Influence of dates of sowing on *kharif* green gram [*Vigna radiata* (L.) Wilczek] varieties under varied weather conditions

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DISSERTATION

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VASANTRAO NAIK MARATHWADA KRISHI VIDYAPEETH,

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2016

CANDIDATE'S DECLARATION

I, hereby declare that this dissertation

or part there of, has not been

previously submitted by

me for a degree of

any University.

Place : PARBHANI **BOBADE B.R.**
Date : / /2016 **(Reg.No.2014A/15M)**

C E R T I F I C A T E - I

This is to certify that dissertation entitled **''INFLUENCE OF DATES OF SOWING ON *KHARIF* GREEN GRAM VARIETIES UNDER VARIED WEATHER CONDITIONS"** submitted by **Shri BOBADE BALAJI RAM** to the Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani in partial fulfillment of the requirement for the degree of **MASTER OF SCIENCE (Agriculture)** in the subject of **AGRICULTURAL METEOROLOGY** is record of original and bonafide research work carried out by him under my guidance and supervision. It is of sufficiently high standard to warrant its presentation for the award of the said degree. I also certify that the dissertation or part thereof has not been previously submitted by him for a degree of any university.

Place : PARBHANI

Date : / /2016

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C E R T I F I C A T E - I I

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In race between Lion and Deer, Many times Deer wins.Because Lion runs for food and Deer for life."Purpose is more important than need".

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Place : Parbhani ***Balaji Bobade***
Date : / /2016 ***(2014A/15M)***

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ABBREVIATIONS

Tmax.	:	Maximum temperature
Tmin.	:	Minimum temperature
Temp.	:	Temperature
RH-I	:	Morning humidity
RH-II	:	Afternoon humidity
RH	:	Relative humidity
R.F.	:	Rainfall
%	:	Per cent
RD	:	Rainy Days
^{0}C	:	Degree Celsius
mm	:	Millimeter
cm	:	Centimeter
G. M	:	Geometric mean
CV	:	Coefficient of variation
SD	:	Standard deviation
hr/day	:	Hours per day
i.e.	:	That is
kg/ha	:	Kilogram per hectare
kmph	:	Kilometer per hour
MSL	:	Mean Sea Level
MW	:	Meteorological week
PAR	:	Photosyntheticaly Active Radiation
BSS	:	Bright sunshine hours
Avg.	:	Average
S	:	Significant
NS	:	Non-significant
yr^{-1}	:	Per year
GDD	:	Growing degree days
HTU	:	Helio-thermal units
PTU	:	Photo-thermal Units
ha^{-1}	:	Per hectare

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THESIS ABSTRACT

a) Title of the Thesis	:	**"INFLUENCE OF DATES OF SOWING ON *KHARIF* GREEN GRAM VARIETIES UNDER VARIED WEATER CONDITIONS"**
b) Name of student	:	BOBADE BALAJI RAM
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		(Bobade B.R.)
i) Name and address of Major Advisor		Dr. B.V. Asewar **Professor & Office Incharge,** Dept. of Agricultural Meteorology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani-431 402 (M.S.)
j) Signature Name and address of forwarding authority	:	Prof. B. V. Asewar Head, Dept. of Agricultural Meteorology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani-431 402 (M.S.)

DEPARTMENT OF AGRICULTURAL METEOROLOGY
VASANTRAO NAIK MARATHWADA KRISHI VIDYAPEETH, PARBHANI

Student Name : Mr. Bobade B.R. **Reg. No.** : 2014A/15M

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ABSTRACT

An experiment was conducted at experimental farm of Department of Agril. Meteorology, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, during *Kharif* season 2015 entitled "Influence of dates of sowing on *kharif* green gram [*Vigna radiate* (L.) Wilczek] varieties under varied weather conditions" to find out most suitable week for sowing of green gram in *kharif* season, to study the relationship between meteorological parameters and different dates of sowing affects on yield of green gram. The experiment was conducted in Spilt plot design with three replications. Treatments comprised of three sowing dates in main plot D_1(25^{th} MW), D_2 (26^{th} MW), D_3 (27^{th}) with four varieties in sub plot viz. BM-4, BPMR-145, BM-2003-2 and BM-2002-1.The experiment was sown with spacing 30×10 cm. Gross and net plot size viz.4.5 m x 4.0 m and 3.9 m x 3.6 m respectively. The sowing was done by dibbling method on respective dates of sowing. The results obtained from the experiment revealed that all the biometric observations (plant height, number of functional leaves ,dry matter, number of pods) in *kharif* green gram were significantly highest in first date 25^{th} MW (21 to 27 June) followed by second sowing date 26^{th} (28 June to 04 July) and third sowing date 27^{th} (05 to 11 July). The green gram variety BM-2003-2 was found to be highly productive as compared to BPMR-145, BM-4 and BM-2002-1. The correlation study was carried out between weather variables prevailed during (P_1) to (P_5) growth stages of different varieties under different sowing dates. The correlation coefficient showing degree of association between seed yield and weather variables prevailed during

phenophages of green gram crop. Rainfall and rainy days were found significantly negative correlated at P_2 (-0.663*) and P_3 (-0.665*), (-0.661*) respectively.

T_{max} and T_{min} were found significantly positive correlation at P_2 (0.698*), P_3 (0.624*) while T_{max} were found significantly negative correlation at P_4 (-0.727*) and T_{min} at P_1 (-0.605*). RH-I was found significantly positive correlation at P_4 (0.685*) and found significantly negative correlated at P_2 (-0.712*), P_3 (-0.692*), and (-0.685*). RH-II was found significantly negatively correlated at P_2 (-0.762*). Evaporation was found significantly negatively correlated at P_1 (-0.691*) and at P_4 (-0.743**) while it found significantly positive correlation at P_2 (0.663*) and at P_3 (0.769**). BSS was found significantly negatively correlated at P_3 (-0.035*) and at P_4 (-0.738**) while it found significantly positive correlation at P_5 (0.676*) Wind velocity was found significantly positive correlation at P_3 (0.640*) and at P_4 (0.698*).

Chapter –I

INTRODUCTION

India is the largest producer of pulses accounting by 22 percent of the world production. However, availability of pulses per capita in country is much lesser (55-56 gm) than recommendations of WHO (125 gm/capita) and thereby around 80 million children of the country are still protein energy under nourished.

Green gram locally called as moong or mung [*Vigna radiata* (L.) Wilczek] belong to the family Leguminoceae, it fixes atmospheric nitrogen and improves soil fertility by adding 20-25 kg N ha^{-1}. The green gram foliage left over after picking of mature pods can either be feed to livestock or it may ploughed as green to manure enrich the soil with organic matter. Mung bean is a short duration crop so it can be grown as catch crop. Due to covering of stand with foliage it is also grown as cover crop, as it checks the erosion by smothering the soil.

Mung bean has originated in India and is a native of India and central Asia. It is grown in these areas since prehistoric period. Mung bean is grown throughout Southern Asia including India, Pakistan, Bangladesh, Srilanka, China etc. In India green gram is mostly grown in Andhra Pradesh, Maharashtra, Orissa, Rajasthan, Gujarat, Madhya pradesh, Punjab and Uttar Pradesh etc.

Green gram [*Vigna radiata* (L.)] is a good source of high quality protein. It contains protein (25%), fats (1.5%), minerals (3.5%), fibre (4.1%) and carbohydrates (56.7%), with high quality of lysine (460mg/g) N and Tryptophan (60mg/g N). It also has remakable quality of Ascorbic acid when sprouted and also bear riboflavin (0.2 mg/100gm). It also contains minerals (3.54%), ca (0.12%) and 334 Kcal of energy from 100 gm of seed.

Among pulses, Green gram is the third most important pulse crop in India. Important green gram growing states in India are Orissa, Andhra Pradesh, Maharastra, Karnataka and Bihar. In The area in Maharashtra is 4.30 lakh ha with production of 2.004 lakh tonnes and productivity of 465.29 Kg ha^{-1} during 2013-14 in Aurangabad region i.e. Aurangabad, Jalna, Beed district is 27500 ha with production of 17700 tonnes and productivity of 642 Kg/ha. during 2013-14. (www.indianstat.com)

Mungbean [*Vigna radiata* (L.) Wilczek] is an important pulse crop of *kharif* season in India. The crop is highly sensitive to environment. Time of sowing is a non-monetery input which influences seed yield extent. (Singh and Sekhon 2003). The optimum time of sowing ensures the complete harmony between the vegetative and reproductive phases on one hand, and the climatic rhythm on the other and helps in realizing the potential yield. (Singh and Dhingra 1993). Therefore time of sowing show remarkable influence on the growth and productivity of Mungbean in *kharif* due to rainy season. (Brar *et al*.1988). Temperature is the prime weather variable which affects plant life. Heat unit concept is the agronomic application of temperature effect on plant, which has been employed to correlate phonological development in crops and to predict maturity dates. (Nuttonson 1955). Crop phenology is an essential component of the crop-weather models, which can be used to specify the most appropriate rate and time of specific plant growth and development process.

The different phases of this crop are subjected to the variation in wind speed throughout its lifecycle. Agronomically, the optimum date of sowing for this crop has been demarcated (Rahman *et al*., 2009, Bhowmick *et al.*, 2006). However, the impact of weather parameter on this important crop is not well studied. As the crop has to pass its lifecycle within a particular atmospheric specification, it is important to study the impact of weather parameter on the crop to demarcate its growing season properly.

Too early sowing may result in poor germination and poor plant stands, while yield from very late sown crop may be low due to unfavorable agro-climatic condition for the growth and development of mungbean (Sadeghipour, 2008).

Optimum dates of sowing vary from variety to variety and season to season due to variation in agro-climatic conditions. Therefore there must be a specific date of sowing for different varieties to obtain maximum yield (Reddy, 2009).

Among the various agronomic practices, planting time is the most important factor influencing the yield of mungbean (Malik *et al.* 2003). Optimum planting time of mungbean may vary from one variety to another and also from one region to another due to variation of agro-ecological conditions (Sarkar *et al.* 2004).

The weather parameters play an important role in deciding the success or failure of the crop, because they strongly influence the physiological expression and genetic potential of the crop. It is well known that yield from any given crop or variety depends on the availability of certain optimum rainfall, solar radiation, temperature, soil moisture, heat units etc. during different stages of crop growth.

The optimum time is mainly dependent on prevailing agro-climatic conditions of an area besides the variety grown. Planting during the optimum period, therefore ensures better harmony between the plant and weather which ultimately results in higher crop yields (Venkateswarulu and Soundara Rajan 1991).

Plants require a specific amount of heat to develop from one point in their life cycle to another, such as from emergence to tri-foliate leaf stage. Research has shown that measuring the heat accumulated over time provides a more accurate physiological estimate than counting calendar days. Temperature and Growing degree days (GDD) represents two important spatially-dynamic climatic variables, as both play vital roles in influencing forest development (Borque *et al*., 2000) by directly affecting plant functions such as evapo-transpiration, photosynthesis, plant respiration, plant water and nutrient movement. Crop growth refers to an increase in crop weight, height, volume or area over a certain time scale. Development refers to the timing or progress of the crop from one phasic stage to the next. During this progress of the crop through its phases of development, considerable variations in growth may occur. Growing degree days are based on the concept that the real time to attain a phenological stage is linearly related to temperature in the range between base temperature and optimum temperature (Monteith, 1981).

Kharif green gram is most traditionally practiced in Marathwada region because of high yield as compared to *summer* green gram and that is due to suitable varieties and other agronomic practices.

In view of above, an experiment entitled, **"Influence of dates of sowing on *kharif* green gram [*Vigna radiata* (L.) Wilczek] varieties under varied weather conditions"** is planned with the following objectives.

Objectives:

1) To study the effect of dates of sowing on green gram varieties.
2) To work out the correlation between yield of green gram and weather parameters.

Chapter –II

REVIEW OF LITERATURE

A brief review of relevant and recent research work related to the research topic entitled **"Influence of dates of sowing on *kharif* green gram [*Vigna radiata* (L.) Wilczek] varieties under varied weather conditions"** has been done and presented in this chapter. This available literature pertaining to the aspect under investigation is received under following heads.

1) To study the effect of dates of sowing on growth and yield of green gram.

Chandra *et al.* (1974) suggested that the proper time of sowing of mung bean was during the first fortnight of July or at latest by 20th July in *kharif.*

Singh and malvia (1981) conducted a field experiment on mung bean during *kharif* season in 1980 at Pantnagar and reported that narrow spacing (30 cm x 10 cm) leads to less availability of solar radiation and more vertical growth, number of branches and leaves plant^{-1} which prone to lodging.

Faroda *et al.* (1983) reported that the higher seed yield with 15th and 30th March sowing date was the result of more number of pods/plant than the 15th, 30th April and 15th May sowings. They further reported that increase in thousand seed weight was due to March sowing.

Krishnamoorthy *et al.* (1984) observed that number of pods/plant was increased with early sowing (January 21) than the February 5 and February 20 sowings. The thousand seed weight was also reduced due to delayed sowing.

Raskar (1984) conducted a field experiment on green gram during 1982 at Rahuri (M.S) and found that though dry matter per plant was not influenced significantly with different densities the dry matter plant^{-1} was the highest under low density (3.33 lakh plants ha^{-1}) with 30×10 cm^2 spacing.

Saharia (1985) conducted experiment at Nagan (Assam) during *kharif* to study the response of green gram to sowing dates under rainfed conditions and found that growth and ancillary characters were affected significantly by different sowing dates. Plants were taller in 16^{th} August sowing which might be due to the favourable weather conditions.

Shrivastava and Verma (1986) field investigations were conducted during *kharif* season to study the effect of sowing dates on the grain yield of black gram and found that sowing on 5 July recorded maximum plant height, branches/plant, pods/plant and test weight. Plant height was more in 20 June sowing than 20 July sown crop.

Nagre (1986) conducted field experiment at PDKV, Akola to study the effect of sowing dates and fertilizers on the seed yield of black gram and indicated that the yields of black gram sown in 26^{th} and 27^{th} MW were at par and significantly superior over the yields of crop sown in 28^{th} MW. Suitable sowing time for black gram is between 26^{th} and 27^{th} MW (last week of June to first week of July).

Saibabu and Garg (1988) carried out a field trial on summer green gram at Varanasi (UP) in 1978 and reported that row spacing of 15 cm produced higher total dry matter as compared to other three row spacing i.e. 30, 45 and 60 cm

Sharma *et al.* (1989) conducted at Gwalior during *kharif* season to study the response of green gram to sowing dates under rainfed conditions and revealed that the highest seed yield was recorded with early date of sowing (13 July) and there was significant reduction in seed yield in successive dates. The increase in seed yield was due to higher number of primary and secondary branches/plant, number of pods/plant, number of seeds/pod, seed weight/plant and 1000 grain weight in early sowing.

Choudhary *et al.* (1989) the experiment conducted at Pantnagar during *kharif* season on productivity of urdbean varieties as influenced by planting dates and revealed that the date fo planting brought about significant variation in seed and stover yield of urdbean where in highest seed and stover yield of 12.0 and 38.12 q/ha, respectively was recorded in the crop planted on 6 July.

Nag *et al*. (1989) an experiment was conducted to study the influence of planting time on the productivity of black gram and observed that the proportionate of total dry matter accumulated in pods was lower during May, June and July plantings. At these plantings vegetative organ accumulated about 27 to 30% of the total dry matter (70.63%) was accumulated in pods which influenced the higher seed yield of black gram.

Dhoble *et al.* (1990) conducted field experiment at Parbhani to assess the performance of green gram crop under varying dates of planting under rainfed conditions. Results revealed that sowing of different *kharif* crops on 15th June (24th MW) and immediately after receipt of monsoon rains (25th and 26th MW) proved most advantageous in respect of productivity and monetary returns.

Reddy *et al.* (1991) reported that the sowing upto mid July was found ideal time for urdbean during *kharif* season under rainfed condition at Warangal (A.P.). Drastic reduction in seed yield was observed if the sowing was delayed beyond July 15 decreases plant height, number of pods/plant and number of seeds/pod resulting in reduced yield.

Sukhadia and Dhoble (1992) conducted at Parbhani during *kharif* season to find out the influence of date of sowing on productivity of rainy-season crops and concluded that sowing of 15th June, immediately after receipt of monsoon, and 15 days after onset of monsoon recorded significantly higher yields.

Choudhary *et al.* (1994) a field experiment was conducted during *kharif* to study the effect of planting dates on growth behavior of urdbean varieties and observed that maximum height, number of branches, spread as well as dry matter accumulation per plant were recorded in early (6^{th} July) planted crop. It produced 23, 140 and 203 per cent taller plants; 25, 59 and 100 per cent more number of branches.

Singh and Singh (2000) an experiment was conducted at Pantnagar (U.P.) during rainy season to determine suitable sowing dates for promising urdbean genotypes and observed that the 24 July sowing date recorded significantly higher number of trifoliate leaves and more accumulation of total dry matter per plant and its partitioning to stem, leaf and reproduction parts than that of 29 August at all stages of growth.

Nisar and Khan (2003) conducted by to study the response of mungbean genotypes to different dates of sowing in *kharif* season under rainfed condition and concluded that the first week of July was to be ideal time of sowing for mungbean and delay in sowing caused substantial decrease in all the growth and development parameters and recorded maximum plant height 79 cm of crop sown on 5^{th} July.

Antony *et al.* (2003) find that effect of sowing date and chemical spray on phenology, heat use efficiency (HUE) and radiation use efficiency (RUE) in green gram cv. K-56. Green gram took 58 and 55 days and 68 and 60 days to attain physiological maturity during 1999 and 2000, respectively. As the sowing date was delayed, the growth occurred under higher temperatures with reduction in phenophase duration.

Malik *et al.* (2003) determine the effect of sowing dates and planting pattern on growth and yield of mung bean (M-6). The maximum height and leaf area per plant was recorded when sowing of green gram crop in third week of June.

Sarkar *et al.* (2004) also reported that number of seeds per pod affected by sowing date. Effect of sowing dates on 1000-seeds weight was significant. June 29 sowing, gave highest 1000-seeds weight (54.74 g) while June 14 sowing, gave lowest 1000-seeds weight (50.45 g). This results are supported by Heatherly (1988) who reported that average seed weight from irrigated late planting of soybean was greater than irrigated early planting. The data showed that sowing dates had significant effect on seed yield.

Rana *et al.* (2006) conducted field experiment to study effect of sowing dates and planting pattern on growth and yield of mungbean and the results revealed that higher number of pods per plant, number of grains per pod, 1000 grain weight and harvest index were produced by 3rd week of July sowing and maximum seed yield (1259.26 kg/ha) was also produced by 3rd week of July

Fraz *et al***.** (2006) revealed that higher number of pods per plant, number of seeds per pod, 1000-seed weight and harvest index were produced by 3rd week of July and similarly maximum biological and grain yield (4530.86, 1259.26 kg ha-1) was produced by 3rd week of July and in case of planting pattern maximum biological and grain yield (4302.47, 1117.28 kg ha-1, respectively) was produced by 20 cm apart 40 cm wide beds.

Owla *et al.* (2007) conducted a field experiment on green gram at Parbhani, Maharashtra and concluded that the inter row spacing of 45 cm recorded significantly higher dry matter per plant than 30 cm and the intra row spacing 15 cm recorded significantly higher dry matter accumulation.

Sadeghipour (2008) results of green gram combined analysis showed that seed yield was significantly affected by sowing dates. The maximum seed yield (102.9 g m- 2) was obtained in June 29 sowing date because the number of pods per plant and 1000-seeds weight were also increased. Varieties also responded significantly towards yield and yield components. The maximum seed yield (114.9 g m- 2) was produced by vc4152 variety. Interaction effects of sowing dates and varieties were found significant, vc4152 variety sowing on June 29 gave the highest seed yield (134.7 g m- 2).

