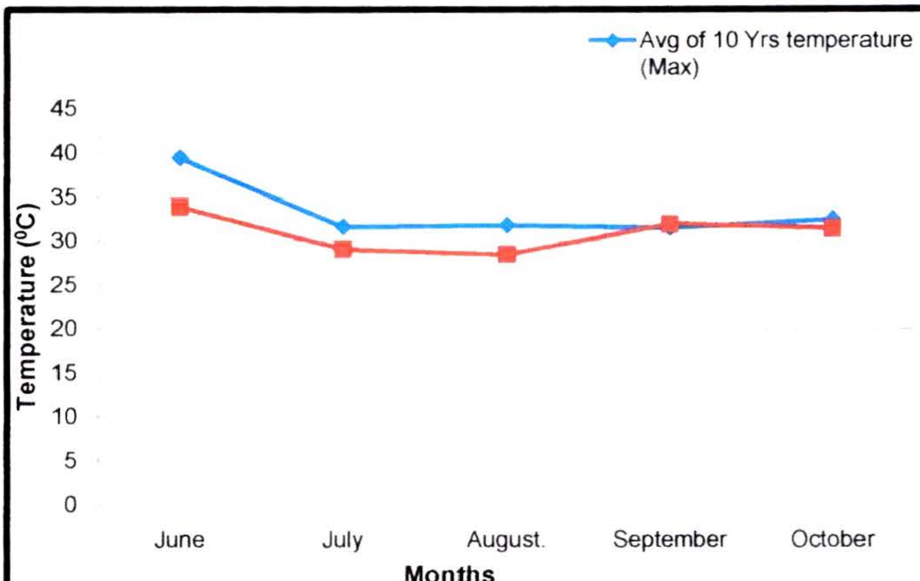

Fig 2: Monthly maximum temperature (^{0}C) during *kharif* 2013-2014

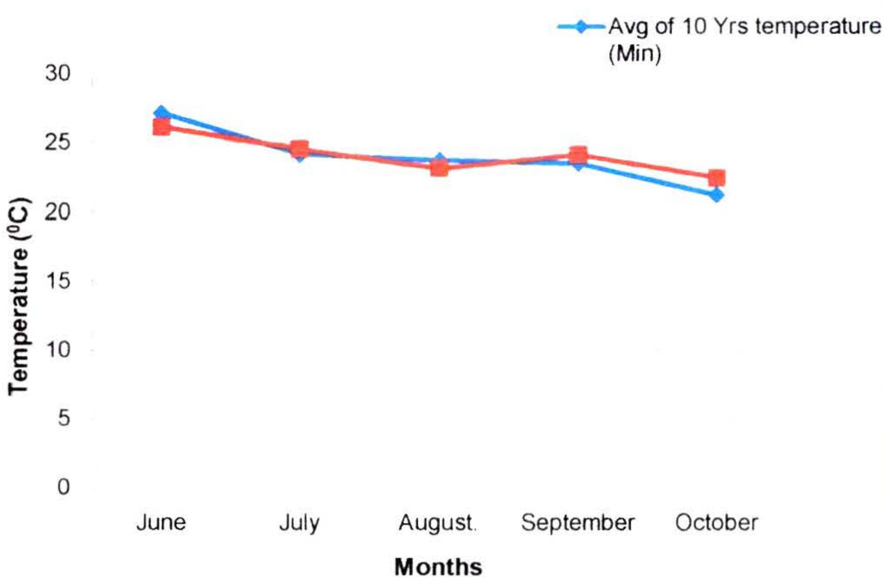

Fig 3: monthly minimum temperature (^{0}C) during *kharif* 2013-2014

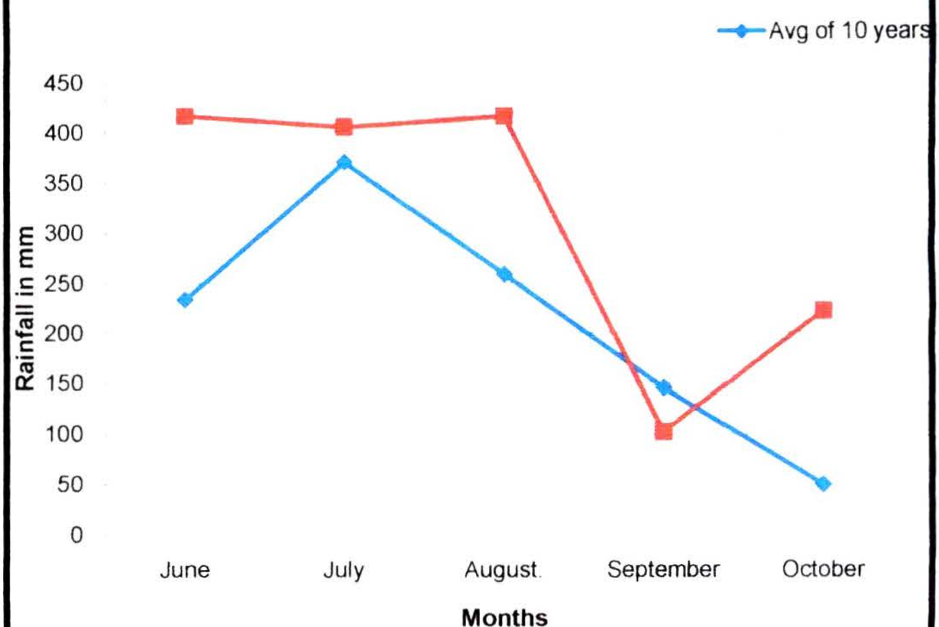

Fig 4: Monthly rainfall (mm) during *kharif* 2013-2014

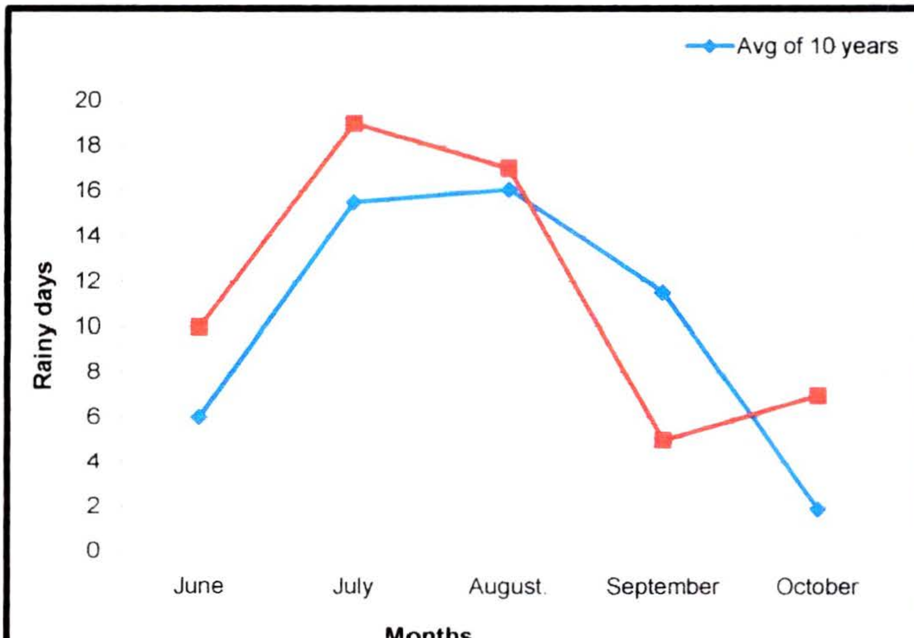

Fig 5: Monthly rainy days during *kharif* 2013-2014

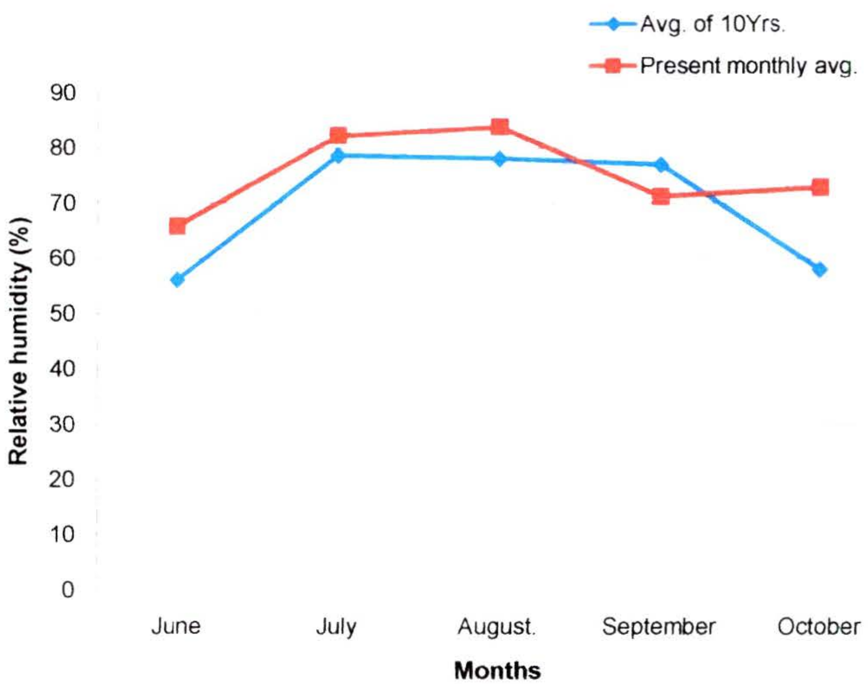

Fig 6: Monthly relative humidity (%) during *kharif* 2013-2014

details of the treatments along with symbols used to denote the treatments are given in.Table 6.

