

**EFFECT OF DATES OF SOWING AND CHEMICALS ON  
SEED YIELD AND QUALITY OF MALE PARENT  
SB (YF)-425 COTTON (*Gossypium barbadense* L.)**

**M. S. ULLAGADDI**



**DEPARTMENT OF SEED SCIENCE AND TECHNOLOGY  
COLLEGE OF AGRICULTURE, DHARWAD  
UNIVERSITY OF AGRICULTURAL SCIENCES,  
DHARWAD-580 005**

AUGUST, 2000

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*Thesis submitted to the  
University of Agricultural Sciences, Dharwad  
In partial fulfillment of the requirements for the*

*Degree of*

**MASTER OF SCIENCE (AGRICULTURE)**

*in*

**SEED SCIENCE AND TECHNOLOGY**

*By*

**M. S. ULLAGADDI**



**DEPARTMENT OF SEED SCIENCE AND TECHNOLOGY  
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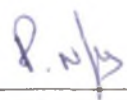
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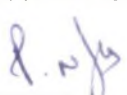
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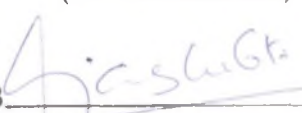
  
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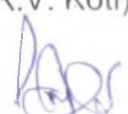
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4   
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*August, 2000*

*ಮಲ್ಲಗಡ್ಡಿ*  
**(M.S.Ullagaddi)**

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# *INTRODUCTION*

## I. INTRODUCTION

Cotton, a king of fibre crop from prehistoric times is enjoying prime status as the most important fibre crop of India even today, inspite of competition from synthetic fibres. Cotton comprises 85 per cent of raw material of our sprawling textile industry. Apart from this, now a days use of cotton is being extended as a material for many industries such as paper making, cushion making and in medical practices. Cotton seed is crushed to get its oil for human consumption and left out cake is used as cattle feed.

The area under cotton has stagnated around 7.6 million hectares since seventies and the efforts to increase production through increase in the productivity continue with success (Basu, 1992). But still, there is an urgent need to increase the area under cotton and its production to meet the domestic needs as well as for export.

India is a major producer of cotton in the world having the largest area under this crop. The cotton growing areas in India fall within 8°-32'N latitude and 70°-80'E longitude with an elevation ranging from 0-950 m, above mean sea level. It is cultivated in areas receiving annual rainfall ranging from 250 to 1500 mm and widely varying soil conditions in terms of colour, texture and nutrient levels.

In the world it is cultivated over an area of 33.0 million hectares with a production of 52.8 million tonnes and with productivity of 1600 kg per hectare, which is almost double that of Indian

productivity (Anon., 1998). Cotton occupies 5 per cent of the total cultivable area in the country. It is estimated that it occupies an area of 9.1 million hectares and a production of 7.7 million tonnes with productivity of 850 kg per hectare. Karnataka produces 0.82 million tonnes of kapas yield in an area of 0.64 million hectares.

According to the estimates, cotton requirement by 2050 A.D. with an estimated population of 1600 million would be 282.0 lakh bales respectively (Narayanan and Bhale, 1987). This could be achieved only through increased productivity. The productivity can be enhanced through increased area under hybrids in the existing command areas by adopting new technologies.

There are many constraints in the presently cultivated inter-specific hybrids such as square and boll dropping which leads in the yield loss by 20 to 25 per cent. This problem is thought to be inherited from the male parent i.e., *Gossypium barbadense*. The male parent SB (YF)-425 is introduced from Russia, where it is adopted to lower temperature. Because of the exposure of this parent to higher temperature in India, there may be occurrence of boll and square drying. The productivity in male parent of Jayalaxmi (SB(YF)-425) is very low and it is difficult to meet even minimum demand of total seed required for seed production. It is because in male parent in addition to normal abscission of buds and bolls there is a loss of fruiting forms, which dry up during peak flowering and boll period due to many reasons.

Particularly adverse environmental and physiological phenomena may result in dropping of squares and bolls.

Research works on cotton are carried out continuously to increase yield levels through improved cultivation practices, use of better hybrids and varieties with proper control methods for pests and diseases.

Among the agronomic practices, suitable time of sowing is most important from the point of high yields. In Northern Karnataka, cotton is generally sown either late in *summer* during April or May or late in *kharif* August or September under irrigated condition. Growth phases of the crop should synchronise with optimum environmental condition for better expression of growth and yield. When cotton is sown late during *kharif* season, growth will be reduced due to prevailing low temperature and moisture stress leading to low yield.

Plant growth regulators have contributed a great deal, to increase the productivity of a crop. The growth behaviour of many crop plants could be modified and controlled by applying small amounts of chemicals to leaves, seeds, stems, fruits and roots. Dastur and Ved Prakash (1954), Negi and Avatar Singh (1956) for the first time observed that the application of hormones increased the dry weight, boll weight, and also the number of flowers and bolls per plant in cotton. In addition it also reduced the shedding of floral parts resulting in increased seed cotton yield.

Generally, the plant requires a wide variety of elements to improve the growth and yield. Boron and Zinc are the essential elements required for the plant growth and development having specific role in cell division and cell metabolism. In cotton flowering is a continuous process. However, all the flowers produced are not fertilized and retained. About 40 to 50 per cent of the flowers and bolls are shed due to either pest incidence or due to physiological disorders. Hence, there is a need to supplement the plant with proper micronutrients and growth regulators to produce more number of flowers and retain them on the plant to develop into bolls for final harvesting so that yield can be increased considerably. Hence, the present seed technological investigation was carried out on male parent SB (YF)-425 *barbadense* cotton crop which is a male parent of DCH-32 hybrid cotton with the following objectives.

- i. To study the effect of dates of sowing on seed yield and quality of *barbadense* cotton.
- ii. To know the influence of growth regulators and micronutrients on reproductive efficiency of male parent.
- iii. To investigate the interaction effect of dates of sowing, growth regulators and micronutrients on seed yield and quality of *barbadense* cotton.

*REVIEW OF LITERATURE*

## II. REVIEW OF LITERATURE

The literature pertaining to effect of dates of sowing and application of chemicals on growth, seed yield and quality of cotton is presented in this chapter.

### 2.1 Effect of dates of sowing on seed yield and quality of cotton.

Growth of crop from emergence to harvesting stage is much influenced by climatic conditions. Early growth with good frame work of plant is very important for higher yield. Harmonious balance of vegetative and reproductive phases for successful crop production has been stressed by Brown and Ware (1958). Growth is affected by different weather parameters like temperature, humidity, rainfall and radiation.

#### 2.1.1 Growth and growth components

An experiment conducted at Indore by Dastur and Singh (1956) noticed the maximum plant height and dry matter production from early sown crop, when crop was sown with 10 day interval from 10<sup>th</sup> May to 5<sup>th</sup> July.

In Rajasthan, Simolote *et al.* (1967) stated that delayed sowing in the month of May was found to be late for producing sufficient vegetative growth of the crop before onset of the reproductive phase, with the result May sown crop produced lower yields.

In Suphan Buri Province with Reva B-50 variety of cotton, Yadee (1968) reported maximum plant height when crop was sown on 1<sup>st</sup> July as compared to 15<sup>th</sup> July.

Under irrigated conditions in Nimbar tract of Madhya Pradesh, Singh *et al.* (1969) noticed that height of cotton was significantly more with May sowing as compared to crop sown on 30<sup>th</sup> May and 14<sup>th</sup> June.

In sowing date trial at Giza (Egypt) with 10 days interval from 20<sup>th</sup> December to 6<sup>th</sup> April, El-Gibali *et al.* (1976) obtained higher plant height from March sowing and lower heights with December sowing.

Based on the results obtained in an experiment with two planting dates in Greece during 1974-75, Galanopoulou *et al.* (1980) reported that early sowing overcomes delayed seedling emergence, produced earliness and increased yield particularly in the shorter growing season. Late planting dates were inferior in flowering rate and maturation rate index.

In a Chambal command area of Madhya Pradesh, Jain *et al.* (1981) noticed that cotton crop planted late after May reached the reproductive phase in the first half of October, coinciding with the cold weather, which affected the boll formation and development adversely, this ultimately resulted in extremely poor yields.

Prabhakar (1981) in a date of sowing trial with Varalaxmi cotton at Dharwad, noticed the reduction in plant growth and dry matter production with late plantings compared to early plantings due to low temperature.

### 2.1.2 Yield and yield components

Sowing time is one of the important factors of production, and it has been studied by several workers. Balanced growth of the crop is observed only when cotton is sown at appropriate time.

In Nimbar tract of Madhya Pradesh, under irrigated conditions, Singh *et al.* (1969) reported the increased number of bolls per plant, boll weight and yield per plant with 15<sup>th</sup> May sowing as compared to late sowings. Crop sown on 30<sup>th</sup> May and 14<sup>th</sup> June, resulted in poor yield due to decreased boll number per plant and yield per plant.

Khan *et al.* (1970) in Lyallapur, observed that cotton sown in mid March or April produced higher yields of seed cotton (24.6 to 26.5 mundas/acre) than cotton sown in mid May or June (20.0 to 7.7 mundas/acre). Increased yields were the results of a greater number of bolls per plant and higher weight of seed cotton per plant.

Bilbro and Roy (1973) stated that at Texas high plains, cotton planted on 20<sup>th</sup> April gave highest yield and the late planting decreased the yields. This was expected because, with the late planting dates, growth, fruiting and maturation periods occurred under low temperature and reduced growing season, which resulted in poor crop performance from late sowings.

Singh and Singh (1974) reported that optimum time of sowing of cotton in Mewar tract of Rajasthan was from 30<sup>th</sup> May and

15<sup>th</sup> June. Sowing earlier or later, reduced the yield of seed cotton. Crop sown on 30<sup>th</sup> May attained more height with greater number of bolls.

At Arabhavi (Karnataka), both 170 Co-2 and Mysore Vijaya varieties of cotton gave higher yield with early planting on 5<sup>th</sup> May; while Hampi variety of cotton gave higher yield when planted on 20<sup>th</sup> July at Siruguppa (Anon., 1979).

Misra and Malik (1979) reported that seed cotton yield per ha was highest under 12<sup>th</sup> May sowing followed by 29<sup>th</sup> May and 15<sup>th</sup> June sowing. The increased seed cotton yield per ha with early sowing may be attributed to its higher number of flowers per plant and the number of mature bolls increased under 12<sup>th</sup> May sown crop due to longer period of crop growth.

In an experiment conducted at Sindos (Greece), Galanopoulou *et al.* (1980) noticed the stronger influence of planting date on earliness. Early sowing overcome the effect of reduced and prolonged seedling emergence, produced earliness and increased yield, particularly in short growing season. Late planting dates were inferior in flowering rate, maturation rate index, flower and boll number, boll weight and yield.

Jain *et al.* (1981) in a two year trial conducted in Chambal area of Madhya Pradesh, noticed that striking reduction in yield due to delay in sowing. A drastic fall in the yield of 13 to 81 per cent in first year and 16 to 74 per cent in second year was noticed due to delay in sowing from third week of March to last week of June. Higher yields

obtained by advancing the sowing date, were attributed significantly higher number of bolls and yield per plant.

Nehra *et al.* (1981) noticed that cotton sown in first fortnight of May gave significantly higher yield of seed cotton than sown either in second fortnight of May or first fortnight of June. The delay in sowing showed significant decrease in number of bolls per plant, which might have reduced the seed cotton yield per ha of June sown crop.

In a date of sowing trial with Varalaxmi hybrid cotton under irrigation at Dharwad, Prabhakar (1981), noticed that July planted crop gave higher yield compared to too early or too late planting. No significant difference in kapas yield was noticed between June and July plantings. However, June planting recorded 4.65 per cent less yield as compared to July planting. Planting in March, April and May resulted in the yield loss of 24.35, 30.37 and 31.21 per cent respectively, as compared to July planting. When the crop was planted in August, September and October, yield was reduced by 14.26, 35.07 and 52.29 per cent respectively over that of July planting. Higher yield with July planting was mainly due to higher boll number per plant.

In a date of sowing trial conducted in Nagarjunsagar project area of Andhra Pradesh, Ramapandu and Rao (1981) obtained the higher yield of MCU-5 cotton when it was sown on 1<sup>st</sup> August as compared to early and late plantings.

Shrivastava *et al.* (1982) reported that date of sowing produced the significant effect on the number of bolls and seed cotton

yield of Bikaneri Narma. The first date of sowing (7<sup>th</sup> May) gave significantly highest yield of 20.0 q per ha over the late sowing dates.

Malik and Malik (1986) recorded higher seed cotton yield per boll with May sowing as compared June and July sowing.

Dhoble *et al.* (1988) noticed that early sowing of cotton on 20<sup>th</sup> June recorded the highest seed cotton yield of 1291 kg per ha and it was significantly superior over sowing of cotton on 30<sup>th</sup> July. This may be attributed to full utilization of rain water right from its sowing and favourable climatic condition resulting in increased number of picked bolls per plant and boll weight.

Tomar *et al.* (1989) showed that four cotton cultivars sown on 15<sup>th</sup> May or 15<sup>th</sup> June gave average seed cotton yields of 1.39 and 1.02 tonnes per hectare respectively.

Raju and Kharche (1990) reported that in rainfed trails with four cotton cultivars, sowing in dry soil in early June before the onset of monsoon rains. On the normal date in late June with onset of monsoon rains or 20 days later gave average cotton yields of 1.10, 0.73 and 0.28 t per ha respectively.

Koraddi *et al.* (1992) observed that early planting of cotton (June II fortnight) increased the yield significantly over normal planting (August II fortnight). But the yield of mid early planting (July II fortnight) was on par with that of early planting except during 1986-87 wherein it was significantly low.