Rehman *et al*. (2009) concluded from the experiment that mungbean could be planted from 1st to 15th April under agroclimatic conditions of Peshawar for obtaining maximum yield.

Singh *et al.* (2010) conducted to study the effect of sowing date on nodulation, growth, thermal requirement and grain yield of *kharif* mungbean genotypes and observed that the maximum plant height, branches/plant was recorded in July 5 and July 15 sowing maximum number of nodules and their dry weight/plant were highest in the case of July 15 while minimum number of nodules and their dry weight were recorded in case of August 5 sowing.

Bhise *et al.* (2010) studied 4 cultivars of green gram in summer (MS) and reported that BM-4 cultivar gave higher seed yield plant^{-1} more pods and seeds on the main stem and the highest yield (737 Kg ha^{-1}) as compared to other cultivars.

Rathore *et al*. (2010) conducted field experiment at Udaipur (Rajasthan) to study the effect of sowing time on productivity and economics of urdbean genotypes and found that urdbean varieties sown at onset of monsoon (7th July) recorded maximum seed yield (1185 kg/ha) when compared to crop sown on 27th July (20 days after first sowing).

Monem *et al*. (2012) results of analysis of variance for row orientation showed significant effects on seed yield, biomass, leaf wet weight, harvest index and fruit wet weight. Seed yield in east- west row orientation was 455 g/m2 while this factor in another orientation method was 379 g/m2 and it represented more than 16% yield loss on this condition. Effect of planting date on many of traits had significant effects which include seed yield, biomass, harvest index, and the number of seed per pod. The first planting date (5th May) with 479 g/m2 had the highest seed yield.

Singh *et al*. (2013) a field experiment was conducted in a split plot design and replicated four times. Five varieties of mung bean *viz,* Pusa 105, Ganga-1, ML682, PMB-14 and Pant mung 4 were sown normal and late. Among the varieties, PMB 14 ranked first in terms of grain yield (549 kg ha^{-1}) should be sown at normal time (1^{st} week of August).

2) To work out the correlation between green gram yield and weather parameters

Srivastava and verma (1986) conducted field experiment at Ranchi (Jharkhand) during *kharif* season to study the effect of dates of sowing on the seed yield of black gram and recorded, as the sowing was delayed beyond July, the crop got too much of moisture in the early phase and low temperature together with low moisture supply at the time of lowering and pod setting.

Rajput *et al.* (1987) reported that the term most often used to quantify temperature, effects on phenological development has been the degree day or heat unit.

Lawn (1989) reported that the photoperiod influences the rate of development in pre and post flowering stages. Change in photo period and temperature are reported to alter the happening of growth stages, the growth and partitioning of dry matter of this photoperiod and thermo sensitive short day C_3 plant.

Sharma and Sonakiya (1990) found that different genotype of chickpea required growing degree days 1.53^{0}C for pod initiation and genotypes showed significant variability in pod for phenological stages. In general high yielding variety had low GDD requirement from sowing to 50% flowering and end of flowering. Accumulated GDD requirements of high yielding genotypes were high for flowering duration and total reproductive stages. Heliothermal unit requirements (HTU) of the cultivars were similar to GDD requirements for phenological stages.

Venkateswarulu and soundara Rajan (1991) conducted field experiment to find out the effect of season and time of sowing on growth and yield attributes of black gram and the results indicated that moderately high temperatures and lesser relative humidities and more number of sunshine hours during the vegetative and reproductive phases appeared factors responsible for high seed yield of black gram.

Goyal *et al.* (1998) reported that the canopy temperature is one of the most reliable indicators of the crop water stress due to its direct relation with the plant water status. The final yield of any crop is a continuous interaction of genotypic variables and environmental factors to which crop is exposed. Supra optimal temperature >35 degrees and reduced water availability during pre monsoon summer period restricts the growth, and studies on many crops shown an inverse relation with mid day temperature and soil moisture availability.

Calvin and Sardas (1999) reported that in soybean higher relative humidity helped the plant to keep the stomata opened for longer period that might have resulted in higher photosynthesis and more dry matter production.

Ajay et *al*. (2000) observed that the relationship between evapotanspiration (ET) temperature and biomass production, experiments were conducted in monsoon seasons. Biomass production of soybean in relation to cumulative ET and accumulated heat units has been evaluated.

Bhardwaj and Thakur (2000) reported that the relationship of interaction effect of flowering with maximum temperature was negative and significant indicating that a rise in temperature would result in a decrease in yield. Maximum relative humidity of 90.7% and rain frequency of 2.95 days/week had a significant positive correlation. Reduced rainfall and its frequency at post-flowering seemed to contribute to low yield of black gram with delayed sowing.

Cutforth (2000) reported that the atmospheric temperatures are expected to increase in the future due to potential climatic change. This may increase the frequency of temperature stress for annual crops. Heavier rainfall seasons show reduced yields due to disease out breaks and stem lodging problems from excessive vegetative growth.

Dubey and Singh (2006) correlation were established between green gram crop and weather parameters and disease development. Temperature was positively whereas relative humidity and sunshine hours were negatively correlated with disease development in field. Depending on the amount of rainfall, its correlation different from positive to negative in different years.

Yadahali and Palled (2004) conducted field experiment to study the response of black gram genotypes to dates of sowing and observed that the early sown crop (16^{th} June) got adequate soil moisture particularly during its flowering and pod filling stages in August and September months as a result of higher rainfall (58.1 mm and 53.6 mm respectively).

Gul *et al.* (2008) studied the correlation among different yield contributing traits of mungbean, at Agricultural Research Farm of the NWFP Agricultural University, Peshawar, during the growing season 2004. Correlation was worked out among plant height, days to flowering, days to maturity, total dry weight plot^{-1}, yield plant^{-1}, 1000-grain weight, harvest index and yield ha^{-1}. Significant differences were observed among different populations for all the parameters. Correlation analysis revealed that earliness had negative correlation with plant height and dry weight per plot while 100-seed weight and harvest index were recorded to be positively correlated. Dry weight per plot was found to have positive correlation with days to maturity, seeds pod^{-1} and plant height while negatively correlated with yield per hectare and harvest index. 100-grain weight showed positive correlation with pods plant^{-1} and harvest index while it had negative correlation with days to maturity, seeds pods^{-1} and plant height. Seed yield plot^{-1} was found to be non-significantly correlated with 100-grain weight. Harvest index had significant positive correlation with seed yield plant^{-1} while it had significant negative correlation with days to maturity, seed pod^{-1}, plant height and dry weight per plot.

Nagdeve *et al.* (2009) reported that weather parameters strongly influence the crop performance of green gram. It is therefore useful to identify such parameters and quantify their contribution besides developing relations with growth and yield of the crop.

Raj Singh *et al.* (2010) reported that the yield attributes like pods per plant, number of seeds per pod and 100- seed weight decreased with subsequent delay in sowing from 7th June on wards during both the seasons. Seed yield, straw yield and biological yield were highest in 7th June sowing as compared to late sown soybean crop.

Singh *et al*. (2010) studied the thermal requirement of mungbean genotypes and found that due to occurrence of higher maximum and minimum temperature that probably accelerated the process of development and as a result duration of 50% flowering as well as physiological maturity was shortened by 2-3 days in case of first sowing. So early sowing resulted in absorbing sufficient amount of heat units in short time due to high temperature but late sowings (July 25 and August 5) acquired more days to mature.

Raikwar *et al*. (2011) conducted field experiment to study the performance of improved production technology of urdbean in Bundelkhand Region of Madhya Pradesh and observed that the urdbean crop received 213.8 mm rains at maturity stage during first week of October. This caused seed sprouting in the pod itself in standing crop condition which lowered the productivity.

Singh *et al.* (2011) Field experiment was carried out at PAU, Ludhiana during *kharif* to study the effect of time of planting on nodulation, growth and yield of urdbean genotypes and results revealed that planting urdbean during July 15-25 was found optimum planting time accumulated growing degree days (GDD) and accumulated photo thermal units (PTU) for 50% flowering as well as maturity were highest in July 5 planted crop and decreased further with delayed planting

Kulkarni and Benagf (2012) revealed that the green gram sown on 4 June recorded significantly less disease severity, which was enhanced in subsequent sowing dates because the weather conditions were very much congenial that is moderate temperature coupled with higher humidity. Correlation of weather parameters indicated that maximum and minimum temperatures had significantly negative correlation with disease. However, correlation coefficient with relative humidity and rainfall were positive but non-significant.

Srivastava and Prajapati (2012) revealed that correlation coefficients were found to be 0.82 for maximum temperature, -0.83 for mean relative humidity and -0.56 for rainfall. The preceding week weather conditions and white fly population as well as highest disease incidence week's rainfall act as determinant for MYMV outbreak. A regression model was developed utilizing these three variables and it was found that the model explained 65 per cent variability of the MYVY outbreak. MYMV outbreak may be estimated through minimum temperature and white fly population of the 34-37th SMW and rainfall of 37-39th SMW. The present analysis enables scientists to devise a system to monitor and develop management strategies for the control of MYMV disease and white fly vector.

Singh *et al.* (2012) revealed that soil temperature was slightly higher in the crop grown in NS direction as compared to the E-W sown crop. However, heat use efficiency was at par in the canopy of both row direction of sowing/the crop sown in the last week of July exhibited 4 % more PAR as compared to the crop sown in first week of August. Radiation interception was 10 per cent more in the crop sown in N-S direction as compared to E-W sown crop. The yield and yield attribute were found in the higher proportion in end July sown crop with 45 cm spacing in NS direction.

Ransing *et al.* (2014) concluded that the early sowing of *kharif* green gram i.e. (20 July) at Raipur, resulted in absorbing sufficient amount of heat units in less time as compared to late sowing i.e. (9 Aug.) which acquired more days to mature and resulted in accumulation of more GDD as compared to early date of sowing. There was a drastic reduction in yield in case of August 9 sowing compared to July 20 sowing date.

Yadav and Pandey (2014) studied correlation analysis between the relative progress of anthracnose depicted positive correlation with rainfall, wind speed, minimum temperature, vapour pressure and relative humidity of mungbean varieties. Bright sun shine hours and maximum temperature were found negatively correlated with the relative progress of the disease.

Chapter III

MATERIAL AND METHODS

The details of the material used and methods adopted during the course of present investigation are presented in this chapter under appropriate heads.

3.1 Details of experimental material

3.2 Experimental method

3.3 Biometric observations

3.4 Phenological observations

3.5 Yield attributes

3.6 Meteorological parameters

3.7 Computation of Agro meteorological indices

3.8 Correlation between green gram yield and weather parameters.

3.1 Details of experimental material

3.1.1 Experimental site

The experiment was conducted on experimental farm, Department of Agricultural Meteorology, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *kharif* 2015.

3.1.2 Climate condition

Geographically Parbhani is situated at the19^{0}16' North latitude and 76^{0}47' East longitude and at an altitude of 409 meter above mean sea level (MSL) in Marathwada division encompassed boundaries. Parbhani comes under subtropical climate zone. The precipitation is assured for *kharif* season and for sowing of *rabi* crop. Most of the rainfall received from south west monsoon. Climate of Parbhani is characterized by hot and dry summer and cold winter Agro-climatologically major part comes under assured rainfall zone and small part comes under scarcity zone.

3.1.3 Soil type

The topography of the field is uniform and leveled the soil is well drained and depth of the soil varied from 2 to 3 meter.

3.1.4 Cultural practices

The field was deeply ploughed to bring the soil to fine condition. The seed of all 4 varieties were dibbled with row to row and plant to plant spacing of 30 cm x 10 cm with 3 different sowing date. The recommended fertilizer dose was applied at the time of sowing. All recommended culture and agronomical practices were carried out to raise good crop as suggested by Krishi Dainandini (2014) published by Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.

Details of cultural operations performed in the experimental plot during the *kharif* 2015 season are given in table 3.1.

Table 3.1 Schedule of field operation followed in the experimental plot during *kharif* 2015.

Sr. No	Name of operation	Frequency	Date of operation
A]	**Pre sowing operation**		
1	Ploughing	1	25/05/2015
2	Harrowing	1	30/05/2015
3	Weed and stubble collection	1	01/06/2015
4	Layout	1	18/06/2015
B]	**Sowing**		
1.	Sowing	1	D_1: 23/06/2015, D_2: 30/06/2015 D_3 :07/07/2015.
C]	**Intercultural operation**		
1	Gap filling	1	D_1 : 04/07/2015, D_2: 10/07/2015 D_3 : 17/07/2015,
2	Thinning	1	D_1 : 06/07/2015, D_2 : 12/07/2015 D_3 : 19/07/2015,
3	Weeding	2	D_1 : 15/07/2015, 03/08/2015 & 1/07/2015 D_2 : 18/07/2015, 08/08/2015 & 26/08/2015, D_3 : 26/08/2015, 10/09/2015 & 18/09/2015.
D]	**Plant protection measures**		
1	Spraying of Quinalphos	2	D_1 : 22/07/2015 & 15/08/2015 D_2: 30/07/2015 & 26/08/2015 D_3 : 08/08/2015 & 01/ 09/ 2015
E]	Harvesting	1	D_1: 02/09/2015, D_2 : 12/09/2015 D_3 : 23/09/2015.

3.1.2 Cropping history of the experimentation field

The relevant information in the cropping history of the experimental field for the preceding three years is given in table 3.2.

Table 3.2 Cropping history of the experimental field.

Sr. No	Year	Season		
		Kharif	***Rabi***	**Summer**
1	2012-2013	Soybean	Gram	Fallow
2	2013-2014	Fallow	Sorghum	Fallow
3	2014-2015	Soybean	Fallow	Fallow
4	2015-2016	Present investigation	----	----

3.1.3 Seed

The seed of variety BM-4, BM-2002-1, BM-2003-2 and BPMR-145 are collected from is the Seed Processing Unit of the Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani.

3.2 Experimental Methods

3.2.1 Experimental details

Design and Treatment

The present experiment was laid out in Split Plot Design with 3 replications and 3 sowing dates with 4 varieties. Treatment details are given below.

3.2.1.1 Treatment details

A) Main plot treatment (Sowing dates)

1. D_1 - 25th MW (23 June, 2015)
2. D_2 - 26th MW (30 June, 2015)
3. D_3 - 27th MW (07 July, 2015)

Where,

D_1, D_2, D_3 - Sowing dates

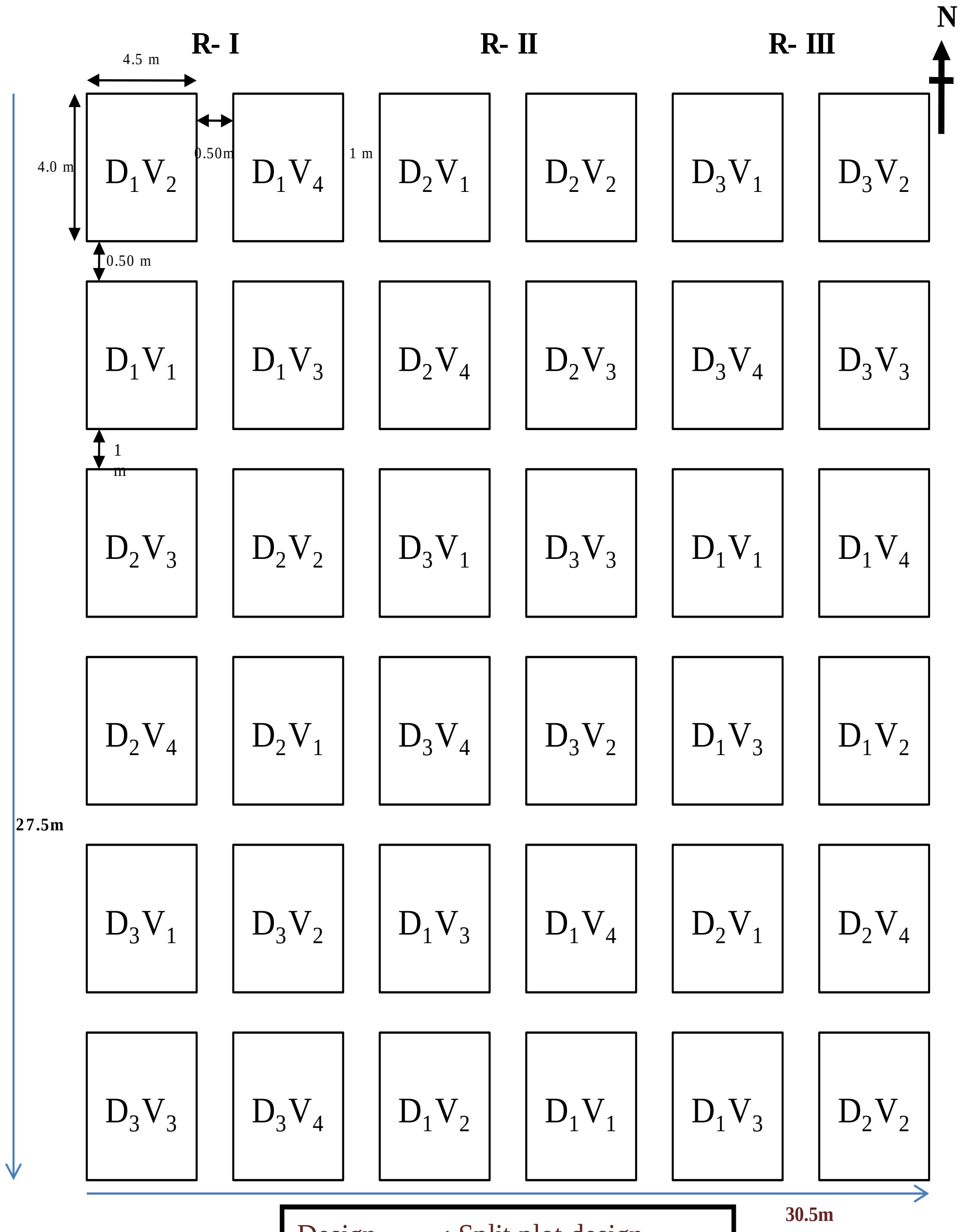
MW - Meteorological week

B) Sub plot treatments (Varieties)

1. V_1 - BM-4
2. V_2 - BM-2002-1
3. V_3 - BM-2003-2
4. V_4 - BPMR-145

Other details of layout

1. Name of Crop : *Kharif* Green gram
2. Design : Split plot Design
3. Number of Replication : Three
4. Treatments : Twelve
5. Plot Size
   Gross : 4.5 m x 4.0 m
   Net : 3.9 m x 3.6 m
6. Total number of plots : 36
7. Spacing Row to Row : 30 cm
   Plant to plant : 10 cm



Design : Split plot design
Replication : Three
Treatment : Twelve
Plot Size : Gross: 4.5 m x 4.0 m
Net : 3.9 m x 3.6 m

Fig. 3.1 Plan of Layout

Plate 1 - General view of plot at initial growth stage

Plate 2 - General view of experimental plot

3.3 Biometric Observations

Five plants were randomly selected from each plot for biometric observations. These plants were tagged and weekly observations were recorded on these plants following observations were recorded.

3.3.1 Plant stand

Emergence count and final plant count. Emergence counts were taken up 08-10 days after sowing where in all emerged plants were counted.

The final plant stand from each net plot was also recorded at harvest.

3.3.2 Plant height (cm)

The height of plant was measured from the base (ground level) to the top in centimeter at different stages of growth. The first observation was recorded on 20th day after sowing (DAS) and there after height was recorded at 20 days interval up to harvest.

3.3.3 Number of functional leaves per plant

The number of functional leaves on observations plants from each net plot was recorded. The observation was recorded at 20 days interval starting from 20 DAS.