3.3.2 Experimental layout

The experimental field was laid out as per plan after preparatory operation. There were 10 treatment combinations laid out in split plot design with three replications. The plan of layout for the present investigation is depicted in Fig.7.

The distance between two replications was 1.2m and 0.9m between two plots. The gross and net plot size were 3.6 m × 4.8 m and 2.7 m × 4.2 m, respectively.

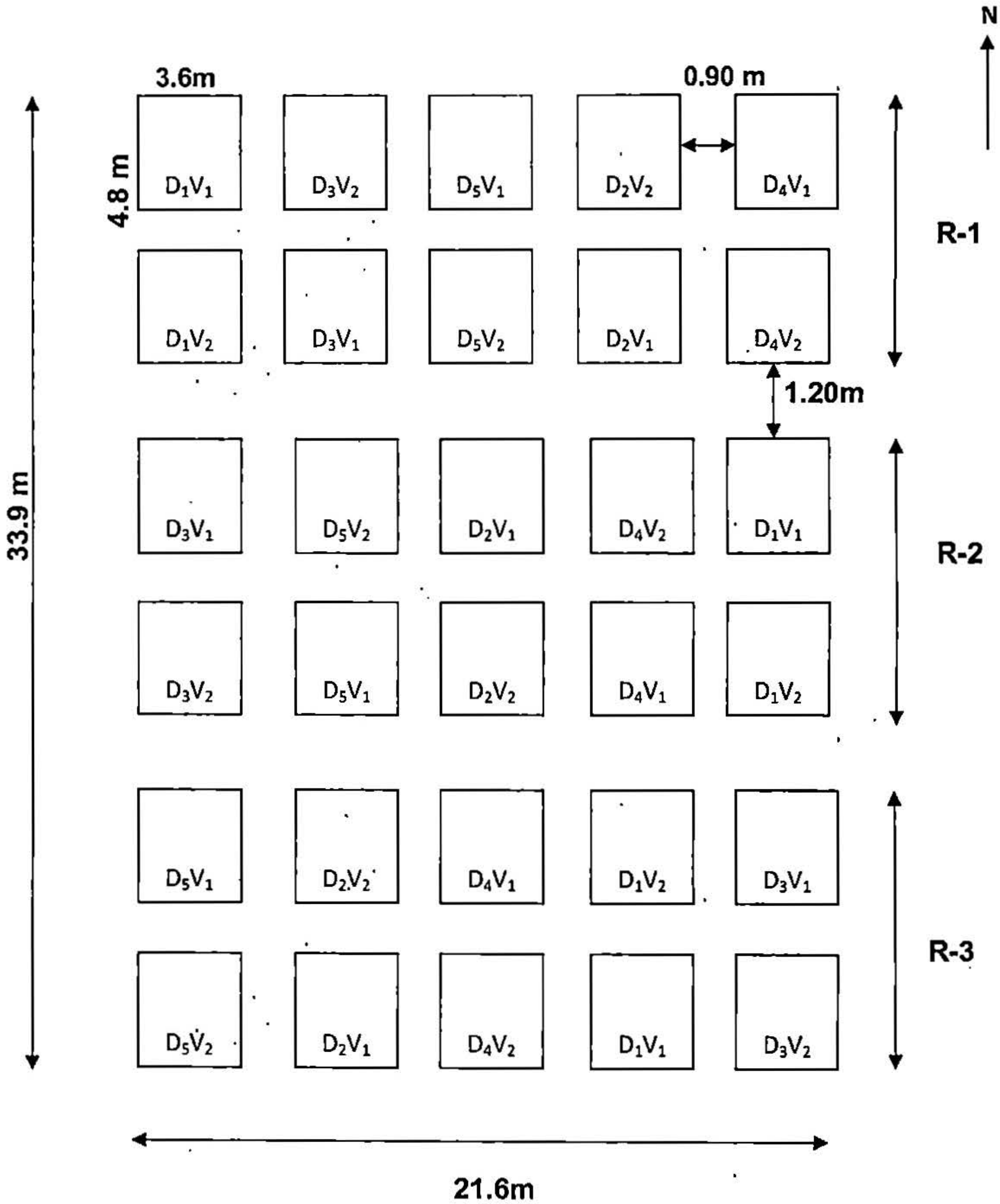

Fig 7: Plan of Layout

Design	Split Plot Design
Replications	Three
Treatment combinations	Ten
Total no. of plots	30
Gross plot size	3.6m x 4.8m
Net plot size	2.7 m x 4.2m

3.4 Cultural operations

3.4.1 Cultural operations carried out during experimentation are given below

Table 5: Details of cultural operations

Sr. No.	Name of Operation	Frequecy	Dates of sowing					
			D_1 26[th] MW		D_2 27[th] MW	D_3 28[th] MW	D_4 29[th] MW	D_5 30[th] MW
A.	**Presowing Operations**							
1.	Ploughing	1	15.06.2013		15.06.2013	15.06.2013	15.06.2013	15.06.2013
2.	Harrowing	1	18.06.2013		18.06.2013	18.06.2013	18.06.2013	18.06.2013
3.	Field layout	1	23.06.2013		23.06.2013	23.06.2013	23.06.2013	23.06.2013
B.	**Sowing and fertilizer application**							
1.	Fertilizer application	1	28.06.2013		05.07.2013	12.07.2013	19.07.2013	26.07.2013
2.	Seed treatment and sowing	1	28.06.2013		05.07.2013	12.07.2013	19.07.2013	26.07.2013
C.	**Post sowing operation**							
1.	Thinning and Gap filling	1	08.07.2013		15.07.2013	22.07.2013	29.07.2013	06.08.2013
2.	Hand weeding	2	18.07.2013		25.07.2013	02.08.2013	09.08.2013	16.08.2013
			08.08.2013		15.08.2013	22.08.2013	29.08.2013	06.09.2013
D.	**Harvesting**		V_1	02.10.2013	07.10.2013	12.10.2013	18.10.2013	24.10.2013
			V_2	07.10.2013	12.10.2013	18.10.2013	24.10.2013	29.10.2013
E.	**Threshing**		07.11.2013		07.11.2013	07.11.2013	07.11.2013	07.11.2013

3.4.2 Seed and sowing

Two varieties of sesame namely AKT-64 and Western-11 were sown in five different dates to evaluate the optimum sowing date for *Kharif* sesame. Sowing of sesame was done by manually, keeping 30 cm distance between the rows.

3.4.3 Details of experimental layout

Table 6: Details of experimental layout

1	Design	Split Plot Design
2	Replications	Three
3	Treatment combinations	Ten
4	Total no. of plots	30
5	Gross plot size	3.6m x 4.8m
6	Net plot size	2.7 m x 4.2m
7	Variety	V_1 - AKT-64 and V_2 – Western-11
8	Fertilizer dose (kg ha^{-1})	40 : 25 : 0 NPK kg ha^{-1}
9	Spacing	
i	Spacing between the rows	30 cm
ii	Space between replication	1.2 m
iii	Space between plots	0.9 m

Treatment details

1. Main Plot - Dates of Sowing

D_1	26^{th} MW
D_2	27^{th} MW
D_3	28^{th} MW
D_4	29^{th} MW
D_5	30^{th} MW

2. **Sub-Plot - Varieties**

V_1	AKT – 64
V_2	Western-11

3.4.4 Fertilizer application

A basal dose of 25 kg P_2O_5 ha^{-1} was applied through single super phosphate while Nitrogen dose @ 40 kg ha^{-1} was applied through urea in two equal splits doses at sowing and 30 DAS.

3.4.5 Thinning and Gap filling

To maintain optimum plant population, thinning and gap filling was carried out at 10 days after sowing by keeping only one healthy seedling per hill.

3.4.6 Hand weeding

Two hand weeding were given to keep the plot weed free at 20 and 40 days of crop.

3.4.7 Harvesting and threshing

The crop plant was harvested at physiological maturity stage. The observation plants were harvested first and then border rows and plants on either sides of gross plot were removed and then plants from net plot area were harvested. The harvesting was done with the help of sickle. The produce was tied in bundles plot wise and carried to threshing yard for sun drying. After complete drying the produce from each net plot area was threshed, winnowed, cleaned separately and grain weight was recorded for each net plot. The details of biometric observations recorded in the field are given in Table-7.

