# Performance of Bell pepper (*Capsicum annuum* L.) varieties under different planting dates

A
Thesis submitted to the
Uttar Banga Krishi Viswavidyalaya
In partial fulfillment of the requirements for the award of the
Degree of Master of Science (Horticulture)

**In**

**VEGETABLE AND SPICE CROPS**

***By***

***Sagar Koner***

**DEPARTMENT OF VEGETABLE AND SPICE CROPS**
**FACULTY OF HORTICULTURE**
**UTTAR BANGA KRISHI VISWAVIDYALAYA**
**PUNDIBARI, COOCH BEHAR, WEST BENGAL**
**2013**

**DEDICATED TO**

**MY BELOVED MAA**

**AND BABA**

**DEPARTMENT OF VEGETABLE AND SPICE CROPS**
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# CERTIFICATE

*This is to certify that the work recorded in the thesis entitled "**Performance of Bell pepper (Capsicum annuum* **L.***) varieties under different planting dates**", submitted by Mr. Sagar Koner in partial fulfillment of the requirements for the degree of M.Sc. in Vegetable and Spice Crops to be conferred by Uttar Banga Krishi Viswavidyalaya, is the faithful and bonafide research work carried out under my personal supervision and guidance. The results of the investigation reported in the thesis have not so far been submitted for any other Degree or Diploma. The assistance and help received from various sources during the course of investigation have been duly acknowledged.*

**(Dr. Ranjit Chatterjee)**
**Chairman**
**Advisory Committee**

# Approval sheet

## APPROVAL OF EXAMINERS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE (HORTICULTURE) IN VEGETABLE AND SPICE CROPS

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We, the undersigned, having been satisfied with the performance of the student Mr. Sagar Koner, M.Sc. (Hort.), Department of Vegetable and Spice Crops in the Viva-Voice examination on final evaluation of thesis conducted today, the 19th August, 2013, recommend that the thesis be accepted for the award of the degree of M.Sc. in Vegetable and Spice Crops.

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| **Degree to be awarded** | **:** | Master of Science (Horticulture) in Vegetable & Spice Crops |
| **Year of Award of Degree** | **:** | 2013 |
| **Total pages in Thesis** | **:** | 41 |


## ABSTRACT

Bell pepper is a high value luxury vegetable belongs to family solanaceae. The prolong winter and high water table of terai region encourages cultivation of bell pepper during winter months. However, delayed planting and wrong selection of varieties results in inconsistent yield and poor return from bell pepper cultivation. The present investigation was designed to study the impact of temperature stress on growth and yield performance of bell pepper varieties and to identify most suitable bell pepper variety(s) for different transplanting dates. The experiment was laid out in split plot design with 3 replications, 3 planting dates ($15^{th}$ November, 30th November, $15^{th}$ December) as main plot treatments and 4 varieties (Mekong, California Wonder, JK Peeyali and Asha) were allotted in sub plots. The observations were recorded on different horticultural characters. The experimental findings revealed that $30^{th}$ November transplanting recorded maximum leaf area, maximum leaf chlorophyll, maximum number of fruits per plant, maximum fruit weight, maximum yield per plant and per hectare along with maximum β-carotene content. Whereas, $15^{th}$ November transplanting resulted in maximum plant height, maximum TSS content and maximum vitamin C content. The results further showed that delayed transplanting ($15^{th}$ December) minimum days to flowering and first fruit harvesting. The interaction effect showed that bell pepper variety Mekong transplanted on $30^{th}$ November proved its superiority in respect of growth and yield characters of bell pepper and resulted in many fold improvement in the form of higher number of fruits per plant, higher yield per plant and per hectare as compared to other varieties It may be concluded that for successful bell pepper cultivation in terai zone of West Bengal, $30^{th}$ November transplanting is ideal. The variety Mekong emerged as best performer and hence may be selected for mid and late transplanting ($30^{th}$ November and $15^{th}$ December) and Asha for mid season transplanting ($30^{th}$ November) where as California Wonder for early transplanting ($15^{th}$ November) for large scale bell pepper cultivation in this region. Again for sequential planting preference should be given to the hybrid varieties over open pollinated varieties.


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**Signature of Chairman, Advisory Committee** **Signature of the student**

# Acknowledgement

*Above all, I am very grateful to my Maa and Baba who always with me in all my steps and helped me to complete this thesis work.*

*I express my deepest sense of gratitude to my revered teacher Dr. Ranjit Chatterjee, Assistant Professor, Department of Vegetable and Spice Crops, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya for suggesting the problem, affectionate guidance, sustained interest and constant encouragement throughout the course of investigation and painstaking help during the preparation of this manuscript. Without his support, it would have been difficult to complete my work on time.*

*It is pleasure on my part to acknowledge the debt I owe to Dr. J.C Jana, Head, Department of Vegetable and Spice Crops, Faculty of Horticulture, Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar for his never ending inspiration for accomplishment of the work.*

*I am extremely grateful to esteemed members of my Advisory Committee, Dr. Suchand Datta, Dr. S. Bandyopadhyay and Dr. P.K. Pal for their valuable suggestion, affection and blessing showered upon me which filled my heart with hope and zeal and encouraged me to carry on the works.*

*A plethora of thanks is extended to my beloved teachers of the university Dr. Partha Choudhuri, Dr. N. Bhowmick and Dr. S. S. Gantait.*

*Sincere thanks are also extended to all the non-teaching staffs of the Dept. of Vegetable and Spice Crops and Library staffs for their help and cooperation during my study.*

*I express my lot of thanks to my well wisher and friends Siddikul, Debojit, Sandip da, Dipika di and Kishore da for their sincere co-operation during the period of my experiment and writing of this manuscript.*

*At last, I want to pay hearty gratitude to my Boro kaku, Boro kakima, Payel didi, Rahul da and Moumita for their sacrifice and moral support throughout my study.*

*Has someone been overlooked in mentioning here, please know that your contribution is well appreciated!*

*In thanking all these people, I must emphasize that I am fully responsible for any shortcoming that remains.*

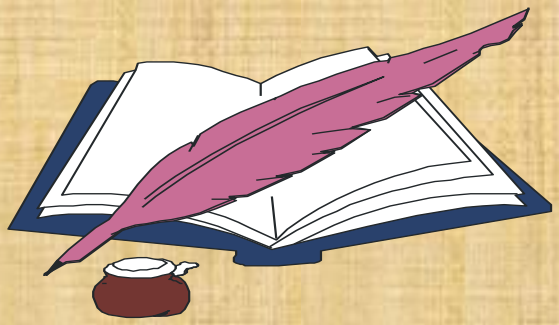
*Dated.....2013* .....

*Pundibari, Cooch Behar.* (Sagar Koner

# List of tables

# list of Figures

# list of plates



# INTRODUCTION

# INTRODUCTION

Bell pepper or sweet pepper or capsicum (*Capsicum annuum* L.) is a high value luxury vegetable belongs to the family solanaceae. Bell pepper is native to Tropical South America. Most of the peppers cultivated in temperate and tropical areas belong to the botanical species *Capsicum annuum*, thought to originate in Mexico and Central America (Andrews, 1984). The species *annuum* includes eleven groups (Farris, 1988) which can be divided into two subgroups (Sweet and hot peppers). The sweet pepper is relatively non-pungent with thick flesh and it is the world's second most important vegetable after tomato (AVRDC, 1989).

Bell pepper is used as either green or red and may be used as cooked or raw as well as in salad. It is also used in pickling in brine, baking and stuffing. The leaves are also consumed as salad, soup or eaten with rice (Lovelook, 1973). Bell pepper occupies a pride of place among vegetables in Indian cuisine because of its delicacy and pleasant flavour coupled with rich colours (green, red, yellow etc.). The high market price it fetches is attributed to the heavy demand from the urban consumers as well as from star hotels in metropolitan cities and export market. It was also discovered to be a good source of medicinal preparation for black vomit, tonic for gout and paralysis (Knott and Deanon, 1967).

Bell pepper has a little energy value. But, the nutritive value of bell pepper is high as it contains 1.29 mg protein, 11 mg calcium, 0.06 mg thiamine, 0.03 mg riboflavin, 0.55 mg niacin per 100 gm edible fruit (Joshi and Singh, 1975). Also, the fruit is rich in nutritional substances especially in vitamin-A (683 mg/100 gm fresh weight) and vitamin-C (321 mg/ 100 gm fresh weight) which act as potential antioxidants. According to Hazra *et al.* (2011), the flavonoids present in red pepper particularly quercetin, kaempferol, myricetin and luteolin are responsible for induction of enzymes that detoxify carcinogens.

Bell pepper is extensively cultivated in Europe and America. However, in India, the cultivation is restricted to Himachal Pradesh, Karnataka, Maharashtra and hilly areas of Uttar Pradesh and Tamil Nadu. Bell pepper is highly sensitive to environmental stresses and the yield is affected significantly. High temperature reduces fruit set in bell pepper (Erickson and Markhart, 2001). High day temperature (20-24$^0$C) along with low light intensity (30 percent shade) or higher night temperature (24$^0$C) prompted flower drop in bell pepper (Rylski and Halevy, 1974). During high temperature certain physiological changes occur within the plant

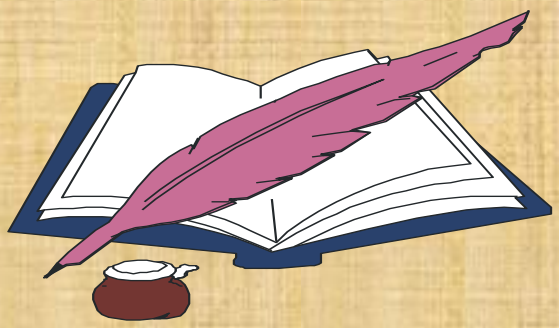
system like decrease in sugar content and lower enzymatic activities which encourage abnormal pollen and anther development, resulting in decrease in pollen viability, pollen tube growth and abortion in buds, flowers and young fruits (Turner and Wien, 1994). Selection of varieties is an important criterion for commercial cultivation of bell pepper and varieties responded differently under stress situation.

Bell pepper is highly sensitive to thermal stress. The optimum temperature favourable for growth of sweet pepper ranges between 20 and 25°C. When temperature falls below 15°C or exceeds 32°C, growth is usually retarded and yield decreases. Shaked *et al*. (2004) found that the temperatures below $10^0$C decrease the fruit size which is due to inefficient pollination and fertilization as a result fruit size reduced and malformation occurs in fruits. However, day temperature of $24^0$C and $15^0$C night temperature are ideal for maximum pollen viability and fruit set compared to 18-$24^0$C night temperature range. Field and controlled environment observations of pepper production indicated that substantial abortion of floral buds occurs when day temperatures are ≥ 34°C and/or night temperatures are ≥ 21°C for extended periods of time (Cochran, 1936). It has been reported that proline content of the sensitive genotypes decreased under high temperature conditions compared to low temperature and the heat tolerant variety produced higher quantity of proline in leaf under high temperature conditions.

Optimum sowing date is an important and uncontroversial factor for maximizing the yield of a crop. Selection of varieties also played significant role for growth and yield of bell pepper. The prolong winter and high water table of terai region encourage cultivation of bell pepper during winter months. However, delayed planting and wrong selection of varieties result in inconsistent yield and poor return from bell pepper cultivation.

Attempt to alleviate the fluctuations in fruit set under different temperature regime has not been taken for terai zone. Considering the tremendous potential of bell pepper in domestic and foreign market the present study is formulated with the following objectives.

i) To access the impact of temperature stress on growth and yield performance of bell pepper varieties.
ii) To identify the optimum planting time of the selected varieties for terai region.
iii) To study the yield variation by different varieties under different temperature regime.
**iv)** To identify most stable performed bell pepper variety(s) for different transplanting dates.



# REVIEW OF LITERATURE

# REVIEW OF LITERATURE

## 2.1 Effect of planting date on growth and yield of bell pepper

Alam *et al*. (2011) of Bangladesh conducted an experiment about the effect of sowing time and plant spacing on the yield and yield attributes of sweet pepper (*Capsicum annuum*). An experiment was carried out at the olericulture field of Horticulture Research Centre of BARJ, Joydebpur, Gazipur during September, 2006 to April, 2007 to investigate the yield and yield attributes of sweet pepper as influenced by plant spacing and sowing time. There were altogether twenty one treatments comprising seven sowing dates viz. 1$^{st}$ September, 15$^{th}$ September, 1$^{st}$ October, 15$^{th}$ October, 30$^{th}$ October, 15$^{th}$ November, 30$^{th}$ November and three spacings viz. 50 cm × 50 cm, 50 cm x 40 cm and 50 cm × 30 cm. They found that the experiment showed that majority of the yield and yield components significantly varied with variation of spacing and sowing time. They suggested that the highest yield (19.36 t/ha) of fruit was recorded from the earlier sowing (1$^{st}$ October) with the closest spacing (50 cm x 30 cm).