Table 3.3 Details of biometric and other observations recorded during present investigation.

Sr. No.	Particulars	Frequency	DAS	Sampling unit
A	**Pre-harvest studies**			
1	Emergence count	1	8 DAS	Net plot
2	Final plant stand	1	At harvest	Net plot
3	Height of plant (cm)	4	20,40,60 and at harvest	Five plants net plot^{-1}
4	Number of leaves plant^{-1}	4	20,40,60 and at harvest	Five plants net plot^{-1}
5	Dry matter plant^{-1}	4	20,40,60 and at harvest	Five plants net plot^{-1}
6	Number of pods plant^{-1}	2	60 DAS and at harvest	Five plant net plot^{-1}
B	**Post harvest studies**			
1	Pod yield plant^{-1} (g)	1	At harvest	Five plants plot^{-1}
2	Seed yield plot^{-1}(kg)	1	At harvest	Five plants plot^{-1}
3	Straw yield plot^{-1} (kg)	1	At harvest	Five plants plot^{-1}
4	Biological yield plot $^{-1}$ (kg)	1	At harvest	Five plant net plot $^{-1}$
5	Harvest index (%)	1	At harvest	Composite sample from produce
C	**Meteorological Observations**	1) Maximum temperature (^{0}C) 2) Rainfall (mm) 3) Minimum temperature (^{0}C)) 4) Rainy days 5) Relative humidity (%) 6) Winds speed (km/hr) 7) Bright sunshine hours (hrs (days).		
D	**Statistical Analysis**	Correlation studies.		
E	**Weather Indices**	1) GDD 2) HTU 3) PTU		

3.4 Phenological parameters

3.4.1 Days required for 50 percent flowering

Number of days required form sowing to 50 per cent flowering of plant in a plot were recorded by visual observations.

3.4.2 Days required for physiological maturity

Numbers of days required from germination to physiological maturity of grain were recorded. Criteria for physiological maturity are leaves become yellow, black spot at grain tip, seed moisture level decrease and easy breaking of peduncle.

3.5 Yield attributes

The plants selected for biometric observations were used for post harvest studies. The following observations were recorded.

3.5.1 Test weight (g)

A random sample of grain was drawn from net plot yield and 1000 seeds were counted and weighted on electronic balance in gm.

3.5.2 Seed Yield ha^{-1}

Seed yield per net plot was calculated from yield per plant. Seed yield per hectare (g) was calculated by multiplying grain yield per net plot with hectare factor for statistical analysis and interpretation of data.

3.5.3 Harvest index

The harvest index was calculated as ratio of economic yield to biological yield and expressed in per cent. It was calculated by the formula given by Donald (1963).

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}} \times 100$$

3.6 Meteorological observations

1) Rainfall (mm) 2) Temperature (^{0}C) 3) Relative humidity (%) 4) Bright sunshine hours 5) Wind speed (kmhr^{-1}) 6) Rainy days are recorded at the observatory of Agriculture meteorology Department situated in V.N.M.K.V. Parbhani.

3.7 Computation of Agro meteorological indices

3.7.1 Growing degree days (^{0}C day)

Growing degree days defined as the total amount of heat required between the lower and upper thresholds, for an organism development from one point to another in its life cycle is calculated in units. GDD was expressed in terms of ^{0}C day.

The growing degree days (GDD) were worked out by considering the base temperature of 10^{0}C. The total growing degree days (GDD) for different phenophases were determined as per Nuttonson (1955).

$$\text{Accumulated GDD } (^0\text{C day}) = \sum_{ds}^{dh} [(T_{max} + T_{min})/2] - Tb$$

Where,

GDD = Growing degree days

T max = Daily maximum temperature (^{0}C)

T min = Daily minimum temperature (^{0}C)

Tb = Base temperature (10 ^{0}C) (Anonymous 1988)

ds = Date of sowing

dh = Date of harvest

3.7.2 Helio-thermal Units (HTU) (^{0}C day hrs)

The HTU may be defined as the accumulated product of GDD and Bright sun shine hours between the developmental thresholds for each day. HTU was expressed in terms of ^{0}C day hrs.

The HTU is the product of GDD and mean daily hours of bright sun shine. The sum of HTU for each phenophase was worked out by following equation which was given by Rajput (1980).

$$\text{Accumulated HTU } (^0\text{C day hrs}) = \sum_{ds}^{dh} (\bar{T} - Tb)\, D$$

Where,

HTU = Helio-Thermal Units

$\bar{T}$ = Mean daily temperature (^{0}C)

Tb = Base temperature (10^{0}C)

ds = Date of sowing

dh = Date of harvest

D = Hours of bright sun shine

3.7.3 Photo-Thermal Unit (^{0}C days day^{-1})

Photo-thermal unit was defined as the product of growing degree days and the day length. Photo-thermal unit is expressed in terms of ^{0}C days day^{-1}.

Photo-thermal unit was computed by using following formula. This was proposed by Gudadhe *et al*. (2013).

$$\text{PTU } (^0\text{C days day}^{-1}) = \text{GDD x Day length}$$

3.8 Correlation between green gram yield and weather parameters.

3.8.1 Statistical analysis and interpretations of data.

The data recorded were statistically analyzed by using computerized based on technique of analysis of variance and significance was determined as given by Panse and Sukhatme (1967). Wherever, differences were significant, C.D. Value were indicated for comparison otherwise only the values of SE ± were indicated wherever the interaction effects were significant, the relevant data were presented.

3.8.2 Correlation studies

Simple correlation between weather parameters i.e. Rainfall, Rainy days, Maximum temperature, Minimum temperature, relative humidity, Evaporation, Bright sun shine hours and wind velocity on the development of green gram was estimated to know the correlation between these weather parameters and green gram yield.

CHAPTER-IV

RESULTS AND DISCUSSION

In this chapter the data collected during the investigation have been analyzed by using appropriate statistical methods and the results are presented under the following heads.

4.1 Weather conditions during crop growth period.

4.2 Pre harvest studies

4.3 Growth studies

4.4 Post harvest studies

4.5 Agro meteorological indices

4.6 Correlation studies

4.1 Weather conditions during crop growth period.

The weather conditions prevailed during the crop growing season i.e. *Kharif* 2015 is presented graphically by plotting different Meteorological elements averaged over standard meteorological weeks. The weather elements discussed viz. rainfall and rainy days, air temperature, relative humidity, evaporation, bright sun shine hours and wind velocity. Weather conditions prevailed at Parbhani during the crop growing season and its impact on growth, development and yield of green gram crop.

Field experiment conducted at experimental Farm, Department of Agricultural Meteorology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during 2015. Plant growth is complex phenomenon, which involves both qualitative and quantitative characteristics, depending upon different weather conditions prevailed during different phenological growth stages of a crop. So to have an insight into effects on crop growth the seasonal weather was studied and discussed in this chapter.

The meteorological data for the corresponding period of experimentation recorded at Central Meteorological Observatory, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani are presented in Table 4.1 and depicted in Fig 4.1 (a) to 4.1 (c).

Table 4.1 Mean weekly weather data during experimental period *kharif* 2015 at Parbhani.

WK (MW)	Period	Rain fall (mm)	R.D.	Temperature ^{o}C		Humidity (%)		EVP	BSS (Hrs.)	W. V. (Kmph)
25	18-24 June	37.5	2.0	31.6	23.5	86	64	4.5	2.5	5.8
26	25-01 July	0.0	0.0	35.1	24.3	75	43	7.3	7.5	6.6
27	02-08 July	5.0	1.0	35.8	23.8	76	38	8.1	9.4	9.4
28	09-15 July	0.0	0.0	36.2	25.8	69	37	6.0	9.4	9.4
29	16-22 July	0.6	0.0	35.8	24.8	76	45	5.5	8.9	8.9
30	23-29 July	8.0	1.0	34.0	24.0	75	47	4.9	8.5	8.5
31	30-05 Aug	19.8	1.0	33.0	23.1	80	59	6.0	8.4	8.4
32	06-12 Aug	28.8	4.0	29.9	23.0	87	68	2.4	5.5	5.5
33	13-19 Aug	23.4	2.0	31.3	23.0	85	57	4.1	5.7	5.7
34	20-26 Aug	11.2	1.0	32.9	23.0	81	49	9.5	6.0	6.0
35	27-02 Sept	0.0	0.0	32.2	23.3	79	50	7.0	6.3	6.3
36	03-09 Sep	88.1	4.0	32.9	22.2	87	60	7.0	4.8	4.8
37	10-16 Sep	38.4	4.0	31.8	22.7	90	63	6.2	3.6	3.9
38	17-23 Sep	57.4	1.0	31.4	22.0	81	59	4.1	5.9	4.7
39	24-30 Sep	0.0	0.0	33.5	20.9	74	44	6.7	7.5	3.6
Total/Mean		318.2	21	33.2	23.3	80	52	6.0	6.7	6.5

4.1.1 Rainfall and rainy days

The data of rainfall is given in Table 4.1 and depicted in Fig 4.1 (a) it revealed that total rainfall during crop growth period (25 MW to 39 MW) received was 318.2 mm in 21 rainy days.

In the month of June from 36 MW rainfall was received 88.1 mm in 05 rainy days, which was useful to initial crop growth stage. Highest rainfall received in the month of September (183.9 mm) in 09 rainy days and lowest rainfall was received in the month of July (13.6 mm) in 2 rainy days.

Among all the treatments of sowing dates total rainfall received during whole crop growth period for third date of sowing i.e. D_3 (26^{th} MW) received highest rainfall 251.8 mm in 16 rainy day followed by second sowing (26^{th} MW) i.e. 233.4 mm in 18 rainy days, in first sowing (25^{th} MW) rainfall received 141.7 mm in 15 rainy days.

In all the treatments at P_3 stage (Bud emergence to Flower emergence) received rainfall was congenial and it was received 43.9 mm, 72.0 mm, and 84.0 mm in D_1, D_2, and D_3 sowing dates respectively.

There was long dry spell during 28 MW, 30 MW crop growth period.

4.1.2 Air temperature

Weekly weather data given in Table 4.1 and graphically presented in Fig. 4.1 (b) showed that the temperature prevailed during different phenological stages and it reported that, maximum and minimum temperature during crop growing period was ranged in between 29.9 to 36.2 ^{0}C and 20.9 to 25.8 ^{0}C respectively.

The highest maximum temperature recorded in 28 MW (36.2 ^{0}C). The average maximum temperature was recorded 33.9, 33.4, and 33.1 ^{0}C in D_1, D_2 and D_3 respectively. This revealed that there was not much variation in the range of maximum temperature.

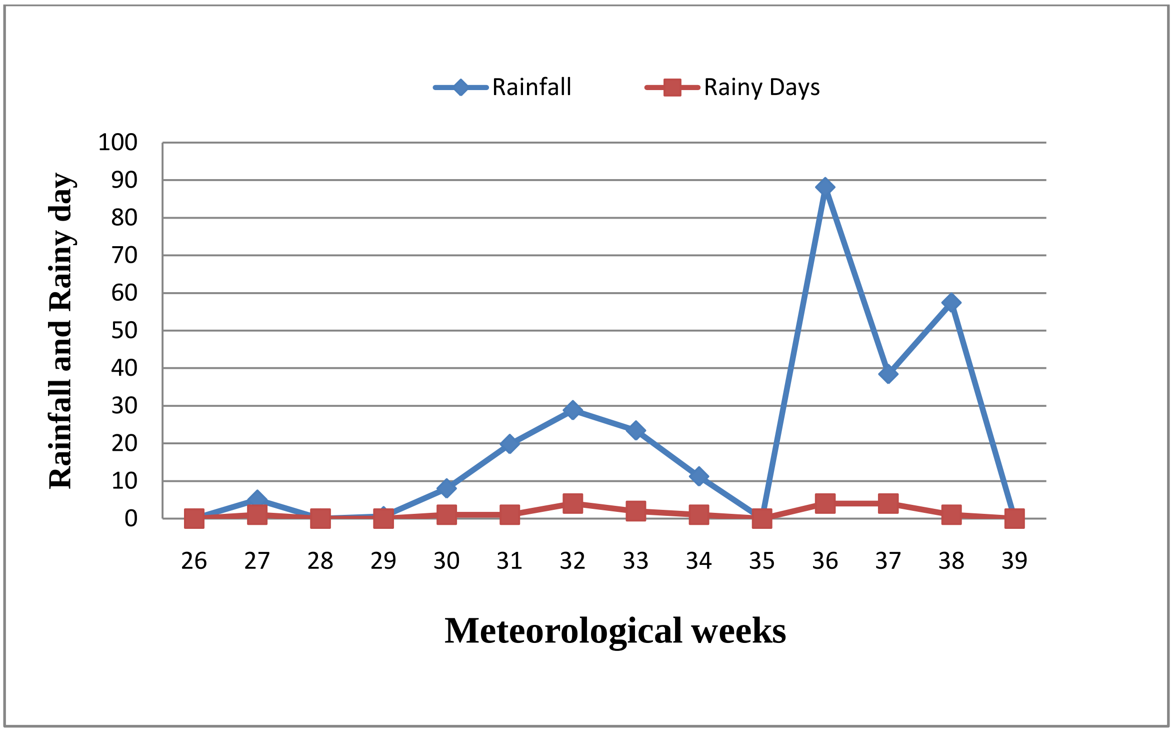


Fig. 4.1 (a) Weekly rainfall (mm) and rainy day during *kharif* season 2015.

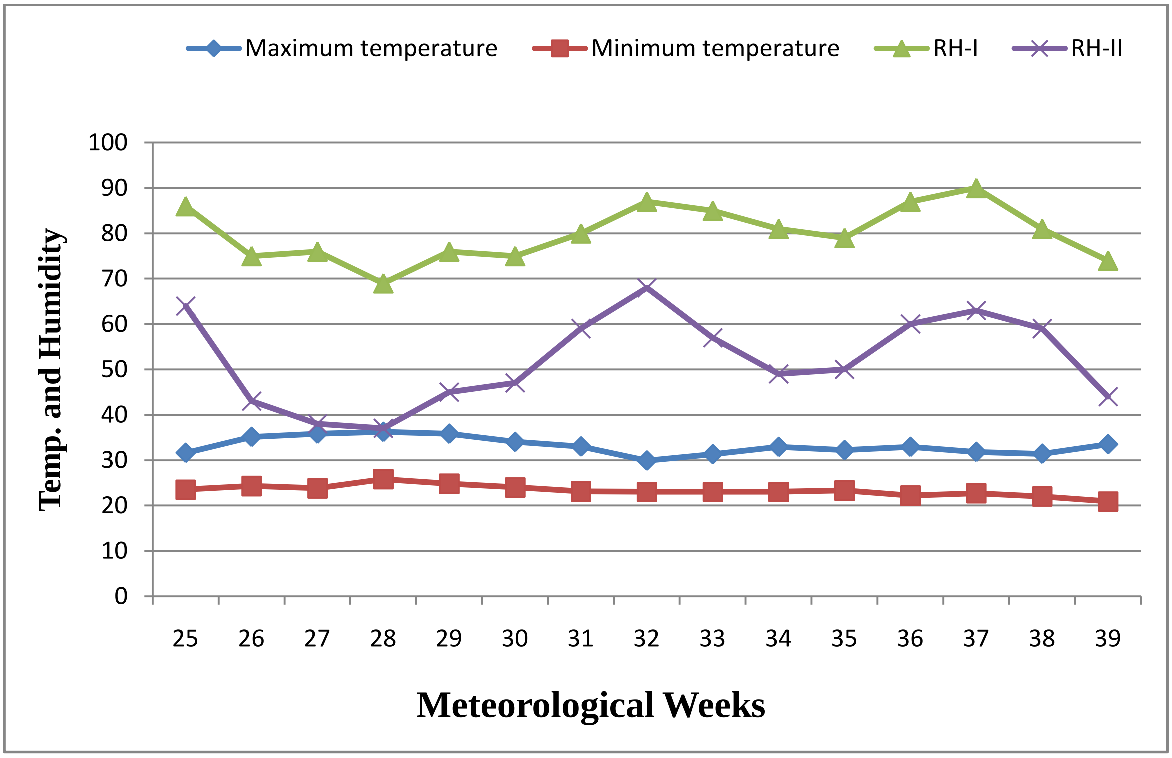


Fig. 4.1 (b) Weekly maximum temp., minimum temp. and morning and afternoon relative humidity during *kharif* season 2015.

The lowest minimum temperature was recorded in 39th MW (20.9 ^{0}C) and highest minimum temperature recorded at 28th MW (25.8 ^{0}C) during the crop growth period. There was not observed much variation in the range of minimum temperature in all the treatments.

4.1.3 Relative humidity

Weekly weather data given in Table 4.1 and graphically presented in Fig. 4.1 (b). It shows that mean relative humidity of morning (RH-I) and afternoon (RH-II) hours during the crop growing period (June to September) was 80 percent and 52 percent, respectively.

Highest morning time relative humidity (RH-I) was recorded in 37 MW (90 %) and lowest in 28 MW (37 %).

Data from Table 4 revealed that the mean morning relative humidity (RH-I) in D_1, D_2 and D_3 was recorded 77.8, 80.4 and 79.9 percent respectively. It means that there is not more variation in the range of morning relative humidity during crop growing season in all the sowing dates.

Highest afternoon relative humidity (RH-II) was recorded in 32 MW (68 %) and lowest in 28 MW (37 %). Data from Table 4 revealed that the mean afternoon relative humidity (RH-II) in D_1, D_2 and D_3 was recorded 48, 51 and 51 percent respectively. It means that there is not more variation in the range of afternoon relative humidity during crop growing season in all the sowing dates.

4.1.4 Evaporation

Data given in Table 4.1 and graphically presented in Fig. 4.1 (c). showed that the mean evaporation during crop growing season (from 25th to 39th MW) was observed 6.0 mm per day. It is observed that lowest and highest EVP 2.4 mm (32nd MW) and 9.5 mm (34th MW) respectively.

The highest values of evaporation were recorded due to maximum temperature and very less quantum of rainfall during this week while, evaporation was recorded lowest in 32nd MW (2.4 mm) because of continuous rainfall and lowest temperature during this period.

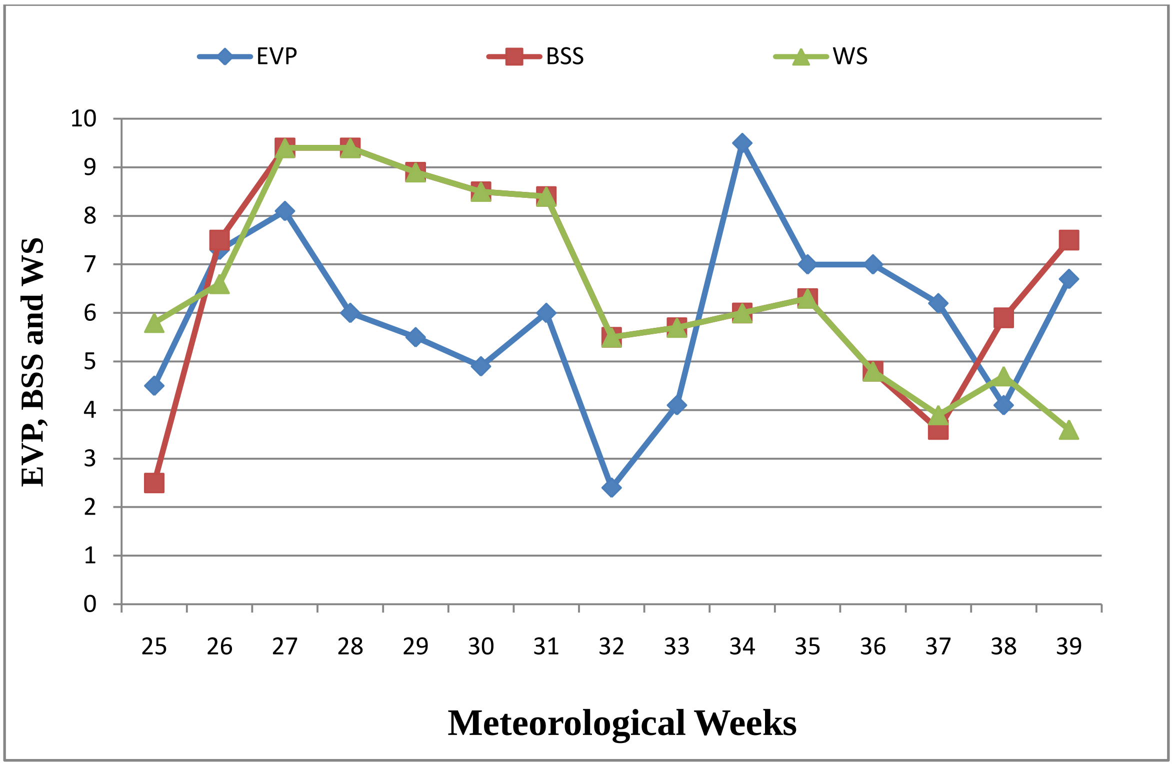


Fig. 4.1 (c) Weekly evaporation, bright sun shine hours and wind speed during *kharif* season 2015.