3.5 Details of observations

3.5.1 Sampling technique

In order to represent the plot, five plants from each net plot were selected randomly for recording various biometric observations of growth studies. The selected five plants were labeled properly and all biometric observations were recorded on these sample plants. Five randomly selected plants from border rows of each plot were uprooted for dry matter studies. They were kept in brown paper bag and labeled properly. These sample plants were first dried in sun and then in hot air oven at 105 ^{0}C.

3.5.2 Pre-harvest studies

3.5.2.1 Emergence count

Emergence count was recorded from each net plot 12 days after sowing. By counting number of seedling per meter row length at five randomly selected rows, emergence count per net plot was worked out.

3.5.2.2 Final plant stand

Final plant stand existed in each net plot was recorded at the time of harvesting. By counting number of plants per meter row length at five recorded randomly selected rows in each net plot, final plant stand was recorded.

3.5.3 Growth studies

3.5.3.1 Plant height (cm)

Height of randomly selected five observation plants were measured from ground level up to the tip of main shoot and average was worked out.

3.5.3.2 Number of branches plants^{-1}

Numbers of branches arising from main stem were counted at 30, 50, 70, 90 DAS and at harvest from five selected sample plants and average number of branches plant^{-1} was worked out.

Table 7: Observation to be recorded

Sr. No.	Observation	Frequency	Stages of observation
A.	**Pre-harvest studies**		
a)	**Crop stand**		
1.	Emergence count	1	12 DAS
2.	Final plant stand	1	At harvest
b)	**Growth studies**		
1.	Plant height (cm)	5	At 30, 50, 70, 90 DAS and at harvest
2.	No. of branches plant^{-1}	5	At 30, 50, 70, 90 DAS and at harvest
3.	Dry matter accumulation plant^{-1}	5	At 30, 50, 70, 90 DAS and at harvest
B.	**Post harvest studies**		
1.	Total no. of capsules plant^{-1}	1	At harvest
2.	Seed yield plant^{-1}	1	At harvest
3.	Straw yield plant^{-1}	1	At harvest
4.	Biological yield ha^{-1}	1	At harvest
5.	Seed yield ha^{-1}	1	At harvest
6.	Straw yield ha^{-1}	1	At harvest
7.	Harvest Index (%)	1	At harvest
C.	**Weather Parameters**		
1.	Temperature requirement of each variety under different dates of sowing.		
2.	Relative humidity requirement of each variety under different dates of sowing.		

3.5.3.3 Dry matter accumulation plant^{-1} (g)

Randomly selected plants from each border rows of each plot were uprooted for recording dry matter accumulation at 30, 50, 70, 90 DAS and at harvest and kept in brown paper bag and labeled properly.

These sample plants were first dried in sun and then in hot air oven at 105 ^{0}C, and their weight was recorded as dry matter accumulation plant^{-1}.

3.5.4 Post harvest studies

3.5.4.1Total number of capsules plant^{-1}

Numbers of matured capsules from the five observation plants were counted and average number capsules plant^{-1} was worked out.

3.5.4.2 Seed yield plant^{-1} (g)

The five sample plants from each net plot were harvested and dried separately. The seeds were separated and weighted to record seed yield plant^{-1}.

3.5.4.3 Straw yield plant^{-1} (g)

The weight of straw after separating the grains was recorded and straw yield plant $^{-1}$ (g) was worked out.

3.5.4.4 Seed yield (q ha^{-1})

As per seed yield obtained from each net plot, the seed yield ha^{-1} was worked out.

3.5.4.5 Straw yield (q ha^{-1})

The weight of straw from each net plot was recorded and straw yield ha^{-1} was worked out.

3.5.4.6 Biological yield (q ha^{-1})

The plants from net plot were cut close to the ground and tied into bundles. The bundles were dried in the sun and their weight was recorded before threshing as per treatments. From this biological yield hectare^{-1} was worked out.

3.5.4.7 Harvest index

Harvest index was calculated at harvest. It is ratio of economic yield to biological yield.

3.5.5 Weather Parameters

3.5.5.1. Temperature requirement of each variety under different dates of sowing (Thermal requirement)

Thermal (temperature) requirement , also referred as thermal unit, for each calendar day during the crop period, for all the treatment were calculated from daily weather data on maximum and minimum temperature as under-

$$\text{Thermal requirement} = \frac{T\,Max + T\,min}{2} - T\,base$$

Where

T_{max} - maximum temperature

T_{min} - minimum temperature

T_{base}- base temp as 10^0C

Base temperature is the temperature below which the physiological activities in plant practically cease and as a result plant does not show any growth. It is considered as 10^0C for sesame crop.

Further total thermal unit requirement over crop period under each treatment was calculated by summation.

In present study, the base temperature of sesame was taken as 10^0C.

3.5.5.2 Relative humidity requirement

Relative humidity for each crop growth period in respect of each treatment were added together so as to obtain relative humidity requirement in percentage during that crop period. Mean relative humidity over crop period under each treatment was calculated by summation.

3.6 Statistical Methods

The statistical analysis of the data was done by statistical method as suggested by Panse and Sukhatme (1985). F- test of significance was used to know the treatment effects for the data in which the treatment effects were significant. The standard errors (S.E.) and critical differences (C.D.) at 5% level of probability were calculated. The value of critical difference was used to interpret the result. Data are illustrated graphically at appropriate places.

3.7 Place/ Duration/ Season of Experiment

The experiment was laid out and conducted on the Agronomy farm, College of Agriculture, Nagpur, during *Kharif season*, 2013-14.

CHAPTER IV

. RESULTS AND DISCUSSION

A field experiment entitled "Crop weather relationship on sesame varieties under different dates of sowing" was carried out during *kharif* 2013 at Agronomy farm, College of Agriculture, Nagpur. The detail results of investigation are presented in this chapter with appropriate reasoning.

4.0 Soil, season and growth

The experimental site was fairly uniform and leveled. The soil analyzed in experimental site have loamy clayey in texture, medium in nitrogen and phosphorous content and rich in potash. Organic carbon content was medium and soil reaction was slightly alkaline (7.7) in nature.

The meteorological data presented in Table-4 indicated that, there was slightly variation in the mean maximum temperature during 2013-14 as compared to their averages. The monthly maximum temperature ranged from 28.5^{0}c to 33.92^{0}c, monthly minimum temperature ranged from 22.46^{0}c to 26.15^{0}c and the monthly relative humidity ranges from 65.9 to 83.9 per cent during the growth period of the crop. The total rainfall during crop period was 1403 mm. Crop sown on 26th MW, 27th MW and 28th experienced favorable temperature and moisture condition and showed better germination and crop growth. However, crop sown later on 29thMW and 30thMW badly affected due to heavy rainfall during germination showing poor germination and stunted growth. As the rainfall rise during germination and on seedling phase of the crop growth sown on 29th MW and 30th MW as it affects vegetative growth, flowering, capsule formation and grain filling resulting into low yields. The temperature and moisture condition for the crop sown on the 26th MW and 27th MW were most favorable throughout the cropping period and thus shows better growth and yield.

4.1 Pre-Harvest Studies

4.1.1 Plant stand per plot

Plant stand of sesame recorded at 12 DAS are presented in Table-8.

Table 8: Emergence count at 12 DAS and final plant stand (per plot) at harvest as influenced by sowing dates and varieties of sesame

Treatments	Emergence count ($plot^{-1}$)	Final plant stand ($plot^{-1}$)
Sowing Dates		
D_1-26th MW	254.00	248.67
D_2-27th MW	255.83	252.00
D_3-28th MW	254.17	248.17
D_4-29th MW	252.00	247.00
D_5-30th MW	249.67	244.17
SE(m) ±	2.81	2.66
CD at 5%	NS	NS
Varieties		
V_1- AKT-64	253.73	249.00
V_2- Western-11	252.53	247.00
SE(m) ±	0.73	0.89
CD at 5%	NS	NS
Interaction		
SE(m) ±	1.64	1.98
CD at 5%	NS	NS
GM	253.13	248.00

Effect of sowing Dates

The data presented in Table-8 revealed that emergence count and final plant stand at harvest of sesame as influenced by different sowing dates was statistically non-significant during the investigation.

Effect of varieties

Data presented in Table-8 revealed that emergence count at 12 DAS and final plant stand at harvest as influenced by varieties of sesame were found to be non-significant during the experiment.

Interaction effect

The data presented in Table-8 revealed that interaction effect due to sowing dates and varieties on emergence count at 12 DAS and final plant stand at harvest was found to be non-significant during the study.

4.2 Growth studies

4.2.1 Plant height

Data collected in respect of mean periodical plant height of sesame as influenced by different treatments are presented in table-9 and graphically depicted in figure 8.

Effect of sowing dates

From the data in Table-9, it was observed that the mean plant height increased with advancement in the age of the crop till harvest. The mean initial plant height was 18.24 cm at 30 days after sowing and increased up to 115.77 cm at harvest.