Cebula (1992) of Canada conducted an experiment about the effect of planting dates on capsicum cv. Red Gold under glasshouse. Six planting dates at fortnightly intervals between 22$^{nd}$ or 29$^{th}$ November and 2$^{nd}$ or 6$^{th}$ February were studied for two years. The result showed that earlier planting took longer period for fruiting where as late planting shortened the harvesting time. However, late planting decreases total yield but the yield differences between the first and fifth planting dates did not exceed 24%. He suggested mid March as the most favourable time for planting of capsicum cv. Red Gold under glasshouse condition.

Cebula (1995) of Poland conducted a field experiment in plastic tunnels using six bell pepper cultivars for two years. Plantings were done in late April or early May in each year. They found that planting in late April results in early fruiting, higher fruit weight (310 and 255 gm, respectively) and highest marketable yield (7.66 and 7.20 kg/m$^2$) respectively for the hybrid cultivars Oasis and Spartacus.

Russo (1995) of USA conducted a field experiment on sequential monthly plantings of bell pepper from May to July and recorded maximum fruit yield of 20.6-20.7 t/ha from mid May planting where as 2.8-8.6 t/ha from July planting. He also observed that sequential monthly plantings increased the cumulative marketable yields (39.5 t/ha) over single planting.

Russo (1996) of USA studied the effect of planting date, fertilizer rate and number of harvest on Jalapeno and banana peppers (*Capsicum annuum* L.). Seedlings of the Jalapeno variety Mitla and banana pepper variety Sweet Banana 504 were transplanted with recommended fertilizer and higher fertilizer rate during April and July, 1995. Significant higher yields were produced from the July planting of both cultivars in combination with once harvesting over three times harvesting. The recommended rate of fertilizer increased the yield of Sweet Banana 504 but Mitla variety recorded higher yield under higher fertilizer rate.

Bevacqua and Vanleeuwen (2003) of Mexico reported that pepper yield was highly variable and was strongly influenced by different weather parameters. They evaluated pepper varieties on six planting dates, i.e., 13$^{th}$, 20$^{th}$, 27$^{th}$ March and 3$^{rd}$, 10$^{th}$ and 17$^{th}$ April, 2001. The results indicated that planting date had a significant effect on crop performance. The best stand establishment and the highest yield were associated with the earliest planting date (13$^{th}$ March).

Taber (2003) studied the response of bell pepper varieties to planting dates at Ames and Muscatine of USA. He observed that 11$^{th}$ June planting date recorded five harvests with maximum fruit weight (7.1 ounce) compared to four harvests from 22$^{nd}$ May planting date and only three from the 26$^{th}$ June planting date. 22$^{nd}$ May and 26$^{th}$ June plantings were at per in fruit production. Fruit weight from the 3$^{rd}$ planting was only 2 ounces due to high day temperatures from 16$^{th}$ August to 28$^{th}$ August.

Islam (2007) of Bangladesh studied the effect of sowing date on growth and yield of sweet pepper cv. California Wonder. Plants were raised at seven sowing dates out of which earlier sowing (1$^{st}$ October) emerged as best in terms of more number of fruits (8.69/plant) and maximum fruit yield (16.33 t/ha) compared to later sowing (30$^{th}$ Nov) with minimum number of fruits ( 3.48/plant) and yield (7.19 t/ha).

Hamma *et al.* (2012) of Nigeria conducted an experiment to study the effect of planting dates and spacing on the growth and yield of sweet pepper. They found that significant increases in most of the growth and yield parameters per plant were obtained from first planting date (20$^{th}$ August of 2010 and 2011) at 60cm spacing. Whereas, lower growth and yield was observed on 4$^{th}$ planting date (1$^{st}$ October 2010 and 2011) at 15cm spacing.

**2.2 Effect of genotypes on growth and yield of bell pepper**

Stofella *et al.* (1995) of Florida, USA conducted an experiment to assess the yield and fruit size among bell pepper cultivars. They observed that fruit production stability differs among

bell pepper cultivars and the cultivars Super Sweet 860, Whopper Improved and Ranger were stable for mean marketable fruit weight and fruit size where as Super Sweet 860 and Whopper Improved were stable for mean fruit size.

Buczkowska and Bednarek (2005) of Poland conducted an experiment to evaluate the yield of two sweet pepper cultivars in the field in relation to temperature conditions. They found a positive correlation between the sum of effective air temperature of the June-September period and the early marketable yield for both the cultivars.

Kowalczyk and Zielony (2007) of Poland studied the effect of environment factors on hybrid cultivars of sweet pepper (Alberto, Barbadillo, Pilot and Toro). The plants were grown on rockwool. The environment conditions during cultivation were monitored for different microclimate parameters for fourteen days before dates of harvest. The early fruit harvest at high temperature, radiation, EC in root zone and low air humidity recorded higher content of dry matter, SSC and mineral components such P and K than the late harvest. The same fruit had far less vitamin C and total sugars than late harvest.

Pevicharova *et al*. (2007) of Bulgaria evaluated fifteen Kapya type pepper (six varieties and nine breeding lines) for dry matter, ascorbic acid and total sugars in ripe maturity stage during 2002 and 2003. Significant differences for chemical components between the cultivars were observed and the cultivars Kapya UV, Slonovo Uvo, Kapya Novi Sad, Sofiyska Kapya and Lines 669/02 and 715/02 had recorded highest ascorbic acid content. However, climatic conditions influenced strongly on the quantity of ascorbic acid and weakly on the total sugars content of the fruits.

Juroszek and Tsai (2009) of Taiwan evaluated six sweet pepper genotypes under two environmental conditions (hot-wet season and cool-dry season) under organic farming. The result revealed that high total (44.6-55.7 t/ha) and marketable yields (36.9-45.6 t/ha) were recorded during the hot-wet season ($7^{th}$ March, 2007 to $30^{th}$ July, 2007) compared to 25.4-45.7 t/ha total yield and 21.1-37.8 t/ha marketable yields for cool-dry season ($27^{th}$ November, 2007 to $7^{th}$ April, 2008). The low yield during cool dry season probably because of reduced fruit set due to late planting date in November and relatively low air temperature.

Todorova *et al*. (2009) studied the association between cultivar performance for morphologic traits and agrometeorological factors in Bulgarian pepper during 1984-2000 in Plovdiv, Bulgaria. Seven Bulgarian pepper cultivars namely ‘Sivriya 600’, ‘Hebar’, ‘Stryama’,

'Kurtovska Kapiya 1619', 'Sofiyska Kapiya', 'Kalinkov 800/7' and 'Maritsa' were studied on phenological development. In most of the established high dependencies (75% of the cases) the pericarp thickness and fruit weight were in close relation with agro meteorological factors. Negative correlation between the pericarp thickness and rainfalls during the whole harvesting period was found in 'Sofiyska Kapiya', 'Maritsa' and 'Kalinkov 800/7'. Positive correlation ($r > 0.7$) was determined between the fruit weight and the active temperatures from transplanting to first harvesting in 'Hebar', 'Sivriya 600' and 'Sofiyska Kapiya'.

Omonijo and Afuye (2009) of Nigeria studied the effect of climatic factors on fruit yield of different pepper groups. This study examined the quantitative response of three different types/species of pepper fruit yield to five environmental climatic parameters (rainfall, evaporation, temperature, relative humidity and sunshine duration) from year 2000 to 2006. The results showed that the medium corrugated fruited hot pepper 'Rodo' has the highest mean yield (750 $g/m^2$), followed by the small fruited chilli pepper 'Shombo' (691 $g/m^2$) and large fruited sweet pepper 'Tatashe' (578 $g/m^2$). Five climatic indices mentioned above were significantly correlated with yield of pepper at different probability level. Multiple regression showed that evaporation contributed 32.8% and rainfall (20.2%) to the yield of large fruited sweet pepper 'Tatashe'. All the climatic variables explained 94% of yield variation in medium corrugated fruited hot pepper 'Rodo' while the five climatic variables combined accounted for 97.7% of the variation in yield of small fruited chilli pepper 'Shombo'.

Saha *et al.* (2010) studied the effect of high temperature stress on the performance of 12 bell pepper genotypes in Taiwan. The results revealed that high temperature reduced the fruit set percentage as well as size of fruit. Maximum fruit weight (125 gm) was recorded at $24/18^0C$ compared to 103.80 gm at $29/23^0C$. They suggested that heat tolerance line produced higher amount of proline in expressing the heat tolerant capability of sweet pepper genotypes.

Vazquez-Garcia *et al.* (2010) of Mexico studied the fruit quality attributes and shelf life of nineteen Serrano group pepper cultivars. Cultivars varied in fruit weight, diameter, length, firmness, color (chroma and tone or hue angle) and physiological weight loss. Fruits from 'Bandido' and 'HMX-5651' cultivars were the largest and had the highest colour intensity, while 'HMX-6671' 'HMX-6661', 'Blakie', 'HS-44' produced fruits of intense colour. 'Centauro' fruits had the highest firmness. Cultivars 'HS-49', 'HS-51', '21-20-1' and '74-5-5' registered high

values of firmness combined with low percentage of weight loss. Cultivars '74-27-5', 'Tampiqueno 74' and '33-12-2' also had low weight losses.

Nkansah *et al.* (2011) of Ghana conducted an experiment on morphological and yield evaluation of some sweet pepper lines in two agro-ecological zones (forest zone and coastal savanna). The results indicated that Line ICPN16-7 recorded the highest yield at two ecological zones and Legon-8 had the lowest yield. Lines ICPN16-7, 4, 3, 6, 10 and 8 recorded very high yields above 20 t/ha. The trial also showed that yield from the forest zone was higher compared to coastal savanna zone.

**2.3 Effect of environmental factors on growth and yield of bell pepper**

Rylski and Spigelman (1982) studied the effect of temperature on fruit set of sweet pepper. They found that reduced fruit set is common when day temperatures are above $32^{o}$C. As, high temperature affects pollen development resulting in production of nonviable pollen grains which fail to set fruits. Sometimes, fruit set doesn't occur as flowers did not shed pollen grains.

Aloni *et al.* (1991) studied the effect of heat stress on abscission of bell pepper flowers. They found that reduction in fruit set at high temperature was associated with decreased concentrations of reducing sugars in flower buds and flowers that may results higher flower drop under high temperature condition.

Marcelis (1992) stated that bell pepper showed a cyclic growth pattern where periods of high fruit set and slow fruit growth alternate with periods of low fruit set and rapid fruit growth. Extreme weather conditions results failure of pollination and induce abscission of flowers.

Bhatt and Rao (1993) of India studied the effect of night temperature on photosynthesis rate, growth, flower and fruit setting patterns in two bell pepper cultivars viz. Arka Mohini (determinate type) and Arka Basant (indeterminate type). Two varieties were grown at two different night temperatures. The result showed that photosynthesis rate and growth were higher at high night temperature ($27/22^{0}$ C day/night) than at low night temperature ($27/17^{0}$ C) in both cultivars. The flower and fruit numbers were higher in the plants grown at $27/17^{0}$ C than at $27/22^{0}$ C.

Rylski and Aloni (1994) conducted an experiment to study the effect of different environmental conditions on flowering, fruit set, fruit development and fruit quality of pepper and tomato crops. At temperatures below $10^{0}$ C, fruit size decreases due to inefficient pollination and fertilization that causes a reduction in fruit length and causes fruit malformation. However,

at a day temperature of $24^0$ C, pollen viability and fruit set are higher at $15^0$ C than 18-$24^0$ C night temperature.

Erickson and Markhart (2001) of USA studied the effect of higher temperature on bell pepper flower and fruit production. They observed reduction in fruit set at high temperature, which is due to decreased flower bud production, increased flower bud abscission and increased mature flower abscission.

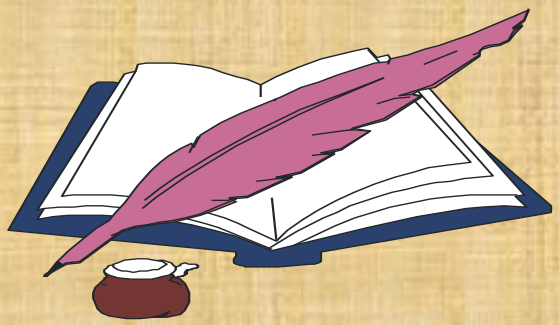
Erickson and Markhart (2002) of USA studied the effect of high temperature on flower development in bell pepper. They observed that high temperature inhibits the development of pollen grains. The duration of high temperature exposure and the developmental stages of flowers exposed are important factors in fruit set of bell pepper. Exposure to high temperatures during pre-anthesis stage does not cause injury to either the female or male organs of the flower. Instead, high post-pollination temperature results in inhibition of fertilization or early fruit development occurs after pollination and is responsible for the reduction of fruit set during the period between anthesis and fruit development.