Eid *et al.* (1993) reported that the number of days from sowing to 50 per cent flowering, number of days from sowing to 50 per cent first open boll and number of bolls per plant were all decreased when sowing of cotton cv. Giza 75 was delayed from January to April. Boll retention and seed cotton yield both decreased with delayed sowing date.

Ishwar Singh and Chouhan (1993) reported that cotton sown on 1<sup>st</sup> May gave the highest bolls per plant and weight of bolls. Consequently, the intensity of boll shedding was lowest, whereas the seed cotton yield was the highest. Delay in sowing by every fortnight not only significantly increased boll shedding intensity but also decreased the seed cotton yield.

Brar and Singh (1994) recorded that sowing time exerted significant effect on seed cotton and this was decreased linearly as the sowing date was shifted from 3<sup>rd</sup> week of April to 2<sup>nd</sup> or 3<sup>rd</sup> week of June. With shift in sowing date from 20-25 April to 10-20 June, the seed cotton yield was reduced to even less than half i.e., from 2640 kg per ha to 1107 kg per ha.

Mukundan *et al.* (1993) studied the effect of sowing date on cotton on 15<sup>th</sup> or 31<sup>st</sup> July or 15<sup>th</sup> or 31<sup>st</sup> August. Delayed sowing after 31<sup>st</sup> July decreased seed cotton yield significantly.

Lakkineni *et al.* (1994) studied the effect of sowing date on cotton cv. Pusa 31. The highest seed cotton yield per plant was obtained with sowing on 11<sup>th</sup> May, delayed sowing after this date reduced yields.

Goudreddy *et al.* (1995) reported that early planting of cotton during June 1<sup>st</sup> and 2<sup>nd</sup> fortnight significantly increased the seed yield over delayed planting of 1<sup>st</sup> fortnight of July.

Hosny and Shahine (1995) studied the effect of sowing date of cotton cv. Giza. Delayed sowing increased the periods from sowing to seedling emergence, first square, first flower, first boll open and full harvest, while number of open bolls per plant and plant survival decreased. However, boll weight was unaffected by sowing date.

Sivasankaran *et al.* (1995) reported that during winter 1989, the seed cotton yield was highest with crop sown on 15<sup>th</sup> August and was significantly superior to other dates of sowing i.e., 1<sup>st</sup> August, 1<sup>st</sup> September and 15<sup>th</sup> September. During summer season, 15<sup>th</sup> February sowing produced the highest seed cotton yield and was significantly higher than other dates of sowing i.e., 1<sup>st</sup> February, 1<sup>st</sup> March and 15<sup>th</sup> March.

Brar *et al.* (1996) reported that cotton sown in first fortnight of May recorded higher yield than sown in first fortnight of June. The favourable effect of May sowing could be seen with retention of maximum or more number of bolls per plant.

Lingaraju (1998) reported that early sowing of cotton during second fortnight of July produced significantly higher kapas yield during both the years (1354 and 1083 kg/ha respectively) over subsequent sowing dates. The higher kapas yield with early sowing was attributed to more number of open bolls and kapas yield per plant.

### **2.1.3 Quality and quality attributes**

Solanke *et al.* (1989) reported that cotton sown on 15<sup>th</sup> June in a dry soil, with seedling sown on 7<sup>th</sup> June and transplanted with the onset of monsoon rains on 1<sup>st</sup> July or with a pre-sowing irrigation on 30<sup>th</sup> May were superior to that sown on normal date with the onset of rains in respect of lint index but not in seed index.

Gadagi *et al.* (1990) reported that cotton sown in June, July and August gave seed cotton yields of 3.47, 2.32 and 1.88 t per ha respectively, and seed index was highest with June sowing.

Brar and Singh (1994) reported that sowing period did not influence on quality character like seed index.

## **2.2 Effect of plant growth regulators and nutrients on seed yield and quality of reproductive efficiency of cotton**

The role of plant growth regulators (PGR's) and nutrients in various physiological and biochemical processes in plant is well known, which enables a rapid change in the physiology of plant within one season to achieve desirable results. The plant growth regulators are known to affect right from seed germination to senescence either by enhancing the growth (growth promoters) or by reducing the plant height (growth retardants), flowering, fruit and seed development, fruit ripening and yield. Similarly, essential mineral elements, which are required in higher concentrations than growth regulators by the plant, have major role in determining the growth and development. Cotton often produces

more vegetative growth, than needed for maximum boll production and yield especially when climatic conditions favour vegetative growth, there by directing the nutrients and photo assimilates towards vegetative growth rather than reproductive growth. This chapter emphasizes the recent work on synthetic plant growth regulators and nutrients in cotton and related crops and their effect on morphological and physiological parameters and seed yield and quality attributes.

### **2.2.1 Growth and growth components**

Tsui (1948) has given convincing evidence on the important role of Zn in the production of growth promoting hormones and it is likely that the appreciable increase in growth might be due to this factor.

The increase in plant height particularly in case of boron is due to its requirement by the meristematic regions of the plant. Berger(1949) has mentioned that boron is very important in cell division and forms an essential component of cell wall.

Chokhey Singh *et al.* (1970) indicated, the increase in plant height was accompanied by increase in number of bolls per plant, where in plant height held strong correlation with boll number, and days to first flower.

Bhatt and Ramanujam (1971) reported that when short branched cotton (*G. hirsutum*) cv. PBS-71 was sprayed with GA<sub>3</sub> (100 ppm) at square formation stage and three weeks later increased the height of the main axis and stem length.

Oosterhuis (1976) reported that application of boron along with insecticides increased the yield of seed cotton, boll weight and plant height as compared to that of control.

GA<sub>3</sub> @ 25 g ai per ha under field conditions changed leaf orientation for several days and increased the plant height in cotton (Dippenaar, 1988).

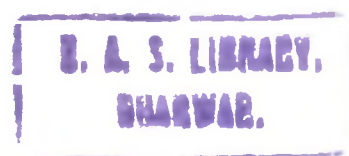
Kapagate *et al.* (1989) reported that, GA<sub>3</sub> (500 ppm) was most effective in increasing plant height followed by NAA (1000 ppm) in cotton cv. Bravil 1007.

Kene and Sontakey (1995) studied the effect of growth regulators like ascorbic acid, succinic acid, gibberellic acid and salicylic acid and found that there was no effect of growth regulators on plant height of sunflower except gibberellic acid, in which slight increase in height was observed.

Pothiraj *et al.* (1995) found that plant height was not influenced by any of the growth regulators and micronutrients in cotton cv. MCU-9 during both the years.

Thakar Singh *et al.* (1997) observed increase in height of cotton plants when biozyme (GA<sub>3</sub> + IAA + zeatin + micronutrients) was applied @ 600 ml per ha.

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### 2.2.2 Yield and yield components

Braud *et al.* (1969) observed the increased number of bolls in cotton cv. D-9 when grown in solution culture containing 0.21 to 3.4 mg boron.

Burkalov (1969) indicated that, spraying with 0.5 per cent boron increased the seed cotton yield by 14.4 per cent.

Application of boron @ 116 lb per acre increased the yield in cotton (Koegh and Mapples, 1969).

Baluch *et al.* (1970) studied the effect of GA<sub>3</sub> in cotton cv. S-57-91 and indicated that, application of 1-10 ppm GA<sub>3</sub> increased yield by 30.0 per cent when applied at 10 DAS and 16.6-17.0 per cent when sprayed at young flower bud stage while, higher concentrations of GA<sub>3</sub> reduced the yield.

Chowdhary and Hisani (1970) reported that increased seed cotton yield with 2.0 ppm boron.

Bharadwaj and Sharma (1971) observed that increased seed cotton yield with application of 1 mg IAA or GA<sub>3</sub>, combination of IAA + GA<sub>3</sub> also increased the seed cotton yield.

Murphy and Lancaster (1971) found a significant increase in yield of seed cotton with boron @ 0.1 kg per ha sprayed at weekly interval for five weeks.

Subbiah and Mariakulandai (1972) observed the increased boll retention in cotton cv. MCV-5 when plants were sprayed with NAA (10 ppm) and GA<sub>3</sub> (15 ppm).

Application of IAA and or GA<sub>3</sub> to a naturally pollinated one day old flowers of cotton retarded the shedding of bolls developed from them. Application of GA<sub>3</sub>, GA<sub>3</sub> + IAA and IAA + GA<sub>3</sub> + kinetin also decreased the boll shedding (Bhardwaj *et al.*, 1975).

Honischo (1975) reported that foliar application of boron to cotton cv. Albar 637 increased the seed cotton yields in five out of eight trials, highest yield was obtained with application of two to four kg boron per hectare.

Madzhidove (1977) found that increase in seed cotton yield in case of fine fibre cotton, with application of boron at bud formation stage.

Monged *et al.* (1979) indicated that application of 0.1 g ZnSO<sub>4</sub> or MnSO<sub>4</sub> per pot had no significant effect on cotton flower number, boll number, shedding or seed cotton yield. Mn content and the ratios of N:Zn, P:Zn, P:Mn and Mn:Zn were significantly correlated with seed yields.

Biag *et al.* (1982) reported that plants sprayed with ascorbic acid and gibberellic acid at flowering stage had maximum height and number of bolls per plant and highest per cent boll set.

Silva *et al.* (1982) reported that application of boron @ 1.23 kg per ha significantly increased the seed cotton yield, boll weight and induced earliness.

He *et al.* (1983) reported that bolls treated with GA<sub>3</sub>, the fresh weight, dry weight and boll number were increased upto 11 days after treatment. This GA<sub>3</sub> treatment also increased the weight of various parts of the bolls and also increased the rate of photosynthesis.

Kosmidou-Demetropoulou (1985) showed that 10, 20 or 30 ppm GA<sub>3</sub> applied to cotton at the beginning of square formation followed by 5, 10 or 15 ppm respectively at the start of anthesis. There was general tendency for GA<sub>3</sub> application to increase boll number and to decrease the percentage of boll shedding, especially when conditions for fruit set were unfavourable.

Lu and Shi (1986) reported that application of 1 to 2 kg Zn per nu as basal dressing to cotton increased boll number per plant and boll weight and foliar spray at 0.1 to 0.3 per cent at the three true leaf stage increased yields by 22.7 per cent.

Sharma and Gupta (1987) reported that 25-50 kg ZnSO<sub>4</sub> applied as broadcast or drilled or a foliar spray of 0.5 per cent ZnSO<sub>4</sub> increased seed cotton yields by 11.8-15.1, 2.5-7.5 and 6.8 per cent respectively.

Sharma *et al.* (1988) reported that application of 5 or 10 kg per ha by 2 methods or 2 foliar application of 0.5 per cent Zn at 50 and

65 DAS gave seed cotton yields of 1.49-1.55, 1.59-1.61 and 1.46 t per ha respectively, compared to 1.18 t without Zn. Zinc increased number of bolls per plant and boll weight, but had no effect on plant height.

Stoyanow and Gikov (1990) reported that foliar application of boron at different growth stages increased seed cotton yield.

Gomma (1991) indicated that cotton cv. Giza 70 was given 0, 5 or 10 kg soil applied ZnSO<sub>4</sub> per feddan or was sprayed with 0.4 kg ZnSO<sub>4</sub> per feddan. Seed cotton yield was slightly increased by soil applied zinc but highest with foliar application of zinc. Total and open boll numbers were only increased by foliar application of zinc (1 feddan = 0.42 ha).

Venkatakrisnan and Pothiraj (1991) found that soil application of 80:60:60 kg NPK per ha and 25 kg ZnSO<sub>4</sub> per ha significantly increased the seed cotton yield.

Livingston *et al.* (1992) and Hickey and Atkins (1992) observed higher number of bolls per plant, boll size and opened bolls per plant, when cotton plants were sprayed with PIX and PGR-IV (GA<sub>3</sub>+IBA).

McConnel *et al.* (1992) found that foliar application of boron at different growth stages increased the seed cotton yield and lint yield significantly.

Shrivastava *et al.* (1993) reported that application of 0, 40, 80, or 120 kg N and 0, 25, 50 or 75 kg ZnSO<sub>4</sub> per ha increased seed cotton yield upto 80 kg N and upto 50 kg ZnSO<sub>4</sub>.

Haq Nawaz *et al.* (1994) studied that seed cotton yields were increased in the order Cu>Zn>Fe>Mn>B trace elements applied together.

Prasad and Prasad (1994) observed that application of 80:40:20 kg, NPK per ha in combination of without or with Zn (Zinc sulphate), S (Gypsum), B (Borax), Mn (Manganese sulphate) or Mg (Magnesium sulphate) resulted in increased seed cotton yield, the highest yield being observed with NPK + Zn or Mg.

Venkatakrisnan (1994) reported highest seed cotton yield of 3.28 t per ha with 80:60:60:25 kg NPK and ZnSO<sub>4</sub> per ha. High yields were associated with increased boll retention, and flower production per plant.

Wankhade *et al.* (1994) revealed that yield of cotton seed and yield attributes were significantly influenced by foliar spray of borax 0.1 per cent at peak square and peak flowering stages recorded significantly more cotton seed yield over control. Similar results were also recorded in respect of bolls per plant, seed cotton yield per plant and seed cotton yield per ha.

Application of Ryzup (4 per cent GA<sub>3</sub>) at 2 g per acre increased the cotton yield significantly (Hansen *et al.*, 1996).

Raja Rajeswari (1996) reported that application of 0.5 per cent ZnSO<sub>4</sub> and 0.5 per cent boron recorded more number of bolls per plant, mean boll weight and kapas yield was significantly higher with boron and zinc sulphate compared to control.

### 2.2.3 Quality and its attributes

Sharma *et al.* (1984) reported that seed germination and seedling growth of cotton cv. H-777 was increased by spraying 50-500 ppm GA<sub>3</sub>. Speed of germination and seedling growth were the highest with 500 ppm GA<sub>3</sub>.