The mean plant height was significantly influenced by different sowing times. The *kharif* sesame sown during 27^{th}MW has recorded significantly superior plant height as compare to other sowing dates and recorded maximum plant height at harvesting stage (118.50 cm).

This might be due to congenial climatic condition for better germination and further growth and development of *kharif* sesame crop. Similar results were reported earlier by Nath *et al.* (2000), Rajib Nath Chakraborthy (2000) and Sarkar *et al.* (2007).

Table 9: Plant height (cm) as influenced by sowing dates and varieties

Treatments	Plant height (cm)				
Sowing dates	**30 DAS**	**50 DAS**	**70 DAS**	**90 DAS**	**At harvest**
D_1-26th MW	18.73	78.50	92.50	105.25	116.67
D_2-27th MW	19.76	80.92	96.83	107.17	118.50
D_3-28th MW	18.57	78.37	93.17	105.08	115.67
D_4-29st MW	17.67	78.15	92.42	104.17	114.17
D_5-30th MW	16.50	76.73	91.83	103.5	113.83
SE(m) ±	0.31	0.72	0.78	0.56	0.47
CD at 5%	1.02	2.28	2.45	1.31	1.49
Varieties					
V_1- AKT-64	18.51	79.29	95.23	105.93	116.27
V_2-Western-11	17.98	77.78	91.47	104.13	115.27
SE(m) ±	0.15	0.37	0.55	0.23	0.30
CD at 5%	0.48	1.18	1.74	0.72	0.96
Interaction					
SE(m) ±	0.34	0.83	1.24	0.51	0.68
CD at 5%	NS	NS	NS	NS	NS
GM	18.24	78.53	93.35	105.03	115.77

Effect of varieties

The data (Table-9) revealed that the height of the plant recorded at 30, 50, 70, 90 DAS and at harvest was significantly influenced by different varieties. The variety AKT-64 recorded significantly taller plants *viz.* 18.51 cm, 79.29 cm, 95.23 cm, 105.93 cm and 116.27 cm at

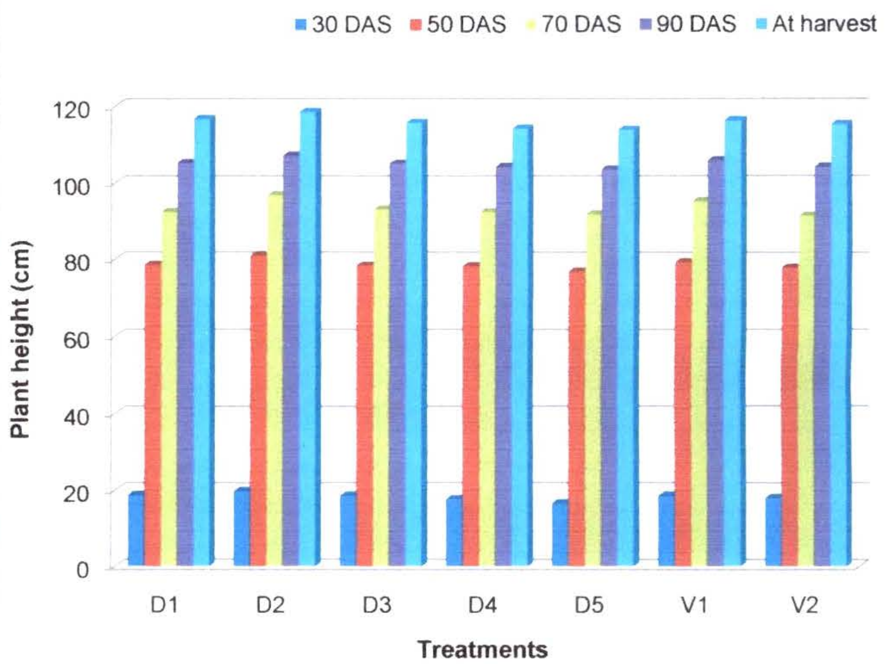

Fig 8: Plant height (cm) as influenced periodically by different treatments

30, 50, 70, 90 DAS and at harvest, respectively, whereas lower plant height was recorded by the variety Western-11. The similar findings were reported by Anonymous (1997), Korhale (2010) and Patil (2012).

Interaction effect

Interaction due to sowing dates with varieties was found to be non significant at all the stages of crop growth.

4.2.2 Number of branches plant^{-1}

Data regarding number of branches per plant as affected periodically by various treatments at various growth stages are presented in Table-10 and graphically depicted in figure 9. It would be revealed that the number of branches per plant increased from 1.73 at 30 DAS to 7.47 at harvest of crop.

Effect of sowing dates

The data presented in Table-10, revealed that number of branches plant^{-1} were influenced significantly by sowing dates at 30, 50, 70, 90 DAS and at harvest. The number of branches plant^{-1} were significantly more on 27th MW viz. 2.08, 3.78, 5.92, 6.70 and 7.75 at 30, 50, 70, 90 DAS and at harvest, respectively than other sowing dates except 26th MW at all growth stages and 28th MW at 30, 90 DAS and at harvest.

The same result was reported by Abdel Rehman *et al.* (2007), Nath *et al.* (2000) and Patil (2012).

Effect of varieties

Data presented in Table-10, indicated that the effect of varieties on number of branches plant^{-1} was significant at all growth stages. The variety AKT-64 has recorded significantly more branches 1.87, 3.06, 5.72, 6.71 and 7.66 than at 30, 50, 70, 90 DAS and at harvest, respectively over variety Western-11. These results are in accordance with those reported by Korhale (2010) and Patil (2012).

Table 10: Number of branches plant^{-1} as influenced by sowing dates and varieties

Treatments	Number of branches plant^{-1}				
Sowing Dates	**30 DAS**	**50 DAS**	**70 DAS**	**90 DAS**	**At harvest**
D_1-26th MW	2.00	3.43	5.62	6.62	7.70
D_2-27th MW	2.08	3.78	5.92	6.70	7.75
D_3-28th MW	1.88	2.55	5.35	6.57	7.60
D_4-29st MW	1.33	2.25	5.22	6.32	7.22
D_5-30th MW	1.35	2.13	4.78	6.17	7.07
SE(m) ±	0.18	0.14	0.16	0.09	0.07
CD at 5%	0.59	0.47	0.52	0.31	0.23
Varieties					
V_1-AKT-64	1.87	3.06	5.72	6.71	7.66
V_2-Western-11	1.59	2.60	5.05	6.23	7.27
SE(m) ±	0.08	0.08	0.07	0.06	0.06
CD at 5%	0.25	0.24	0.21	0.18	0.18
Interaction					
SE(m) ±	0.18	0.17	0.15	0.13	0.13
CD at 5%	NS	NS	NS	NS	NS
GM	1.73	2.83	5.39	6.47	7.47

Interaction effect

Interaction due to sowing dates with varieties was found to be non-significant at all the stage of crop growth.

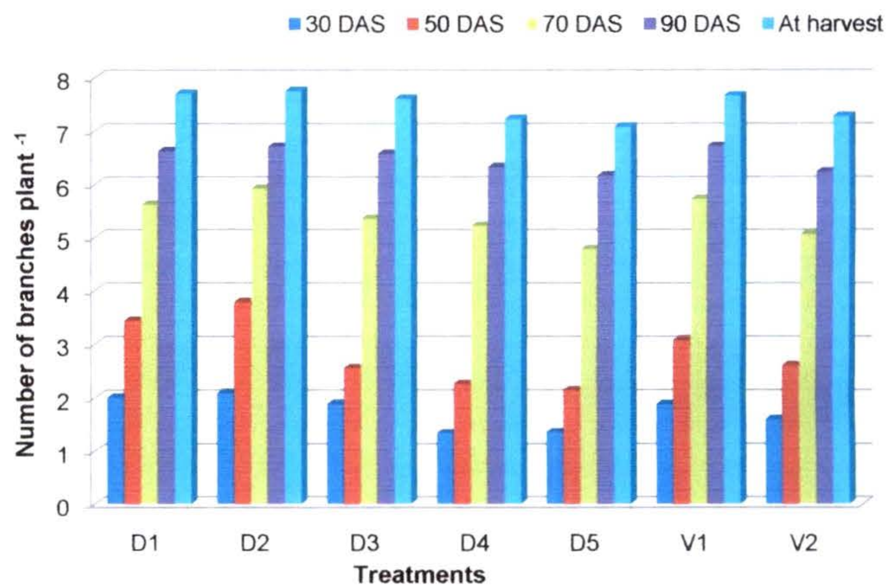

Fig 9: Number of branches plant^{-1} as influenced periodically by various treatments

4.2.3 Dry matter accumulation plant^{-1}

Data regarding mean dry matter accumulation plant^{-1} at various growth stages are presented in Table-11 and graphically depicted in figure 10.