Shaked *et al*. (2004) studied the impact of temperature on flower and fruit set of bell peppers. They found that at the temperatures below $10^0$ C, the fruit size decreases due to inefficient pollination and fertilization. As a result, fruit size reduces and malformation occurs in fruits. However, at a day temperature of $24^0$ C and $15^0$ C night temperature are ideal for maximum pollen viability and fruit set compared to 18-$24^0$ C night temperature range.

Taskovics *et al.* (2010) of Romania studied the effect of some environmental factors on the growth of sweet pepper cv. Ho F1. They observed that fruit development depends on the light intensity and the temperature of the growing season. Fruit growth is also influenced by the variation in maximum and minimum temperature. The ideal temperature for fruit development is 18–$20^0$ C. Under high temperature condition, the internodes become short, fruit set becomes poor and less developed fewer fruits are produced. The vegetative phase becomes longer and the bloom and harvest got delayed.

Thanopoulos *et al.* (2013) of Greece studied the impact of season on the growth and maturation of bell peppers. Three bell pepper cultivars (Yolo Wonder, California Wonder and E84066) were grown in an unheated greenhouse during summer and autumn season. Fruit size, fresh weight and fruit volume were higher in the autumn due to increased fruit length and pericarp weight. However, colour transition from green to red was significantly delayed in the

autumn and the vitamin C concentration was also lower than in the summer. Differences between growing seasons (summer and autumn) led to an increase in fruit size (fresh weight and volume) in the autumn, which resulted from an increase in fruit length and pericarp weight. However, the colour transition from green to red was significantly delayed in the autumn and the vitamin C concentration was greatly reduced compared to the corresponding fruit in the summer. They concluded that the growth and size of bell pepper fruits are highly influenced by air temperature, daylight and relative humidity particularly during anthesis, fruit set, fruit development and maturation stages.



# MATERIALS & METHODS

# MATERIALS AND METHODS

## 3.1 Experimental site

The field experiments were conducted at Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar and West Bengal, India. The place is situated in terai region of West Bengal at 26° 19′ N latitude and 89° 23′ E longitude at an elevation of 43 meters above mean sea level.

**Table 1. Meteorological parameters during the period of field experiment**

| Parameters | November | | December | | January | | February | | March | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2011 | 2012 | 2011 | 2012 | 2012 | 2013 | 2012 | 2013 | 2012 | 2013 |
| Rainfall (mm) | 0.95 | 0.00 | 0.81 | 0.00 | 0.35 | 0.00 | 2.38 | 6.80 | 3.55 | 0.60 |
| Temperature ($^0$C) | | | | | | | | | | |
| Maximum | 27.25 | 29.13 | 23.80 | 24.32 | 21.15 | 23.71 | 25.02 | 28.39 | 29.14 | 32.10 |
| Minimum | 15.17 | 13.33 | 11.82 | 11.20 | 9.60 | 7.32 | 10.86 | 11.93 | 15.20 | 16.65 |
| Relative humidity (%) | | | | | | | | | | |
| Maximum | 98.93 | 81.97 | 98.84 | 92.55 | 98.87 | 92.10 | 99.00 | 78.64 | 93.61 | 55.39 |
| Minimum | 51.90 | 78.57 | 56.19 | 86.61 | 57.45 | 76.16 | 46.48 | 55.54 | 37.10 | 38.16 |

**Source: Meteorological Station, Department of Agriculture, Govt. of W.B., Coocbehar**

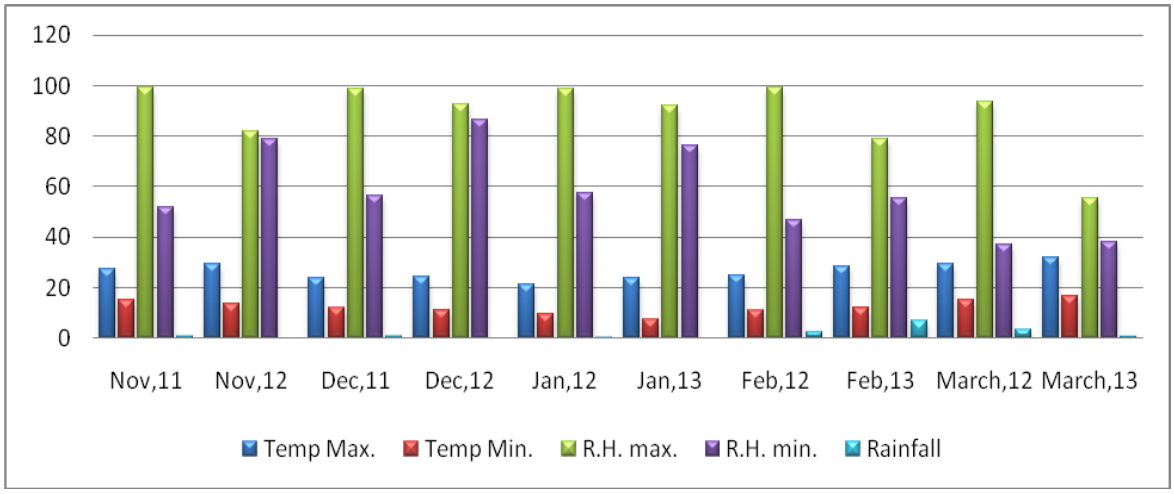



**Fig. 1. Graphical representation of meteorological parameters during the period of field experiment.**

**Table 2. Chemical properties of experimental soil**

| Particulars | 2011-12 | 2012-13 | Method employed |
|---|---|---|---|
| $P^H$ | 5.78 | 5.90 | pH meter (Baruah and Barthakur, 1997) |
| Organic Carbon (%) | 0.82 | 0.89 | Rapid titration method (Walkley and Black, 1934) |
| Available Nitrogen (kg per hectare) | 172.12 | 182.64 | Modified Macro Kjeldahl method (Jackson, 1967) |
| Available Phosphorus (kg per hectare) | 20.11 | 21.38 | Bray's No. I Method (Jackson, 1967) |
| Available Potassium (kg per hectare) | 122.80 | 157.92 | Flame photometer method (Jackson, 1967) |

### 3.2 Experimental Details:

**3.2.1** **Title:** Effect of planting dates and varieties on bell pepper (*Capsicum annuum* L.)

**3.2.2** **Crop period**: November to February of 2011-12 and 2012-2013
(Transplanting was done on 15th November, 30th November and 15th December for both the years).

**3.2.3** **Number of treatments**: 12.

**3.2.4** **Experimental design**: Split plot.

**3.2.5** **Replications**: 3

**3.2.6** **Spacing**: 60 cm x 60 cm.

**3.2.7** **Plot size**: 3 m x 3 m.

**3.2.8** **Recommended Fertilizer Dose:** 120: 60: 60 N, $P_2O_5$ and $K_2O$ kg/ha.

**3.2.9** **Farm Yard Manure (FYM):** 15 t/ha.

**3.2.10** **Year of Study:** 2011-12 and 2012-13.

### 3.3 Treatment details

**3.3.1** **Main Plot: 3 Different planting dates**
**$S_1$** - 15th November
**$S_2$** - 30th November
**$S_3$** - 15th December

**3.3.2** **Sub Plot: 4 Varieties of bell pepper**
**$V_1$** – Mekong ($F_1$)
**$V_2$** - California Wonder
**$V_3$** - JK Peeyali ($F_1$)
**$V_4$** – Asha ($F_1$)

### 3.4 Treatment combinations:

| Sl. No. | Treatment combinations | Planting Dates | Varieties |
|---|---|---|---|
| 1 | $S_1V_1$ | 15th November | Mekong |
| 2 | $S_1V_2$ | 15th November | California Wonder |
| 3 | $S_1V_3$ | 15th November | JK Peeyali |
| 4 | $S_1V_4$ | 15th November | Asha |
| 5 | $S_2V_1$ | 30th November | Mekong |
| 6 | $S_2V_2$ | 30th November | California Wonder |
| 7 | $S_2V_3$ | 30th November | JK Peeyali |
| 8 | $S_2V_4$ | 30th November | Asha |
| 9 | $S_3V_1$ | 15th December | Mekong |
| 10 | $S_3V_2$ | 15th December | California Wonder |
| 11 | $S_3V_3$ | 15th December | JK Peeyali |
| 12 | $S_3V_4$ | 15th December | Asha |

### 3.5 Raising of crop in the main field

#### 3.5.1 Crop and variety

Bell pepper (*Capsicum annuum* L.) a popular winter season solanaceous crop was selected for the experiment. Four varieties, i.e., Mekong, California Wonder, JK Peeyali and Asha, were selected for the experiment.

#### 3.5.2 Preparatory tillage

The experimental fields were cross ploughed started twice for second week of October 2011 and 2012 by tractor drawn plough followed by tractor drawn laddering to break the big clods. The weeds and stubbles were removed to make the field clean. Then fields were ploughed twice by power tiller to bring the land to a good tilth. After final removal of weeds and stubbles, the fields were leveled by bullock drawn laddering.

#### 3.5.3 Preparation of layout

Total experimental area was divided into unit plots of 3 m x 3 m size according to the need for each experiment to accommodate all the treatments each having three replications. Channel of 1 meter width demarcated each replication and each plot was separated by 0.25 meter width bunds.

#### 3.5.4 Fertilizer application

Well rotten farmyard manure and inorganic fertilizers were applied as per requirement. Full dose of phosphorus and full dose of potassium was given as basal at time of land

preparation. Nitrogen fertilizer was given in two equal splits. Half nitrogen was applied as basal at the time of transplanting and rest of nitrogen as top dressing during hoeing at 30 days after planting.

### 3.5.5 Other intercultural operations

Light irrigation was given on alternate days at the time of transplanting for quick stand of the crop and there after irrigation was given at 7-12 days interval depends on soil moisture condition. Weeding, hoeing and other intercultural operations were also done as and when required.

### 3.5.6 Harvesting

Harvesting of bell pepper was done at marketable stage when they were still green and full grown, firm and crisp with an upward twist with a piece of stem attached. Harvesting can be done once in 10-12 days with 5-6 pickings in open-pollinated varieties and 8-10 pickings in the hybrids.

## 3.6 Observations recorded

Ten plants from each plot were selected randomly for taking observations on plant height, number of leaves per plant, leaf area, leaf chlorophyll, days to 50% flowering, days to 1$^{st}$ harvesting, number of fruits/plant, fruit weight, yield per plant, yield (Kg/ha), TSS content, ß-carotene content and vitamin C content of the produce.

### 3.6.1 Growth parameters

**Plant height**

The height of the plant was measured in cm with the help of a meter scale from the base to the highest point of tip at the time of first harvest.

**Number of leaves per plant**

Total numbers of leaves per plant were counted from each of ten tagged plants at the time of final harvest.

**Days to 50% Flowering**

Number of days taken from transplanting to the 50 % flowering stage were calculated as days to 50% flowering.

**Days to first Harvesting**

Days to 1st harvesting was calculated by number of days taken from transplanting to harvesting by taking average maturity of fruits of ten plants selected from each plot individually.

**Leaf area**

Leaf area was recorded from leaves with the help of leaf area meter. At first, values were recorded and then mean was calculated.

### 3.6.2 Yield parameters

**Fruit Weight (g)**

Total weights of marketable fruits from each selected plant were taken in grams and mean values were worked out.

**Number of fruits per plant**

The number of fruits were counted from each selected plant and finally summed up to work out the total number of fruits per plant.

**Yield per plant (g)**

The weight of fruits were recorded in gram per plant at each harvest and finally summed up for total yield per plant.

**Yield (kg per hectare)**

First the total yield per plot was worked out and then converted to per hectare basis as ton per hectare with a reduction of 20% yield for making the field layout with channels and ridges.

### 3.6.3 Quality parameters of bell pepper

**Vitamin C content of fruits**

Vitamin C content of fruits (mg/100g) was determined by the procedure given by Ranganna (1997)

**ß-carotene content of fruits**

ß-carotene content of fruits (µg/100g) was determined by the procedure given by Srivastava and Kumar (2010).