Kashyap *et al.* (1988) studied the effects of 0, 5, 10, 15 and 20 ppm Zn on seed weight of 2 cotton cultivars and found that 100 seed weight increased with increase in Zn levels upto 50 ppm and decreased at 20 ppm.

# *MATERIAL AND METHODS*

### **III. MATERIAL AND METHODS**

The details of materials used, methods followed and the techniques adopted during the course of investigation are described in this chapter.

#### **3.1 General description**

##### **3.1.1 Location**

The experiment was conducted during *kharif* season of 1998-1999 under irrigated condition at Main Research Station, University of Agricultural Sciences, Dharwad in plot number ABH/3D. Dharwad is situated at 15°26' N latitude of 75°07' E longitude with an altitude of 678 m above mean sea level.

##### **3.1.2 Soil**

The soil of the experimental plot was medium black and clay loam in texture. Composite soil sample from experimental site was drawn from 0 to 30 cm depth in each replication before sowing and a composite soil sample was prepared. The soil sample was analyzed for its physical and chemical properties and the data along with methods employed for their determination are furnished in Appendix I.

##### **3.1.3 Climate**

The data on the climatic parameters viz., rainfall, maximum and minimum temperature and relative humidity during the period of experimentation and the average values of rainfall, maximum and minimum temperature and relative humidity of previous 50 years

recorded at the Meteorological Observatory, College of Agriculture, University of Agricultural Sciences, Dharwad are presented in Appendix II.

The average annual rainfall of fifty years received at the Main Research station, Dharwad is 806.80 mm. The rainfall during the year 1999-2000 was 422.8 mm which is distributed over a period of seven months (April to October). The mean maximum temperature varied from 27.1°C to 33.6°C and the mean minimum temperature varied from 15.1°C to 20.8°C. The relative humidity was maximum (89%) during the month of July, while it was minimum (51%) during the month of December.

#### **3.1.4 Previous crop of the experimental site**

On the experimental site wheat was grown during previous season with usual package of practice for commercial production.

### **3.2 Experimental details**

The experiment consisted of two dates of sowing (main plots) and nine treatments involving (two growth regulators, two micronutrients and their combination as sub plots).

The treatment details are given below :

#### **1. Main plots : Dates of sowing (D)**

D<sub>1</sub> = 20.5.99 (May sowing)

D<sub>2</sub> = 10.6.99 (June sowing)

## 2. Sub plots : Treatments (T)

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T<sub>1</sub> : ZnSO<sub>4</sub> @ 10 kg per ha (soil application)

T<sub>2</sub> : Boron @ 5 kg per ha (soil application)

T<sub>3</sub> : ZnSO<sub>4</sub> + Boron @ 10 + 5 kg per ha (soil application)

T<sub>4</sub> : ZnSO<sub>4</sub> + Boron @ 10 + 5 kg per ha (soil application) + GA<sub>3</sub> @ 50 ppm (foliar application)

T<sub>5</sub> : ZnSO<sub>4</sub> + Boron @ 10 + 5 kg per ha (soil application) + Acetyl salicylic acid @ 2 mM (foliar application)

T<sub>6</sub> : ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1% (foliar application)

T<sub>7</sub> : ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1% + GA<sub>3</sub> @ 50 ppm (foliar application)

T<sub>8</sub> : ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1% + Acetyl salicylic acid @ 2mM (foliar application)

T<sub>9</sub> : Control

The above chemicals were sprayed at square initiation stage.

### 3.2.1 The treatment combinations are given below :

D <sub>1</sub> T <sub>1</sub>	D <sub>2</sub> T <sub>1</sub>
D <sub>1</sub> T <sub>2</sub>	D <sub>2</sub> T <sub>2</sub>
D <sub>1</sub> T <sub>3</sub>	D <sub>2</sub> T <sub>3</sub>
D <sub>1</sub> T <sub>4</sub>	D <sub>2</sub> T <sub>4</sub>
D <sub>1</sub> T <sub>5</sub>	D <sub>2</sub> T <sub>5</sub>
D <sub>1</sub> T <sub>6</sub>	D <sub>2</sub> T <sub>6</sub>
D <sub>1</sub> T <sub>7</sub>	D <sub>2</sub> T <sub>7</sub>
D <sub>1</sub> T <sub>8</sub>	D <sub>2</sub> T <sub>8</sub>
D <sub>1</sub> T <sub>9</sub>	D <sub>2</sub> T <sub>9</sub>

### **3.2.2 Design and plan of layout**

The design adopted for the experiment was Split Plot Design with three replications. The plot size was 3.0 X 3.0 m. The detailed plan of layout of the experiment is given in Fig 1.

### **3.2.3 Seed source**

The breeder seed SB (YF)-425 male parental line of DCH-32 was obtained from Main Research Station, Dharwad.

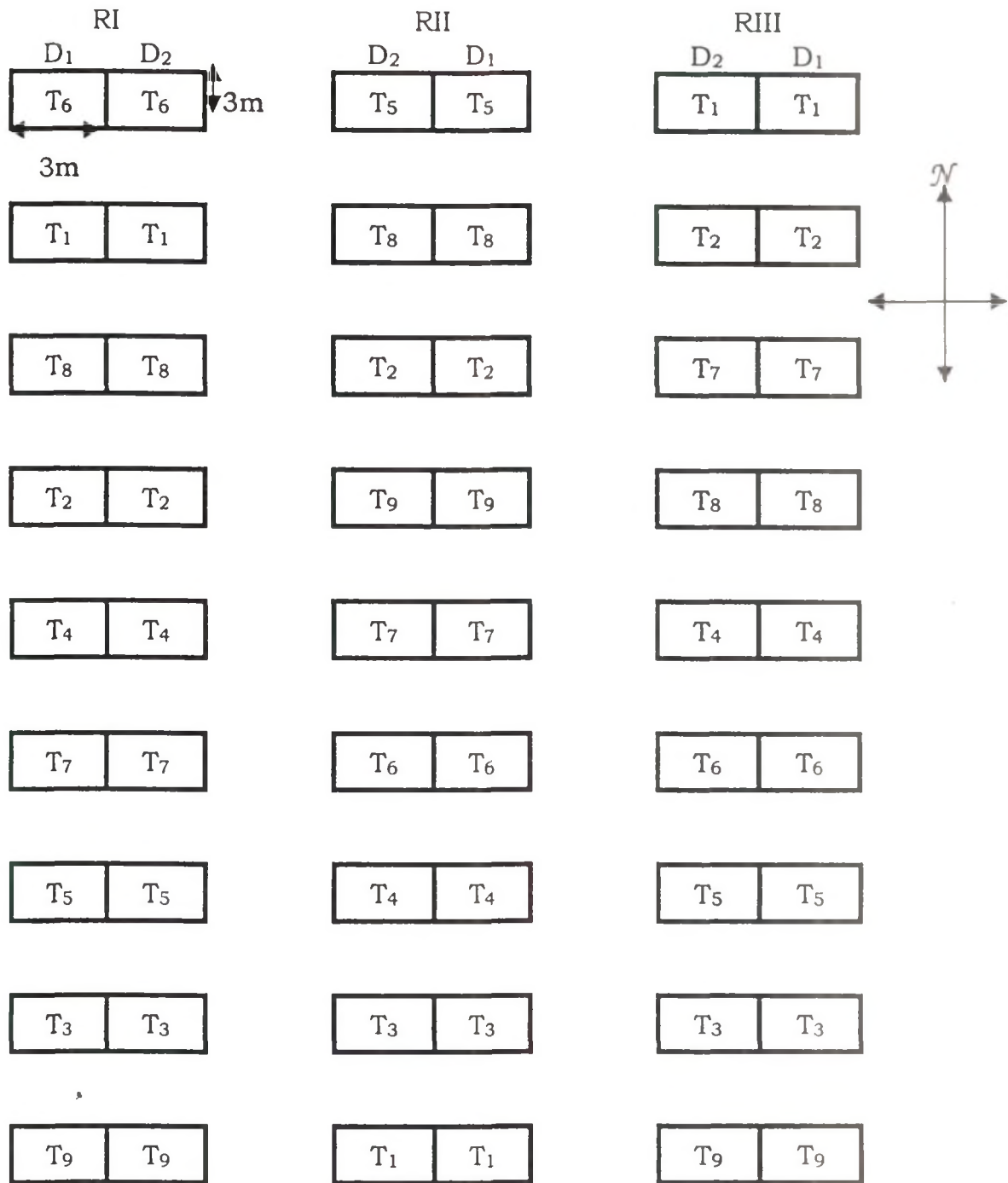
## **3.3 Cultural practices**

### **3.3.1 Preparation of land**

The land was prepared by repeated ploughing and harrowing to break the clods and soil was brought to fine tilth. Then FYM was applied at the rate of 25 tonnes per hectare and mixed well in the soil. The land was levelled with wooden plank to facilitate uniform sowing. Plots were prepared as per plan given in Fig.1.

### **3.3.2 Sowing of seeds and spacing**

Sowing was taken up by hand dibbling with inter row spacing of 60 cm and intra-row spacing of 60 cm. Two seeds were dibbled per hill in the rows to ensure even stand and to maintain required plant population. The thinning was attended on 25<sup>th</sup> day after sowing by keeping only one healthy plant per hill.



**Fig. 1. Plan of layout**

**LEGEND**

D<sub>1</sub> = 20.5.99

D<sub>2</sub> = 10.6.99

T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha

T<sub>4</sub> = T<sub>3</sub> + GA<sub>3</sub> @ 50ppm

T<sub>7</sub> = T<sub>6</sub> + GA<sub>3</sub> @ 50ppm

T<sub>2</sub> = Boron @ 5kg/ha

T<sub>5</sub> = T<sub>3</sub> + Acetyl salicylic acid @ 2mM

T<sub>8</sub> = T<sub>6</sub> + Acetyl salicylic acid @ 2mM

T<sub>3</sub> = ZnSO<sub>4</sub> + Boron (10+5kg/ha)

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%

T<sub>9</sub> = Control

### **3.3.3 Fertilizer application**

A fertilizer dose of 150 kg N, 75 kg P<sub>2</sub>O<sub>5</sub> and 75 kg K<sub>2</sub>O per ha was applied. Out of this 75 kg N and full dose of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O per ha were applied at the time of planting and the remaining 75 kg N was applied in three equal splits by ring method at an interval of 30 days commencing from 50 days after sowing.

### **3.3.4 After care**

In order to keep the plot free from weeds five hand weeding and two interculture operations were carried out at an interval of 15 days.

### **3.3.5 Plant protection**

The schedule of recommended plant protection measure was taken through out the crop growth period.

### **3.3.6 Irrigation**

Irrigations were given with an interval of 12 to 15 days so as to maintain adequate soil moisture in the soil.

## **3.4 Sampling Procedure**

In each plot five plants were selected randomly and tagged for recording observations at monthly interval on growth, yield and yield attributes.

### **3.4.1 Growth parameters**

#### **3.4.1.1 Plant height**

The height of five plants at 60, 90, 120 and 150 days after sowing in all the treatments were measured from the base of the plant to the growing tip. The mean of these five plants was taken as plant height and was expressed in centimeters.

#### **3.4.1.2 Number of leaves per plant**

The number of leaves per plant was counted at 60, 90, 120 and 150 days after sowing in all the treatments and the mean of five plants was computed and expressed as number of leaves per plant.

### **3.4.2 Yield and yield components**

#### **3.4.2.1 Days to 50 per cent flowering**

The date on which 50 per cent of the total plants in a net plot entered flowering was recorded as days to 50 per cent flowering.

#### **3.4.2.2 Number of squares per plant**

Total number of squares was recorded from five tagged plants at 60, 90, 120 and 150 days after sowing in all the treatments and mean of these five plants was taken as number of squares per plant.

#### **3.4.2.3 Number of flowers per plant**

Total number of flowers was recorded from five tagged plants at 70, 100, 130 and 160 days after sowing in all the treatments and

mean of these five plants was taken as number of flowers produced per plant.

#### **3.4.2.4 Number of matured bolls per plant**

At each picking, the total number of bolls picked from the tagged plants were counted and expressed as number of matured bolls per plant.

#### **3.4.2.5 Mean boll weight**

Seed cotton obtained from 10 randomly selected bolls from net plot covering top to bottom in each picking were weighed and the mean boll weight was worked out and expressed in grams.

#### **3.4.2.6 Seed cotton (kapas) weight per boll**

Randomly selected ten bolls from net plot covering top to bottom in each picking were weighed and the mean kapas yield per boll was worked out and expressed in grams.

#### **3.4.2.7 Number of seeds per boll**

Number of seeds per boll was counted. Mean value was recorded as seed number per boll averaging from ten bolls.

#### **3.4.2.8 Seed weight per boll**

Seed weight was taken from ten bolls. Mean value of this was recorded seed weight per boll in grams averaging from ten bolls and expressed in grams.

#### **3.4.2.9 Seed index**

One hundred seeds in each replication were randomly picked after ginning of each picking of seed cotton and sun dried. The average weight of eight replications was recorded in grams as 100 seed weight.

#### **3.4.2.10 Seed yield per ha**

First, all the plants in border area were harvested leaving the net plot area. Later, cotton was picked from the plants in the net plot area and weighed. The yield of five plants observation and ten bolls of first picking which were taken for mean boll weight, were also added to this. The yield per ha was worked out based on the net plot yield from all the pickings.

### **3.4.3 Quality parameters**

#### **3.4.3.1 Germination**

The standard germination test was conducted by using between paper method prescribed by ISTA Rules (Anon., 1996). Hundred seeds in each treatment were used in four replications. The germination counts were recorded on 4<sup>th</sup> and 12<sup>th</sup> day and per cent germination was expressed based on normal seedlings.