Effect of sowing dates

Data presented in Table-11, indicated that, dry matter production was not significantly influenced by sowing time. However sowing on 27th MW recorded higher dry matter accumulation than other sowing dates. During the present investigation, it was observed that there was progressive decrease in dry matter accumulation as sowing was delayed and the lowest dry matter accumulation was recorded under sowing on 30th meteorological week (D_5).

Effect of varieties

The dry matter production at different growth stages was not significantly influenced by different varieties. However variety AKT -64 recorded higher dry matter production at all the growth stages. Similar results were reported by Korhale (2010) and Patil (2012).

Interaction effect

Interaction effect between sowing dates with varieties was found to be non-significant at all the stage of crop growth during the experimentation.

Table 11: Dry matter accumulation plant^{-1} (g) as influenced by sowing dates and varieties

Treatments	Dry matter accumulation plant^{-1} (g)				
Sowing dates	**30 DAS**	**50 DAS**	**70 DAS**	**90 DAS**	**At harvest**
D_1-26th MW	3.55	15.98	24.32	32.17	42.18
D_2-27th MW	3.70	16.05	24.35	32.18	42.83
D_3-28th MW	3.40	15.90	24.30	32.15	42.80
D_4-29th MW	3.37	15.72	24.23	32.13	42.75
D_5-30th MW	3.27	15.70	24.18	32.12	42.73
SE(m) ±	0.19	0.11	0.04	0.07	0.03
CD at 5%	NS	NS	NS	NS	NS
Varieties					
V_1 – AKT-64	3.51	15.92	24.30	32.19	42.80
V_2- Western-11	3.41	15.82	24.25	32.11	42.77
SE(m) ±	0.04	0.04	0.03	0.03	0.02
CD at 5%	NS	NS	NS	NS	NS
Interaction					
SE(m) ±	0.09	0.08	0.06	0.06	0.04
CD at 5%	NS	NS	NS	NS	NS
GM	3.46	15.87	24.28	32.15	42.79

4.3 Post harvest studies

4.3.1 Total number of capsules plant^{-1}

Data recorded on mean number of capsules plant^{-1} are presented in Table-12 and graphically depicted in figure 11.

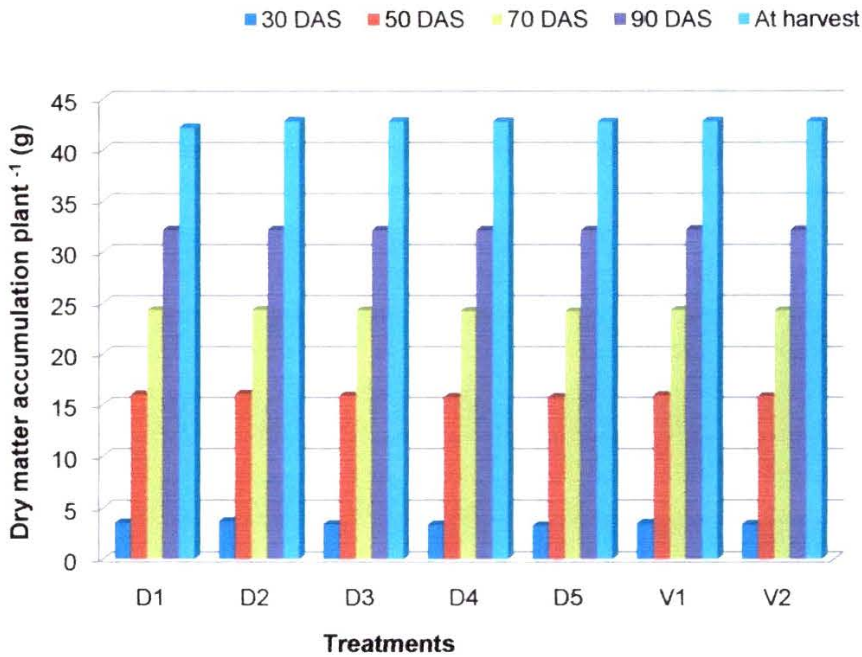

Fig 10: Dry matter accumulation plant^{-1} (g) as influenced periodically by various treatments

Table 12: Total number of capsules plant^{-1} as influenced by sowing dates and varieties

Treatments	Total number of capsule plant^{-1}
Sowing dates	
D_1-26th MW	43.87
D_2-27th MW	44.85
D_3-28th MW	43.33
D_4-29st MW	43.25
D_5-30th MW	42.88
SE(m)±	0.30
CD at 5%	1.00
Varieties	
V_1-AKT-64	44.41
V_2 –Western-11	42.86
SE(m)±	0.34
CD at 5%	1.08
Interaction	
SE(m)±	0.77
CD at 5%	NS
GM	43.64

Effect of sowing dates

A mean number of capsule plant^{-1} was significantly influenced by different sowing dates. The sowing of sesame on 27th meteorological week recorded significantly higher number of capsules plant^{-1} (44.85) than rest of the sowing dates except sowing on 26th MW.

The next in order of was sowing on 26th MW. This was due to better climatic condition prevailed with 27th MW sowing. Similar finding

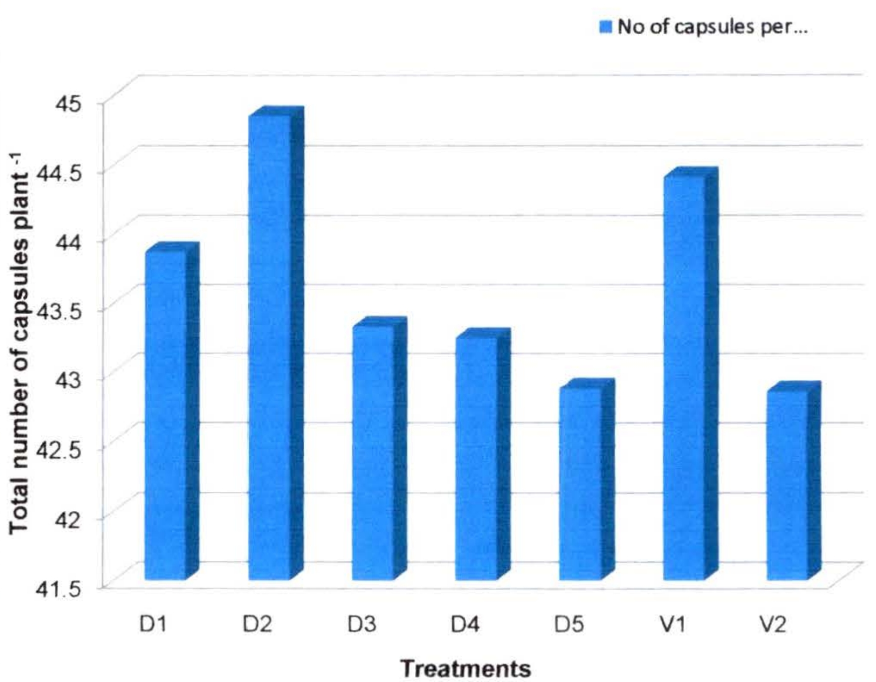

Fig 11: Total number of capsules plant^{-1} as influenced by various treatments

were reported by Olowe (2007), Abdel Rehman *et al.* (2007) and Patra (2001).

Effect of varieties

Mean number of capsule plant^{-1} was significantly influenced by the different varieties. However, AKT-64 recorded significantly more number of capsules plant^{-1} (44.41) as compare to variety Western-11 (42.86).

It was found that the significant difference in number of capsule per plant was might be due to number of branches plant^{-1}. These results are in accordance with those reported by Korhale (2010).

Effect of interaction

The interaction between sowing times and varieties were non significant in respect of number of capsules per plant at harvest.

4.3.2 Seed yield plant^{-1} (g)

Effect of sowing dates

The data pertaining to mean seed yield per plant as influenced significantly by different sowing dates are presented in Table-13 and graphically depicted in figure-12.

Sowing taken on 27th MW had recorded significantly higher seed yield plant^{-1} (4.02g) than other sowing dates. This was due to optimum temperature prevailed during flowering resulted in low flower drop and more fruit setting during this period. Nath *et al.* (2000), Kadam (2001) and Patil (2012) also supported the favorable effect of sowing times on seed yield in sesame.

Effect of varieties

Significantly higher seed yield plant^{-1} (3.97g) was recorded by variety AKT-64 over Western-11 (3.38g). Higher seed yield in AKT-64 is attributed to higher number of branches plant^{-1} which resulted into more of mature and productive capsules. Similar results were reported by Korhale (2010).

Table 13: Seed and straw yield plant^{-1} (g) as influenced by sowing dates and varieties

Treatments	Seed yield plant^{-1} (g)	Straw yield plant^{-1} (g)
Sowing dates		
D_1-26th MW	3.68	12.89
D_2-27th MW	4.02	14.51
D_3-28th MW	3.66	12.69
D_4-29th MW	3.72	12.99
D_5-30th MW	3.28	12.27
SE(m)±	0.10	0.40
CD at 5%	0.31	1.31
Varieties		
V_1- AKT-64	3.97	13.62
V_2 –Western-11	3.38	12.52
SE(m)±	0.08	0.25
CD at 5%	0.24	0.79
Interaction		
SE(m)±	0.17	0.56
CD at 5%	NS	NS
GM	3.67	13.07

Effect of interaction-

The interaction effect between sowing times and varieties were non significant for seed yield per plant at harvest.