Data from Table 04 revealed that the mean evaporation during whole crop growth stage in D_1, D_2 and D_3 was recorded 7.8, 7.0 and 6.7 mm respectively. It means that there is not more variation in the range of evaporation during crop growing season in all the sowing dates.

4.1.5 Bright sunshine hours

Data given in Table 4.1 and graphically presented in Fig. 4.1 (c). revealed that the mean BSS during crop growing period (from 25^{th} to 39^{th} MW) were 6.7 hrs per day. It was observed that the highest value of bright sunshine hours 9.4 hrs day^{-1} were recorded in 27 MW and 28 MW while, lowest BSS 2.5 hrs per day in 25 MW.

From Table 4.1 data revealed that the mean BSS during whole crop growth stage in D_1, D_2, D_3 and D_4 was recorded 6.3, 6.1 and 6.1 hours respectively. It shows that highest BSS was recorded in D_1 (6.3 hrs) and lowest in D_2 (6.1 hrs) and D_3 (6.1) sowing date.

4.1.6 Wind velocity

The data on weekly mean wind velocity during crop growing season of green gram crop are presented in Table 4.1 and graphically presented in Fig. 4.1 (c).

data revealed that, the mean wind velocity during crop growing period (from 25th to 39th MW) was recorded 6.5 $kmhr^{-1}$. It was observed that highest wind velocity 9.4 $kmhr^{-1}$ was recorded in 27th MW and 28th MW, while lowest wind velocity 3.6 $kmhr^{-1}$ was recorded in 39 MW. Lower wind velocity seems to be helpful for decrease in ET.

Data from Table 4.1 revealed that the mean wind speed during whole crop growth stage in D_1, D_2, and D_3 was recorded 7.6, 6.8 and 6.3 $kmhr^{-1}$ respectively. It showed that highest wind speed was recorded in D_1 (7.6 $kmhr^{-1}$) and in D_2 (6.8 $kmhr^{-1}$) and lowest W.S. was recorded in D_3 (6.3 $kmhr^{-1}$) sowing date.

4.1.7 Phenophasewise weather parameters

The data on phenophase wise weather parameters among the different treatments are presented in Table 4.2 to 4.4.

The weather conditions prevailed during the crop growing season i.e. *kharif* 2015 are presented graphically for different meteorological elements viz. rainfall and rainy days, air temperature, relative humidity, evaporation, bright sunshine hours and wind velocity, at Parbhani, during the crop growing season (June to September) and its impact on growth, development and yield of green gram.

Overall precipitation received during the crop growth period i.e. P_1 to P_5 (Sowing to harvest stage of green gram) was 141.7 mm in D_1 (23rd June), 233.4 mm in D_2 (30th June), 251.8 mm in D_3 (07th July) and total rainy days for D_1, D_2 and D_3 was about 15, 18 and 17 days, respectively. The highest rainfall recorded in D_3 (07th June) i.e. 251.8 mm and highest rainy days recorded in D_2 (30th June) i.e. 18 days. The lowest rainfall and rainy days were recorded in D_1 (23rd June) i.e. 141.7 mm in 15 rainy days.

The nature and distribution of rainfall and the time of its receipt during the crop growing period seems to be much more important than the total quantity of rainfall with reference to the performance and yield of green gram.

The meteorological data for corresponding period of experimentation recorded at Meteorological observatory, V.N.M.K.V., Parbhani are presented in table 4.2.

Table 4.2 Phenophases wise effect of weather parameters of green gram D_1 (25 MW).

Weather parameters	Phenophase stages in D_1						
	P1	**P2**	**P3**	**P4**	**P5**	**Total**	**Mean**
Rainfall (mm)	4.1	13.5	43.9	45.5	34.8	141.7	---
Rainy days	1.0	2.0	5.0	4.0	3.0	15.0	---
T max (^{0}C)	36.1	36.1	32.5	31.9	32.7	---	33.9
T min (^{0}C)	24.9	24.9	23.4	23.2	22.9	---	23.9
Tmean	30.5	30.5	27.9	27.6	27.8	---	28.9
R.H.-I. (%)	72.5	72.5	79.7	84.2	80.3	---	77.8
R.H.-II (%)	39	38.9	56.2	56.0	52.4	---	48
R.H. Mean (%)	55.7	55.7	67.9	70.1	66.3	---	63.2
EVP (mm)	10.5	10.5	6.6	5.2	6.2	---	7.8
B.S.S. (hrs day^{-1})	7.0	7.0	4.4	5.3	7.6	---	6.3
W.V. (kmph)	9.2	9.2	7.8	5.7	6.0	---	7.6

P_1 : Sowing to Germination

P_2 : Germination to Bud emergence

P_3 : Bud emergence to Flower emergence

P_4 : Flower emergence to Pod emergence

P_5 : Pod emergence to Harvest

Table 4.3 Phenophase wise effect of weather parameters of green gram D_2 (26 MW).

Weather parameters	Phenophase stages in D_2						
	P1	**P2**	**P3**	**P4**	**P5**	**Total**	**Mean**
Rainfall (mm)	12.3	5.9	72	37.3	105.9	233.4	---
Rainy days	1.0	1.0	7.0	3.0	6.0	18.0	---
T max (^{0}C)	35.4	35.7	31.0	32.3	32.7	---	33.4
T min (^{0}C)	24.0	25.2	23.1	23.1	22.5	---	23.6
Tmean	29.7	30.5	27.0	27.7	27.6	---	28.5
R.H.-I. (%)	75.6	72.9	86.0	82.4	84.9	---	80.4
R.H.-II (%)	39.7	42.4	64.5	52.7	56.0	---	51
R.H. Mean (%)	57.6	57.6	75.2	67.6	70.4	---	65.7
EVP (mm)	8.7	10.1	5.2	5.4	5.7	---	7.0
B.S.S. (hrs day^{-1})	7.5	5.6	3.7	6.4	7.2	---	6.1
W.V. (kmph)	8.3	8.9	6.1	5.9	5.0	---	6.8

P_1 : Sowing to Germination

P_2 : Germination to Bud emergence

P_3 : Bud emergence to Flower emergence

P_4 : Flower emergence to Pod emergence

P_5 : Pod emergence to Harvest

Table 4.4 Phenophase wise effect of weather parameters of green gram D_3 (27 MW).

Weather parameters	Phenophase stages in D_3						
	P1	**P2**	**P3**	**P4**	**P5**	**Total**	**Mean**
Rainfall (mm)	19.7	13.0	84.0	52.5	82.7	251.8	---
Rainy days	1.0	1.0	7.0	4.0	4.0	17.0	---
T max (^{0}C)	34.9	33.9	31.5	32.9	32.3	---	33.1
T min (^{0}C)	24.8	23.7	22.6	22.1	21.3	---	22.9
Tmean	29.8	28.8	27.1	27.5	26.8	---	28.0
R.H.-I. (%)	74.6	76.5	84.6	79.6	84.2	---	79.9
R.H.-II (%)	44.0	47.8	60.1	49.6	55.6	---	51
R.H. Mean (%)	59.3	62.1	72.3	64.6	69.9	---	65.7
EVP (mm)	9.7	7.4	5.2	6.1	5.0	---	6.7
B.S.S. (hrs day^{-1})	6.2	5.8	4.7	7.6	6.1	---	6.1
W.V. (kmph)	8.5	7.8	5.4	5.3	4.5	---	6.3

P_1 : Sowing to Germination

P_2 : Germination to Bud emergence

P_3 : Bud emergence to Flower emergence

P_4 : Flower emergence to Pod emergence

P_5 : Pod emergence to Harvest

The performance of green gram yield under D_1 (23rd June) was superior to rest of the treatments. It might be due to well distribution of rainfall during the crop period.

The mean maximum temperature during the crop growth period in D_1 (23rd June), D_2 (30th June) and D_3 (07th July) was (33.9^{0}C), (33.4^{0}C) and (33.1^{0}C) having no much variation among the all dates of sowing.

In case of P_4 and P_5 (Flower emergence to Pod emergence, Pod emergence to Harvest) the maximum temperature ranged from (33.1^{0}C) to (33.9^{0}C) due to which pod formation and seed formation in D_1 was better than other dates of sowing the maximum temperature seems to have the effect on the yield of green gram and also on the duration of the crop season in different dates of sowing. The highest mean maximum temperature recorded in D_1 (23rd June) i.e. (33.9^{0}C) while lowest mean maximum temperature recorded in D_3 i.e. (22.9^{0}C).

The mean minimum temperature was 23.9^{0}C in D_1 (23rd June) while D_2 (30th June) and D_3 (10th July) was about 23.6^{0}C, 22.9^{0}C, respectively. The highest minimum temperature was recorded in D_1 (20th June) i.e. (22.9^{0}C) where as lowest minimum temperature was recorded in D_3 (07th July) i.e. (21.3^{0}C).

The highest morning time mean relative humidity was observed in D_2 (30th June) i.e. 80.4 % and lowest was observed in D_1 (23rd June) i.e. 77.8 %. While highest mean afternoon relative humidity was recorded during D_2 and D_3 i.e. 51 % and lowest was recorded in D_1 i.e. 48 %. The morning time relative humidity (R.H.-I) ranged from 72 to 85 % in different phenophase of all dates of sowing i.e. (from P_1 to P_5 stages in D_1 to D_3 dates of sowing).

Overall the morning time relative humidity and afternoon relative humidity was play very important role in crop emergence flowering, pod formation, seed formation and all other growth stages which was resulted in more green gram yield.

The highest mean evaporation during crop growing period (7.8 mm) and lowest (6.7 mm) was recorded in D_1 (23rd June) and D_2 (30th June) respectively.

The B.S.S. and wind velocity also plays important role in growth and development in different phenophases of green gram crop, which was indirectly resulted in more green gram yield.

4.2 Pre-harvest studies

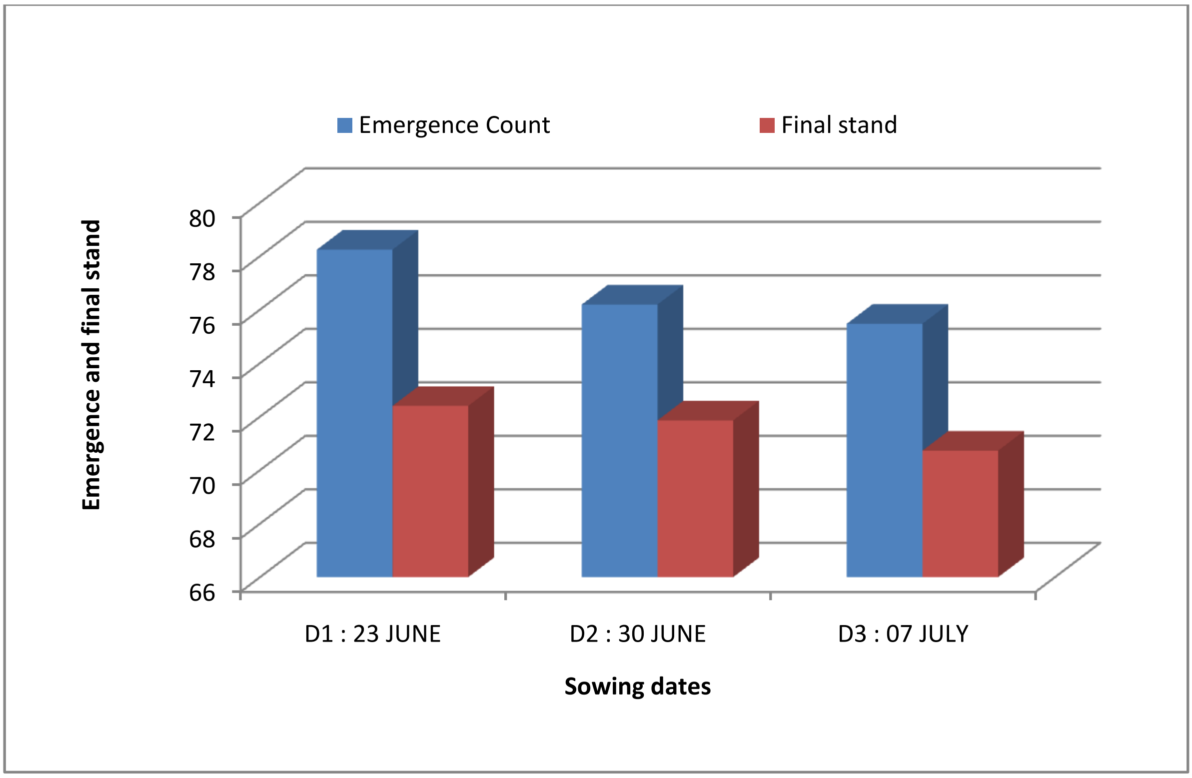
4.2.1 Mean emergence count and final plant stand

The data on emergence count was recorded eight days after each sowing date, whereas final plant stand was recorded at the time of harvesting. The data recorded on emergence count and final plant stand per net plot, as influenced by different treatments were presented in Table 4.5 and graphically presented in fig.4.2

Table 4.5 Mean emergence count and final plant stand as influenced by various treatments.

Treatments	Arcsine Value	
	Emergence Count	**Final stand**
Sowing dates (D)		
D1 : 25 MW (23rd June)	78.24	72.40
D2 : 26 MW (30th June)	76.19	71.86
D3 : 27 MW (07th July)	75.47	70.73
SE ±	0.57	0.34
CD at 5 %	NS	NS
Varieties (V)		
V1 : BM-4	75.88	70.61
V2 : BM-2002-1	76.37	71.27
V3 : BM-2003-2	79.40	74.37
V4 : BPMR-145	74.89	70.37
SE ±	0.50	0.36
CD at 5 %	NS	NS
Interaction (D x V)		
SE ±	0.86	0.62
CD at 5 %	NS	NS
General Mean	76.63	71.66

The mean emergence count and final plant stand were 76.63 and 71.66 arcsine values, respectively.



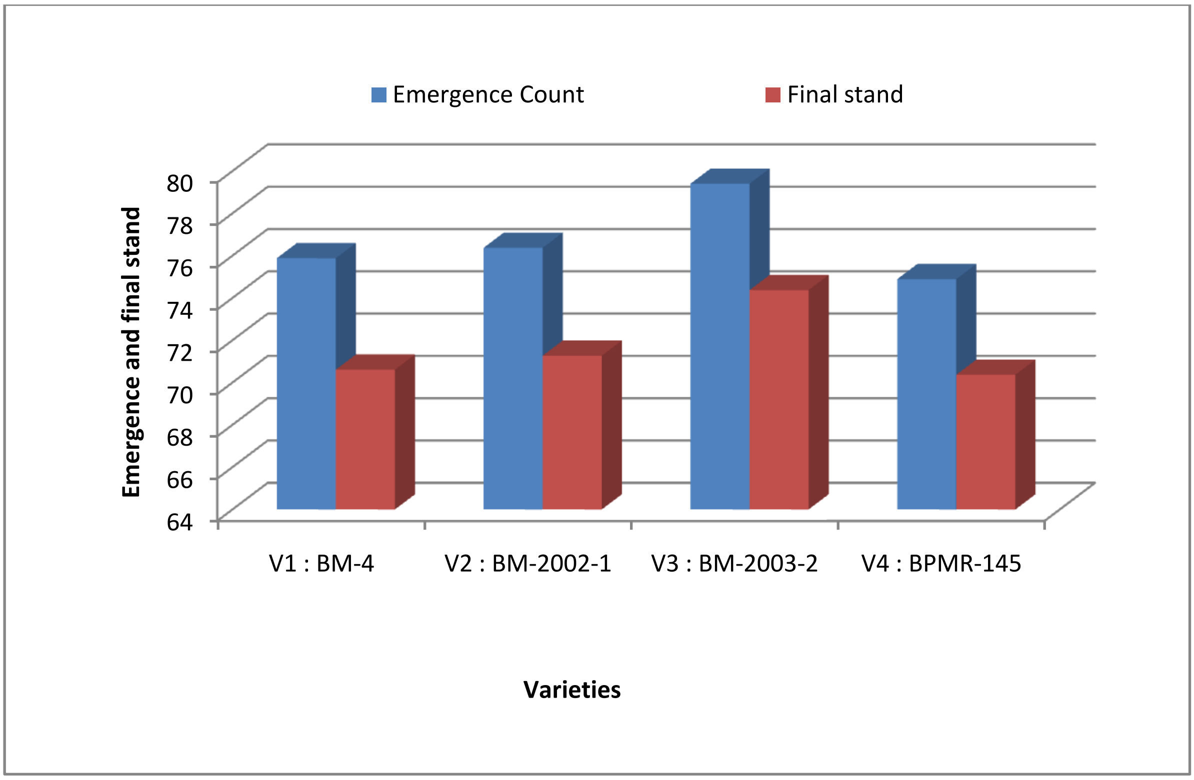


Fig. 4.2 Mean emergence count and final stand as influenced by various treatments.

The effect of various treatments i.e. sowing dates, varieties and their interaction on emergence count and final plant stand were non-significant indicating the differences observed in growth and yield attributes were due to the effect of different treatments.

4.3 Growth studies

4.3.1 Plant height

Data on periodical mean plant height (cm) recorded at various stages of crop growth is presented in Table 4.6 and graphically presented in fig 4.3

Table 4.6 Periodical mean plant height (cm) as influenced by various treatments.

Treatments	Days after sowing			At harvest
	20	40	60	
Sowing dates (D)				
D1 : 25 MW (23rd June)	11.67	27.29	39.06	40.98
D2 : 26 MW (30th June)	10.66	24.64	34.23	37.07
D3 : 27 MW (07th July)	9.87	22.75	29.09	32.92
SE ±	0.97	0.84	1.68	1.52
CD at 5 %	NS	2.51	5.00	4.52
Varieties (V)				
V1 : BM-4	10.47	24.25	33.27	36.10
V2 : BM-2002-1	10.72	25.04	34.62	37.45
V3 : BM-2003-2	11.31	26.47	35.84	40.67
V4 : BPMR-145	10.44	23.81	32.79	33.74
SE ±	0.53	0.47	0.72	1.04
CD at 5 %	NS	1.39	2.14	3.09
Interaction (D x V)				
SE ±	0.92	0.81	1.25	1.80
CD at 5 %	NS	NS	NS	NS
General Mean	10.73	24.89	34.13	36.99

Data presented in Table 4.6 revealed that the mean plant height progressively increased and reached to maximum (36.99 cm) at harvest. The rate of increase in plant height was rapid from 20 to 40 days and there after it increased gradually upto the harvest. The mean plant height at 20, 40, 60 DAS and at harvest was found to be 10.73, 24.89, 34.13 and 36.99 cm, respectively. It shows that the mean plant height increased with increase in age of crop.