#### **3.4.3.2 Germination rate index (GRI)**

During germination test, daily counts were made for the emergence of seedlings and based on this observation the rate of germination was calculated by using the following formula.

$$\text{GRI} = \frac{N_1}{D_1} + \frac{N_2}{D_2} + \frac{N_3}{D_3} + \dots + \frac{N_n}{D_n}$$

Where,

GRI = Germination Rate Index

$N_1, N_2, N_3, \dots, N_n$ , = Number of seedlings emerged on  $D_1, D_2, D_3$  and  $D_n$  th day after sowing.

#### **3.4.3.3 Shoot length**

From the germination test, ten normal seedlings were selected randomly from each treatment replication-wise on 12<sup>th</sup> day. The shoot length was measured from base of the primary leaf to base of hypocotyle and mean shoot length was expressed in centimeters.

#### **3.4.3.4 Root length**

Ten normal seedlings, used for shoot length measurement, were also used for the measurement of root length. It was measured from tip of primary root to base of hypocotyl and mean root length was expressed in centimeters.

#### **3.4.3.5 Seedling dry weight (mg)**

The same ten normal seedlings selected for shoot and root length measurement were put in butter paper pocket and were kept in an oven maintained at  $70 \pm 1^\circ\text{C}$  for 24 hours. After drying, the seedlings were kept in a desiccator for cooling. The weight of dried seedlings were recorded and mean weight was calculated and expressed in milligrams.

#### **3.4.3.6 Seedling vigour index**

The vigour index of the seedling was calculated for all the three pickings of seed. The vigour index was calculated by following the method suggested by Abdul-Baki and Anderson (1973).

$$\text{Vigour index} = \text{Germination (\%)} \times \text{Seedling length (cm)}$$

### **3.5 Statistical Analysis**

The data collected were subjected to the statistical analysis by the procedures described by Panse and Sukhatme (1967). Whenever 'F' test was found significant the critical difference (CD) values were calculated and the treatment means were compared. The level of significance used to test the results in 'F' test was at five per cent probability levels.

The data relating to percentage germination were transformed into arc sine values and analysed statistically.

# *EXPERIMENTAL RESULTS*

## IV. EXPERIMENTAL RESULTS

A field experiment was conducted during *kharif*, 1999 at Main Research Station, Dharwad to study the effect of dates of sowing and application of chemicals on seed yield and quality of cotton cv. SB (YF)-425. The results obtained from the experiment are presented in this chapter.

### 4.1 Plant growth parameters

#### 4.1.1 Plant height

The data on plant height recorded at 60, 90, 120 and 150 days after sowing (DAS) as influenced by dates of sowing and chemicals are presented in Table 1.

May sowing (D<sub>1</sub>) recorded significantly higher plant height (66.3, 93.6, 120.2 and 156.8 cm) compared to June sowing (D<sub>2</sub>) (54.9, 70.9, 98.2 and 130.6 cm) at 60, 90, 120 and 150 DAS respectively.

Chemicals showed significant effect on plant height at all stages of plant growth. Among the chemicals, T<sub>7</sub> (ZnSO<sub>4</sub> 0.1% + boron 0.1% + GA<sub>3</sub> 50 ppm) recorded significantly higher plant height (69.1, 92.8, 119.8 and 154.1 cm at 60, 90, 120 and 150 DAS, respectively) compared to all other chemicals and control (51.3, 71.0, 97.9 and 132.9 cm respectively) except T<sub>4</sub> (ZnSO<sub>4</sub> 10 kg/ha + boron 5 kg/ha + GA<sub>3</sub> 50 ppm) (66.3, 88.2, 115.4 and 149.1 cm) and T<sub>6</sub> (ZnSO<sub>4</sub> 0.1% + boron 0.1%) (64.7, 87.1, 114.2 and 147.9 cm at 30, 60, 120 and 150 DAS respectively). The T<sub>4</sub> and T<sub>6</sub> were on par with each other at 90, 120 and

**Table 1. Plant height (cm) of cotton as influenced by dates of sowing and chemicals at different stages of crop growth**

Treatments	60 DAS			90 DAS			120 DAS			150DAS		
	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean
T <sub>1</sub>	64.73	54.07	59.40	94.13	70.60	82.36	120.83	98.33	109.58	157.40	130.13	143.76
T <sub>2</sub>	64.27	53.87	59.07	88.63	69.20	78.91	116.47	96.40	106.43	153.13	129.53	141.33
T <sub>3</sub>	67.47	54.27	60.87	98.13	71.40	84.76	123.23	98.67	110.95	160.47	131.00	145.73
T <sub>4</sub>	72.46	60.13	66.29	102.07	74.40	88.23	128.90	101.93	115.41	165.13	133.13	149.13
T <sub>5</sub>	63.40	50.20	56.80	86.80	67.93	77.36	113.70	94.00	103.85	150.07	127.87	138.97
T <sub>6</sub>	71.27	58.20	64.73	100.53	73.73	87.13	126.87	101.53	114.20	162.80	133.13	147.96
T <sub>7</sub>	73.20	64.93	69.06	108.13	77.47	92.80	134.53	105.07	119.80	171.20	137.00	154.10
T <sub>8</sub>	63.67	52.00	57.83	87.67	68.20	77.93	114.13	95.80	104.96	150.40	128.40	139.40
T <sub>9</sub>	55.87	46.73	51.30	76.87	65.20	71.03	103.27	82.47	97.87	140.60	125.33	132.96
Mean	66.26	54.93	60.59	93.65	70.90	82.27	120.21	98.24	109.22	156.80	130.61	143.70
For comparing the means of	SEm±	CD (0.05)	SEm±	CD (0.05)	SEm±	CD (0.05)	SEm±	CD (0.05)	SEm±	CD (0.05)	SEm±	CD (0.05)
Dates of sowing (D)	1.06	6.48	0.77	4.66	1.21	7.36	1.61	9.82	1.99	5.72	2.15	6.19
Chemicals (C)	1.16	3.34	2.01	5.78	1.99	5.72	2.81	8.09	2.81	8.09	3.04	8.76
C at same level of D	1.64	4.72	2.84	8.18	2.81	8.09	2.91	8.39	2.91	8.39	3.29	9.47
D at same or different levels of C	1.88	5.40	2.78	8.02	2.91	8.39	3.29	9.47	3.29	9.47	3.29	9.47

D<sub>1</sub> = 20.5.99

D<sub>2</sub> = 10.6.99

T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha

T<sub>2</sub> = Boron @ 5kg/ha

T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)

T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm

T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2 mM

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%

T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm

T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM

T<sub>9</sub> =Control

DAS= Days after sowing

150 DAS, while at 60 DAS, T<sub>7</sub> was only on par with T<sub>4</sub>. These treatments were followed by T<sub>3</sub> (ZnSO<sub>4</sub> 10 kg/ha + boron 5 kg/ha) (60.9, 84.8, 110.9 and 145.7 cm), T<sub>1</sub> (ZnSO<sub>4</sub> 10 kg/ha) (59.4, 82.4, 109.6 and 143.8 cm) and T<sub>2</sub> (boron 5 kg/ha) (59.1, 78.9, 106.4 and 141.3 cm) which were on par with each other, at 120 and 150 DAS, but at 60 DAS T<sub>8</sub> was only on par with T<sub>3</sub>.

The first order of interactions exhibited significant effect on plant height at all stages of plant growth. T<sub>7</sub> at both D<sub>1</sub> and D<sub>2</sub> recorded significantly maximum plant height compared to other treatment combinations but it was on par with T<sub>4</sub> and T<sub>6</sub> at all stages in D<sub>1</sub>. However in D<sub>2</sub>, T<sub>7</sub>, T<sub>4</sub>, T<sub>6</sub>, T<sub>3</sub>, T<sub>1</sub>, T<sub>2</sub>, and T<sub>8</sub> were on par with each other at 150 DAS.

Interactions of dates of sowing at same or different levels of chemicals differed significantly with each other for plant height. The D<sub>1</sub>T<sub>7</sub> recorded significantly higher plant height compared to any other combinations except D<sub>1</sub>T<sub>4</sub> and D<sub>1</sub>T<sub>6</sub> which were on par with each other. All chemicals at D<sub>2</sub> sowing recorded lower plant height compared to D<sub>1</sub> sowing.

#### **4.1.2 Number of leaves per plant**

The data on number of leaves per plant recorded at 60, 90, 120 and 150 DAS as influenced by dates of sowing and chemicals are presented in Table 2.

**Table 2. Number of leaves per plant of cotton as influenced by dates of sowing and chemicals at different stages of crop growth**

Treatments	60 DAS			90 DAS			120 DAS			150DAS		
	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean
T <sub>1</sub>	27.20	18.40	22.80	39.87	28.40	34.13	52.20	50.87	51.53	62.93	61.73	62.33
T <sub>2</sub>	26.60	17.47	22.03	39.07	27.47	33.27	51.26	49.80	50.53	62.33	60.80	61.57
T <sub>3</sub>	28.53	19.80	24.16	40.40	29.80	35.10	52.60	51.20	51.90	63.47	62.20	62.83
T <sub>4</sub>	29.70	20.53	25.07	41.47	30.53	36.00	61.60	52.53	57.07	72.20	63.33	67.77
T <sub>5</sub>	24.87	17.00	20.93	37.07	27.00	32.03	49.27	40.20	44.73	60.07	51.40	55.73
T <sub>6</sub>	29.07	20.37	24.63	40.87	30.20	35.53	57.80	51.87	54.83	68.47	62.73	65.60
T <sub>7</sub>	31.27	22.00	26.63	43.60	32.00	37.80	63.93	55.20	59.57	75.00	66.13	70.57
T <sub>8</sub>	25.33	17.27	21.30	37.27	27.27	32.27	50.67	42.00	46.33	61.87	52.87	57.37
T <sub>9</sub>	23.13	15.20	19.17	35.13	25.20	30.17	43.80	38.87	41.33	54.73	49.80	52.27
Mean	27.29	18.65	22.97	39.41	28.65	34.03	53.68	48.06	50.87	64.56	59.00	61.78
For comparing the means of	SEm±	CD (0.05)		SEm±	CD (0.05)		SEm±	CD (0.05)		SEm±	CD (0.05)	
Dates of sowing (D)	0.11	0.70		0.14	0.87		0.75	4.54		0.72	4.36	
Chemicals (C)	0.40	1.15		0.57	1.66		1.33	3.83		1.33	3.83	
C at same Level of D	0.57	1.63		0.81	2.34		1.88	5.41		1.88	5.42	
D at same or different levels of C	0.54	1.57		0.78	2.25		1.92	5.54		1.91	5.51	

D<sub>1</sub> = 20.5.99  
D<sub>2</sub> = 10.6.99

T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha  
T<sub>2</sub> = Boron @ 5kg/ha  
T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)  
T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2mM

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM  
T<sub>9</sub> =Control  
DAS= Days after sowing

May sowing (D<sub>1</sub>) showed significant effect on number of leaves produced per plant at all stages of plant growth (27.2, 39.4, 53.6 and 64.5 respectively) compared to June sowing (D<sub>2</sub>) (18.6, 28.6, 48.0 and 59.0 respectively).

Chemicals significantly increased the number of leaves per plant at all stages of plant growth. The T<sub>7</sub> treatment recorded significantly more number of leaves per plant (26.6, 37.8, 59.6 and 70.6 at 60, 90, 120 and 150 DAS, respectively) compared to other chemicals except T<sub>4</sub> at 120 and 150 DAS. The T<sub>4</sub> was on par with T<sub>6</sub> at all stages of plant growth and with T<sub>6</sub> and T<sub>3</sub> at 60 and 90 DAS. These were followed by T<sub>1</sub> and T<sub>2</sub>, which were on par with each other at all stages of plant growth.

The first order of interactions showed significant effect on number of leaves per plant at all stages of plant growth. T<sub>7</sub> at both D<sub>1</sub> and D<sub>2</sub> recorded significantly more number of leaves per plant compared to other combinations. But, T<sub>7</sub> was on par with T<sub>4</sub> in D<sub>1</sub> at all stages of plant growth and with T<sub>4</sub>, T<sub>6</sub>, T<sub>3</sub>, T<sub>1</sub> and T<sub>2</sub> in D<sub>2</sub> at 120 and 150 DAS.

The interactions of dates of sowing at same or different levels of chemicals also differed significantly with each other for number of leaves. The combination of D<sub>1</sub>T<sub>7</sub> recorded more number of leaves per plant (31.2, 43.6, 63.9 and 75.0 at 60, 90, 120 and 150 DAS, respectively) compared to any other combinations except D<sub>1</sub>T<sub>4</sub> (29.7, 41.4, 61.6 and 72.2), while these were on par with each other.

## 4.2 Seed yield and yield components

### 4.2.1 Days to 50 per cent flowering

The data on days taken for 50 per cent flowering as influenced by dates of sowing and chemicals are presented in Table 3.

The sowing dates differed significantly for the number of days taken to 50 per cent flowering. In general, June sowing (D<sub>2</sub>) accounted for more days to 50 per cent flowering (78.1) compared to May sowing (71.1).

The days to 50 per cent flowering differed significantly due to chemicals. Significantly earlier flowering was noticed in T<sub>7</sub> (71.33 days) compared to other chemicals, except T<sub>4</sub> (71.66 days) which was on par with it. The control (77.50 days) accounted for significantly more number days to 50 per cent flowering compared to all other chemicals except T<sub>5</sub> (76.67) and T<sub>8</sub> (76.33) which were on par with each other.

Interaction of chemicals at same date of sowing also exhibited significant effect on days to 50 per cent flowering. T<sub>7</sub> took significantly less number of days to 50 per cent flowering compared to other combinations, but it was on par with T<sub>4</sub>, T<sub>6</sub>, T<sub>3</sub>, T<sub>1</sub>, and T<sub>2</sub> at both D<sub>1</sub> and D<sub>2</sub> at all stages of plant growth.