**Leaf Chlorophyll content**

It was measured with the help of Chlorophyll Meter (Made of Konica Minolta Sensing, INC, Japan) with the unit of SPAD-502 at harvest. Ten randomly selected plants were used from each plot and reading was taken from the leaves.

**TSS content of fruits**

It was measured with the help of hand refractometer with the unit of $^{0}$brix. Ten randomly selected plants were used from each plot and reading was taken from the fruits.

### 3.6.4 Soil parameters

**Method of collecting soil samples to initial soil nutrient status**

Soil samples from the experimental plots were collected at 15 cm depth with the help of soil auger before land preparation. The samples were thoroughly dried in shade, mixed together, pulverized, sieved through 0.2 mm sieve and then analyzed in the following way.

**Determination of soil pH**

Soil pH was determined by potentiometric method as described by Baruah and Barthakur (1997).

**Determination of organic carbon (%)**

Organic carbon was estimated in percentage by Rapid Titration Method (Walkley and Black, 1934).

**Determination of available nitrogen**

The Modified Kjeldahl method was used to determine the available nitrogen (kg per hectare) in the soil (Jackson, 1967).

**Determination of available phosphorus**

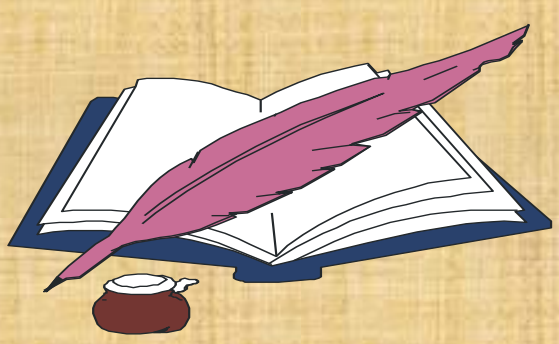
Available phosphorus (kg per hectare) was determined by Bray's method as described by Bray and Kurtz 1945 (Jackson, 1967).

**Determination of available potassium**

Available potassium content (kg per hectare) of the soil was estimated with the help of a flame photometer (Jackson, 1967).

### 3.7 Method of statistical analysis

The data obtained from field and laboratory was subjected to statistical analysis with the help of Indostat statistical package (7.0). Analysis of Variance method and the significance of different sources of variations were tested by for determination of critical difference at 5% level of significance, Fisher and Yates' table was consulted.



# RESULTS AND DISCUSSION

# RESULTS AND DISCUSSION

This experiment was conducted to evaluate the effect of planting dates on the performance of different varieties of bell pepper (*Capsicum annuum* L.). The result obtained during the course of study is presented and discussed hereunder.

### 4.1 Plant height (cm)

The observation recorded on plant height of bell pepper at 60 days for the year 2011-12 and 2012-13 has been presented in Table 3. The result revealed that the plant height was significantly influenced by planting dates and varieties. Among the planting dates, 15$^{th}$ November planting ($S_1$) recorded the maximum plant height for both the years as well as pooled analysis (44.32 and 44.88 in 2011-12 and 2012-13, respectively and 44.60 in pooled analysis). Among the varieties, Asha ($V_4$) recorded the highest plant height for both the years and pooled analysis (44.16 and 44.66 in 2011-12 and 2012-13, respectively and 44.41 in pooled analysis). The interaction effect depicted that Asha planted on 15$^{th}$ November ($S_1V_4$) recorded the highest plant height for both the years and pooled analysis (54.18 and 51.49 in 2011-12 and 2012-13, respectively and 52.84 in pooled analysis). Increased plant height with earlier planting dates was previously reported by Islam (2007) in bell pepper. This is in conformity with the findings of Hamma *et al.* (2012).

### 4.2 Number of leaves per plant

The data recorded on number of leaves per plant of bell pepper for the year 2011-12 and 2012-13 has been presented in the Table 4. A perusal of data showed that the number of leaves per plant was significantly influenced by planting dates and varieties. Among the planting dates, 15$^{th}$ December planting ($S_3$) recorded the maximum number leaves for both the years as well as pooled analysis (180.72 and 180.97 in 2011-12 and 2012-13, respectively and 180.84 in pooled analysis).Among the varieties, California Wonder ($V_2$) recorded the highest number of leaves for both the years and pooled analysis (205.80 and 207.16 in 2011-12 and 2012-13, respectively and 206.48 in pooled analysis).The interaction effect showed that California Wonder planted on 15$^{th}$ December ($S_3V_2$) recorded the maximum number of leaves for both the year and pooled analysis (233.10 and 237.14 in 2011-12 and 2012-13, respectively and 235.12 in pooled analysis). Higher number of leaves in the treatment $S_3V_2$ may be due to the favourable temperature that might have

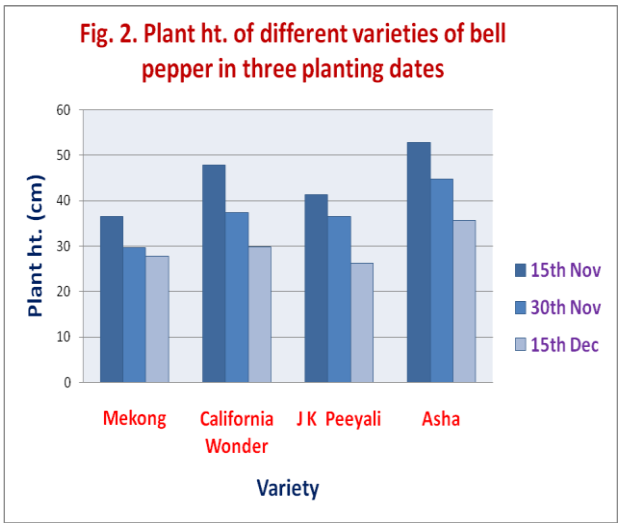


Fig. 2. Plant ht. of different varieties of bell pepper in three planting dates
Plant ht. (cm)
60
50
40
30
20
10
0
Mekong
California Wonder
J K Peeyali
Asha
Variety
15th Nov
30th Nov
15th Dec

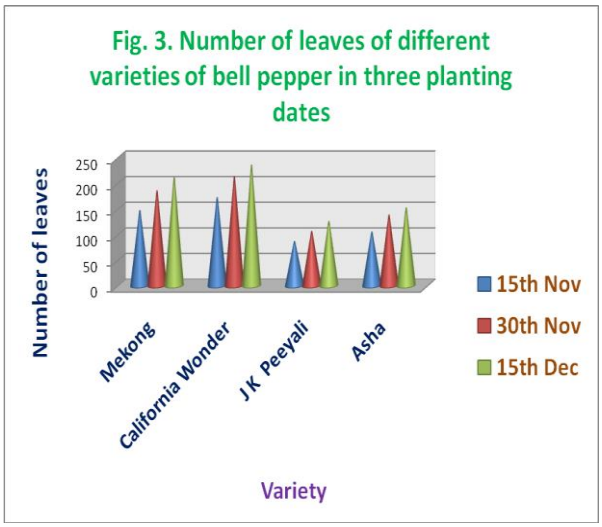


Fig. 3. Number of leaves of different varieties of bell pepper in three planting dates
Number of leaves
250
200
150
100
50
0
Mekong
California Wonder
J K Peeyali
Asha
Variety
15th Nov
30th Nov
15th Dec

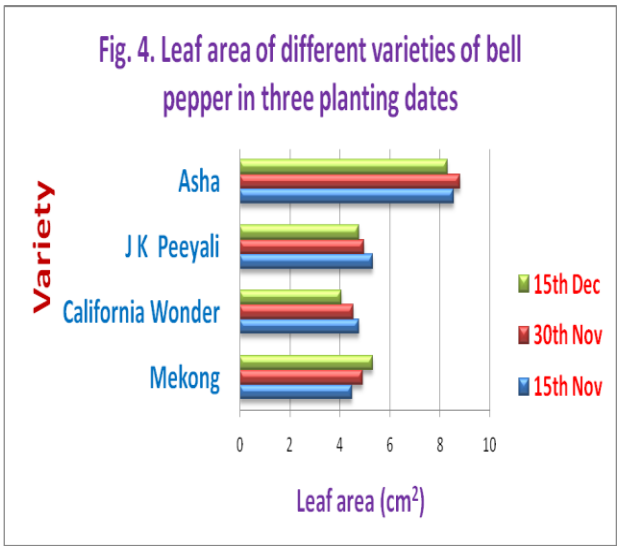


Fig. 4. Leaf area of different varieties of bell pepper in three planting dates
Variety
Asha
J K Peeyali
California Wonder
Mekong
0
2
4
6
8
10
Leaf area (cm²)
15th Dec
30th Nov
15th Nov

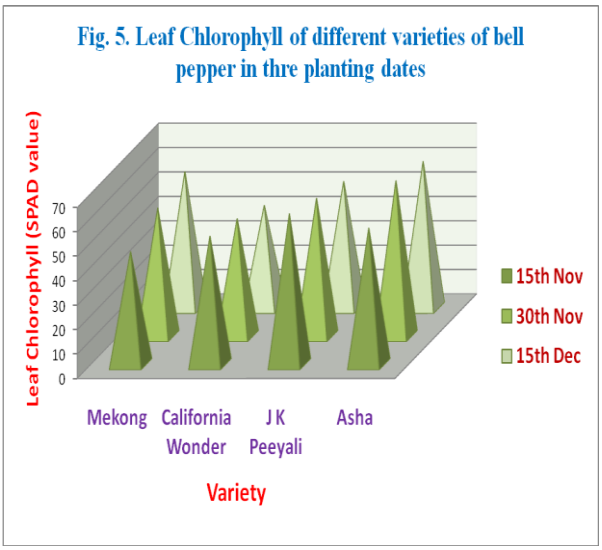


Fig. 5. Leaf Chlorophyll of different varieties of bell pepper in thre planting dates
Leaf Chlorophyll (SPAD value)
70
60
50
40
30
20
10
0
Mekong
California Wonder
J K Peeyali
Asha
Variety
15th Nov
30th Nov
15th Dec

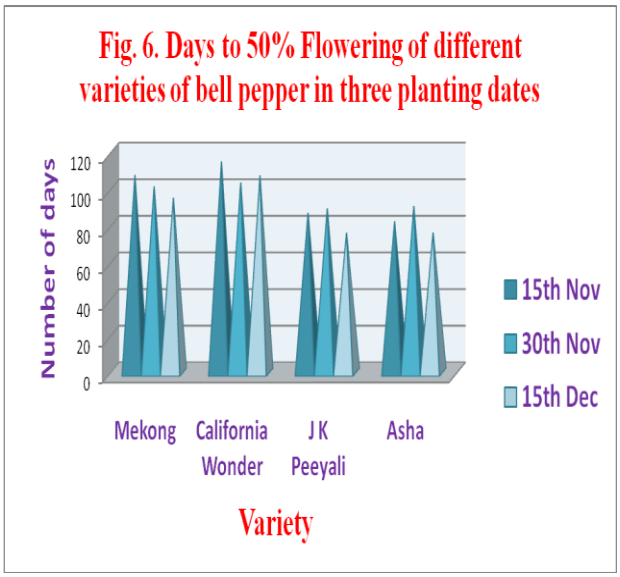


Fig. 6. Days to 50% Flowering of different varieties of bell pepper in three planting dates
Number of days
120
100
80
60
40
20
0
Mekong
California Wonder
J K Peeyali
Asha
Variety
15th Nov
30th Nov
15th Dec

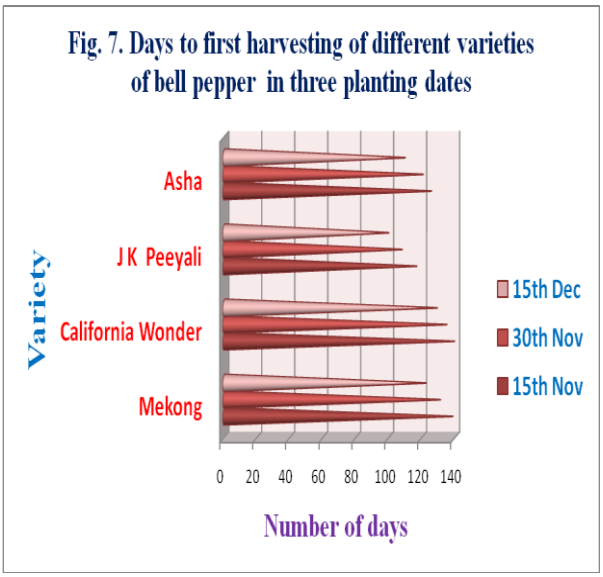


Fig. 7. Days to first harvesting of different varieties of bell pepper in three planting dates
Variety
Asha
J K Peeyali
California Wonder
Mekong
0
20
40
60
80
100
120
140
Number of days
15th Dec
30th Nov
15th Nov