Fig. 4.3 Mean plant height (cm) as influenced by various treatments.

4.3.1.1 Effect of sowing dates

Persual of data revealed that the mean plant height of green gram was affected significantly due to sowing dates at all growth stages of crop.

The plant height was observed significantly highest in first date of sowing i.e. D_1 (25 MW) 40.98 cm at harvest than other date of sowing at all stages of crop growth, the plant height was significantly highest at 40 DAS. Lowest plant height was recorded in D_3 during all growth stages of crop.

Similar results for date of sowing for plant height were reported by Saharia P. (1985), Choudhary et *al*. (1994), Nisar and Khan (2003), Shrivastava and Verma (1986).

4.3.1.2 Effect of varieties

The effect of varieties on mean plant height was significant at all the growth stages.

The variety BM-2003-2 was found significantly superior over other varieties in producing taller plant up to harvest. The mean plant height of BM-2002-1 is significantly superior at 20, 40, 60 DAS and at harvest i.e. 11.31, 26.47, 35.84 and 40.67 respectively, over varieties BM-2002-1, BM-4 and BPMR-145 during all the growth stages. It might be due to genetic character of BM-2003-2.

4.3.1.3 Interaction effect

However, the mean plant height was not influenced significantly by interaction effect of sowing dates and varieties at all the stages of observations.

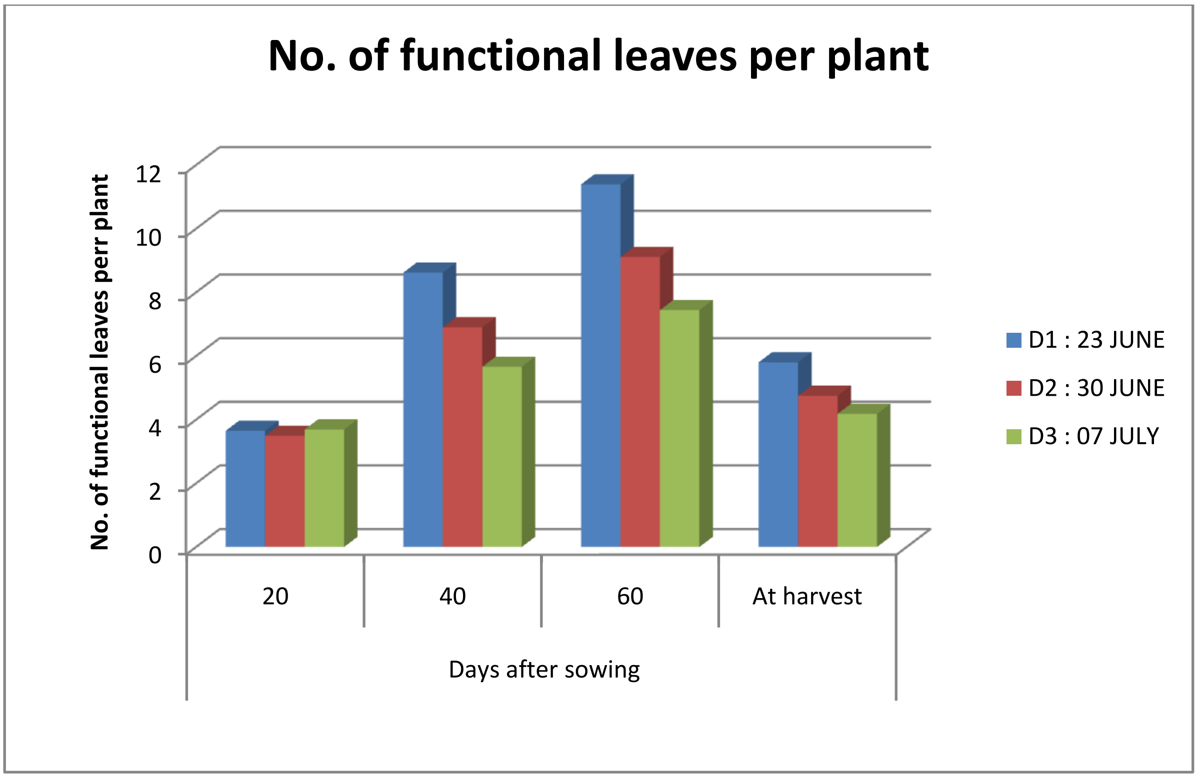
4.2.3 Number of functional leaves plant^{-1}

The data on mean number of functional leaves per plant recorded at 20 days of interval were given in Table 4.7 and graphically presented in Fig.4.4

Data on mean no. of trifoliate functional leaves plant^{-1} recorded at various stages of the crop growth are presented in Table 4.7 The mean number of functional leaves at 20, 40, 60 DAS and at harvest was found to be 3.61, 7.06, 9.31 and 4.91 respectively. It was observed that number of functional leaves per plant was increased continuously up to 60 DAS (days after sowing), thereafter it was decreased due to crop senescence.

Table 4.7 Periodical mean number of functional leaves plant^{-1} as influenced by various treatments

Treatment	Days after sowing			At harvest
	20	40	60	
Sowing dates (D)				
D1 : 25 MW (23rd June)	3.65	8.62	11.39	5.80
D2 : 26 MW (30th June)	3.49	6.90	9.11	4.75
D3 : 27 MW (07th July)	3.69	5.66	7.44	4.18
SE ±	0.23	0.35	0.55	0.17
CD at 5 %	NS	1.04	1.64	0.53
Varieties (V)				
V1 : BM-4	3.50	6.95	9.20	4.80
V2 : BM-2002-1	3.79	7.24	9.49	5.09
V3 : BM-2003-2	3.88	8.00	10.58	5.52
V4 : BPMR-145	3.27	6.06	7.97	4.24
SE ±	0.22	0.27	0.40	0.15
CD at 5 %	NS	0.80	1.21	0.46
Interaction (D x V)				
SE ±	0.38	0.47	0.70	0.27
CD at 5 %	NS	NS	NS	NS
General Mean	3.61	7.06	9.31	4.91



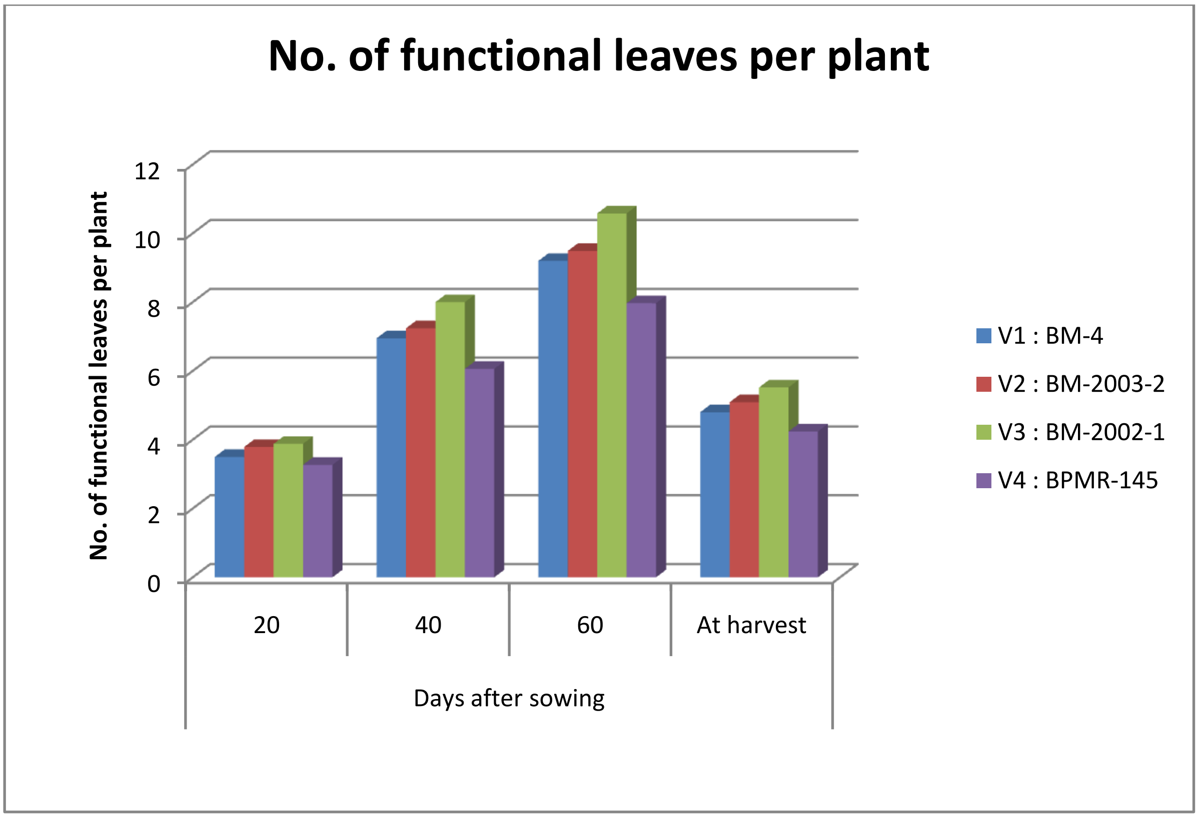


Fig. 4.4 Mean number of leaves plant^{-1}as influenced by various treatments.

4.3.2.1 Effect of sowing dates

A significant effect of sowing dates on mean no. of functional leaves plant^{-1} was observed at all the stages of crop growth and significant difference were observed from 20 DAS to at harvest. The crop sown on D_1 (23rd June) produced significantly higher number of functional leaves per plant at 60 DAS i.e. 11.39 and at harvest reduced number of functional leaves i.e. 5.80 over rest of all other sowing dates

.4.3.2.2 Effect of varieties

Data presented in Table 4.7 revealed that mean no. of functional leaves plant^{-1} was significantly influenced by different varieties at all growth stages of crop.

At 20, 40, 60, and at harvest variety BM-2003-2 (V_3) was found significantly superior in producing maximum number of leaves per plant over varieties BM-2002-1, BM-4 and BPMR-145. Similar results was obtained by Singh *et al.* (2010).

4.3.2.3 Interaction effect

Mean number of leaves per plant^{-1} was not influenced significantly by the interaction effect of sowing dates and varieties during different crop growth stages.

4.3.3 Mean total dry matter production plant^{-1} (g)

Data in respect of periodical accumulation of mean total dry matter plant^{-1} (g) amongst the various plant parts as affected by various treatments are presented in Table 4.8 and graphically presented in Fig.4.5 Mean of dry matter per plant at 20, 40, 60 DAS and at harvest was 0.45, 4.91, 8.88 and 9.56 gm plant^{-1} respectively.

At initial stages it was very slow between emergence to 20 DAS. At 20 DAS of crop, it was only 0.45 (g) plant^{-1}. However, the rate of increase of dry matter was highest between 40 DAS to 60 DAS.

Table 4.8 Periodical mean total dry matter production (g) plant^{-1}as influenced by various treatments.

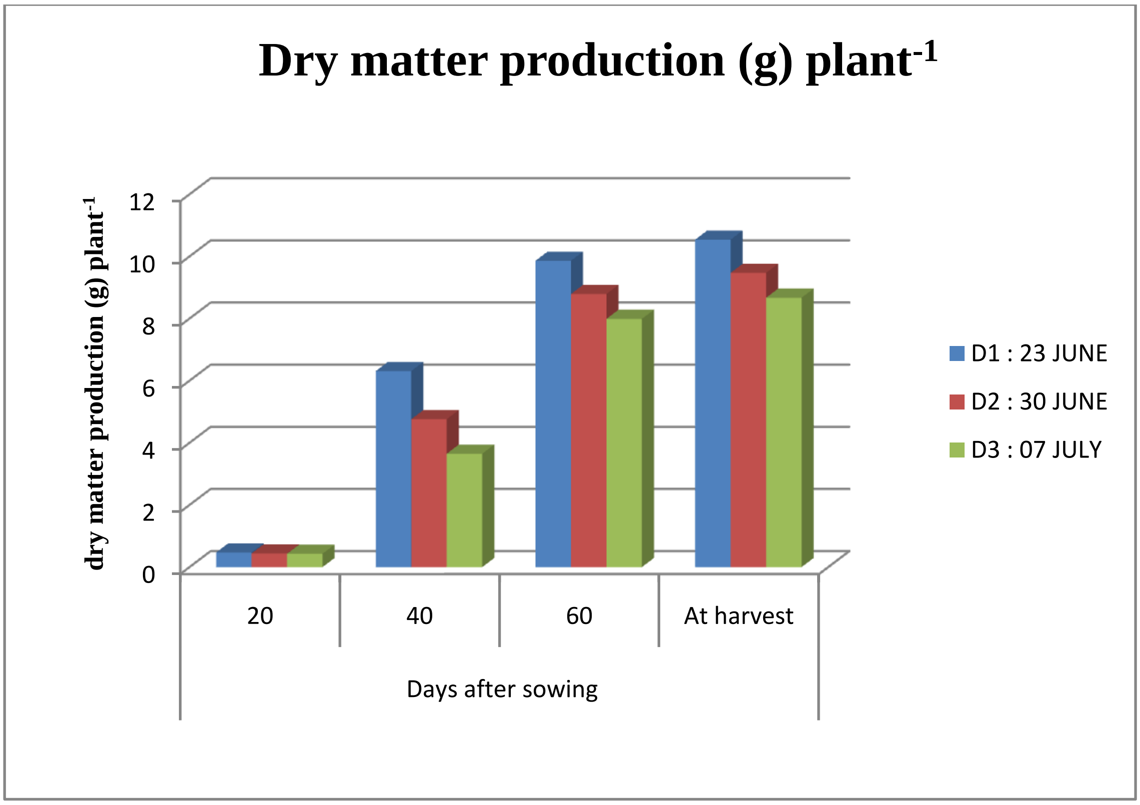
Treatments	Days after sowing			At harvest
	20	40	60	
Sowing dates (D)				
D1 : 25 MW (23rd June)	0.47	6.31	9.86	10.54
D2 : 26 MW (30th June)	0.44	4.76	8.79	9.47
D3 : 27 MW (07th July)	0.43	3.65	7.99	8.67
SE ±	0.01	0.27	0.18	0.18
CD at 5 %	NS	0.80	0.55	0.54
Varieties (V)				
V1 : BM-4	0.40	4.35	8.15	8.83
V2 : BM-2002-1	0.48	5.04	9.27	9.94
V3 : BM-2003-2	0.51	5.52	10.51	11.18
V4 : BPMR-145	0.39	4.71	7.61	8.29
SE ±	0.03	0.25	0.38	0.30
CD at 5 %	NS	0.76	0.11	0.90
Interaction (D×V)				
SE ±	0.05	0.44	0.65	0.52
CD at 5 %	NS	NS	NS	NS
General Mean	0.45	4.91	8.88	9.56

4.3.3.1 Effect of sowing dates

Persual of data in Table 4.8 revealed that the mean total dry matter accumulation per plant was significantly influenced due to sowing dates at different stages of crop growth. The treatment D_1 i.e. (23rd June) was produced significantly higher dry matter per plant at 20, 40, 60 DAS and at harvest i.e.0.47, 6.31, 9.86 and 10.54 respectively over D_2 i.e. (30th June) and lowest dry matter per plant produced in sowing date D_3 i.e. (07th July) at 20, 40, 60 DAS and at harvest.

4.3.3.2 Effect of varieties

Mean total dry matter accumulation per plant was significantly influenced due to varieties at different stages of crop growth. The variety BM-2003-2 (V_3) was found significantly superior at 20, 40, 60 DAS and at harvest i.e. 0.51, 5.52, 10.51 and 11.18 over variety BM-2002-1, BM-4 and BPMR-145 and produced maximum dry matter per plant at all stages of crop.



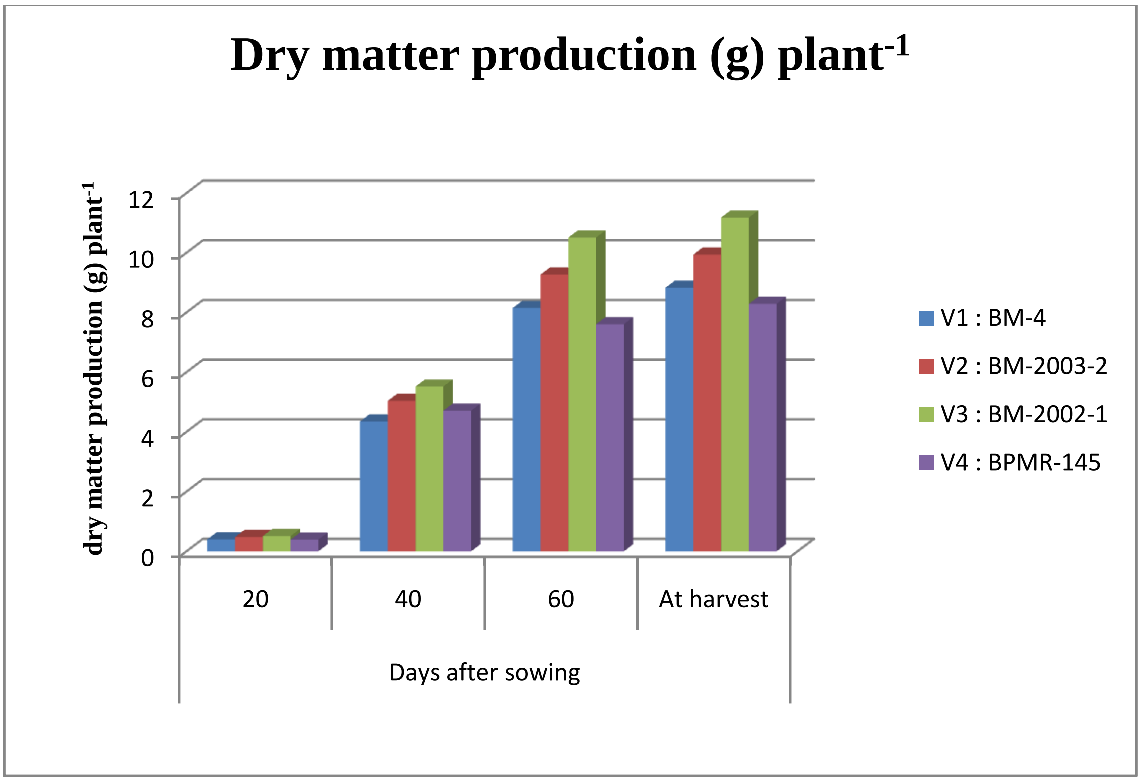


Fig. 4.5 Mean total dry matter production plant^{-1} as influenced by various treatments.

Similar result was reported by Singh *et al.* (2010), Raskar (1984) and Owla *et al.* (2007).