4.3.3 Straw yield plant^{-1} (g)

Data recorded on mean straw yield plant^{-1} (13.07g) is presented in Table-13 and graphically depicted in figure-12.

Effect of sowing dates

The pertaining to straw yield of sesame at harvest as influenced by sowing times is presented in Table-13. It was significantly influenced by different sowing times.

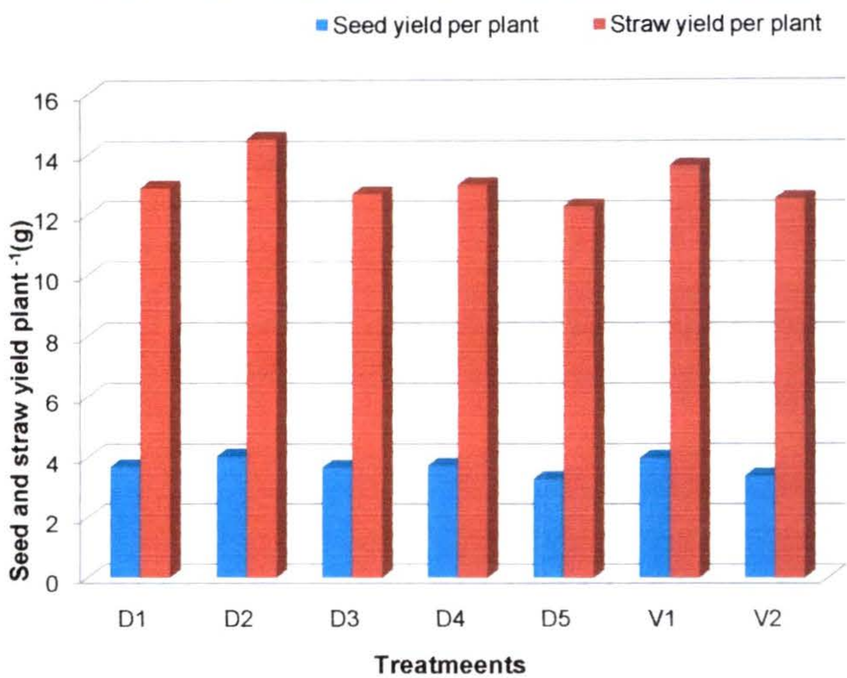

Fig 12: Seed and straw yield plant^{-1} (g) as influenced by various treatments

Sowing taken on 27^{th} MW recorded significantly higher straw yield (14.51g) over other sowing dates. This was due to production of more number of branches $plant^{-1}$ and dry matter accumulation $plant^{-1}$.

Effect of varieties

Data presented in Table-13 revealed that varieties AKT-64 recorded significantly higher straw yield (13.62g) than Western-11 (12.52).

This was due to more plant height, number of capsules and number of branches per plant in which contributed towards increased straw yield per plant.

Interaction effect

The interaction effect between sowing times and varieties were non significant for straw yield per plant at harvest.

4.3.4 Seed yield (qha^{-1})

The data regarding seed yield (qha^{-1}) are presented in Table 14 and graphically depicted in figure-13.

Effect of sowing dates

Sowing taken on 27^{th} MW had recorded significantly higher seed yield ($9.52qha^{-1}$) than rest of the sowing dates. Sowing taken on 26^{th}, 28^{th}, 29^{th} and 30^{th} MW were at per with each other in respect of seed yield. Lowest seed yield ($7.06qha^{-1}$) was recorded under 30^{th} MW.

This might be due to optimum temperature prevailed during flowering resulted in low flower drop and higher fruit setting. Similar results were reported by Olowe (2007), Abdel Rahman *et al.* (2007) and Rajib Nath and Chakraborthy (2001).

Effect of varieties

Data presented in Table-14 revealed that variety AKT-64 produced significantly higher seed yield ($8.85qha^{-1}$) than variety

Western-11 (7.49qha^{-1}). This might be due to the less flower drop and more number of branches plant^{-1} which helped in increased seed yield per hectare. Similar results were reported by Korhale (2010) and Kadam (2001).

Interaction effect

The interaction effect between sowing times and varieties were non significant for seed yield per hectare at harvest.

4.3.5 Straw yield (qha^{-1})

Data in respect of straw yield (q ha^{-1}) as influenced by various treatments are presented in Table-14 and graphically depicted in figure-13.

Effect of sowing dates

Sowing taken on 27th MW had recorded significantly higher straw yield (33.97qha^{-1}) than rest of the sowing dates. Sowing taken on 26th, 28th, 29th and 30th MW were at per with each other in respect of straw yield. Lowest straw yield recorded under 30th MW (26.34qha^{-1}). This is attributed due to the higher number of capsules and branches per plant. Similar results were also reported by Nath *et al.* (2000) and Thanki *et al.* (2004).

Effect of varieties

Data presented in Table-14 revealed that variety AKT-64 recorded significantly higher straw yield (31.99qha^{-1}) than Western-11 (27:74qha^{-1}) under study.

This might be due to the higher number of branches plant^{-1} and ultimately the higher dry matter accumulation per plant. Similar results were reported by Korhale (2010).

Table 14: Seed yield (qha^{-1}), straw yield (qha^{-1}), biological yield (qha^{-1}) and Harvest index (%) as influenced by sowing dates and varieties

Treatments	Seed yield (qha^{-1})	Straw yield (qha^{-1})	Biological yield (qha^{-1})	Harvest Index (%)
Sowing dates				
D_1-26th MW	8.17	29.73	37.90	21.55
D_2-27th MW	9.52	33.97	43.49	21.84
D_3-28th MW	8.00	29.62	37.62	21.28
D_4-29th MW	8.12	29.68	37.80	21.42
D_5-30th MW	7.06	26.34	33.41	21.09
SE(m)±	0.39	1.09	1.45	-
CD at 5%	1.27	3.56	4.37	-
Varieties				
V_1 –AKT-64	8.85	31.99	40.85	21.65
V_2- Western-11	7.49	27.74	35.23	21.22
SE(m)±	0.22	0.69	0.88	-
CD at 5%	0.68	2.17	2.79	-
Interaction				
SE(m)±	0.48	1.54	1.98	-
CD at 5%	NS	NS	NS	-
GM	8.17	29.87	38.04	21.43

Interaction effect

The interaction effect between sowing times and varieties were non significant for straw yield per hectare at harvest.

4.3.6 Biological yield (qha^{-1})

Data in respect of total biological yield are presented in Table-14 and graphically depicted in figure-13.

Effect of sowing dates

Biological yield differed significantly due to various sowing dates. The crop sown at 27th MW recorded significantly higher biological yield (43.49qha^{-1}) than rest of the sowing dates. Sowing taken on 26th, 28th, 29th and 30th MW were at per with each other in respect of biological yield.

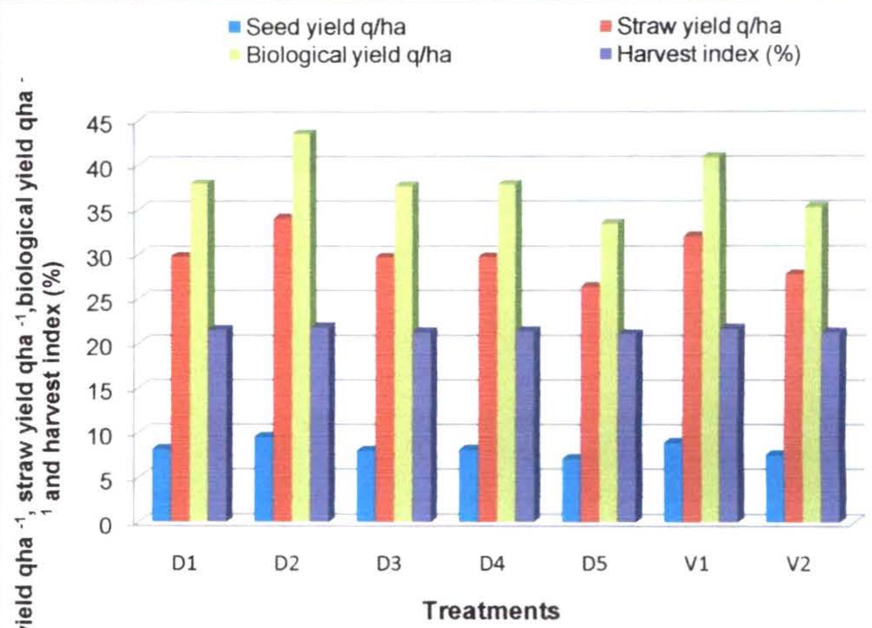

Fig 13: Seed yield qha^{-1}, straw yield qha^{-1}, biological yield qha^{-1} and harvest index (%) as influenced by various treatments

Sowing on 27th MW has accumulated higher photosynthates which helped in higher accumulation of dry matter which resulted in higher biological yield.