**Table 3. Plant height (cm) of bell pepper varieties with respect to different planting dates**

| Variety | 2011-12 | | | | 2012-13 | | | | Pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean |
| Mekong | 33.90 | 28.32 | 29.26 | 30.49 | 38.98 | 30.84 | 26.34 | 32.05 | 36.44 | 29.58 | 27.80 | 31.27 |
| California Wonder | 49.24 | 37.81 | 28.69 | 38.58 | 46.41 | 36.88 | 31.04 | 38.11 | 47.83 | 37.35 | 29.87 | 38.35 |
| J K Peeyali | 39.96 | 38.04 | 25.83 | 34.61 | 42.63 | 34.85 | 26.55 | 34.68 | 41.30 | 36.45 | 26.19 | 34.64 |
| Asha | 54.18 | 43.21 | 35.08 | 44.16 | 51.49 | 46.23 | 36.25 | 44.66 | 52.84 | 44.72 | 35.67 | 44.41 |
| Mean | 44.32 | 36.85 | 29.72 | | 44.88 | 37.20 | 30.05 | | 44.60 | 37.02 | 29.88 | |
| | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | |
| SEm± | 0.76 | 1.26 | 2.19 | | 1.36 | 1.22 | 2.12 | | 0.78 | 0.88 | 1.52 | |
| CD (P= 0.05) | 3.00 | 3.75 | 6.50 | | 5.33 | 3.64 | 6.30 | | 2.54 | 2.52 | 4.37 | |

**Table 4. Number of leaves/plant of bell pepper varieties with respect to different planting dates**

| Variety | 2011-12 | | | | 2012-13 | | | | Pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean |
| Mekong | 147.18 | 183.27 | 213.29 | 181.25 | 146.17 | 187.11 | 209.31 | 180.86 | 146.68 | 185.19 | 211.30 | 181.06 |
| California Wonder | 169.09 | 215.20 | 233.10 | 205.80 | 174.13 | 210.21 | 237.14 | 207.16 | 171.61 | 212.71 | 235.12 | 206.48 |
| J K Peeyali | 85.33 | 104.37 | 126.28 | 105.33 | 87.32 | 107.39 | 124.31 | 106.34 | 86.33 | 105.88 | 125.30 | 105.83 |
| Asha | 106.18 | 136.31 | 150.20 | 130.90 | 103.14 | 139.31 | 153.12 | 131.86 | 104.66 | 137.81 | 151.66 | 131.38 |
| Mean | 126.95 | 159.79 | 180.72 | | 127.69 | 161.00 | 180.97 | | 127.32 | 160.40 | 180.84 | |
| | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | |
| SEm± | 1.11 | 1.35 | 2.34 | | 1.08 | 1.25 | 2.16 | | 0.78 | 0.92 | 1.59 | |
| CD (P= 0.05) | 4.36 | 4.01 | 6.94 | | 4.25 | 3.71 | 6.43 | | 2.53 | 2.64 | 4.57 | |

promoted excess vegetative growth in the form of more leaf production. Maximum number of leaves per plant with earlier planting dates was previously reported by Islam (2007) in bell pepper.

### 4.3 Leaf area ($cm^2$)

The observation recorded on leaf area of bell pepper varieties for the year 2011-12 and 2012-13 has been presented in the Table 5. The result revealed that leaf area was significantly influenced by planting dates and varieties. Among the planting dates, 30$^{th}$ November planting ($S_2$) recorded the maximum leaf area for the year 2011-2012 as well as pooled analysis (5.78 $cm^2$ in 2011-12 and 5.80 $cm^2$ in pooled analysis ), whereas 15$^{th}$ November planting ($S_1$) recorded the maximum leaf area for the year 2012-13 (5.88 $cm^2$ in 2012-13). Among the varieties, Asha ($V_4$) recorded the highest leaf area for both the years and pooled analysis (8.32 $cm^2$ and 8.77 $cm^2$ in 2011-12 and 2012-13, respectively and 8.30 $cm^2$ in pooled analysis). The interaction effect depicted that Asha planted on 30$^{th}$ November ($S_2V_4$) recorded the highest leaf area for both the years as well as pooled analysis (8.59 $cm^2$ and 8.98 $cm^2$ in 2011-12 and 2012-13, respectively and 8.79 $cm^2$ in pooled analysis). Higher leaf area in the treatment ($S_2V_4$) may be due to the genotypic differences and favourable temperatures that might have encouraged more vegetative growth and production of larger leaves compared to others. The present results are closely in lined with previous results by Erickson and Markhart (2001).

### 4.4 Leaf chlorophyll (SPAD value)

The data recorded on leaf chlorophyll content of bell pepper varieties for the year 2011-12 and 2012-13 has been presented in the Table 6. The result showed that leaf chlorophyll content was significantly influenced by planting dates and varieties. Among the planting dates, 30$^{th}$ November planting ($S_2$) recorded the maximum leaf chlorophyll content for both the years as well as pooled analysis (55.27 and 55.51 in 2011-12 and 2012-13, respectively and 55.39 in pooled analysis). Among the varieties, Asha ($V_4$) recorded the maximum leaf chlorophyll content for both the years and pooled analysis (58.26 and 61.63 in 2011-12 and 2012-13, respectively and 60.03 in pooled analysis). The interaction effect revealed that Asha planted on 30$^{th}$ November ($S_2V_4$) recorded the highest leaf chlorophyll content for both the years and pooled analysis (62.37 and 65.42 in 2011-12 and 2012-13, respectively and 63.90 in pooled analysis). The present results are closely in lined with previous results by Erickson and Markhart (2001).

**4.5 Days to 50% flowering**

The observation recorded on days to 50% flowering of bell pepper varieties for the year 2011-12 and 2012-13 has been presented in the table 7. A perusual of data showed that the trends for days to 50% flowering were significantly affected by planting dates and varieties. Among the planting dates, 15$^{th}$ December planting ($S_3$) recorded the minimum days to 50% flowering for both the years and pooled analysis (89.04 and 88.93 in 2011-12 and 2012-13, respectively and 88.98 in pooled analysis), whereas 15$^{th}$ November planting ($S_1$) recorded the maximum days to 50% flowering for 2011-12 as well as pooled analysis (98.39 in 2011-12 and 98.24 in pooled analysis) and 30$^{th}$ November ($S_2$) planting indicated the maximum days to 50% flowering for 2012-13 (100.24 in 2012-13). Among the varieties, Asha ($V_4$) recorded the minimum days to 50% flowering for both the years and pooled analysis (80.34 and 86.34 in 2011-12 and 2012-13, respectively and 83.34 in pooled analysis), whereas California Wonder ($V_2$) recorded the maximum days to 50% flowering for both the years as well as pooled analysis (110.22 and 107.66 in 2011-12 and 2012-13, respectively and 108.94 in pooled analysis). The interaction effect depicted that JK Peeyali planted on 15$^{th}$ December ($S_3V_3$) recorded the minimum days to 50% flowering for 2011-12 and pooled analysis (75.31 in 2011-12 and 76.35 in pooled analysis). Whereas, Asha planted on 15$^{th}$ December ($S_3V_4$) recorded the minimum days to 50% flowering for 2012-13 (75.43 in 2012-13). On the other hand, California Wonder planted on 15$^{th}$ November ($S_1V_2$) recorded the maximum days to 50% flowering for both the years and pooled analysis (114.33 and 116.32 in 2011-12 and 2012-13, respectively and 115.33 in pooled analysis). Alam *et al.* (2011) found the similar results previously.

**4.6 Days to first harvesting**

Days to first harvesting of bell pepper were significantly affected by planting dates and varieties (Table 8). Among the planting dates, 15$^{th}$ December planting ($S_3$) recorded the minimum days to 1$^{st}$ harvesting for both the years as well as pooled analysis (115.43 and 115.22 in 2011-12 and 2012-13, respectively and 115.32 in pooled analysis), whereas 15$^{th}$ November planting ($S_1$) recorded the maximum days to 1$^{st}$ harvesting for both the years as well as pooled analysis (130.39 and 130.02 in 2011-12 and 2012-13, respectively and 130.21 in pooled analysis). Among the varieties, JK Peeyali ($V_3$) recorded the minimum days to 1$^{st}$ harvesting for both the years and pooled analysis (107.66 and 108.60 in 2011-12 and 2012-13, respectively and

**Table 5. Leaf area ($cm^2$) of bell pepper varieties with respect to different planting dates**

| Variety | 2011-12 | | | | 2012-13 | | | | Pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean |
| Mekong | 4.27 | 5.01 | 5.41 | 4.90 | 4.68 | 4.79 | 5.23 | 4.90 | 4.48 | 4.90 | 5.32 | 4.90 |
| California Wonder | 4.93 | 4.67 | 3.91 | 4.50 | 4.61 | 4.39 | 4.21 | 4.40 | 4.77 | 4.53 | 4.06 | 4.45 |
| J K Peeyali | 5.16 | 4.83 | 4.65 | 4.88 | 5.46 | 5.11 | 4.87 | 5.15 | 5.31 | 4.97 | 4.76 | 5.01 |
| Asha | 8.34 | 8.59 | 8.03 | 8.32 | 8.75 | 8.98 | 8.57 | 8.77 | 8.55 | 8.79 | 8.30 | 8.54 |
| Mean | 5.68 | 5.78 | 5.50 | | 5.88 | 5.82 | 5.72 | | 5.78 | 5.80 | 5.61 | |
| | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | |
| SEm± | 0.08 | 0.11 | 0.18 | | 0.11 | 0.12 | 0.20 | | 0.07 | 0.08 | 0.14 | |
| CD (P= 0.05) | 0.30 | 0.32 | 0.56 | | 0.42 | 0.35 | 0.60 | | 0.22 | 0.23 | 0.40 | |

**Table 6. Leaf chlorophyll (SPAD value) of bell pepper varieties with respect to different planting dates**

| Variety | 2011-12 | | | | 2012-13 | | | | Pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean |
| Mekong | 45.28 | 54.23 | 55.04 | 51.52 | 47.35 | 51.19 | 57.04 | 51.86 | 46.32 | 52.71 | 56.04 | 51.69 |
| California Wonder | 54.19 | 49.27 | 41.21 | 48.22 | 51.19 | 47.28 | 43.14 | 47.20 | 52.69 | 48.28 | 42.18 | 47.71 |
| J K Peeyali | 61.56 | 55.19 | 50.70 | 55.82 | 62.24 | 58.14 | 53.37 | 57.92 | 61.90 | 56.67 | 52.04 | 56.87 |
| Asha | 53.66 | 62.37 | 58.76 | 58.26 | 58.34 | 65.42 | 61.63 | 61.80 | 56.00 | 63.90 | 60.20 | 60.03 |
| Mean | 53.67 | 55.27 | 51.43 | | 54.78 | 55.51 | 53.80 | | 54.23 | 55.39 | 52.61 | |
| | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | |
| SEm± | 0.28 | 1.11 | 1.93 | | 0.73 | 0.76 | 1.32 | | 0.39 | 0.67 | 1.17 | |
| CD (P= 0.05) | 1.09 | 3.31 | 5.74 | | 2.86 | 2.26 | 3.91 | | 1.27 | 1.94 | 3.35 | |

108.13 in pooled analysis), whereas California Wonder ($V_4$) recorded the maximum days to 1st harvesting for both the years and pooled analysis (134.26 and 135.09 in 2011-12 and 2012-13, respectively and 134.67 in pooled analysis). The interaction effect showed that JK Peeyali planted on 15th December ($S_3V_3$) recorded the minimum days to 1st harvesting for both the years as well as pooled analysis (98.38 and 101.17 in 2011-12 and 2012-13, respectively and 99.78 in pooled analysis), whereas Mekong ($V_1$) planted on 15th November ($S_1V_1$) recorded the maximum days (140.97) to 1st harvesting for the year 2011-12 and California Wonder ($V_2$) planted on 15th November ($S_1V_2$) recorded maximum days to 1st harvesting for the year 2012-13 as well as pooled analysis (141.19 in 2012-13 and 139.68 in pooled analysis). This is in conformity with the earlier findings of Islam (2007).