4.3.3.3 Interaction effect

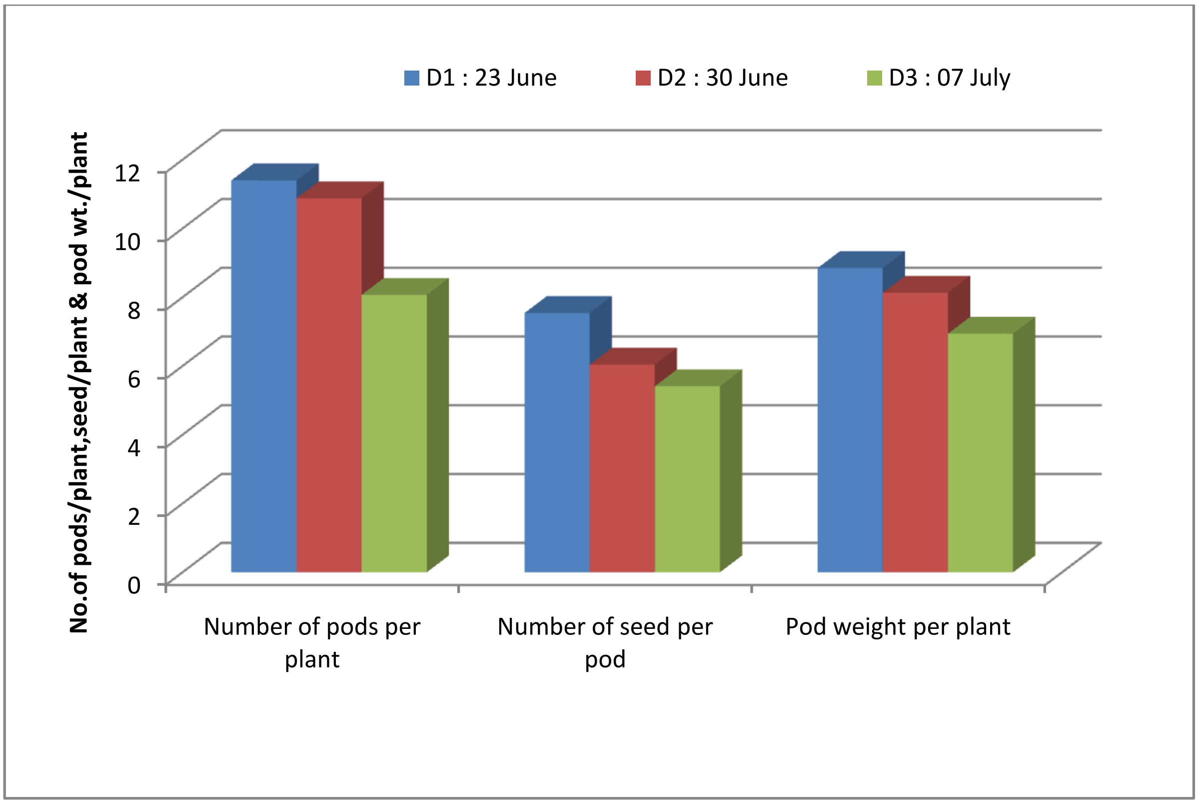
The interaction effect between sowing dates and varieties was found to be non-significant at all stages of crop.

4.4 Post harvest studies

The five plants labeled for biometric observations were harvested separately and the data on yield attributes were collected and analyzed per plants basis.

Table 4.9 Mean number of pods plant^{-1}, number of seed pod^{-1}, pod weight plant^{-1}, seed yield plant^{-1} and test weight as influenced by various treatments.

Treatments	Number of pods plant^{-1}	Number of seed pod^{-1}	Pod weight plant^{-1}	Seed yield (gm) plant^{-1}	Test weight
Sowing dates (D)					
D1 : 25 MW (23rd June)	11.40	7.54	8.85	2.54	41.3
D2 : 26 MW (30th June)	10.88	6.04	8.13	2.26	40.3
D3 : 27 MW (07th July)	8.07	5.41	6.94	1.86	37.6
SE ±	0.57	0.24	0.13	0.02	0.61
CD at 5 %	1.70	0.73	0.39	0.07	2.05
Varieties (V)					
V1 : BM-4	7.06	5.01	7.54	2.08	36.4
V2 : BM-2002-1	12.56	7.56	8.39	2.37	42.6
V3 : BM-2003-2	14.38	8.07	8.58	2.51	46.1
V4 : BPMR-145	6.46	4.68	7.39	1.92	33.8
SE ±	0.53	0.25	0.15	0.04	0.63
CD at 5 %	1.59	0.74	0.45	0.12	2.11
Interaction (D×V)					
SE ±	0.92	0.43	0.26	0.07	1.39
CD at 5 %	NS	NS	NS	NS	NS
General Mean	10.11	6.33	7.97	2.22	39.7



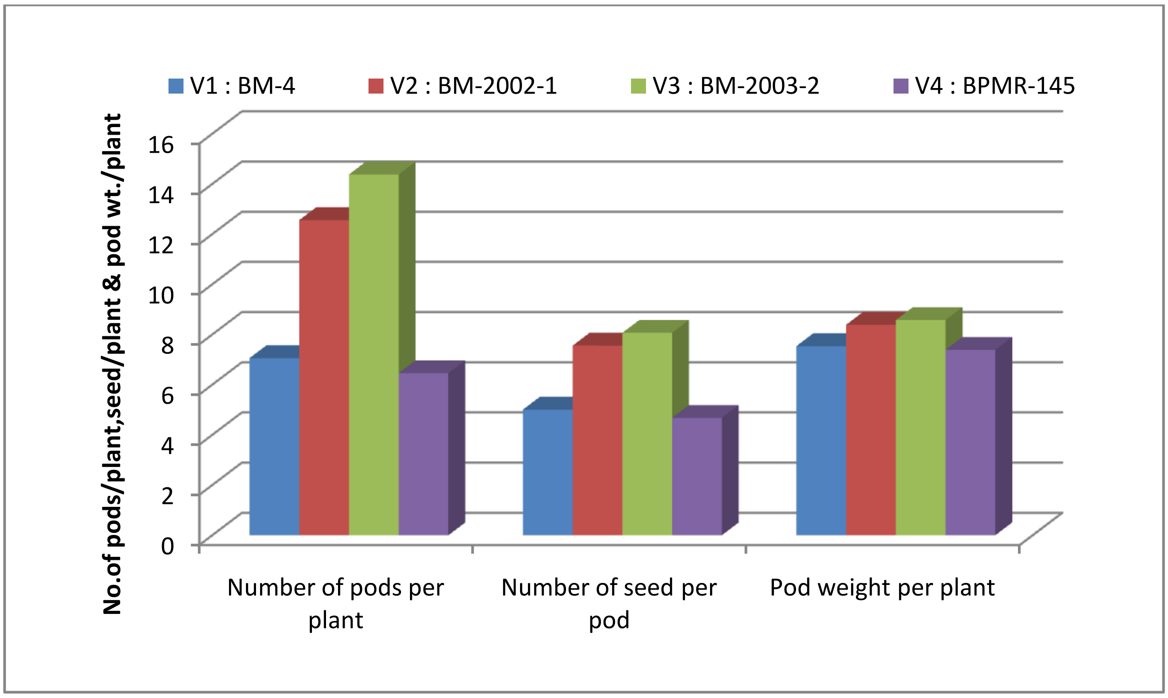


Fig. 4.6 Mean number of pods plant^{-1} , number of seeds pod^{-1} and pod weight plant^{-1} as influenced by various treatments.

4.4.1 Number of pods per plant

Data presented in Table 4.9 and graphically presented in Fig.4.6 indicated that the number of pods per plant was influenced significantly by different treatments. The mean number of pods per plant was 10.11.

4.4.1.1 Effect of sowing dates

Persual of data presented in Table 4.9 indicted that maximum number of pods per plant were observed with the crop sown on D_1 25 MW i.e. (23rd June) was found significantly superior it produced 11.40 pods per plant over D_2 (26 MW) and D_3 (27 MW) sowing dates. Similar result was reported by Rana *et al.* (2006) and Fraz *et al.* (2006).

4.4.1.2 Effect of varieties

A significant effect was found on mean number of pods per plant due to varietal effect. Higher number of pods per plant was produced by variety BM-2003-2 (V_3) i.e. 14.38 and was significantly superior over variety BM-2002-1 (V_2) i.e.12.56, BM-4 (V_1) i.e.7.06 and variety BPMR-145 (V_4) i.e. 6.46. Similar result was reported by Faroda *et al*. (1983).

4.4.1.3 Interaction effect

The interaction effect could not reach to the level of significance in influencing the number of pods per plant.

4.4.2 Number of seeds per pod

Data pertaining to number of seeds per pod is furnished in Table 4.9 and graphically presented in Fig.4.6. The mean number of seeds per pod was 6.33.

4.4.2.1 Effect of sowing dates

Persual of data revealed that number of seeds per pod was significantly influenced by different sowing dates. The crop sown on D_1 25 MW i.e. (23rd June) has recorded maximum number of seeds per pod i.e.7.54 followed by D_2 (26 MW) i.e. 6.04 and D_3 (27 MW) i.e. 5.41.

4.4.2.2 Effect of varieties

The mean number of seeds per pod was significantly influenced by different varieties. The variety BM-2003-2 (V_3) has recorded the higher number of seeds per pod (8.07) was significantly superior over rest of varieties. Same results were reported by Sharma *et al.* (1989) and Reddy *et al.* (1991).

4.4.2.3 Interaction effect

The interaction effect could not reach to the level of significance in influencing the no. of seeds per pod.

4.4.3 Pod weight per plant

The data furnished in Table 4.9 and graphically presented in Fig.4.6 revealed that pod weight per plant was significantly influenced by different sowing dates and varieties.

4.4.3.1 Effect of sowing dates

Pod weight per plant of green gram was significantly influenced by sowing dates. The crop sowing at D_1 (23rd June) has produced highest pod weight per plant i.e. 8.85 (gm) and significantly superior over rest of the sowing dates. The lowest pod weight per plant recorded by crop sown on D3 (07th July) i.e. 6.94 (gm). Similar results were obtained by Singh *et al.* (2010).

4.4.3.2 Effect of varieties

Pod weight per plant was significantly influenced due to different varieties. The variety BM-2003-2 (V_3) produced maximum pod weight per plant (8.58 gm) and found significantly superior as compared to varieties BM-2002-1 (V_2) i.e.8.39 (gm), BM-4 (V_1) i.e. 7.54 (gm) and BPMR-145 (V_4) i.e.7.39 (gm). Similar results were obtained by Sharma *et al.* (1989).

4.4.3.3 Interaction effect

The interaction effect between sowing dates and varieties could not influence the pod weight per plant significantly.

4.4.4 Seed yield per plant

The data on seed yield per plant given in Table 4.9 revealed that the mean seed yield per plant was (2.22 gm). Seed yield per plant of green gram has significantly influenced by different sowing dates and varieties.

4.4.4.1 Effect of sowing dates

Various sowing dates significantly influenced seed yield per plant in green gram. The crop sown i.e. 23rd June (D_1) produced maximum seed yield per plant (2.54 gm) was significantly influenced as compared to the rest of sowing dates. Lowest seed yield per plant produced sowing date D_3 (27 MW) i.e.1.86 (gm). Similar results were reported by Singh *et al*. (2012).

4.4.4.2 Effect of varieties

The seed yield per plant was significantly influenced due to varieties of green gram. The variety BM-2003-2 (V_3) produced maximum seed yield per plant i.e. (2.51 gm) was significantly superior over BM-2002-1 (2.37 gm), BM-4 (2.08 gm) and BPMR-145 (1.92 gm). Similar results were reported by Monem *et al*. (2012).

4.4.4.3 Interaction effect

The interaction effect between sowing dates and varieties could not influenced the seed yield per plant significantly.

4.4.5 Test weight

Data presented in Table 4.9 revealed that test weight (1000 seed weight) was not influenced by different sowing dates, varieties and their interactions. The effect of different sowing dates on tests weight (1000 seeds) was found to be non significant. But the highest test weight was observed at D_1 23rd June (41.3 gm) followed by sowing date D_2 30th June (40.3 gm) and D_3 30th June (37.6 gm).

Similar results were reported by Rana *et al*. (2006), Krishnamoorthy *et al*. (1984) and Sarkar *et al*. (2004).

4.4.6 Seed yield (kg ha^{-1}), straw yield (kg ha^{-1}), biological yield (kg ha^{-1}) and Harvest Index (HI)

The data on seed yield, straw yield, biological yield and harvest Index as influenced by different treatment are presented in Table 4.10 and graphically illustrated in fig.4.7

4.4.7 Seed yield (kg ha^{-1})

Mean seed yield was 431 kg ha^{-1}which was significantly influenced by different sowing dates and varieties.

4.4.7.1 Effect of sowing dates

The data presented in Table 4.10 and graphically presented in Fig.4.7 revealed that the seed yield of green gram was significantly influenced by different sowing dates.

The crop sown on D_1 (23rd June) produced maximum seed yield (524 kg ha^{-1}) which was significantly superior over rest of sowing dates.

Similarly close results were reported by Nagre (1986) and Sadeghipour (2008).

Table 4.10 Mean seed yield, straw yield, biological yield (kg ha^{-1}) and harvest index as influenced by various treatments.

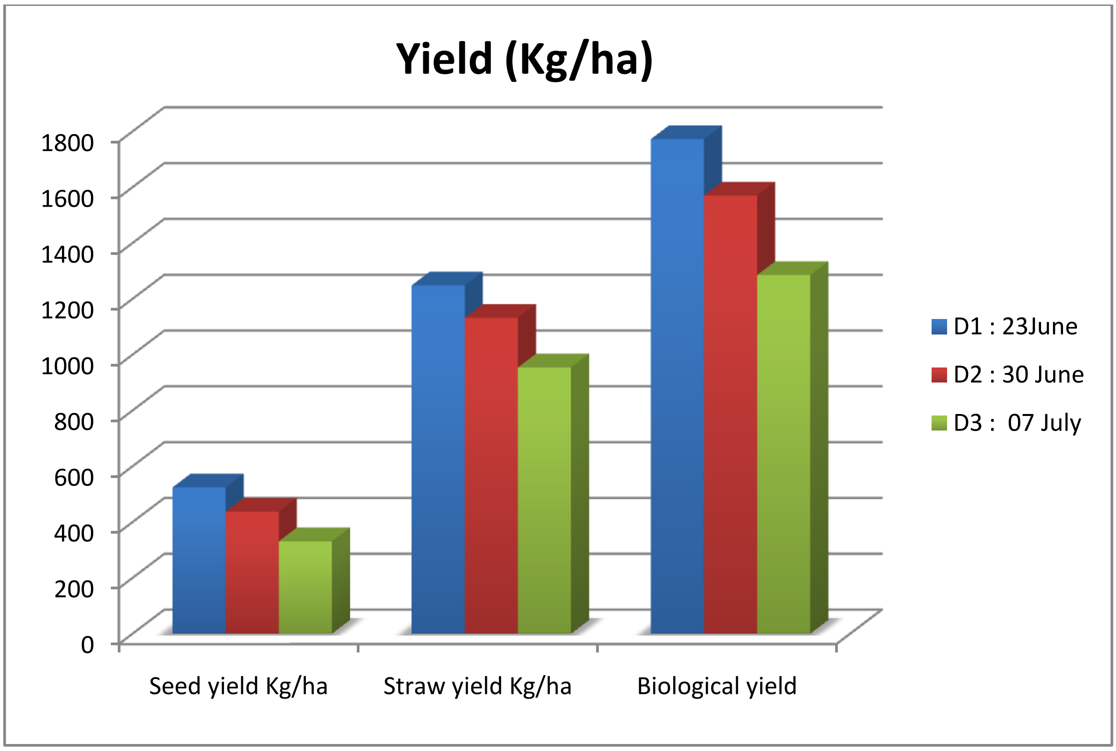
Treatments	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index (%)
Sowing dates (D)				
D1 : 25 MW (23rd June)	524	1248	1772	29.46
D2 : 26 MW (30th June)	437	1132	1570	27.76
D3 : 27 MW (07th July)	331	954	1285	25.53
SE ±	5.05	21.59	26.20	0.13
CD at 5 %	19.84	84.77	102.88	0.52
Varieties (V)				
V1 : BM-4	402	1028	1429	27.78
V2 : BM-2002-1	467	1205	1672	27.72
V3 : BM-2003-2	510	1254	1763	28.75
V4 : BPMR-145	346	959	1304	26.09
SE ±	10.28	27.88	36.98	0.27
CD at 5 %	30.54	82.84	109.88	0.82
Interaction (D×V)				
SE ±	17.80	48.29	64.05	0.47
CD at 5 %	NS	NS	NS	NS
General Mean	431	1111	1543	27.59

4.4.7.2 Effect of varieties

The seed yield was significantly influence due to varieties. The variety BM-2003-2 (V_3) produced maximum seed yield (510 kg ha^{-1}) which was significantly superior over other varieties. Similarly close results were reported by Yadahalli and Palled (2004), Dubey and Singh (2006), Rathore *et al.* (2010) and Bhise *et al.* (2010).

4. 4.7.3 Interaction effect

The interaction effect could not reach to the level of significance in influencing the seed yield of green gram.



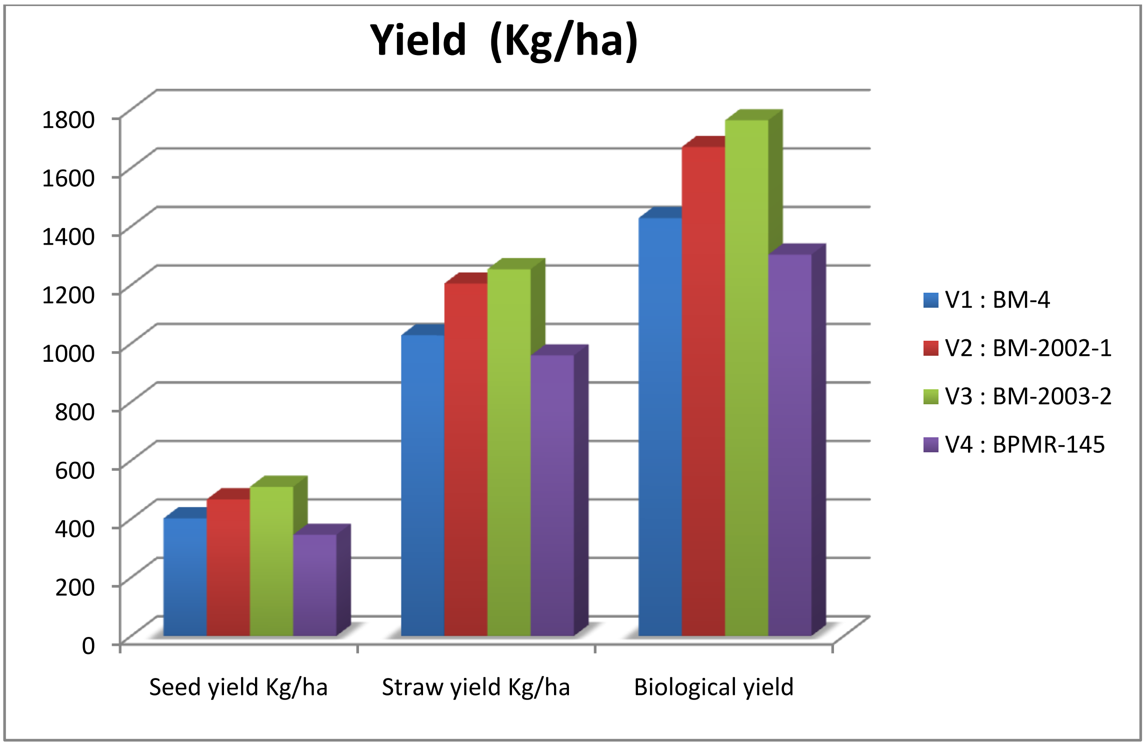


Fig. 4.7 Mean seed, straw and biological yield (kg ha^{-1}) as influenced by various treatments.

4.4.8 Straw yield (Kg ha^{-1})

Data presented in Table 4.10 and graphically presented in Fig.4.7 indicated that the mean straw yield of green gram was 1111 kg ha^{-1}and was significantly influenced by sowing dates and varieties.