Interactions of dates of sowing at same or different levels of chemicals were also found significant with respect to days 50 per cent flowering. The combination of D<sub>1</sub>T<sub>7</sub> was significantly early in flowering as

**Table 3. Days to 50 per cent flowering of cotton as influenced by dates of sowing and chemicals**

Treatments	Dates of sowing		
	D <sub>1</sub>	D <sub>2</sub>	Mean
T <sub>1</sub>	70.67	78.67	74.67
T <sub>2</sub>	71.33	79.00	75.16
T <sub>3</sub>	70.33	78.33	74.33
T <sub>4</sub>	68.00	75.33	71.66
T <sub>5</sub>	73.67	79.67	76.67
T <sub>6</sub>	70.33	78.33	74.33
T <sub>7</sub>	68.00	74.67	71.33
T <sub>8</sub>	73.67	79.00	76.33
T <sub>9</sub>	74.67	80.33	77.50
Mean	71.18	78.15	74.66
For comparing the means of	SEm±		CD (0.05)
Dates of sowing (D)	0.32		1.94
Chemicals (C)	0.86		2.49
C at same level of D	1.22		3.52
D at same or different levels of C	1.20		3.44

D<sub>1</sub> = 20.5.99    T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha  
 D<sub>2</sub> = 10.6.99    T<sub>2</sub> = Boron @ 5kg/ha  
                     T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)  
                     T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm  
                     T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2mM  
                     T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
                     T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
                     T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM  
                     T<sub>9</sub> =Control

compared to all other treatment combinations except D<sub>1</sub>T<sub>1</sub>, D<sub>1</sub>T<sub>2</sub>, D<sub>1</sub>T<sub>3</sub>, D<sub>1</sub>T<sub>4</sub> and D<sub>1</sub>T<sub>6</sub> which were on par with D<sub>1</sub>T<sub>7</sub>.

#### 4.2.2 Number of squares per plant

The results obtained due to effect of dates of sowing and chemicals on number of squares produced per plant at 60, 90, 120 and 150 DAS are presented in Table 4.

Significantly higher number of squares per plant was recorded in May sowing (18.6, 29.2, 41.1 and 46.6) compared to June sowing (6.5, 15.5, 25.5 and 29.7) at 60, 90, 120 and 150 DAS, respectively.

Chemicals also showed significant influence on number of squares per plant compared to control. The T<sub>7</sub> recorded significantly higher number of squares per plant (15.8, 30.4, 42.7 and 47.3, respectively) at all stages. This was followed by T<sub>4</sub>, T<sub>6</sub> and T<sub>3</sub>, however these were on par with each other at 90 and 120 DAS. But at 60 and 150 DAS, T<sub>4</sub> and T<sub>6</sub> were on par with each other. These were followed by T<sub>1</sub> and T<sub>2</sub>.

Interactions of chemicals at same date of sowing showed significant effect on number of squares per plant. The T<sub>7</sub> at D<sub>1</sub> and D<sub>2</sub> recorded significantly more number of squares over other combinations, except T<sub>4</sub> and T<sub>6</sub> in D<sub>1</sub> at 60 DAS and T<sub>4</sub> and T<sub>6</sub> in D<sub>2</sub> at 90 DAS which were on par with each other. These were followed by T<sub>3</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>8</sub> and T<sub>5</sub> however, T<sub>3</sub>, T<sub>1</sub>, T<sub>2</sub> were on par with each other in D<sub>1</sub> at 60 and 90

**Table 4. Total number of squares per plant of cotton as influenced by dates of sowing and chemicals at different stages of crop growth**

Treatments	60 DAS			90 DAS			120 DAS			150DAS		
	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean
T <sub>1</sub>	18.27	6.27	12.27	30.47	16.07	23.27	41.93	25.60	33.76	47.60	29.47	38.53
T <sub>2</sub>	17.80	6.00	11.90	26.93	13.60	20.26	38.47	23.47	30.97	43.53	27.20	35.36
T <sub>3</sub>	18.90	6.33	12.62	30.47	16.60	23.53	43.60	26.33	34.96	47.87	30.00	38.93
T <sub>4</sub>	20.80	7.53	14.17	32.20	19.80	26.00	43.73	29.53	36.63	49.87	33.67	41.77
T <sub>5</sub>	16.40	5.53	10.97	24.07	12.27	18.17	35.93	22.20	29.07	41.40	25.80	33.60
T <sub>6</sub>	20.53	7.27	13.90	31.80	17.93	24.87	43.73	27.27	35.50	49.67	31.80	40.73
T <sub>7</sub>	22.17	9.40	15.78	40.53	20.33	30.43	52.47	33.00	42.73	57.93	36.73	47.33
T <sub>8</sub>	17.67	5.60	11.63	25.60	12.87	19.23	38.20	23.00	30.60	42.73	26.40	34.57
T <sub>9</sub>	15.07	4.73	9.90	21.20	10.47	15.83	32.17	19.33	25.75	39.07	26.20	32.63
Mean	18.62	6.52	12.57	29.25	15.55	22.40	41.14	25.53	33.33	46.63	29.70	38.16
For comparing the means of	SEm±		CD (0.05)	SEm±		CD (0.05)	SEm±		CD (0.05)	SEm±		CD (0.05)
Dates of sowing (D)	0.25		1.55	0.31		1.89	0.82		4.98	0.46		2.79
Chemicals (C)	0.50		1.40	0.86		2.49	0.76		2.18	0.81		2.35
C at same Level of D	0.70		1.98	1.22		3.52	1.07		3.09	1.15		3.32
D at same or different levels of C	0.70		2.01	1.19		3.44	1.30		3.75	1.18		3.40

D<sub>1</sub> = 20.5.99  
D<sub>2</sub> = 10.6.99

T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha  
T<sub>2</sub> = Boron @ 5kg/ha  
T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)  
T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2mM

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM  
T<sub>9</sub> =Control  
DAS = Days after sowing

DAS, where as in D<sub>2</sub>, T<sub>3</sub>, T<sub>1</sub> and T<sub>2</sub> were on par with each other at all stages except at 60 DAS, where T<sub>8</sub>, T<sub>5</sub> and T<sub>9</sub> were also on par with T<sub>3</sub>, T<sub>1</sub> and T<sub>2</sub> in D<sub>2</sub> at same stage.

Interactions of dates of sowing and chemicals had significant effect on number of squares per plant. Treatment combination of D<sub>1</sub>T<sub>7</sub> (22.2, 40.5, 52.5 and 57.9 at 60, 90, 120 and 150 DAS, respectively) recorded significantly higher number of squares compared to any other combinations. This was on par with D<sub>1</sub>T<sub>4</sub> and D<sub>1</sub>T<sub>6</sub> at 60 DAS, while at other stages D<sub>1</sub>T<sub>7</sub> was followed by D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub>, D<sub>1</sub>T<sub>3</sub> and D<sub>1</sub>T<sub>1</sub> which were on par with each other.

#### 4.2.3 Number of flowers per plant

The data on number of flowers produced per plant at 70, 100, 130 and 160 DAS as influenced by dates of sowing and chemicals are presented in Table 5.

May sowing (D<sub>1</sub>) showed significant effect on number of flowers per plant at all stages of plant growth. Significantly higher number of flowers per plant was observed in May sowing (3.97, 9.16, 13.48 and 18.27 at 70, 100, 130 and 160 DAS, respectively) compared to June sowing (3.12, 7.77, 12.47 and 17.26, respectively).

Chemicals significantly influenced the number of flowers per plant at all stages of plant growth. T<sub>7</sub> had significantly more number of flowers per plant (4.2, 9.8, 14.5 and 19.3 respectively) compared to other chemicals and control (3.0, 7.5, 11.9 and 16.9 respectively), except T<sub>4</sub> at

**Table 5. Total number of flower per plant of cotton as influenced by Dates of sowing and chemicals at different stages of crop growth**

Treatments	70 DAS			100 DAS			130 DAS			160DAS		
	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean
T <sub>1</sub>	4.13	3.00	3.56	8.93	7.80	8.36	13.47	12.47	12.97	18.13	17.33	17.73
T <sub>2</sub>	3.80	2.87	3.33	8.90	7.73	8.31	13.07	12.46	12.76	17.93	17.20	17.56
T <sub>3</sub>	4.20	3.13	3.66	9.13	7.87	8.50	13.67	12.53	13.10	18.40	17.40	17.90
T <sub>4</sub>	4.33	3.53	3.93	9.80	8.00	8.90	14.07	13.13	13.60	18.73	17.80	18.26
T <sub>5</sub>	3.47	2.67	3.07	8.60	7.40	8.00	12.67	11.93	12.30	17.73	16.53	17.13
T <sub>6</sub>	4.33	3.40	3.86	9.28	7.94	8.62	13.73	12.67	13.20	18.47	17.40	17.93
T <sub>7</sub>	4.47	3.93	4.20	10.93	8.67	9.80	15.47	13.46	14.46	20.27	18.40	19.33
T <sub>8</sub>	3.70	2.87	3.28	8.87	7.47	8.17	12.87	12.00	12.43	17.73	16.87	17.30
T <sub>9</sub>	3.33	2.67	3.00	8.03	7.07	7.55	12.33	11.60	11.96	17.40	16.40	16.90
<b>Mean</b>	<b>3.97</b>	<b>3.12</b>	<b>3.55</b>	<b>9.16</b>	<b>7.77</b>	<b>8.47</b>	<b>13.48</b>	<b>12.47</b>	<b>12.98</b>	<b>18.27</b>	<b>17.26</b>	<b>17.76</b>
<b>For comparing the means of</b>	SE <sub>mt</sub> CD (0.05)			SE <sub>mt</sub> CD (0.05)			SE <sub>mt</sub> CD (0.05)			SE <sub>mt</sub> CD (0.05)		
<b>Dates of sowing (D)</b>	0.07	0.42		0.19	1.19		0.10	0.61		0.16	0.95	
<b>Chemicals (C)</b>	0.12	0.34		0.41	1.18		0.20	0.58		0.22	0.64	
<b>C at same Level of D</b>	0.17	0.48		0.58	NS		0.28	0.82		0.32	0.91	
<b>D at same or different levels of C</b>	0.17	0.49		0.58	NS		0.29	0.82		0.34	0.97	

D<sub>1</sub> = 20.5.99  
D<sub>2</sub> = 10.6.99

T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha  
T<sub>2</sub> = Boron @ 5kg/ha  
T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)  
T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub>@ 50ppm  
T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2mM

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM  
T<sub>9</sub> =Control

DAS = Days after sowing  
NS = Non significant

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM  
T<sub>9</sub> =Control

70 and 100 DAS. T<sub>4</sub> was on par with T<sub>6</sub> at all stages of plant growth and with T<sub>3</sub> at 130 and 160 DAS. These were followed by T<sub>1</sub>, T<sub>2</sub>, T<sub>8</sub>, T<sub>5</sub> and T<sub>9</sub>, but all these were on par with each other at 100 DAS. However, T<sub>1</sub>, T<sub>2</sub> and T<sub>8</sub> showed on par with each other at 70, 130 and 160 DAS.

Interaction of chemicals at same date of sowing also exhibited significant effect on number of flowers per plant at all stages except at 100 DAS. The T<sub>7</sub> at D<sub>1</sub> and D<sub>2</sub> had significantly more number of flowers per plant compared to other combinations. This was on par with T<sub>4</sub> and T<sub>6</sub> in D<sub>1</sub> and D<sub>2</sub> at 70 and 130 DAS.

Among the interaction of dates of sowing at same or different levels of chemicals found to be significant at all stages of plant growth except at 100 DAS. D<sub>1</sub>T<sub>7</sub> recorded more number of flowers per plant (4.47, 10.93, 15.47 and 20.27 at 70, 100, 130 and 160 DAS, respectively) compared to any other combinations except D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub>, D<sub>1</sub>T<sub>3</sub> and D<sub>1</sub>T<sub>1</sub>, which were on par with D<sub>1</sub>T<sub>7</sub> at 70 DAS.

#### **4.2.4 Number of matured bolls per plant at different pickings**

Total number of matured bolls harvested per plant at different stages as influenced by effect of dates of sowing and chemicals are given in Table 6.

Significantly more number of bolls per plant were recorded in May sowing (8.0, 5.6 and 3.4 at first, second and third pickings, respectively) compared to June sowing (6.7, 3.4 and 1.7, respectively).