**4.7 Number of fruits per plant**

Number of fruits per plant of bell pepper was significantly affected by different planting dates as well as different varieties (Table 9). Among the planting dates, 30th November planting ($S_2$) recorded the maximum number of fruits/plant for the year 2011-2012 as well as pooled analysis (8.47 in 2011-12 and 8.59 in pooled analysis), whereas 15th November planting ($S_1$) recorded the maximum number of fruits/plant (8.72) for the year 2012-2013. Among the varieties, Mekong ($V_1$) recorded the maximum number of fruits/plant for both the years and pooled analysis (9.62 and 10.85 in 2011-12 and 2012-13, respectively and 10.24 in pooled analysis). The interaction effect revealed that Mekong planted on 15th December ($S_3V_1$) recorded the highest number of fruits/plant for both the years as well as pooled analysis (11.15 and 12.36 in 2011-12 and 2012-13, respectively and 11.76 in pooled analysis), whereas California Wonder planted on 15th December ($S_3V_2$) recorded the minimum number of fruits/plant for both the years as well as pooled analysis (4.84 and 4.57 in 2011-12 and 2012-13, respectively and 4.71 in pooled analysis). This is in conformity with the earlier findings of Islam (2007) in bell pepper.

**4.8 Fruit weight (g)**

Fruit weight of bell pepper was significantly affected by different planting dates as well as different varieties (Table 10). Among the planting dates, 30th November planting ($S_2$) recorded the maximum fruit weight for the year 2011-2012 as well as pooled analysis (65.66 gm in 2011-12 and 64.94 gm in pooled analysis), whereas 15th November planting ($S_1$) recorded the maximum fruit weight (65.18 gm) for the year 2012-13. Islam (2007) recorded that fruit weight

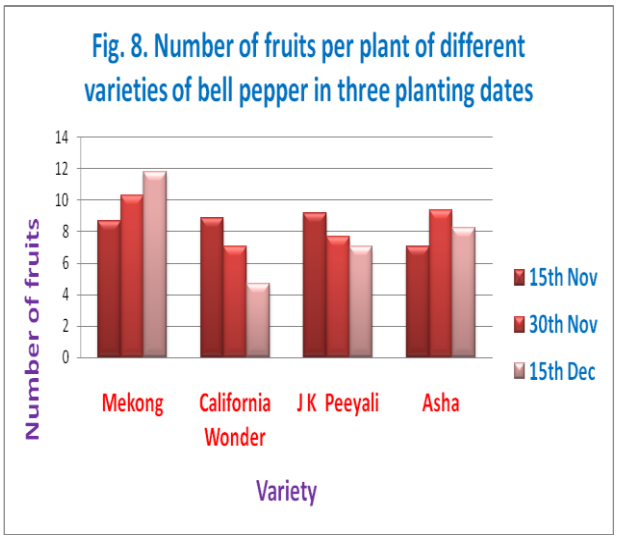


Fig. 8. Number of fruits per plant of different varieties of bell pepper in three planting dates
Number of fruits
14
12
10
8
6
4
2
0
Mekong
California Wonder
J K Peeyali
Asha
Variety
15th Nov
30th Nov
15th Dec

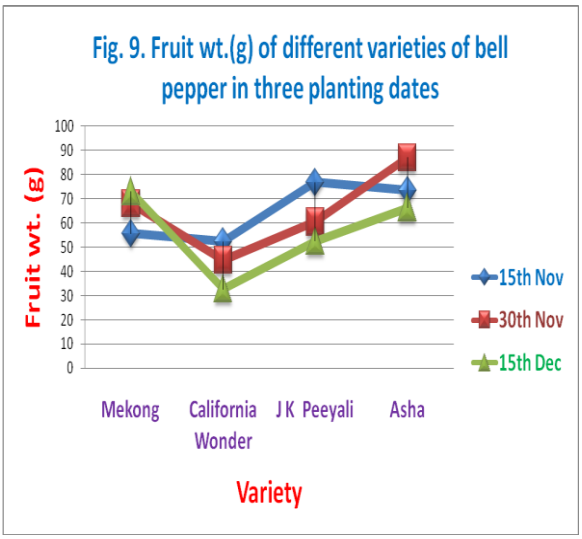


Fig. 9. Fruit wt.(g) of different varieties of bell pepper in three planting dates
Fruit wt. (g)
100
90
80
70
60
50
40
30
20
10
0
Mekong
California Wonder
J K Peeyali
Asha
Variety
15th Nov
30th Nov
15th Dec

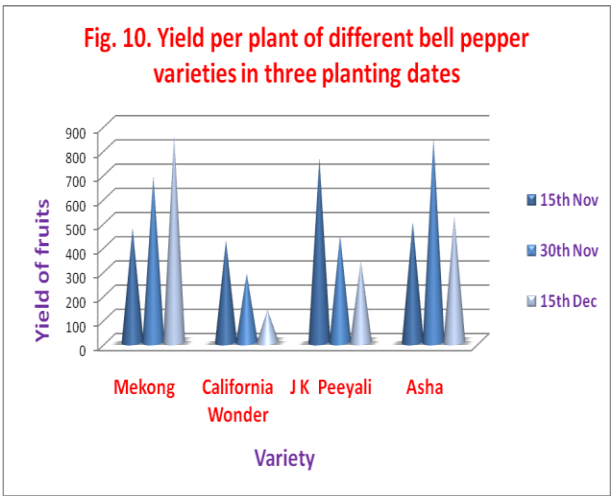


Fig. 10. Yield per plant of different bell pepper varieties in three planting dates
Yield of fruits
900
800
700
600
500
400
300
200
100
0
Mekong
California Wonder
J K Peeyali
Asha
Variety
15th Nov
30th Nov
15th Dec

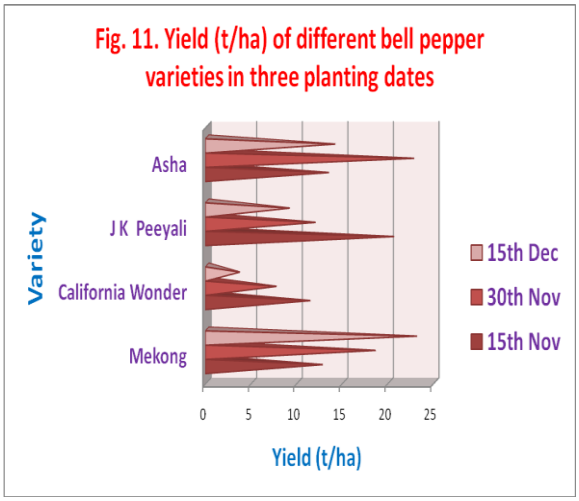


Fig. 11. Yield (t/ha) of different bell pepper varieties in three planting dates
Variety
Asha
J K Peeyali
California Wonder
Mekong
0
5
10
15
20
25
Yield (t/ha)
15th Dec
30th Nov
15th Nov

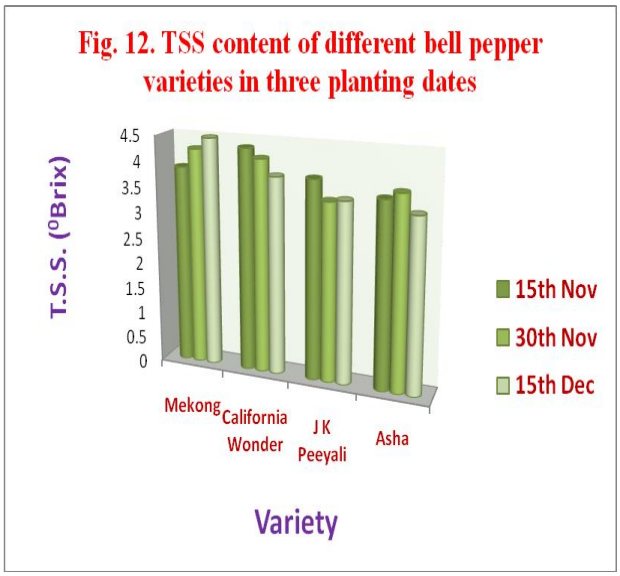


Fig. 12. TSS content of different bell pepper varieties in three planting dates
T.S.S. (°Brix)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Mekong
California Wonder
J K Peeyali
Asha
Variety
15th Nov
30th Nov
15th Dec

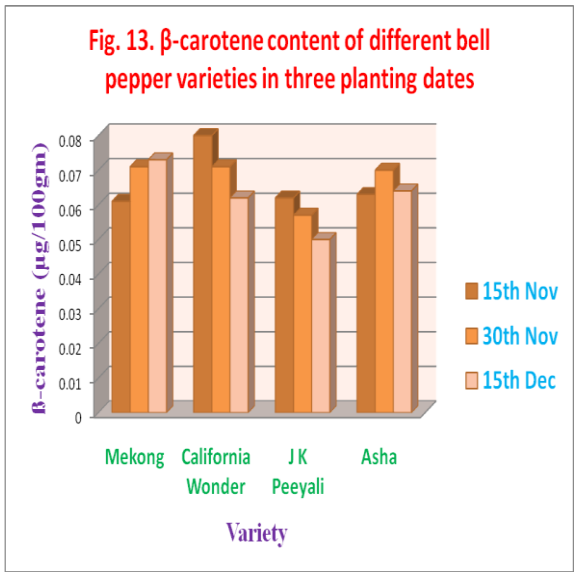


Fig. 13. β-carotene content of different bell pepper varieties in three planting dates
β-carotene (µg/100gm)
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0
Mekong
California Wonder
J K Peeyali
Asha
Variety
15th Nov
30th Nov
15th Dec

**Table 7. Days to 50% flowering of bell pepper varieties with respect to different planting dates**

| Variety | 2011-12 | | | | 2012-13 | | | | Pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean |
| Mekong | 109.05 | 103.15 | 94.38 | 102.19 | 106.59 | 100.24 | 96.47 | 101.10 | 107.82 | 101.70 | 95.43 | 101.65 |
| California Wonder | 114.33 | 107.38 | 108.95 | 110.22 | 116.32 | 100.24 | 106.42 | 107.66 | 115.33 | 103.81 | 107.69 | 108.94 |
| J K Peeyali | 88.21 | 79.20 | 75.31 | 80.91 | 86.14 | 100.24 | 77.39 | 87.92 | 87.18 | 89.72 | 76.35 | 84.42 |
| Asha | 81.95 | 81.55 | 77.51 | 80.34 | 83.34 | 100.24 | 75.43 | 86.34 | 82.65 | 90.90 | 76.47 | 83.34 |
| Mean | 98.39 | 92.82 | 89.04 | | 98.10 | 100.24 | 88.93 | | 98.24 | 96.53 | 88.98 | |
| | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | |
| SEm± | 0.93 | 0.68 | 1.18 | | 0.65 | 0.91 | 1.58 | | 0.56 | 0.57 | 0.99 | |
| CD (P=0.05) | 3.64 | 2.03 | 3.52 | | 2.53 | 2.70 | 4.68 | | 1.84 | 1.63 | 2.83 | |

**Table 8. Days to first harvesting of bell pepper varieties with respect to different planting dates**

| Variety | 2011-12 | | | | 2012-13 | | | | Pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean |
| Mekong | 140.97 | 133.13 | 120.97 | 131.69 | 136.43 | 129.19 | 123.96 | 129.86 | 138.70 | 131.16 | 122.47 | 130.78 |
| California Wonder | 138.16 | 133.57 | 131.05 | 134.26 | 141.19 | 136.57 | 127.50 | 135.09 | 139.68 | 135.07 | 129.28 | 134.67 |
| J K Peeyali | 118.24 | 106.34 | 98.38 | 107.66 | 115.21 | 109.43 | 101.17 | 108.60 | 116.73 | 107.89 | 99.78 | 108.13 |
| Asha | 124.20 | 122.20 | 111.31 | 119.24 | 127.24 | 119.21 | 108.24 | 118.23 | 125.72 | 120.71 | 109.78 | 118.73 |
| Mean | 130.39 | 123.81 | 115.43 | | 130.02 | 123.6 | 115.22 | | 130.21 | 123.71 | 115.32 | |
| | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | |
| SEm± | 0.50 | 1.06 | 1.84 | | 0.49 | 1.04 | 1.80 | | 0.35 | 0.74 | 1.29 | |
| CD (P= 0.05) | 1.95 | 3.16 | 5.47 | | 1.91 | 3.08 | 5.34 | | 1.13 | 2.13 | 3.69 | |