Effect of varieties

Data presented in Table-14 revealed that variety AKT-64 produced significantly higher biological yield (40.85qha^{-1}) than the variety Western-11 (35.23qha^{-1}).

Interaction effect

Interaction due to sowing dates and varieties in respect of biological yield was found to be non significant (Table-14).

4.3.7 Harvest index (%)

The data in respect of harvest index ~~are~~ is presented in table-14 and graphically depicted in figure-13. The mean harvest index was 21.43 percent.

Effect of sowing dates

The data in table-14 revealed that sowing on 27th MW recorded comparatively higher harvest index (21.84%) as compare to all other treatments.

Effect of varieties

The harvest index was comparatively higher in sesame variety AKT-64 (21.65%). Similar results were found by Anonymous (1997).

4.4 Weather Parameters

4.4.1 Temperature (Thermal) requirement of each variety under different dates of sowing (Thermal)

The data on temperature requirement are presented in table-15 and graphically depicted in figure- 14. The temperature requirement (GDD) for *kharif* sesame was calculated by using daily maximum, minimum and base temperature of sesame. Mean thermal requirement of sesame during growth period is 16.95 heat units.

Table 15: Temperature (thermal) requirement for *kharif* sesame as influenced periodically by different treatments

Treatments	Temperature requirement
Sowing dates	
D_1-26[th] MW	16.92
D_2-27[th] MW	17.73
D_3-28[th] MW	16.65
D_4-29[st] MW	16.78
D_5-30[th] MW	16.68
Varieties	
V_1- AKT-64	17.01
V_2 –Western-11	16.90
GM	16.95

Effect of sowing dates

The temperature requirement (GDD) varied with sowing time. The sesame sown during 27[th] MW showed maximum GDD (17.73 heat units) with respect to 26[th] MW (16.92 heat units), 29[th] MW (16.78 heat units), 30[th] MW (16.68 heat units) and 28[th] MW (16.65 ~~hat~~ heat units) as more number of bright sunshine hours associated with 27[th] MW sowing.

It might be due to difference in duration of crop growth and difference in maximum and minimum temperatures.

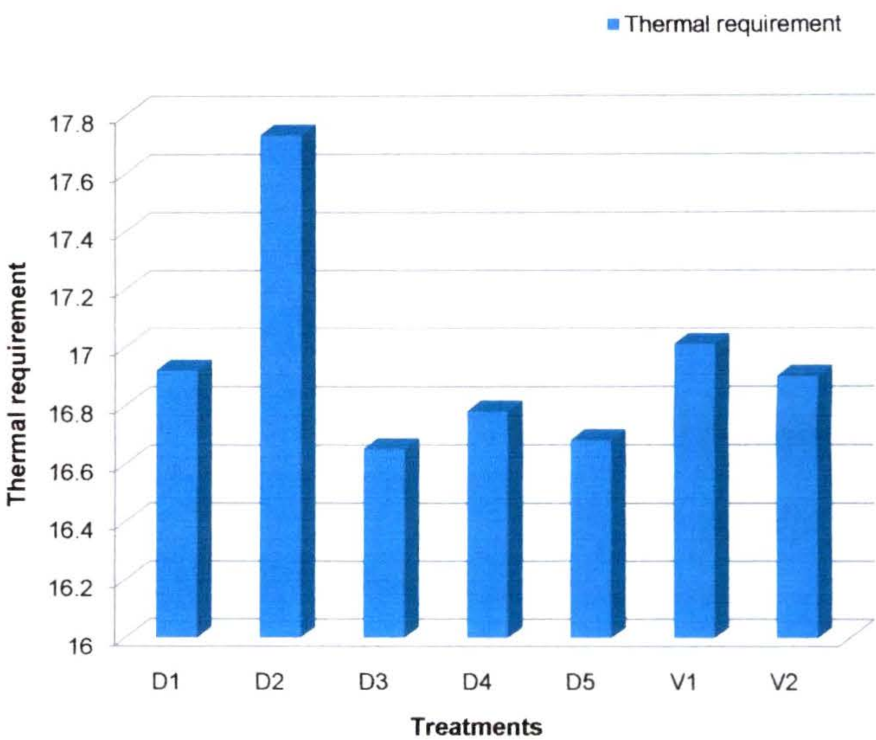

Fig 14: Temperature (Thermal) requirement for *kharif* Sesame as influenced periodically by various treatments

Effect of varieties

Variety AKT-64 (17.01 heat units) recorded higher thermal requirement as compare to Western-11 (16.90 heat units).

4.4.2 Relative humidity requirement of each variety under different dates of sowing

The data on relative humidity requirement are presented in table-16 and graphically depicted in figure- 15. The relative humidity requirement for *kharif* sesame was calculated by using average relative humidity during crop period.

Table 16: Relative humidity requirement for *kharif* sesame as influenced periodically by different treatments

Treatments	Relative humidity (%)
Sowing dates	
D_1-26th MW	75.26
D_2-27th MW	78.92
D_3-28th MW	81.94
D_4-29st MW	79.71
D_5-30th MW	78.97
Varieties	
V_1- AKT-64	79.68
V_2 –Western-11	78.23
GM	78.96

Effect of sowing dates

The relative humidity requirement varied with sowing dates. Sowing taken on 28th MW recorded highest relative humidity during crop period as higher number of rainy or cloudy days are associated with 28th MW.

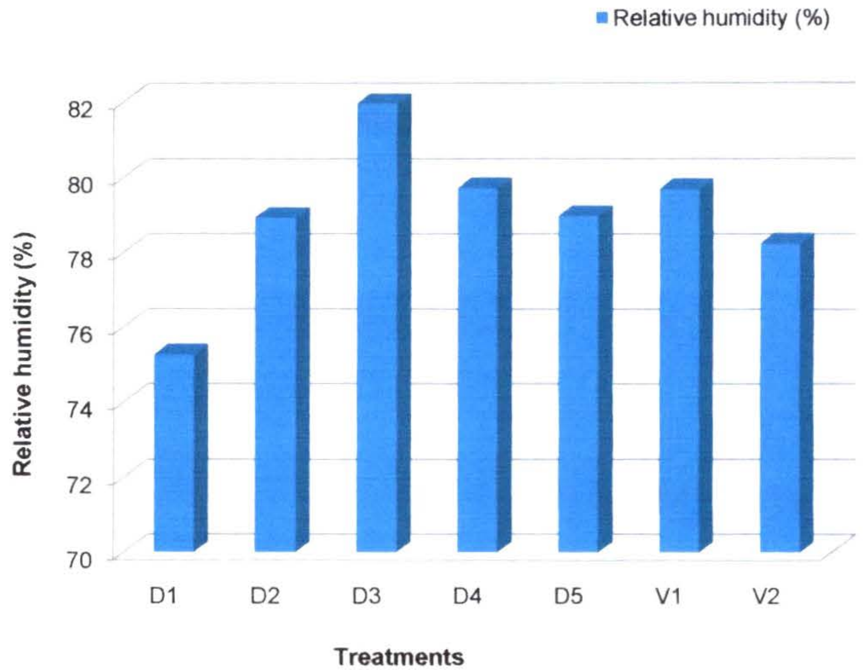

Fig 15: Relative humidity (%) requirement for *kharif* Sesame as influenced periodically by variouus treatments

Effect of varieties

The relative humidity requirement varied with varieties. Variety Akt-64 recorded higher relative humidity (%) during crop period as compare to Western-11.

4.5 Economics

4.5.1 Gross monetary returns and net monetary returns

Data on gross and net monetary returns as affected by different treatments are presented in Table 17 and graphically depicted in Fig.16 Mean gross and net monetary returns were Rs 53122 and Rs 35932 ha^{-1}, respectively.

4.5.1.1 Effect of Sowing dates

Highest gross and net monetary returns of Rs 61848 ha^{-1} and Rs 44657 ha^{-1} respectively, were recorded when crop sown on 27^{th} MW which was significantly superior over other sowing dates. Increase in net and gross monetary returns is due to significant increase in the economic yield of sesame. Similar results were found by Bahale *et al.* (2001).

4.5.1.2 Effect of varieties

Significantly higher gross monetary returns of Rs 57555 ha^{-1} and net monetary returns of Rs 40365 ha^{-1} were recorded with variety AKT-64 than Western-11.

4.18.1.3 Interaction

The interaction of sowing dates and varieties was found to be non significant.

4.5.2: B: C ratio

Mean B: C ratio of sesame crop obtained was 3.09.