**Table 6. Number of matured bolls per plant of cotton as influenced by dates of sowing and chemicals at different pickings**

Treatments	First picking			Second picking			Third picking		
	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean
T <sub>1</sub>	7.80	6.40	7.10	5.80	3.40	4.60	3.60	1.60	2.60
T <sub>2</sub>	7.73	6.27	7.00	5.67	3.27	4.47	3.33	1.53	2.43
T <sub>3</sub>	8.53	6.80	7.67	6.00	3.53	4.77	3.67	1.80	2.73
T <sub>4</sub>	9.60	7.40	8.50	6.36	3.87	5.10	3.80	2.00	2.90
T <sub>5</sub>	6.87	6.07	6.47	4.73	3.07	3.90	2.60	1.40	2.00
T <sub>6</sub>	8.93	7.13	8.03	6.13	3.60	4.86	3.80	1.93	2.86
T <sub>7</sub>	10.20	8.00	9.10	7.00	4.33	5.67	4.53	2.40	3.46
T <sub>8</sub>	7.00	6.13	6.57	4.87	3.13	4.00	2.67	1.47	2.07
T <sub>9</sub>	5.93	5.80	5.87	4.27	2.89	3.57	2.27	1.20	1.73
Mean	8.05	6.68	7.37	5.64	3.45	4.55	3.36	1.70	2.53
<b>For comparing the means of</b>	<b>SEM±</b>			<b>SEM±</b>			<b>SEM±</b>		
<b>Dates of sowing (D)</b>	0.13			0.14			0.03		
<b>Chemicals (C)</b>	0.34			0.16			0.07		
<b>C at same level of D</b>	0.48			0.22			0.10		
<b>D at same or different levels of C</b>	0.47			0.25			0.10		
	<b>CD (0.05)</b>			<b>CD (0.05)</b>			<b>CD (0.05)</b>		
	0.77			0.84			0.21		
	0.98			0.45			0.21		
	1.39			0.64			0.29		
	1.36			0.72			0.29		

D<sub>1</sub> = 20.5.99  
D<sub>2</sub> = 10.6.99

T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha  
T<sub>2</sub> = Boron @ 5kg/ha  
T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)  
T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2mM

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM  
T<sub>9</sub> =Control

Chemicals showed significant effect on number of bolls per plant harvested at different pickings. Significantly more number of bolls were picked in T<sub>7</sub> (9.1, 5.7 and 3.5 at first, second and third pickings, respectively) compared to other chemicals and control (5.9, 3.6 and 1.7, respectively), it was followed by T<sub>4</sub>, T<sub>6</sub> and T<sub>3</sub> which were on par with each other. These were followed by T<sub>1</sub>, T<sub>2</sub>, T<sub>8</sub> and T<sub>5</sub>, these were on par with each other at first picking, however at second and third pickings only T<sub>1</sub> and T<sub>2</sub> were on par with each other.

Interaction of chemicals at same date of sowing produced significant difference for number of matured bolls per plant. T<sub>7</sub> at D<sub>1</sub> and D<sub>2</sub> recorded significantly more number of matured bolls per plant as compared to any other combinations. This was on par with T<sub>4</sub> in D<sub>1</sub> and D<sub>2</sub> at first and second pickings. T<sub>7</sub> and T<sub>4</sub> were followed by T<sub>6</sub> and T<sub>3</sub> at same date of sowing, which were on par with each other. Next best treatments were T<sub>1</sub> and T<sub>2</sub> in D<sub>1</sub> and D<sub>2</sub> at all pickings, but these two were on par with each other.

Interactions of dates of sowing at same or different levels of chemicals found significant for number of bolls harvested per plant. The treatment combination of D<sub>1</sub>T<sub>7</sub> followed by D<sub>1</sub>T<sub>4</sub> and D<sub>1</sub>T<sub>6</sub> gave higher number of matured bolls per plant, however D<sub>1</sub>T<sub>7</sub> and D<sub>1</sub>T<sub>4</sub> were on par with each other at first and second pickings. The D<sub>1</sub>T<sub>4</sub> was followed by D<sub>1</sub>T<sub>6</sub>, D<sub>1</sub>T<sub>3</sub>, D<sub>1</sub>T<sub>1</sub> and D<sub>1</sub>T<sub>2</sub> which were on par with each other at first and second pickings, and also with third picking except for D<sub>1</sub>T<sub>2</sub>.

#### 4.2.5 Mean boll weight

The data on mean boll weight are presented in Table 7.

May sowing (D<sub>1</sub>) recorded significantly higher mean boll weight (4.35, 3.96 and 2.56 g at first, second and third pickings respectively) compared to June sowing (D<sub>2</sub>) (3.44, 3.22 and 2.13 g, respectively).

Chemicals also showed significant effect on mean boll weight. T<sub>7</sub> recorded significantly maximum boll weight (4.24, 3.78 and 2.69 g at first, second and third pickings respectively), compared to other chemicals and control (3.54, 3.32 and 2.04 g respectively) except T<sub>4</sub> which was on par with it at all pickings, however T<sub>6</sub> was on par with T<sub>7</sub> during second picking. The next best chemical was T<sub>3</sub>, which was on par with T<sub>1</sub> and T<sub>2</sub> at second and third pickings. These were followed by T<sub>8</sub> and T<sub>5</sub>, however the former chemicals were on par with each other at second and third pickings.

Among the interaction of chemicals at same date of sowing found to be significant with respect to boll weight. The T<sub>7</sub> at D<sub>1</sub> and D<sub>2</sub> recorded significantly maximum boll weight as compare to any other combinations. However, T<sub>7</sub> was on par with T<sub>4</sub>, T<sub>6</sub>, T<sub>3</sub>, T<sub>1</sub> and T<sub>2</sub> in D<sub>1</sub> at first and second pickings and also in D<sub>2</sub> at second picking.

Among the interaction of dates of sowing at same or different levels of chemicals found to be significant. D<sub>1</sub>T<sub>7</sub> was followed by D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub>, D<sub>1</sub>T<sub>3</sub>, D<sub>1</sub>T<sub>1</sub> and D<sub>1</sub>T<sub>2</sub> recorded maximum boll weight compared to

Table 7. Boll weight (g) of cotton as influenced by dates of sowing and chemicals at different pickings

Treatments	First picking			Second picking			Third picking			
	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	
T <sub>1</sub>	4.37	3.33	3.85	3.99	3.27	3.62	2.45	2.05	2.25	
T <sub>2</sub>	4.36	3.26	3.81	3.99	3.25	3.61	2.44	2.05	2.25	
T <sub>3</sub>	4.41	3.55	3.98	4.00	3.29	3.64	2.56	2.19	2.37	
T <sub>4</sub>	4.49	3.91	4.20	4.10	3.38	3.74	2.91	2.38	2.64	
T <sub>5</sub>	4.20	3.02	3.61	3.80	3.01	3.40	2.30	2.00	2.15	
T <sub>6</sub>	4.46	3.66	4.06	4.06	3.30	3.68	2.87	2.22	2.55	
T <sub>7</sub>	4.50	3.98	4.24	4.15	3.41	3.78	2.98	2.40	2.69	
T <sub>8</sub>	4.31	3.20	3.75	3.85	3.14	3.49	2.32	2.02	2.17	
T <sub>9</sub>	4.06	3.02	3.54	3.71	2.93	3.32	2.05	1.91	2.04	
Mean	4.35	3.44	3.89	3.96	3.22	3.59	2.56	2.13	2.35	
For comparing the means of			SEm±	CD (0.05)			SEm±	CD (0.05)		
Dates of sowing (D)			0.02	0.13			0.02	0.12		
Chemicals (C)			0.04	0.11			0.04	0.11		
C at same level of D			0.06	0.16			0.06	0.16		
D at same or different levels of C			0.06	0.16			0.06	0.16		

D<sub>1</sub> = 20.5.99  
D<sub>2</sub> = 10.6.99

T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha  
T<sub>2</sub> = Boron @ 5kg/ha  
T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)  
T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2mM

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM  
T<sub>9</sub> = Control

any other combinations at all pickings, however all these combinations were on par with each other at first and second pickings, but at third picking only D<sub>1</sub>T<sub>7</sub>, D<sub>1</sub>T<sub>4</sub> and D<sub>1</sub>T<sub>6</sub> were on par with each other.

#### **4.2.6 Seed cotton weight per boll**

The results on the seed cotton weight per boll at three pickings as influenced by dates of sowing and chemicals are presented in Table 8.

May sowing (D<sub>1</sub>) recorded significantly highest seed cotton weight per boll (2.45, 2.36 and 1.95 g at first, second and third pickings respectively) compared to June sowing (1.52, 1.36 and 1.13 g respectively).

The differences in the seed cotton weight per boll due to chemicals were significant. Among the chemicals, T<sub>7</sub> significantly recorded higher seed cotton weight per boll (2.36, 2.12 and 1.76 g at first, second and third pickings, respectively) compared to any other chemicals and control except T<sub>4</sub> and T<sub>6</sub> at second and third pickings which were on par with each other. These were followed by T<sub>3</sub>, T<sub>1</sub> and T<sub>2</sub> which were on par with each other at all pickings.

Interaction between chemicals at same date of sowing differed significantly with respect to seed cotton weight per boll. The T<sub>7</sub> at D<sub>1</sub> and D<sub>2</sub> showed significantly more seed cotton weight per boll compared to any other combinations except T<sub>4</sub> at all pickings. This was

**Table 8. Seed cotton weight per boll (g) of cotton as influenced by dates of sowing and chemicals at different pickings**

Treatments	First picking			Second picking			Third picking		
	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean
T <sub>1</sub>	2.42	1.46	1.94	2.36	1.32	1.84	1.91	1.10	1.50
T <sub>2</sub>	2.40	1.43	1.92	2.35	1.27	1.81	1.91	1.05	1.49
T <sub>3</sub>	2.45	1.56	2.00	2.38	1.47	1.92	1.91	1.21	1.56
T <sub>4</sub>	2.57	1.74	2.16	2.55	1.65	2.10	2.10	1.32	1.71
T <sub>5</sub>	2.28	1.30	1.79	2.25	1.07	1.66	1.85	1.01	1.43
T <sub>6</sub>	2.50	1.62	2.06	2.39	1.61	2.00	2.05	1.22	1.63
T <sub>7</sub>	2.81	1.91	2.36	2.57	1.66	2.12	2.12	1.41	1.76
T <sub>8</sub>	2.35	1.41	1.88	2.26	1.14	1.70	1.89	1.01	1.45
T <sub>9</sub>	2.24	1.28	1.76	2.10	1.06	1.58	1.77	0.89	1.33
<b>Mean</b>	<b>2.45</b>	<b>1.52</b>	<b>1.98</b>	<b>2.36</b>	<b>1.36</b>	<b>1.86</b>	<b>1.95</b>	<b>1.13</b>	<b>1.54</b>
<b>For comparing the means of</b>	<b>SEm±</b>			<b>SEm±</b>			<b>SEm±</b>		
<b>Dates of sowing (D)</b>	0.02			0.03			0.03		
<b>Chemicals (C)</b>	0.07			0.06			0.02		
<b>C at same level of D</b>	0.10			0.08			0.03		
<b>D at same or different levels of C</b>	0.09			0.08			0.05		
	0.15			0.20			0.19		
	0.20			0.17			0.07		
	0.28			0.24			0.10		
	0.27			0.24			0.13		
	<b>CD (0.05)</b>			<b>CD (0.05)</b>			<b>CD (0.05)</b>		

D<sub>1</sub> = 20.5.99  
D<sub>2</sub> = 10.6.99

T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha  
T<sub>2</sub> = Boron @ 5kg/ha  
T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)  
T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2mM

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM  
T<sub>9</sub> =Control

followed by T<sub>6</sub>, T<sub>3</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>8</sub> and T<sub>5</sub> in D<sub>1</sub> at first and second pickings which were on par with each other.

The interaction of dates of sowing at same or different levels of chemicals were found to be significant for seed cotton weight per boll. The treatment combination of D<sub>1</sub>T<sub>7</sub> recorded more seed cotton weight per boll (2.81, 2.57 and 2.12 g at first, second and third pickings, respectively), followed by D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub> and D<sub>1</sub>T<sub>3</sub>. However, D<sub>1</sub>T<sub>7</sub> and D<sub>1</sub>T<sub>4</sub> at first picking, D<sub>1</sub>T<sub>7</sub>, D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub>, D<sub>1</sub>T<sub>3</sub>, D<sub>1</sub>T<sub>1</sub> and D<sub>1</sub>T<sub>2</sub> at second picking and D<sub>1</sub>T<sub>7</sub>, D<sub>1</sub>T<sub>4</sub> and D<sub>1</sub>T<sub>6</sub> at third pickings were on par with each other.

#### **4.2.7 Number of seeds per boll**

The data on number of seeds per boll as influenced by dates of sowing and chemicals at different pickings are given in Table 9.

Number of seeds per boll (26.4, 23.2 and 18.9 at first, second and third pickings, respectively) was significantly higher in May sowing (D<sub>1</sub>) compared to June sowing (D<sub>2</sub>) (19.1, 17.3 and 13.1, respectively).

The chemicals had significant influence on number of seeds per boll. T<sub>7</sub> treatment recorded significantly more number of seeds per boll (25.4, 23.2 and 17.8 at first, second and third pickings, respectively), compared to other chemicals except T<sub>4</sub> at third picking which was on par with it. This was followed by T<sub>4</sub>, T<sub>6</sub> and T<sub>3</sub> at all pickings, however T<sub>4</sub>, T<sub>6</sub> and T<sub>3</sub> were on par with each other at first and second pickings, but at second picking only T<sub>4</sub> and T<sub>6</sub> were on par with

**Table 9. Number of seed per boll of cotton as influenced by dates of sowing and chemicals at different pickings**

Treatments	First picking		Second picking		Third picking		
	D <sub>1</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>2</sub>	Mean
T <sub>1</sub>	26.33	18.73	23.40	17.67	19.40	12.87	16.13
T <sub>2</sub>	26.20	18.73	23.07	15.93	19.40	12.73	16.06
T <sub>3</sub>	26.47	19.67	23.53	17.67	19.73	13.47	16.61
T <sub>4</sub>	26.73	20.53	24.93	19.27	20.20	14.67	17.43
T <sub>5</sub>	25.67	17.53	21.40	15.33	17.80	12.20	15.00
T <sub>6</sub>	26.60	19.93	24.13	18.80	19.80	14.00	16.90
T <sub>7</sub>	28.87	21.93	25.73	20.67	20.67	14.87	17.77
T <sub>8</sub>	25.80	18.13	22.00	15.47	18.13	12.33	15.24
T <sub>9</sub>	24.60	17.07	21.00	14.87	15.47	10.60	13.03
<b>Mean</b>	<b>26.36</b>	<b>19.14</b>	<b>23.24</b>	<b>17.30</b>	<b>18.96</b>	<b>13.08</b>	<b>16.02</b>
<b>For comparing the means of</b>	<b>SEM±</b>	<b>CD (0.05)</b>	<b>SEM±</b>	<b>CD (0.05)</b>	<b>SEM±</b>	<b>CD (0.05)</b>	
<b>Dates of sowing (D)</b>	0.15	0.91	0.14	0.88	0.06	0.37	
<b>Chemicals (C)</b>	0.24	0.70	0.29	0.83	0.28	0.82	
<b>C at same level of D</b>	0.34	0.99	0.41	1.17	0.40	1.15	
<b>D at same or different levels of C</b>	0.36	1.03	0.41	1.18	0.38	1.10	

D<sub>1</sub> = 20.5.99  
D<sub>2</sub> = 10.6.99

T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha  
T<sub>2</sub> = Boron @ 5kg/ha  
T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)  
T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2mM

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM  
T<sub>9</sub> = Control

each other. These were followed by T<sub>1</sub>, T<sub>2</sub> and T<sub>8</sub>, T<sub>1</sub> and T<sub>8</sub> were on par with each other at all pickings.