**Table 9. No of fruits per plant of bell pepper varieties with respect to different planting dates**

| Variety | 2011-12 | | | | 2012-13 | | | | Pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean |
| Mekong | 7.91 | 9.80 | 11.15 | 9.62 | 9.42 | 10.78 | 12.36 | 10.85 | 8.67 | 10.29 | 11.76 | 10.24 |
| California Wonder | 9.46 | 7.31 | 4.84 | 7.20 | 8.24 | 6.81 | 4.57 | 6.54 | 8.85 | 7.06 | 4.71 | 6.87 |
| J K Peeyali | 8.41 | 7.94 | 7.29 | 7.88 | 9.91 | 7.39 | 6.83 | 8.04 | 9.16 | 7.67 | 7.06 | 7.96 |
| Asha | 6.83 | 8.84 | 7.96 | 7.88 | 7.31 | 9.85 | 8.47 | 8.54 | 7.07 | 9.35 | 8.22 | 8.21 |
| Mean | 8.15 | 8.47 | 7.81 | | 8.72 | 8.71 | 8.06 | | 8.44 | 8.59 | 7.93 | |
| | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | |
| SEm± | 0.15 | 0.28 | 0.48 | | 0.21 | 0.28 | 0.49 | | 0.13 | 0.20 | 0.34 | |
| CD (P= 0.05) | 0.61 | 0.82 | 1.42 | | 0.83 | 0.83 | 1.44 | | 0.43 | 0.56 | 0.98 | |

**Table 10. Fruit weight (g) of bell pepper varieties with respect to different planting dates**

| Variety | 2011-12 | | | | 2012-13 | | | | Pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean |
| Mekong | 54.05 | 66.95 | 71.42 | 64.14 | 57.12 | 69.14 | 74.32 | 66.86 | 55.59 | 68.05 | 72.87 | 65.50 |
| California Wonder | 53.40 | 45.60 | 33.60 | 44.20 | 51.24 | 43.36 | 31.78 | 42.13 | 52.32 | 44.48 | 32.69 | 43.16 |
| J K Peeyali | 75.25 | 64.37 | 53.65 | 64.42 | 78.14 | 56.25 | 51.13 | 61.84 | 76.70 | 60.31 | 52.39 | 63.13 |
| Asha | 72.33 | 85.73 | 65.21 | 74.42 | 74.21 | 88.13 | 67.29 | 76.54 | 73.27 | 86.93 | 66.25 | 75.48 |
| Mean | 63.76 | 65.66 | 55.97 | | 65.18 | 64.22 | 56.13 | | 64.47 | 64.94 | 56.05 | |
| | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | |
| SEm± | 0.53 | 0.96 | 1.67 | | 0.96 | 0.79 | 1.37 | | 0.55 | 0.62 | 1.08 | |
| CD (P= 0.05) | 2.07 | 2.86 | 4.96 | | 3.75 | 2.35 | 4.08 | | 1.78 | 1.79 | 3.10 | |

of bell pepper significantly differ for various dates of planting. Among the varieties, Asha ($V_4$) recorded the maximum fruit weight for both the years and pooled analysis (74.42 gm and 76.54 gm in 2011-12 and 2012-13, respectively and 75.48 gm in pooled analysis). The interaction effect showed that Asha planted on 30$^{th}$ November ($S_2V_4$) recorded the maximum fruit weight for both the years as well as pooled analysis (85.73 gm and 88.13 gm in 2011-12 and 2012-13,respectively and 86.93 gm in pooled analysis).

**4.9 Yield per plant (g)**

The yield of bell pepper was significantly affected by different planting dates as well as different varieties (Table 11). Among the planting dates, 30$^{th}$ November planting ($S_2$) recorded the maximum yield per plant for the both the years as well as pooled analysis (569.10 gm. and 558.77 gm. in 2011-12 and 2012-13, respectively and 563.94 gm. in pooled analysis). Among the varieties, Mekong ($V_1$) recorded the maximum yield per plant for both the years and pooled analysis (647.48 gm. and 694.03 gm. in 2011-12 and 2012-13, respectively and 670.76 gm. in pooled analysis). The interaction effect revealed that Asha planted on 30$^{th}$ November ($S_2V_4$) recorded the maximum yield per plant (859.55 gm.) for 2011-2012 whereas Mekong planted on 15$^{th}$ December ($S_3V_1$) recorded the maximum yield per plant for 2012-2013 as well as pooled analysis (878.47 gm. in 2012-13 and 854.69 gm. in pooled analysis). The result is in conformity with the findings of Islam (2007) in bell pepper.

**4.10 Yield (t/ha)**

The observation on yield per hectare of bell pepper was significantly affected by different planting dates as well as different varieties (Table 12). Among the planting dates, 30th November planting ($S_2$) recorded the maximum yield (t/ha) for the both the years as well as pooled analysis (15.37 t/ha and 15.09 t/ha in 2011-12 and 2012-13, respectively and 15.23 t/ha in pooled analysis). Among the varieties, Mekong ($V_1$) recorded the maximum yield (t/ha) for both the years and pooled analysis (17.48 t/ha and 18.74 t/ha in 2011-12 and 2012-13, respectively and 18.11 t/ha in pooled analysis). The interaction effect depicted that Asha planted on 30$^{th}$ November ($S_2V_4$) recorded the highest yield (t/ha) (23.21 t/ha) for 2011-2012 and Mekong planted on 15$^{th}$ December ($S_3V_1$) recorded the maximum yield (t/ha) for 2012-13 as well as pooled analysis (23.72 in 2012-13 and 23.08 in pooled analysis). The present results are closely in lined with previous results by Islam (2007).

### 4.11 TSS ($^0$Brix)

The total soluble solid ($^0$Brix) of bell pepper as influenced by planting dates and varieties was presented in the Table 13. A perusal of data showed that TSS was significantly affected by planting dates and varieties. Among the planting dates, 15$^{th}$ November planting ($S_1$) recorded the maximum TSS for both the years as well as pooled analysis (3.91 and 3.92 in 2011-12 and 2012-13, respectively and 3.92 in pooled analysis). Among the varieties, Mekong ($V_1$) recorded the maximum TSS for both the years and pooled analysis (4.21 and 4.17 in 2011-12 and 2012-13, respectively and 4.19 in pooled analysis). The interaction effect showed that Mekong planted on 15$^{th}$ December ($S_3V_1$) recorded the maximum TSS for both the years and pooled analysis (4.51 and 4.43 in 2011-12 and 2012-13, respectively and 4.47 in pooled analysis).

### 4.12 β-carotene (µg/100g)

The observation recorded on β-carotene (µg) content of bell pepper varieties for the year 2011-12 and 2012-13 has been presented in the Table 14. It was showed that β-carotene was significantly influenced by planting dates and varieties. Among the planting dates, 30$^{th}$ November planting ($S_2$) recorded the maximum β-carotene content for both the years as well as pooled analysis (0.068 µg and 0.067 µg in 2011-12 and 2012-13, respectively and 0.067 µg in pooled analysis). Among the varieties, California Wonder ($V_2$) recorded the maximum β-carotene content for both the years and pooled analysis (0.072 µg and 0.070 µg in 2011-12 and 2012-13, respectively and 0.071 µg in pooled analysis). The interaction effect revealed that California Wonder planted on 15$^{th}$ November ($S_1V_2$) recorded the maximum β-carotene content for both the years and pooled analysis (0.081 µg and 0.078 µg in 2011-12 and 2012-13, respectively and 0.080 µg in pooled analysis). The present results are closely in lined with previous results by Perucka and Materska (2007).This is in conformity with the earlier findings of Mathews *et al.* (1975).

### 4.13 Vitamin-C (mg/100g)

The data recorded on vitamin C content of bell pepper varieties for the year 2011-12 and 2012-13 has been presented in the Table 15. A perusal of data showed that vitamin C content was significantly influenced by planting dates and varieties. Among the planting dates, 15$^{th}$ November planting ($S_1$) recorded the maximum vitamin C content for both the years as well as pooled analysis (143.11 mg and 143.31 mg in 2011-12 and 2012-13, respectively and 143.21 mg in pooled analysis). Among the varieties, California Wonder ($V_2$) recorded the maximum vitamin

**Table 11. Yield per plant (g) of bell pepper varieties with respect to different planting dates**

| Variety | 2011-12 | | | | 2012-13 | | | | Pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean |
| Mekong | 445.60 | 665.94 | 830.90 | 647.48 | 496.21 | 707.42 | 878.47 | 694.03 | 470.91 | 686.68 | 854.69 | 670.76 |
| California Wonder | 450.95 | 298.00 | 145.19 | 298.05 | 391.32 | 269.11 | 123.17 | 261.20 | 421.14 | 283.56 | 134.18 | 279.62 |
| J K Peeyali | 783.08 | 452.92 | 353.62 | 529.87 | 739.40 | 432.24 | 321.19 | 497.61 | 761.24 | 442.58 | 337.41 | 513.74 |
| Asha | 481.90 | 859.55 | 506.55 | 616.00 | 511.39 | 826.31 | 537.31 | 625.00 | 496.65 | 842.93 | 521.93 | 620.50 |
| Mean | 540.38 | 569.10 | 459.07 | | 534.58 | 558.77 | 465.03 | | 537.48 | 563.94 | 462.05 | |
| | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | |
| SEm± | 13.37 | 9.11 | 15.78 | | 7.06 | 10.25 | 17.76 | | 7.56 | 6.86 | 11.88 | |
| CD (P= 0.05) | 52.51 | 27.06 | 46.87 | | 27.74 | 30.47 | 52.77 | | 24.66 | 19.67 | 34.07 | |

**Table 12. Yield (t/ha) of bell pepper varieties with respect to different planting dates**

| Variety | 2011-12 | | | | 2012-13 | | | | Pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean |
| Mekong | 12.03 | 17.98 | 22.43 | 17.48 | 13.40 | 19.1 | 23.72 | 18.74 | 12.72 | 18.54 | 23.08 | 18.11 |
| California Wonder | 12.18 | 8.04 | 3.92 | 8.05 | 10.56 | 7.26 | 3.32 | 7.05 | 11.37 | 7.65 | 3.62 | 7.55 |
| J K Peeyali | 21.14 | 12.23 | 9.55 | 14.31 | 19.96 | 11.67 | 8.67 | 13.43 | 20.55 | 11.95 | 9.11 | 13.87 |
| Asha | 13.01 | 23.21 | 13.68 | 16.63 | 13.81 | 22.31 | 14.51 | 16.87 | 13.41 | 22.76 | 14.10 | 16.76 |
| Mean | 14.59 | 15.37 | 12.39 | | 14.43 | 15.09 | 12.55 | | 14.51 | 15.23 | 12.48 | |
| | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | |
| SEm± | 0.36 | 0.25 | 0.43 | | 0.19 | 0.28 | 0.48 | | 0.20 | 0.19 | 0.32 | |
| CD (P= 0.05) | 1.42 | 0.73 | 1.27 | | 0.74 | 0.82 | 1.42 | | 0.67 | 0.53 | 0.92 | |

C content for both the years and pooled analysis (155.04 mg and 154.56 mg in 2011-12 and 2012-13, respectively and 154.80 mg in pooled analysis). The interaction effect depicted that California Wonder planted on 15$^{th}$ November ($S_1V_2$) recorded the highest vitamin C content for both the years and pooled analysis (166.26 mg and 164.21 mg in 2011-12 and 2012-13, respectively and 165.24 mg in pooled analysis). The present results are closely in lined with previous results by Thanopoulos *et al.* (2013).This is in conformity with the earlier findings of Perucka & Materska (2007) and Golcz & Kozik (2004).