Table 17: Economic studies of sesame as influenced by various treatments

Treatments	cost of cultivation (Rs ha^{-1})	Gross monetary return (Rs ha^{-1})	Net monetary return (Rs ha^{-1})	B.C. ratio
Sowing dates				
D_1-26th MW	17190	53094	35904	3.09
D_2-27th MW	17190	61848	44657	3.59
D_3-28th MW	17190	52028	34837	3.03
D_4-29th MW	17190	52748	35557	3.07
D_5.30th MW	17190	45895	28705	2.67
SE(m)±	-	2522	2522	-
CD at 5%	-	8239	8239	-
Varieties				
V_1 –AKT-64	17190	57555	40365	3.35
V_2- Western-11	17190	48689	31499	2.83
SE(m)±	-	1398	1398	-
CD at 5%	-	4412	4412	-
Interaction				
SE(m)±	-	3128	3128	-
CD at 5%	17190	NS	NS	-
GM	17190	53122	35932	3.09

4.5.2.1 Effect of sowing dates

Highest B: C ratio of (3.59) was recorded with sowing on 27th MW as compare to other sowing dates. Increase in B:C ratio is due to significant increase in gross monetary return.

4.5.2.2 Effect of varieties

Comparatively higher B: C ratio 3.35was recorded with variety AKT-64 over Western-11 (2.83).

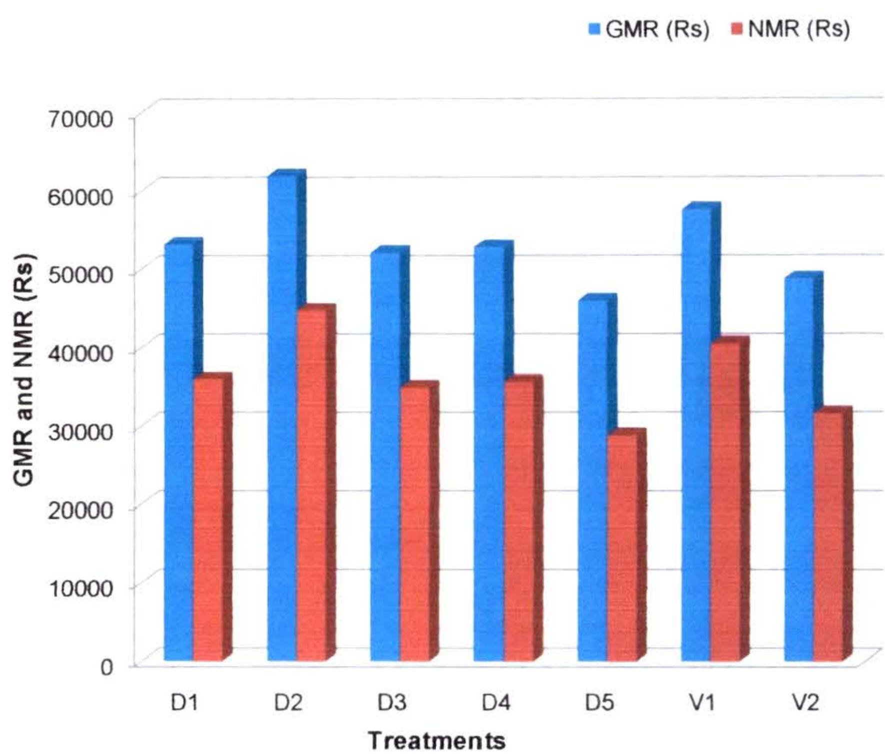

Fig 16: GMR and NMR of sesame as influenced by various treatments

CHAPTER V

SUMMARY AND CONCLUSIONS

5.1 Summary-

The present investigation entitled "Crop weather relationship on sesame varieties under different dates of sowing" was carried out during *kharif* 2013 at Agronomy farm, College of Agriculture, Nagpur.

The field experiment was laid out in a Split Plot Design with three replications. There were ten treatment combination comprising of five sowing times (26^{th}, 27^{th}, 28^{th}, 29^{th} and 30^{th} MW) and two varieties (AKT-64 and Western-11). The gross and net plot size were 3.6m x 4.8m and 2.7m x 4.2m, respectively. A spacing of 30 x 15 cm was adopted by using 3 kg seed per hectare. A recommended dose of fertilizers (40: 25: 0 kg N, P and K ha^{-1}) was applied uniformly to all the treatments. Nitrogen was supplied through urea, phosphorus through single super phosphate. 50 percent nitrogen was applied basally and remaining 50 percent at 30 days after sowing. The sowing is done by drilling method as per treatments.

Two hand weeding were given to keep the plots weed free. No any plant protection measures and no irrigation were given. The periodical observations on growth and yield contributing characters were recorded to access the treatments effects. The important findings of investigation are summarized as below.

5.1.1 Effect of sowing dates-

Sowing of sesame during different sowing dates significantly influenced growth and yield parameters. The growth attributing characters *viz.* Plant height, number of branches $plant^{-1}$ and dry matter accumulation per plant were significantly more when sesame sowing during 27^{th} MW.

The yield attributing characters *viz.*, number of capsules per plant, seed and straw yield per plant, seed, straw and biological yield per hectare and harvest index were favorably influenced when sesame was sown during 27th MW.

5.1.2 Effect of varieties-

Different varieties of sesame showed significant influence on growth and yield parameters. Variety AKT-64 recorded higher growth contributing characters as well as yield contributing characters like plant height, number of branches plant^{-1}, dry matter accumulation plant^{-1}, number of capsules plant^{-1}, seed and straw yield plant^{-1}, seed, straw and biological yield per hectare and harvest index.

5.1.3 Effect of interaction-

The effect of interaction between sowing dates and varieties was non significant for all the growth and yield contributing characters and yield during the experiment.

5.2 Conclusions-

1. Sowing of *kharif* sesame during 27th MW significantly improved all the growth and yield components resulted in significant increase in seed yield of sesame as compare to sowing of sesame during 26th, 28th, 29th and 30th MW.

2. Among the two different cultivars of sesame, AKT-64 recorded significantly higher growth and yield components resulting in increase in seed yield as compare to Western-11.

3. The temperature requirement of sesame was more when crop sown on 27th MW.

4. The relative humidity requirement of sesame was more when crop sown on 28th MW.

IMPLICATION

1) Sesame has to be tested for its response to various sowing dates.

2) There is a need to study the effect of sowing dates on growth and yield component of sesame and to study the varietal response of sesame to weather elements for increased sesame production.

CHAPTER VI

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VITA

1. **Name of Student** : Neelesh Kumar Sahu

2. **Date of Birth** : 20^{th} Feb 1989

3. **Name of the College** : College of Agriculture, Nagpur

4. **Residential Address along with Phone No.** : Neelesh Kumar Sahu
Village + Post- Narayanganj,
Tehsil - Narayanganj
Dist – Mandla (MP)
Pin – 481662
Mob No. 9691958383

E - mail ID : neel8383@gmail.com

6. **Academic Qualifications :**

Sr. No	Name of Degrees awarded	Year in which obtained	Division / class	Name of awarding university	Subject
1	B.Sc.(Agri.)	2012	First	J.N.K.V.V. Jabalpur (MP)	Agriculture
2	H.S.S.C	2007	First	BSEMP, Bhopal	Biology Science
3	H.S.C.	2005	First	BSEMP, Bhopal	General

7. **Field of Interest** : Research in Agronomy.

Place: Nagpur

Date :

Signature of student

Appendix-I

Common cost of cultivation

Sr.No.	Particulars	Frequency	Bullock Pair	Male	Female	Tractor	Total (Rs ha^{-1})
1	Ploughing	1	2	6	-		1220
2	Harrowing	2	2	6	-	-	2440
3	Clod crushing	2	1	-	4	-	1460
4	Stubble Picking	1	-	-	6	-	720
5	Planking	1	1	1	-	-	370
6	Cost of seed	1	-	-	-	-	450
7	Sowing	5	1	1	4	-	3050
8	Gap filling	1	-	-	4	-	480
9	Hoeing	2	2	4	-	-	1960
10	Harvesting	6	-	-	5	-	3600
11	Threshing and cleaning	1	-	4	8	-	1440
	Total cost of cultivation						**17190**

APPENDIX – II

Treatment wise cost of cultivation (Rs ha^{-1})

(Additional Expenditure)

Treat. No.	Particulars	Male	Female	Bullock pair	Input cost	Total Rs
D_1	Sowing on 26^{th} MW	-	-	-	-	-
D_2	Sowing on 27^{th} MW	-	-	-	-	-
D_3	Sowing on 28^{th} MW	-	-	-	-	-
D_4	Sowing on 29^{th} MW	-	-	-	-	-
D_5	Sowing on 30^{th} MW	-	-	-	-	-
V_1	Variety- AKT-64	-	-	-	-	-
V_2	Variety- Western-11	-	-	-	-	-

Appendix-III

Prevalent rates of various operational inputs and materials (Rs)

Sr. No.	Particulars	Rates (Rs)
1	Urea	5.78 Kg^{-1}
2	SSP	7.60 Kg^{-1}
3	Sesame seed	150 Kg^{-1}
4	Bullock pair	250 /day
5	Labour charge	
	Male	120/day
	Female	120/day