The first order of interaction between chemicals at same date of sowing differed significantly with respect to number of seeds per boll. The T<sub>7</sub> at D<sub>1</sub> and D<sub>2</sub> recorded significantly more number of seeds per boll as compared to any other combinations except T<sub>4</sub> and T<sub>6</sub>. These T<sub>4</sub> and T<sub>6</sub> at D<sub>1</sub> and D<sub>2</sub> in third picking were on par with each other.

Interaction between dates of sowing at same or different levels of chemicals found significant. The treatment combination of D<sub>1</sub>T<sub>7</sub> recorded more number of seeds per bolls (28.9, 25.7 and 20.7 at first, second and third pickings, respectively) followed by D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub> and D<sub>1</sub>T<sub>3</sub>, however D<sub>1</sub>T<sub>7</sub> and D<sub>1</sub>T<sub>4</sub> at second and D<sub>1</sub>T<sub>7</sub>, D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub> and D<sub>1</sub>T<sub>3</sub> at third pickings were on par with each other.

#### **4.2.8 Seed weight per boll**

The data on seed weight per boll as influenced by the dates of sowing and chemical at different pickings are furnished in Table 10.

Seed weight per boll was significantly higher (1.86, 1.49 and 1.14 g at first, second and third pickings respectively) in May sowing (D<sub>1</sub>) compared to June sowing (D<sub>2</sub>) (1.21, 1.10 and 0.71 g, respectively).

With respect to chemicals, T<sub>7</sub> recorded significantly higher seed weight per boll (1.79, 1.50 and 1.17 g at first, second and third pickings, respectively) compared to other chemicals and control (1.24, 0.92 and 0.65 g, respectively) except T<sub>4</sub> at first and third and T<sub>4</sub>, T<sub>6</sub> and

**Table 10. Seed weight per boll of cotton as influenced by dates of sowing and chemicals at different pickings**

Treatments	First picking			Second picking			Third picking			
	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	
T <sub>1</sub>	1.86	1.22	1.54	1.56	1.15	1.35	1.22	0.70	0.95	
T <sub>2</sub>	1.83	1.21	1.52	1.50	1.06	1.29	1.18	0.66	0.92	
T <sub>3</sub>	1.93	1.26	1.59	1.63	1.16	1.39	1.22	0.74	0.98	
T <sub>4</sub>	2.01	1.37	1.69	1.69	1.20	1.45	1.33	0.84	1.09	
T <sub>5</sub>	1.74	1.06	1.40	1.31	1.02	1.16	0.92	0.63	0.77	
T <sub>6</sub>	1.94	1.33	1.63	1.64	1.19	1.41	1.22	0.76	0.99	
T <sub>7</sub>	2.21	1.38	1.79	1.70	1.29	1.50	1.35	0.99	1.17	
T <sub>8</sub>	1.74	1.07	1.41	1.38	1.06	1.22	0.92	0.65	0.79	
T <sub>9</sub>	1.48	1.00	1.24	1.03	0.81	0.92	0.90	0.40	0.65	
Mean	1.86	1.21	1.54	1.49	1.10	1.30	1.14	0.71	0.92	
For comparing the means of			SEM±	CD (0.05)			SEM±			CD (0.05)
Dates of sowing (D)	0.02		0.10	0.02		0.12	0.01		0.05	
Chemicals (C)	0.05		0.14	0.04		0.12	0.03		0.09	
C at same level of D	0.06		0.19	0.06		0.16	0.05		0.13	
D at same or different levels of C	0.07		0.19	0.06		0.16	0.05		0.13	

D<sub>1</sub> = 20.5.99  
D<sub>2</sub> = 10.6.99

T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha  
T<sub>2</sub> = Boron @ 5kg/ha  
T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)  
T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2mM

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM  
T<sub>9</sub> =Control

T<sub>3</sub> at second pickings which were on par with each other. These were followed by T<sub>6</sub>, T<sub>3</sub>, T<sub>1</sub> and T<sub>2</sub> which were on par with each other followed by T<sub>8</sub> and T<sub>5</sub> which were also on par with each other at all pickings.

The first order of interaction between chemicals at same date of sowing differed significantly with respect to seed weight per boll. The T<sub>7</sub> at D<sub>1</sub> and D<sub>2</sub> showed significantly higher seed weight per boll compared to any other combinations except T<sub>4</sub>, T<sub>6</sub>, T<sub>3</sub> and T<sub>1</sub> in D<sub>1</sub> at second and third pickings and in D<sub>2</sub> at first and second pickings which were on par with each other.

Among the interaction of dates of sowing at same or different levels of chemicals showed significant effect on seed weight per boll. The treatment combination of D<sub>1</sub>T<sub>7</sub> recorded significantly higher seed weight per boll (2.21, 1.70 and 1.35 g at first, second and third pickings respectively), which was followed by D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub>, D<sub>1</sub>T<sub>3</sub> and D<sub>1</sub>T<sub>1</sub>, however D<sub>1</sub>T<sub>7</sub>, D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub>, D<sub>1</sub>T<sub>3</sub> and D<sub>1</sub>T<sub>1</sub> were on par with each other at second and third pickings.

#### **4.2.9 Hundred seed weight**

The data pertaining to 100 seed weight at different pickings as influenced by dates of sowing and chemicals are given in Table 11.

May sowing (D<sub>1</sub>) recorded significantly highest 100 seed weight (8.24, 7.13 and 6.67 g at first, second and third pickings, respectively) compared to June sowing (7.61, 6.51 and 5.27 g, respectively).

**Table 11. Seed index (g/100 seeds) of cotton as influenced by dates of sowing and chemicals at different pickings**

Treatments	First picking			Second picking			Third picking		
	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean
T <sub>1</sub>	8.33	7.47	7.90	7.27	6.47	6.87	6.78	5.37	6.07
T <sub>2</sub>	8.20	7.46	7.83	7.15	6.37	6.76	6.66	5.04	5.85
T <sub>3</sub>	8.46	7.84	8.15	7.31	6.64	6.97	6.78	5.50	6.14
T <sub>4</sub>	8.62	8.17	8.39	7.51	7.03	7.27	6.99	5.87	6.43
T <sub>5</sub>	7.78	7.18	7.48	6.62	6.14	6.38	6.33	4.58	5.45
T <sub>6</sub>	8.47	7.85	8.16	7.37	6.79	7.08	6.98	5.71	6.34
T <sub>7</sub>	8.75	8.31	8.53	7.71	7.29	7.50	7.22	6.24	6.73
T <sub>8</sub>	7.98	7.47	7.72	6.69	6.17	6.43	6.38	4.63	5.50
T <sub>9</sub>	7.57	6.75	7.16	6.51	5.70	6.11	5.90	4.46	5.18
Mean	8.24	7.61	7.93	7.13	6.51	6.82	6.67	5.27	5.97
For comparing the means of	SEm± CD (0.05)			SEm± CD (0.05)			SEm± CD (0.05)		
Dates of sowing (D)	0.03	0.20		0.04	0.27		0.15	0.94	
Chemicals (C)	0.09	0.26		0.08	0.24		0.12	0.36	
C at same level of D	0.13	0.37		0.12	0.34		0.18	0.51	
D at same or different levels of C	0.13	0.36		0.12	0.34		0.23	0.65	

D<sub>1</sub> = 20.5.99  
D<sub>2</sub> = 10.6.99

T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha  
T<sub>2</sub> = Boron @ 5kg/ha  
T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)  
T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2mmM

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mmM  
T<sub>9</sub> = Control

Similarly, chemicals also showed significant effect on 100 seed weight. Among the chemicals, T<sub>7</sub> recorded significantly higher values for 100 seed weight (8.53, 7.50 and 6.73 g at first, second and third pickings, respectively) compared to other chemicals and control (7.16, 6.11 and 5.18 g, respectively) except T<sub>4</sub> at all pickings which was on par with T<sub>7</sub>. T<sub>4</sub> was followed by T<sub>6</sub>, T<sub>3</sub> and T<sub>1</sub>, the latter three chemicals were on par with each other. These were followed by T<sub>2</sub> and T<sub>8</sub>, which were on par with each other at first and third pickings.

The first order of interaction differed significantly for 100 seed weight. The T<sub>7</sub> at D<sub>1</sub> and D<sub>2</sub> recorded significantly higher 100 seed weight compared to any other combinations except T<sub>4</sub>, T<sub>6</sub> and T<sub>3</sub> at D<sub>1</sub> in all pickings and T<sub>7</sub> and T<sub>4</sub> at D<sub>2</sub> in all pickings, which were on par with each other.

The interaction of dates of sowing at same or different levels of chemicals significantly influenced the 100 seed weight at all pickings. The treatment combination of D<sub>1</sub>T<sub>7</sub> recorded higher 100 seed weight followed by D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub>, D<sub>1</sub>T<sub>3</sub>, D<sub>1</sub>T<sub>1</sub> and D<sub>1</sub>T<sub>2</sub>, which were on par with each other at third picking, but at first, D<sub>1</sub>T<sub>7</sub>, D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub> and D<sub>1</sub>T<sub>3</sub> and at second pickings D<sub>1</sub>T<sub>7</sub>, D<sub>1</sub>T<sub>4</sub> and D<sub>1</sub>T<sub>6</sub> were on par with each other.

#### **4.2.10 Seed yield per hectare**

The data on seed yield per hectare as influenced by dates of sowing and chemicals are presented in Table 12 and Fig.2.

**Table 12. Seed yield kg per hectare of cotton as influenced by dates of sowing and chemicals**

Treatments	Dates of sowing		
	D <sub>1</sub>	D <sub>2</sub>	Mean
T <sub>1</sub>	235.90	187.57	<b>211.73</b>
T <sub>2</sub>	218.57	170.07	<b>194.32</b>
T <sub>3</sub>	241.73	194.03	<b>217.88</b>
T <sub>4</sub>	249.87	204.57	<b>227.22</b>
T <sub>5</sub>	203.80	150.87	<b>177.33</b>
T <sub>6</sub>	244.37	198.36	<b>221.36</b>
T <sub>7</sub>	252.76	210.40	<b>231.58</b>
T <sub>8</sub>	206.27	153.80	<b>180.03</b>
T <sub>9</sub>	200.50	147.37	<b>173.93</b>
<b>Mean</b>	<b>228.20</b>	<b>179.67</b>	<b>203.93</b>
<b>For comparing the means of</b>	SEm±		CD (0.05)
<b>Dates of sowing (D)</b>	1.78		10.83
<b>Chemicals (C)</b>	2.76		7.95
<b>C at same level of D</b>	3.91		11.24
<b>D at same or different levels of C</b>	4.09		11.77

D<sub>1</sub> = 20.5.99 T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha

D<sub>2</sub> = 10.6.99 T<sub>2</sub> = Boron @ 5kg/ha

T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)

T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm

T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2mM

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%

T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm

T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM

T<sub>9</sub> =Control

## LEGEND

- T<sub>1</sub> : ZnSO<sub>4</sub> @ 10 kg per ha (soil application)
- T<sub>2</sub> : Boron @ 5 kg per ha (soil application)
- T<sub>3</sub> : ZnSO<sub>4</sub> + Boron @ 10 + 5 kg per ha (soil application)
- T<sub>4</sub> : ZnSO<sub>4</sub> + Boron @ 10 + 5 kg per ha (soil application) + GA<sub>3</sub>  
@ 50 ppm (foliar application)
- T<sub>5</sub> : ZnSO<sub>4</sub> + Boron @ 10 + 5 kg per ha (soil application) + Acetyl  
salicylic acid @ 2 mM (foliar application)
- T<sub>6</sub> : ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1% (foliar application)
- T<sub>7</sub> : ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1% + GA<sub>3</sub> @ 50 ppm  
(foliar application)
- T<sub>8</sub> : ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1% + Acetyl salicylic acid @ 2mM  
(foliar application)
- T<sub>9</sub> : Control