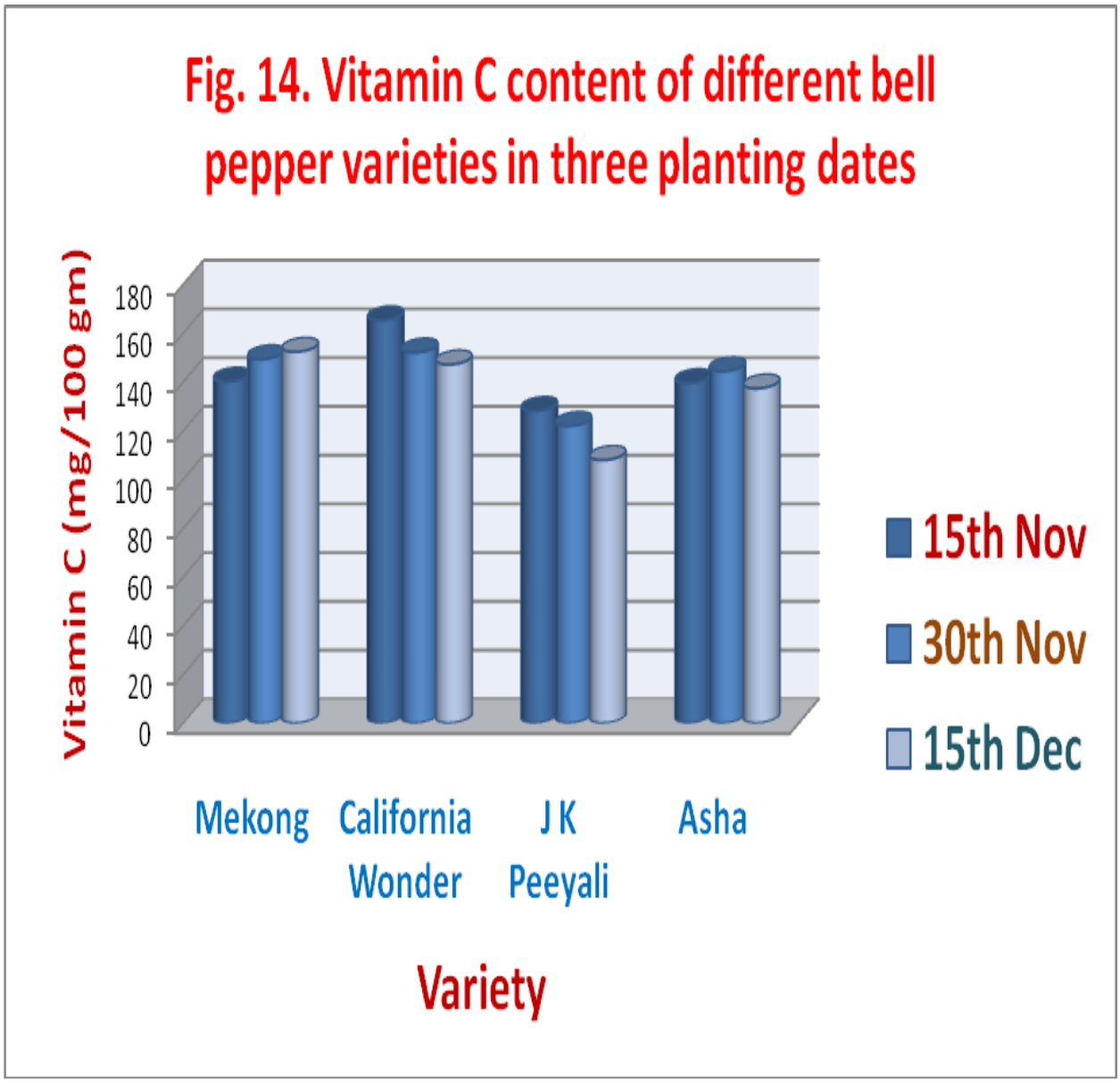


**Table 13. T.S.S. ($^{o}$Brix) content of bell pepper fruits with respect to different planting dates**

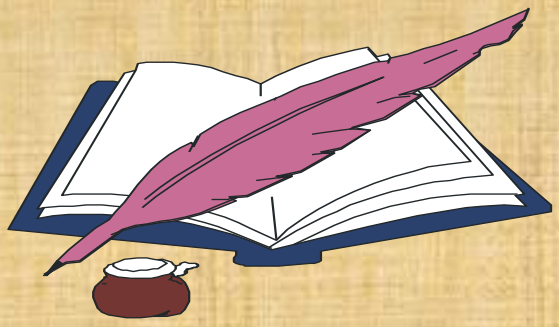
| Variety | 2011-12 | | | | 2012-13 | | | | Pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean |
| Mekong | 3.82 | 4.30 | 4.51 | 4.21 | 3.92 | 4.17 | 4.43 | 4.17 | 3.87 | 4.24 | 4.47 | 4.19 |
| California Wonder | 4.38 | 4.24 | 3.80 | 4.14 | 4.27 | 4.06 | 3.87 | 4.07 | 4.33 | 4.15 | 3.84 | 4.10 |
| J K Peeyali | 3.89 | 3.38 | 3.54 | 3.60 | 3.82 | 3.56 | 3.47 | 3.62 | 3.86 | 3.47 | 3.51 | 3.61 |
| Asha | 3.55 | 3.66 | 3.34 | 3.52 | 3.67 | 3.83 | 3.41 | 3.64 | 3.61 | 3.75 | 3.38 | 3.58 |
| Mean | 3.91 | 3.90 | 3.80 | | 3.92 | 3.91 | 3.80 | | 3.92 | 3.90 | 3.80 | |
| | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | |
| SEm± | 0.05 | 0.12 | 0.20 | | 0.11 | 0.10 | 0.17 | | 0.06 | 0.08 | 0.13 | |
| CD (P= 0.05) | 0.20 | 0.35 | 0.60 | | 0.43 | 0.30 | 0.51 | | 0.20 | 0.22 | 0.38 | |

**Table 14. β-carotene (µg per 100g) content of bell pepper fruits with respect to different planting dates**

| Variety | 2011-12 | | | | 2012-13 | | | | Pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean |
| Mekong | 0.059 | 0.071 | 0.072 | 0.067 | 0.062 | 0.071 | 0.074 | 0.069 | 0.061 | 0.071 | 0.073 | 0.068 |
| California Wonder | 0.081 | 0.072 | 0.062 | 0.072 | 0.078 | 0.069 | 0.062 | 0.070 | 0.080 | 0.071 | 0.062 | 0.071 |
| J K Peeyali | 0.061 | 0.056 | 0.049 | 0.055 | 0.063 | 0.058 | 0.051 | 0.057 | 0.062 | 0.057 | 0.050 | 0.056 |
| Asha | 0.065 | 0.071 | 0.064 | 0.067 | 0.061 | 0.068 | 0.063 | 0.064 | 0.063 | 0.070 | 0.064 | 0.065 |
| Mean | 0.067 | 0.068 | 0.062 | | 0.066 | 0.067 | 0.063 | | 0.066 | 0.067 | 0.062 | |
| | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | |
| SEm± | 0.007 | 0.006 | 0.012 | | 0.004 | 0.008 | 0.013 | | 0.004 | 0.005 | 0.009 | |
| CD (P= 0.05) | 0.029 | 0.020 | 0.034 | | 0.015 | 0.023 | 0.040 | | 0.014 | 0.015 | 0.025 | |

**Table 15. Vitamin-C (mg) content of bell pepper varieties with respect to different planting dates**

| Variety | 2011-12 | | | | 2012-13 | | | | Pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean | 15th Nov | 30th Nov | 15th Dec | Mean |
| Mekong | 138.91 | 150.27 | 151.29 | 146.83 | 141.24 | 148.24 | 153.34 | 147.61 | 140.08 | 149.26 | 152.32 | 147.22 |
| California Wonder | 166.26 | 150.76 | 148.11 | 155.04 | 164.21 | 153.31 | 146.17 | 154.56 | 165.24 | 152.04 | 147.14 | 154.80 |
| J K Peeyali | 126.79 | 122.54 | 106.48 | 118.61 | 129.31 | 121.26 | 109.39 | 119.99 | 128.05 | 121.90 | 107.94 | 119.30 |
| Asha | 140.48 | 145.35 | 138.15 | 141.33 | 138.47 | 143.29 | 136.47 | 139.41 | 139.48 | 144.32 | 137.31 | 140.37 |
| Mean | 143.11 | 142.23 | 136.01 | | 143.31 | 141.53 | 136.34 | | 143.21 | 141.88 | 136.18 | |
| | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | | Season | Variety | Season x Variety | |
| SEm± | 0.64 | 1.02 | 1.77 | | 0.41 | 0.93 | 1.62 | | 0.38 | 0.69 | 1.20 | |
| CD (P=0.05) | 2.52 | 3.04 | 5.26 | | 1.60 | 2.78 | 4.81 | | 1.24 | 1.99 | 3.44 | |



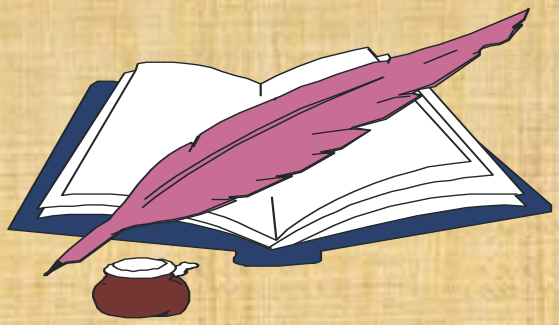
# SUMMARY & CONCLUSIONS

# SUMMARY AND CONCLUSION

The present experiment entitled "Performance of bell pepper (*Capsicum annuum* L.) varieties under different planting dates" was carried out during November-February of 2011-12 and 2012-13 at the instructional farm of UBKV, Pundibari, West Bengal ($26^0 19'$ N latitude and $89^0 23'$ E longitude). The experiment was conducted to access the impact of temperature stress on growth and yield performance of bell pepper varieties and to identify most stable performed bell pepper variety(s) for different transplanting dates. The experiment was laid out in split plot design with 3 replications where three planting dates (15th November, 30th November, 15th December of each year) were arranged as main plot treatment and four varieties (Mekong, California Wonder, JK Peeyali and Asha) were allotted in sub plots. The observation were recorded on different horticultural traits namely plant height, number of leaves/plant, leaf area, days to first harvest and days to 50% flowering, fruit weight, number of fruits/plant, yield per plant and per hectare, T.S.S. of fruit, ß-carotene content and vitamin C content of fruit. The experimental findings revealed that among the different planting dates, 30th November transplanting recorded maximum leaf area, maximum leaf chlorophyll, maximum number of fruits per plant, maximum fruit weight, maximum yield per plant and per hectare along with maximum β-carotene content. Whereas, 15th November transplanting resulted in maximum plant height, maximum TSS content and maximum vitamin C content. The results further showed that delayed transplanting (15th December) recorded lower plant height and low vitamin C content of fruits, but possessed maximum number of leaves and minimum days to flowering and first fruit harvesting. Results on suitability of varieties showed that Mekong emerged as promising variety with maximum number of fruits per plant, maximum yield per plant and per hectare and maximum TSS content. Whereas, Asha recorded maximum plant height, maximum leaf area, maximum leaf chlorophyll, maximum fruit wt. as well as minimum days to 50% flowering. The variety California wonder resulted best quality fruit with highest β-carotene content and vitamin C content. The interaction effect showed that bell pepper variety Mekong transplanted on 30th November proved its superiority in respect of growth and yield characters of bell pepper and resulted in many fold improvement in the form of higher number of fruits per plant, higher yield per plant and per hectare as compared to other varieties, whereas the variety Asha transplanted

on 30th November resulted in maximum leaf area, maximum leaf chlorophyll and maximum fruit weight.

The experimental results demonstrated that for successful bell pepper cultivation in terai zone of West Bengal, 30th November transplanting is ideal. The variety Mekong emerged as best performer and hence may be selected for mid and late transplanting (30th November and 15th December) and Asha for mid season transplanting (30th November) where as California Wonder for early transplanting (15th November) for large scale bell pepper cultivation in this region. Again for sequential planting preference should be given to the hybrid varieties over open pollinated varieties.



# FUTURE SCOPE OF RESEARCH

# FUTURE SCOPE OF RESEARCH

The present experiment was carried out to access the impact of temperature stress on growth and yield performance of bell pepper varieties and to identify most stable performed bell pepper variety for different transplanting dates. The outcome of the present experiment clearly indicate that 30$^{th}$ November is ideal for bell pepper transplanting in terai zone of West Bengal and the Mekong emerged as best performer. However to popularize bell pepper cultivation among wide range of farmers the following research work may be under taken in future for terai zone of West Bengal.

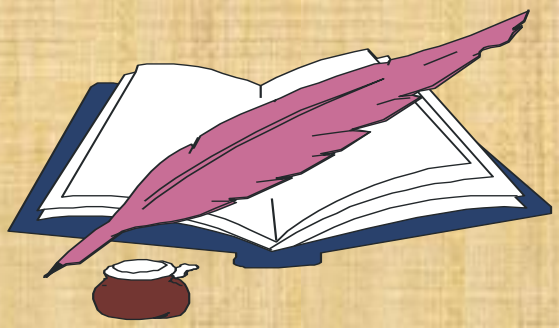
1. Research work involving more number of hybrid and open pollinated varieties may be carried out to find best hybrid and open pollinated variety for this region.

2. Experiments involving more number of planting dates and sequential planting may be carried out to find more accurate results on bell pepper transplanting in terai zone of West Bengal

3. Research work on interaction effect of inorganic fertilizers, vermicompost and biofetilizers along with varieties and planting dates may be carried out.

4. Different intervention like shade house cultivation, use of growth regulators may be may be initiated to compensate the yield reduction under high temperature stress.

5. Storage behavior of different hybrids and open pollinated varieties under different nutritional treatments and planting dates may be carried out to identify the longer shelf life varieties of bell pepper in this region.



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