4.4.8.1 Effect of sowing dates

The straw yield significantly influenced by different sowing dates. The sowing on D_1 (23rd June) produced (1248 kg ha-1) straw yield which was significantly superior over rest of the sowing dates. Similar results were reported by Raj Singh *et al.* (2010).

4.4.8.2 Effect of varieties

The straw yield was significantly influenced by different varieties. Maximum straw yield (1254 kg ha^{-1}) was recorded by variety BM-2003-2 (V_3) which was significantly superior over other varieties. Choudhary et *al.* (1989) reported similar results.

4.4.8.3 Interaction effect

Interaction effect were non significant in influencing straw yield of green gram.

4.4.9 Biological yield (Kg ha^{-1})

The data presented in 4.10 and graphically presented in Fig.4.7 indicated that the biological yield was significantly influenced by different treatments. The average biological yield was 1543 kg ha^{-1}.

4.4.9.1 Effect of sowing dates

The biological yield of green gram was significantly influenced by sowing dates. The sowing D_1 (23rd June) recorded maximum biological yield (1772 kg ha^{-1}) of green gram which was significantly superior over rest of the sowing dates. Similar results were reported by Fraz *et al.* (2006) and Raj Singh *et al.* (2010).

4.4.9.2 Effect of varieties

The biological yield of green gram was influenced significantly due to varieties. Maximum biological yield was recorded by variety BM-2003-2 i.e. (1763 kg ha^{-1}) which was significantly superior over variety BM-2002-1 (V_2), BM-4 (V_1) and BPMR-145. Same results were reported by Dhoble *et al.* (1990) and Saharia P. (1988).

4.4.9.3 Interaction effect

The interaction effect could not reach to the level of significance in influencing the biological yield of green gram.

4.4.10 Harvest Index (%)

Data presented in Table 4.10 revealed that the mean harvest index of green gram was 27.59. It was influenced due to sowing dates and varieties.

4.4.10.1 Effect of sowing dates

The data in Table 4.10 indicated that the harvest index of green gram was influenced due to different sowing dates. The sowing at D_1 (23^{rd} June) recorded higher (29.46) harvest Index over D_2 and D_3 sowing dates.

4.4.10.2 Effect of varieties

The highest harvest index was recorded by variety BM-2003-2 i.e. (28.75) than rest of the other three varieties i.e.BM-4, BM-2002-1 and BPMR-145. Same result was reported by Rana *et al.* (2006).

4.4.10.3 Interaction effect

Significant interaction effect was not found in case of green gram harvest index.

4.5 Agro meteorological indices

The data recorded on these aspects were not subjected 'F' of variance and results are interpreted on the basis of values

4.5.1 Growing Degree Days (GDD)

Growing degree days (GDD) for green gram crop under different sowing dates and varieties from sowing to maturity are presented in Table 4.11 and graphically depicted in Fig. 4.8.

The data presented in Table 4.11 revealed that the mean heat unit requirement from the life cycle i.e. emergence to harvest stage (P_1 to P_5) stage was 479.58^{0}C day. The mean heat load was reported during D_1 (MW 25) was 479.58^{0}C day and it was followed by D_2 (MW 26) and D_3 (MW 27) i.e. 480.21^{0}C day and 459.74^{0}C day. It indicated that the mean heat load was decreased from D_1 to D_3 it may be due to delayed sowing.

Date of sowing D_2 (MW 26) indicated more heat load (i.e. 480.21^{0}C day) than rest of the treatments it may be due to maximum air temperature prevailed at sowing time. The lowest (i.e. 459.74^{0}C day) heat unit required for attaining various phenophases in D_3 (MW 27) date of sowing due to effect of temperature and delayed sowing during the crop growing season.

It is cleared that, when temperature of air was maximum then it will definitely affect GDD of green gram crop. The highest mean value i.e. 390.87^{0}C day was recorded in phenophase P_2 of all date of sowing.

The data depicted in Table 4.11 revealed that the mean heat unit requirement of all the varieties during crop life cycle was 471.27^{0}C, 465.92^{0}C, 474.24^{0}C and 481.42^{0}C for BM-4, BM-2002-1, BM-2003-2 and BPMR-145 respectively. It might be due to the different crop duration in above four varieties. Similar results were reported by Ransing *et al.* (2014), Sharma and Sonakiya (1990).

Table 4.11 Cumulative Growing degree days (GDD) at different phenophase stages of green gram crop under different treatments.

Treatments	Phenophses						
	P1	**P2**	**P3**	**P4**	**P5**	**Total**	**Mean**
Date of sowing							
D1 (MW25)	181.07	390.87	367.49	271.18	228.12	1438.7	479.58
D2 (MW26)	235.89	328.62	324.86	325.02	226.25	1440.6	480.21
D3 (MW27)	228.78	325.07	334.86	298.09	192.42	1379.2	459.74
Varieties							
V1(BM-4)	240.24	322.36	339.75	302.02	209.45	1413.8	471.27
V2(BM-2002-1)	198.24	341.77	339.27	313.48	205.01	1397.8	465.92
V3(BM-2003-2)	208.96	358.53	344.07	286.58	224.6	1422.7	474.25
V4(BPMR-145)	213.76	370.08	346.52	290.3	223.6	1444.2	481.42
Mean	215.3	348.19	342.4	298.1	215.67	1419.6	473.22

P_1 : Sowing to Germination

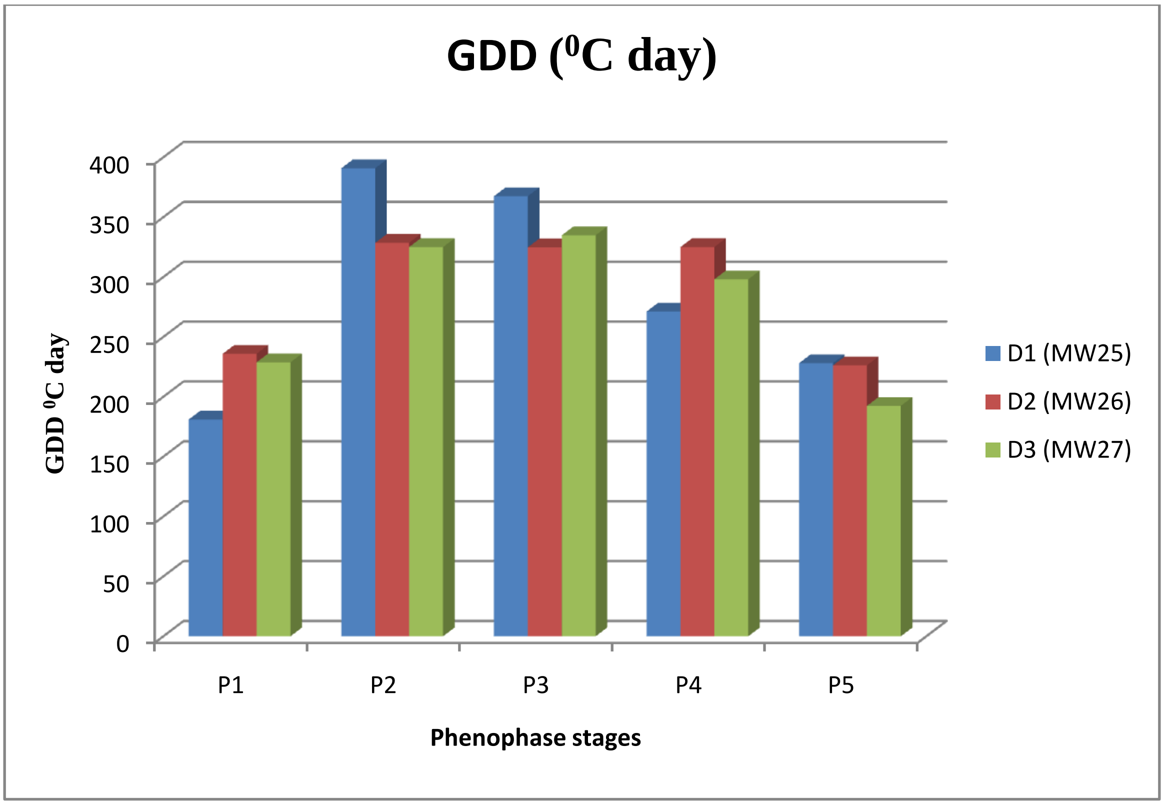
P_2 : Germination to Bud emergence

P_3 : Bud emergence to Flower emergence

P_4 : Flower emergence to Pod emergence

P_5 : Pod emergence to Harvest

The data presented in Table 4.11 showed that total GDD required during total crop growth period was highest in D_2 (MW 26) 480.21^0C as compare to remaining treatments. In case of varieties V_4 (BPMR-145) required highest total GDD i.e. 481.42^0C as compare to $V_{1,}$ V_2, V_3. It may be due to different growth period. Similar results were reported by Ransing *et al.* (2014).



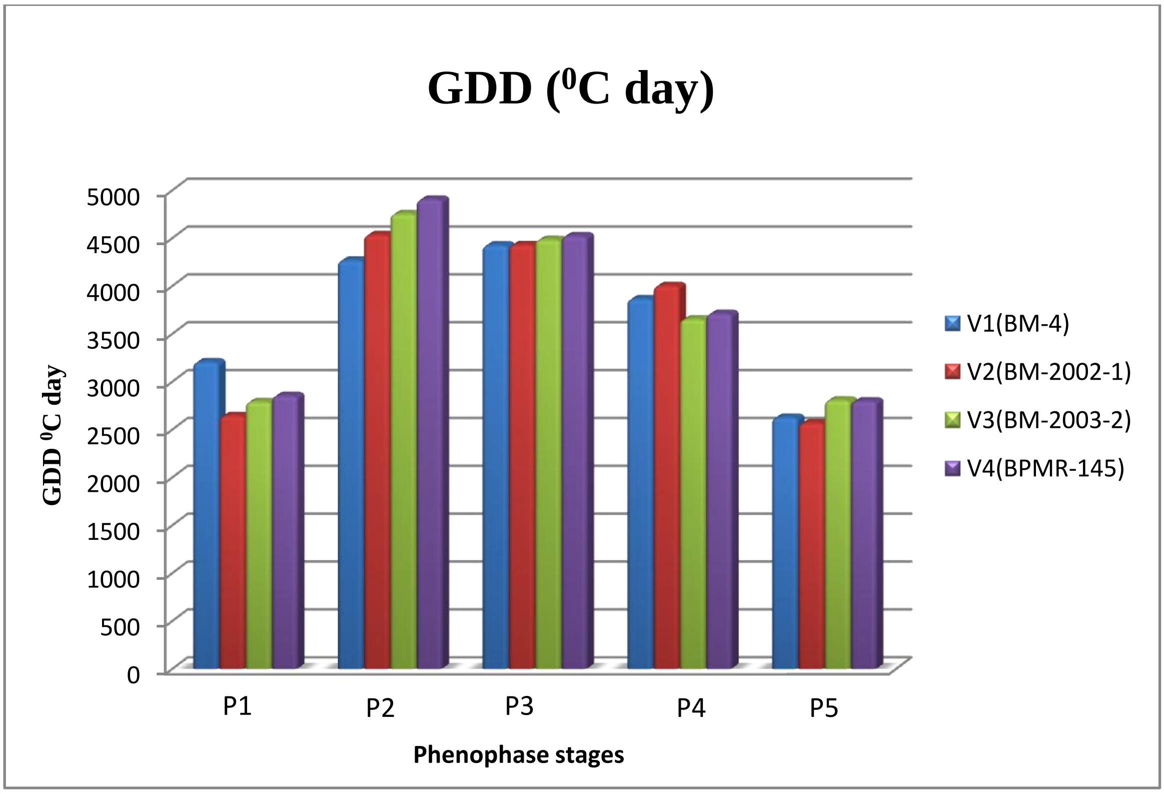


Fig. 4.8 Effect of date of sowings and varieties on growing degree days (^oC day).

4.5.2 Helio-thermal Units (HTU)

The data presented in Table 4.12 and graphically depicted in Fig. 4.9 represent helio-thermal unit requirement for each phenophases were different required by different dates of sowing.

The mean helio-thermal units were observed in date of sowing (D_1 to D_3) ranged from 1035.57 to 1937.12 ^{0}C day hour. The helio-thermal units were higher in first date of sowing i.e. 2876.47 ^{0}C day hour in D_1 (MW 25). The lowest HTU were observed in D_3 (MW 27) i.e. 2627.46^{0}C day hour than rest of the treatments due to variation of temperature and bright sunshine hours during the crop growing season.

The data depicted in Table 4.12 revealed that the helio-thermal unit requirement for all the varieties during crop life cycle was 2768.28^{0}C day hour, 2743.56^{0}C day hour, 2801.43^{0}C day hour, and 2849.69^{0}C day hour, for BM-4, BM-2002-1, BM-2003-2 and BPMR-145 respectively. It may be due to the different crop duration in above two varieties.

The data presented in Table 4.12 showed that total HTU required during total crop growth period was highest in D_1 (MW 25) i.e. 2876.47^{0}C day hour as compare to remaining treatments. In case of varieties V_4 (BPMR-145) required highest total HTU i.e. 2849.69^{0}C day hour as compare to other three varieties. It might be due to different growth period. Similar results were reported by Sharma and Sonakiya (1990).

Table 4.12 Cumulative Helio-thermal units (HTU) at different phenophases green gram crop under different treatments.

Treatments	Phenophses						
	P1	**P2**	**P3**	**P4**	**P5**	**Total**	**Mean**
Date of sowing							
D1 (MW25)	1145.45	2744.88	1761.72	1470.44	1506.93	8629.42	2876.47
D2 (MW26)	1676.37	1854.18	1523.04	1937.12	1614.18	8604.89	2868.29
D3 (MW27)	1595.74	1730.35	1469.04	2051.7	1035.57	7882.4	2627.46
Varieties							
V1(BM-4)	1558.84	1999.94	1580.42	1829.37	1336.29	8304.86	2768.28
V2(BM-2002-1)	1396.89	2100.83	1496.8	1924.51	1311.66	8230.69	2743.56
V3(BM-2003-2)	1438.11	2183.36	1572.22	1750.19	1460.41	8404.29	2801.43
V4(BPMR-145)	1496.23	2155.08	1688.96	1774.94	1433.88	8549.09	2849.69
Mean	1472.52	2109.8	1584.6	1819.75	1385.56	8372.23	2790.74

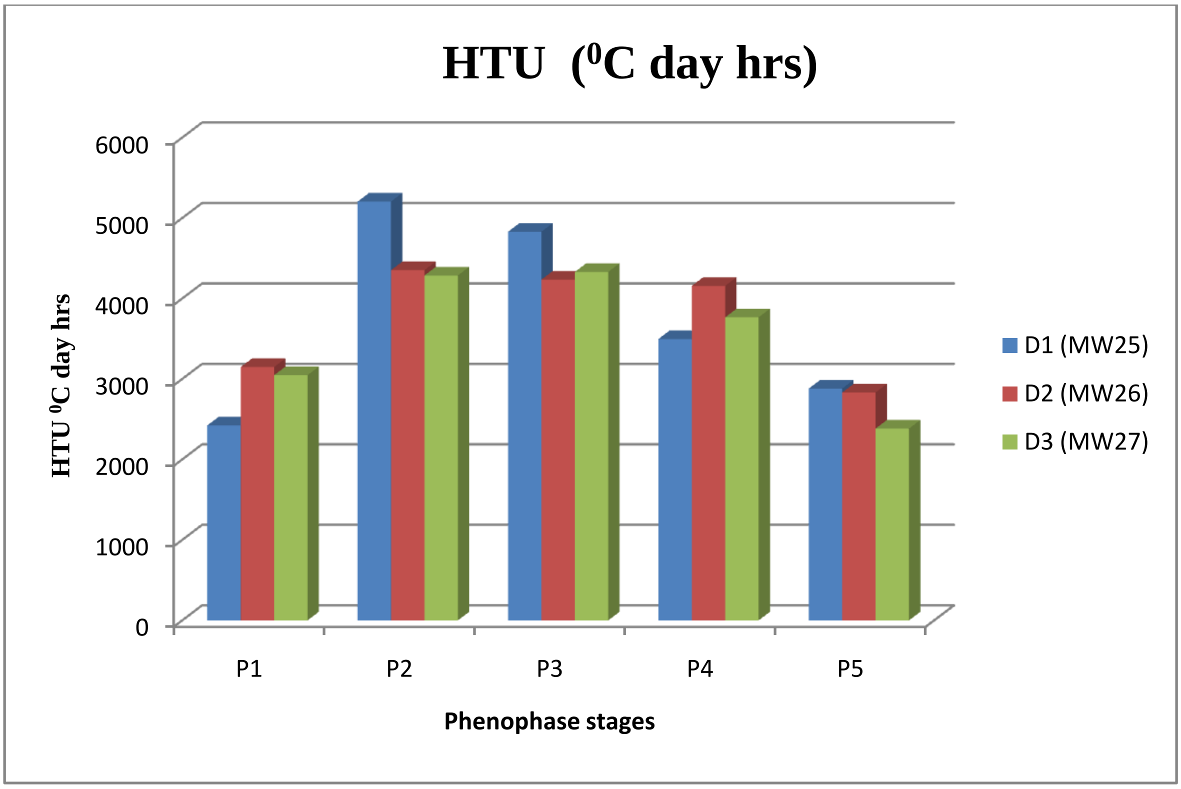
P_1 : Sowing to Germination

P_2 : Germination to Bud emergence

P_3 : Bud emergence to Flower emergence

P_4 : Flower emergence to Pod emergence

P_5 : Pod emergence to Harvest



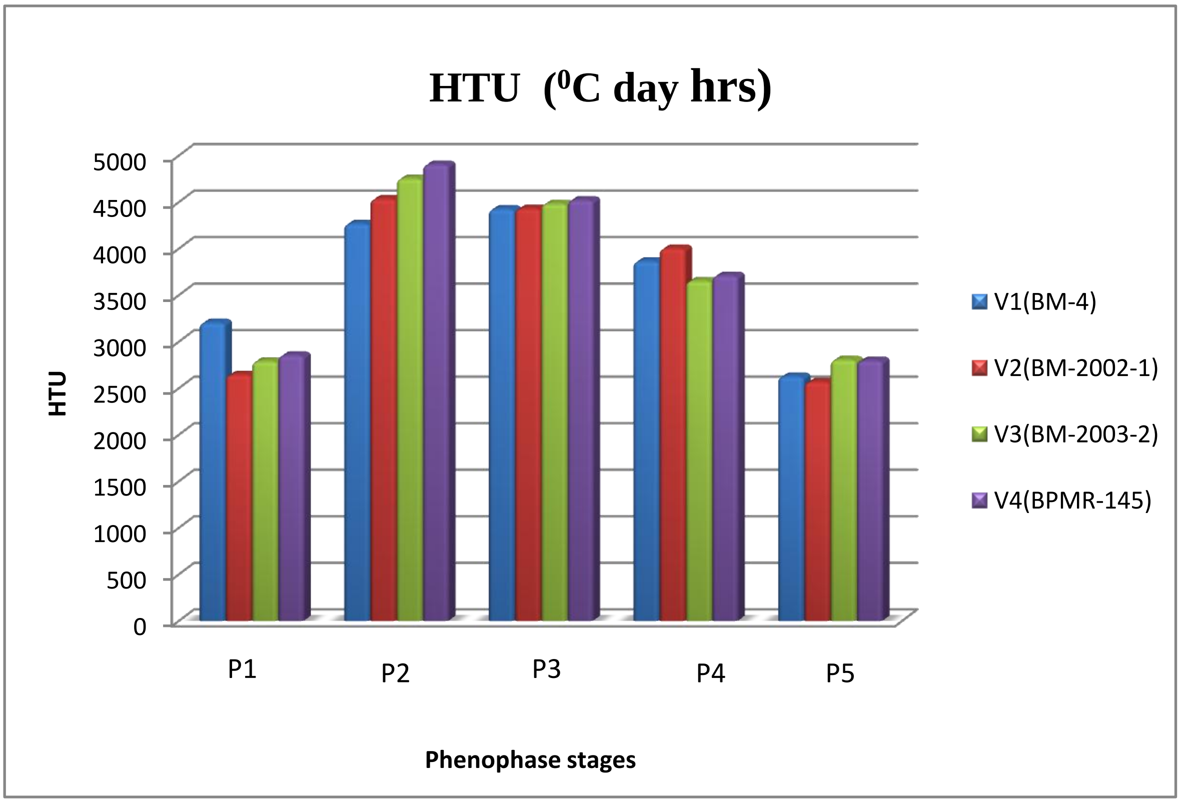


Fig. 4.9 Effect of sowing dates and varieties on helio thermal unit (^{o}C day hrs).

4.5.3 Photo-thermal Units (PTU)

The data presented in Table 4.13 and graphically depicted in Fig. 4.10 represent helio-thermal unit requirement for each phenophases were different required by different dates of sowing.

The mean photo-thermal units were observed in date of sowing (D_1 to D_3) ranged from 2383.25 to 4352.49 ^{0}C day hour. The helio-thermal units were higher in first date of sowing i.e. 6278.09 ^{0}C day hour in D_1 (MW 25). The lowest HTU were observed in D_3 (MW 27) i.e. 5937.47^{0}C day hour than rest of the treatments due to variation of temperature and bright sunshine hours during the crop growing season.

The data depicted in Table 4.13 revealed that the helio-thermal unit requirement for all the varieties during crop life cycle was 6128.85^{0}C day hour, 6058.48^{0}C day hour, 6161.07^{0}C day hour, and 6261.27^{0}C day hour, for BM-4, BM-2002-1, BM-2003-2 and BPMR-145 respectively. It may be due to the different crop duration in above two varieties.

The data presented in Table 4.13 showed that total HTU required during total crop growth period was highest in D_1 (MW 25) i.e. 6278.09^{0}C day hour as compare to remaining treatments. In case of varieties V_4 (BPMR-145) required highest total HTU i.e. 6261.27^{0}C day hour as compare to other three varieties. It might be due to different growth period. Similar results were reported by Singh *et al.* (2011).

Table 4.13 Cumulative Photo-thermal units (PTU) at different phenophases of green gram under different treatments.

Treatments	Phenophses						
	P1	P2	P3	P4	P5	Total	Mean
Date of sowing							
D1 (MW25)	2422.5	5204.5	4829.3	3496.7	2881.0	18834.3	6278.093
D2 (MW26)	3148.47	4352.49	4234.6	4157.56	2831.95	18725.1	6241.697
D3 (MW27)	3046.38	4285.97	4330.2	3766.57	2383.25	17812.4	5937.477
Varieties							
V1 (BM-4)	3204.29	4267.09	4425.6	3863.49	2626.06	18386.6	6128.857
V2 (BM-2002-1)	2643.49	4533.7	4429.4	4002.11	2566.7	18175.5	6058.483
V3 (BM-2003-2)	2789.31	4752.66	4482.6	3652.71	2805.9	18483.2	6161.077
V4 (BPMR-145)	2852.77	4903.88	4521.2	3709.5	2796.4	18783.8	6261.277
Mean	2872.47	4614.33	4464.7	3806.95	2698.77	18457.3	6152.423

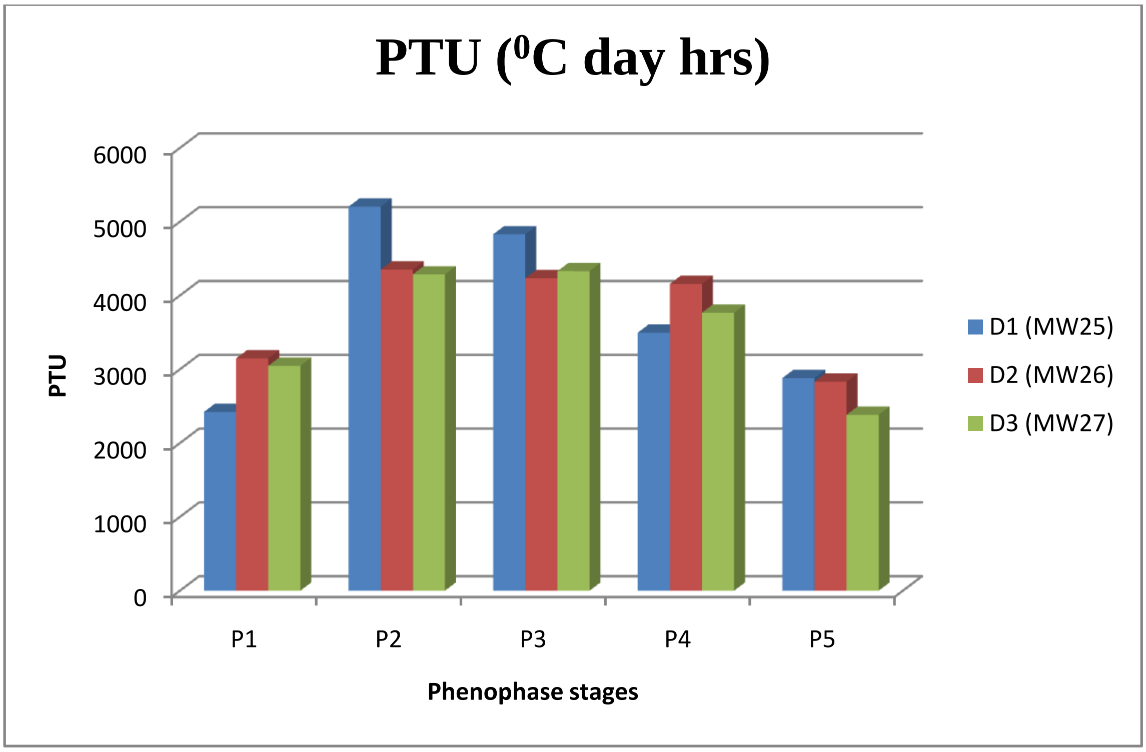
P_1 : Sowing to Germination

P_2 : Germination to Bud emergence

P_3 : Bud emergence to Flower emergence

P_4 : Flower emergence to Pod emergence

P_5 : Pod emergence to Harvest



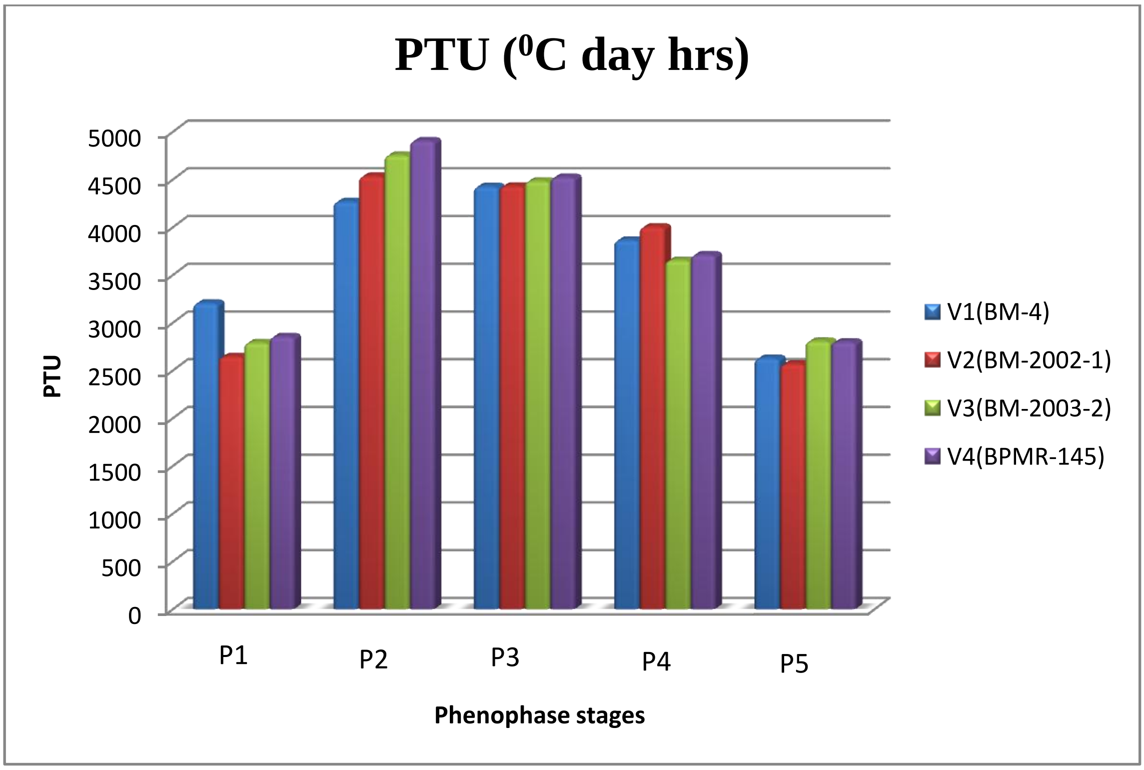


Fig. 4.10 Effect of sowing dates and varieties on photo thermal unit (^oC day hrs).

4.6 Correlation studies

The correlation coefficient prevailed in phenophages stage of green gram crop were estimated and prescribed in Table 4.14.

The correlation study was carried out between weather variables prevailed during (P_1) to (P_5) growth stages of different varieties under different sowing dates. The correlation coefficient showing degree of association between seed yield and weather variables prevailed during phenophases of green gram crop are presented in Table 4.14 The data revealed that during sowing to germination stage (P_1), minimum temperature and rate of evaporation showed negative association. During germination to bud emergence stage (P_2), maximum temperature, mean temperature and evaporation showed significant positive association whereas rainfall, RH-I, RH-II and RH mean showed negative association. During bud emergence to flower emergence stage (P_3) maximum temperature, mean temperature and wind speed showed significant positive association and evaporation rate showed highly positive significance. Whereas rainfall, rainy day, morning relative humidity and mean relative humidity showed negative association. During flower emergence to pod emergence stage (P_4), morning relative humidity and mean relative humidity showed positive association whereas maximum temperature showed negative association and evaporation rate and bright sun shine hours showed highly negative association. During pod emergence to harvest stage (P_5), evaporation rate, bright sun shine hours and wind speed showed significant positive association.

Table 4.14 Correlation coefficient between weather parameters and yield of green gram

WEATHER PARAMETERS	P1	P2	P3	P4	P5
Rainfall (mm)	-0.102	-0.663*	-0.665*	-0.271	-0.420
Rainy days	-0.221	-0.597	-0.661*	0.211	-0.272
T max (^{0}C)	-0.325	0.698*	0.624*	-0.727*	0.386
T min (^{0}C)	-0.605*	0.500	0.373	0.450	0.433
T mean	-0.511	0.630*	0.672*	-0.123	0.486
R.H.-I. (%)	0.536	-0.712*	-0.692*	0.685*	-0.443
R.H.-II (%)	0.071	-0.762**	-0.499	0.585	-0.345
R.H. Mean (%)	0.276	-0.757**	-0.608*	0.636*	-0.394
EVP (mm)	-0.691*	0.663*	0.769**	-0.743**	0.651*
B.S.S. (hrs day^{-1})	0.039	0.601	-0.035	-0.738**	0.676*
W.V. (kmph)	-0.320	0.500	0.640*	0.293	0.698*

* Significant at 5% ** Significant at 1%

P_1 : Sowing to Germination

P_2 : Germination to Bud emergence

P_3 : Bud emergence to Flower emergence

P_4 : Flower emergence to Pod emergence

P_5 : Pod emergence to Harvest

CHAPTER-V

SUMMARY AND CONCLUSION

A field investigation entitled "Influence of dates of sowing on *kharif* green gram varieties under varied weather condition" was carried out at Department of Agricultural Meteorology, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *kharif* season of 2015.

The experiment was laid out in a split plot design where in main plots were assigned to three sowing dates and sub-plots to four varieties of green gram, with twelve treatment combinations and three replications.

The gross and net plot size of the experiment was 4.5 x 4.0 m and 3.9 x 3.6 m, respectively. Sowing was done by adopting dibbling method on 23rd June, 30th June, and 07th July, 2015 for D_1, D_2, and D_3 respectively at a spacing 30 cm x 10 cm and the varieties used were, BPMR-145, BM-2002-1, BM-2003-2 and BM-4. The recommended dose of fertilizer (RDF), 25:50:00 NPK kg ha^{-1} were applied at the time of sowing.

The recommended cultural practices and plant protection measures were under taken as per requirement of crop.

To evaluate the treatment effect, the various growth observations were recorded in the experiment from 20 DAS up to the harvest at an interval of 20 days, while the observations on yield attributing characters and post harvest studies were recorded at respective stages. The crop was harvested at the maturity stage on 02nd September, 12th September, and 23rd September 2015 for D_1, D_2, and D_3 sowing dates, respectively.

Important findings emerged from the present investigations are summarized below, with conclusion.

Weather variables affect crop growth differentially at different growth stages and whole life cycle. Effect of weather variables on different phenophases of green gram is important for deciding the critical growth stages with following objectives.

1) To study the effect of dates of sowing on green gram varieties.

2) To work out the correlation between yield of green gram and weather parameters.

5.1 To study the effect of dates of sowing on green gram varieties.

The plant height was observed significantly highest in first sowing date i.e. D_1 (25 MW) 36.99 cm at harvest than other date of sowing at all stages of crop growth except in $D_{3.}$ However, in D_2 (26 MW) sowing dates shows results of plant height was obtained secondly with D_1 at all the growth stages of crop. Lowest plant height was recorded in D_3 (27 MW) during all growth stages of crop.

The mean number of functional trifoliate leaves per plant was observed significantly highest in first date of sowing i.e. D_1 (25 MW). While, D_2 (26 MW) was second date of sowing at 20, 40 and 60 DAS and at harvest. While, among varieties it was recorded significantly highest in V_3 (BM-2003-2) at all the growth stages of crop over other varieties.

Among sowing dates significantly higher dry matter was observed in sowing D_1 (25 MW) at all growth stages than other date of sowing dates and Among four varieties significantly highest dry matter was observed in V_3 (BM-2003-2) at all the growth stages i.e. at 20 DAS, 40 DAS, 60 DAS and at harvest than other three varieties i.e. V_1 (BM-4), V_2 (BM-2002-1) and V_4 (BPMR-145).

The mean number of pods per plant was observed significantly highest in first date of sowing i.e. D_1 (25 MW) i.e. 11.40 number of pods per plant and lowest at D_3 (27 MW) i.e. 8.07 pods per plant. While, among varieties it was recorded significantly highest in V_3 (BM-2003-2) i.e. 14.38 pods per plants and lowest in V_4 (BPMR-145) i.e. 6.46 pods per plants.

Test weight (g) was found to be significant. D_1 (25MW) date of sowing recorded significantly more in mean hundred seed weight than other date of sowing and lower in D_3 (27 MW). Among varieties V_1 (BM-2003-2) found to be significantly superior (46.1 gm) in mean hundred seed weight than other varieties. While, it was lower in V_4 (33.8 gm).

Seed yield was recorded significantly highest first sowing date D_1 (25 MW) i.e. 524 kg ha^{-1} and lowest seed yield was observed in third date of sowing D_3 (27 MW) i.e. 331 kg ha^{-1}. D_1 was significantly superior over D_2 i.e. 546 kg ha^{-1}. While amongst the four varieties highest seed yield Kg per ha^{-1} was observed in variety V_3 (BM-2003-2) i.e. 510 kg $ha^{-1}$and it was recorded significantly superior yield over all the other varieties while, lowest in V_4 (BPMR-145) i.e. 346 kg ha^{-1}.

Among the sowing dates second sowing date D_1 (25 MW) significantly highest straw yield was recorded i.e. 1248 kg ha^{-1} and lowest in D_3 954 kg ha^{-1}. While, amongst the varieties and it was observed that straw yield highest in V_3 (BM-2003-2) i.e. 1254 kg ha^{-1} and lowest recorded in V_4 (BPMR-145) i.e.959 kg ha^{-1}.

Significantly highest biological yield was recorded in D_1 (25 MW) i.e. 1772 kg ha^{-1}) and lowest in D_3 (27 MW) i.e. 1285 kg ha^{-1}. While amongst varieties highest biological yield was observed in variety V_1 (BM-2003-2) i.e. 1763 kg ha^{-1}) and lowest in V_4 (BPMR-145) i.e. 1304 kg ha^{-1}.

Data on harvest index showed that there was no any significant effect of sowing dates on harvest index. The highest harvest index was observed (29.46) by the sowing at D_1 (23rd June).

5.3 To workout correlation between green gram yield and weather parameters.

Correlation between weather parameter and yield of green gram showed that significantly negatively correlated at P2 and P3 stage. While, no correlation was fond during P_1, P_4, and P_5 respectively.

The correlation between rainy days and different phenophases of green gram showed that rainy days are significantly positively correlated at P_4 stage. While, it was negatively correlated at P_3 (-0.661) and significantly negatively correlated at $P_{1,}$ $P_{2,}$ P_5 stage.

Maximum temperature (Tmax) shows significantly positively correlated at P_2, P_3 and P_5. While, it was negatively significantly correlated at P_1 and at P_4 stage (-0.727).

Minimum temperature (Tmin) shows significantly positively correlated at $P_{2,}$ P_3, P_4 and $P_{5.}$ While, it was significantly negatively correlated at P_1 stage.

Morning relative humidity (RH-I) was significantly positively correlated at P_1, and $P_{4.}$ While, it was significantly negatively correlated at P_2, P_3 and P_5 stage.

Afternoon relative humidity (RH-II) was significantly positively correlated at P_1 and P_4 stage. While, it was showed significantly negatively correlation at P_3 and P_5 stage and it was highly significantly negatively correlated at P_2 (-0.762).

Mean relative humidity (RH-II) was significantly positively correlated at P_1 and P_4 stage. While, it was showed significantly negatively correlation at P_3 and P_5 stage and it was highly significantly negatively correlated at P_2 (-0.757).

Evaporation was significantly positively correlated at P_2 and P_5 stage and it was highly significantly positive correlation at P_3 (0.769) stage. While, it was significantly negatively correlated at P_1 stage and highly significantly negatively correlated at P_4 (-0.743).

Bright sunshine hours (BSS) were significantly positively correlated at $P_{2,}$ $P_{1,}$ and P_5 stage. It was negatively significantly correlated at P_3 stage and highly significantly negatively correlation at (-0.738) stage.

Wind speed (W.S.) showed significantly positively correlation at $P_{2,}$ $P_{3,}$ P_4 and P_5 stage. Wind speed was significantly negatively correlated at P_1 stage (-0.320).

CONCLUSIONS:

On the basis of the field experimentation for a season, it could be concluded that,

1. Among different sowing dates sowing at D_1 25 MW (23rd June) was found significantly superior in respect of seed yield (524 kg ha^{-1}) over D_2 26 MW (30 June) and D_3 27 MW (07 July) sowing dates and among four green gram varieties BM-2003-2 produced significantly higher seed yield (510 kg ha^{1}) which over BM-2002-1, BM-4 and BPMR-145.
2. Significant positive correlation was found with seed yield during the phenophases P_2 (Tmax., Tmin., Evaporation), P_3 (Tmax., Tmin., Evaporation and Wind speed), P_4 (RH-I, RH-II) and P_5 (B.S.S. Evaporation and Wind speed).

However, the results are based on one year experimentation and require further confirmation to draw sound conclusion.

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