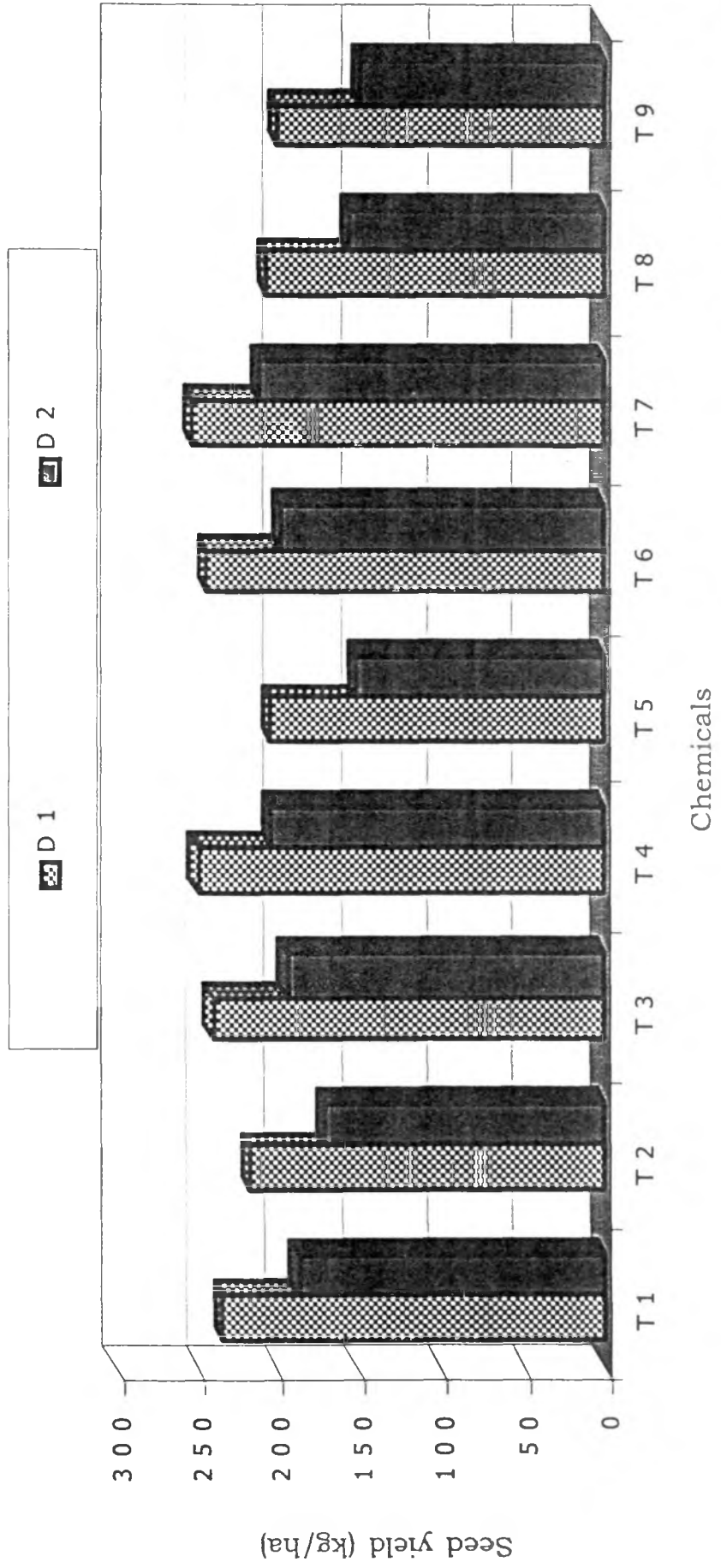


Fig. 2. Seed yield of cotton as influenced by dates of sowing and chemicals

May sowing (D<sub>1</sub>) exhibited significantly higher seed yield (228.2 kg/ha) than June (D<sub>2</sub>) sowing (179.7 kg/ha).

Among the chemicals, T<sub>7</sub> recorded significantly higher seed yield per hectare (231.6 kg) compared to any other chemicals except T<sub>4</sub> (227.4 kg) which was on par with each other. This was followed by T<sub>6</sub>, T<sub>3</sub>, T<sub>1</sub> and T<sub>2</sub>, however T<sub>6</sub> and T<sub>3</sub> were on par with each other. These were followed by T<sub>8</sub>, T<sub>5</sub> and T<sub>9</sub> which showed on par with each other.

The first order of interaction between chemicals at same date of sowing differed significantly with respect to seed yield. The T<sub>7</sub> at D<sub>1</sub> and D<sub>2</sub> recorded significantly higher seed yield per ha compared to any other combinations, except T<sub>4</sub>, T<sub>6</sub> and T<sub>3</sub> at D<sub>1</sub> which were on par with each other. The T<sub>7</sub> was followed by T<sub>1</sub>, T<sub>2</sub>, T<sub>8</sub>, T<sub>5</sub> and T<sub>9</sub> but, T<sub>8</sub>, T<sub>5</sub> and T<sub>9</sub> at both D<sub>1</sub> and D<sub>2</sub> were on par each other.

The interaction of dates of sowing at same or different levels of chemicals were also found to be significant. The treatment combination D<sub>1</sub>T<sub>7</sub> had recorded highest seed yield (252.8 kg/ha) compared to any other combinations except for D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub> and D<sub>1</sub>T<sub>3</sub> which were on par with D<sub>1</sub>T<sub>7</sub>. These were followed by D<sub>1</sub>T<sub>1</sub>, D<sub>1</sub>T<sub>2</sub> and D<sub>1</sub>T<sub>8</sub>.

### **4.3 Seed quality attributes**

#### **4.3.1 Germination percentage**

The results on the germination per cent as influenced by different dates of sowing and application of chemicals under different pickings were presented in Table 13 and Fig.3.

**Table 13. Germination percentage of cotton as influenced by dates of sowing and chemicals at different pickings**

Treatments	First picking		Second picking		Third picking	
	D <sub>1</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>2</sub>	D <sub>1</sub>	D <sub>2</sub>
	Mean	Mean	Mean	Mean	Mean	Mean
T <sub>1</sub>	90.00 (71.58)	83.33 (65.93)	87.33 (69.16)	79.33 (63.03)	80.00 (63.44)	72.67 (58.48)
T <sub>2</sub>	89.67 (71.32)	83.00 (65.67)	87.00 (68.88)	79.00 (62.73)	79.33 (62.96)	70.67 (57.22)
T <sub>3</sub>	90.33 (71.23)	84.00 (66.43)	87.67 (69.46)	80.33 (63.68)	81.33 (64.42)	74.00 (59.34)
T <sub>4</sub>	91.67 (73.23)	85.00 (67.50)	89.33 (70.94)	82.67 (65.41)	84.33 (66.70)	76.67 (61.12)
T <sub>5</sub>	88.33 (70.05)	82.33 (65.21)	84.67 (66.98)	77.33 (61.58)	76.00 (60.68)	67.67 (55.35)
T <sub>6</sub>	91.33 (72.92)	84.67 (66.96)	88.67 (70.38)	81.33 (64.42)	82.67 (65.41)	75.33 (60.22)
T <sub>7</sub>	94.67 (76.73)	86.33 (68.32)	93.00 (74.68)	83.67 (66.16)	88.66 (70.33)	78.00 (62.03)
T <sub>8</sub>	89.00 (70.64)	82.33 (65.15)	86.00 (68.06)	77.67 (61.80)	78.33 (62.26)	69.00 (56.18)
T <sub>9</sub>	88.00 (69.77)	80.00 (63.49)	82.67 (65.40)	74.33 (59.56)	73.00 (58.70)	64.33 (53.33)
Mean	90.33 (72.02)	83.48 (66.07)	87.37 (69.33)	79.52 (63.15)	83.44 (66.24)	72.04 (58.14)
For comparing the means of	SEm±		SEm±		SEm±	
Dates of sowing (D)	0.26	1.56	0.18	1.11	0.35	2.15
Chemicals (C)	0.60	1.72	0.45	1.31	0.30	0.88
C at same level of D	0.84	2.43	0.64	1.86	0.43	1.24
D at same or different levels of C	0.83	2.41	0.63	1.83	0.54	1.55
	CD (0.05)		CD (0.05)		CD (0.05)	

D<sub>1</sub> = 20.5.99  
D<sub>2</sub> = 10.6.99  
T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha  
T<sub>2</sub> = Boron @ 5kg/ha  
T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)  
T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2mM

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM  
T<sub>9</sub> = Control

Note :- Figures in parenthesis are arcsine transformed values

## LEGEND

- T<sub>1</sub> : ZnSO<sub>4</sub> @ 10 kg per ha (soil application)
- T<sub>2</sub> : Boron @ 5 kg per ha (soil application)
- T<sub>3</sub> : ZnSO<sub>4</sub> + Boron @ 10 + 5 kg per ha (soil application)
- T<sub>4</sub> : ZnSO<sub>4</sub> + Boron @ 10 + 5 kg per ha (soil application) + GA<sub>3</sub>  
@ 50 ppm (foliar application)
- T<sub>5</sub> : ZnSO<sub>4</sub> + Boron @ 10 + 5 kg per ha (soil application) + Acetyl  
salicylic acid @ 2 mM (foliar application)
- T<sub>6</sub> : ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1% (foliar application)
- T<sub>7</sub> : ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1% + GA<sub>3</sub> @ 50 ppm  
(foliar application)
- T<sub>8</sub> : ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1% + Acetyl salicylic acid @ 2mM  
(foliar application)
- T<sub>9</sub> : Control

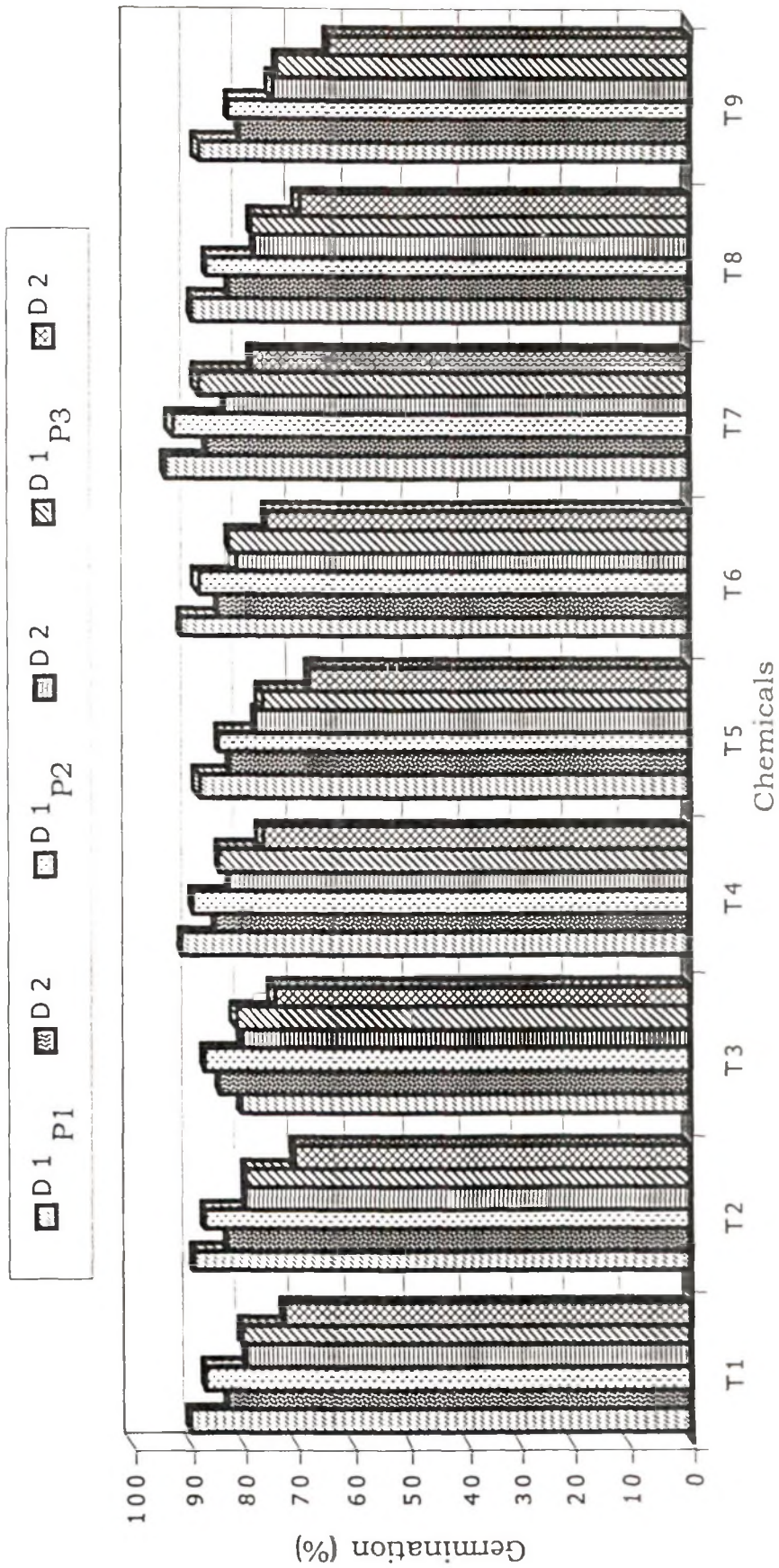


Fig. 3. Germination percentage of cotton as influenced by dates of sowing and chemicals

The germination percentage was significantly influenced by dates of sowing. The highest germination (90.3%) was recorded in May (D<sub>1</sub>) sowing compared to June (D<sub>2</sub>) sowing (83.4%).

Among the chemicals, T<sub>7</sub> recorded significantly higher germination percentage (90.5, 88.3 and 83.3, at first, second and third pickings, respectively) compared to other chemicals and control (84.0, 78.5 and 68.7 respectively). This was followed by T<sub>4</sub>, T<sub>6</sub>, T<sub>3</sub> and T<sub>1</sub> but these were on par with each other at first picking and T<sub>4</sub> and T<sub>6</sub> in second and T<sub>6</sub> and T<sub>3</sub> in third pickings were on par with each other. These were followed by T<sub>2</sub>, T<sub>8</sub> and T<sub>5</sub> which were on par with each other at first picking.

Interaction between chemicals at same date of sowing differed significantly with respect to germination percentage. The T<sub>7</sub> at both D<sub>1</sub> and D<sub>2</sub> recorded significantly higher germination percentage compared to any other combinations however, T<sub>4</sub>, T<sub>6</sub>, T<sub>3</sub> and T<sub>1</sub> with T<sub>7</sub> in D<sub>2</sub> at first picking except T<sub>3</sub> and T<sub>1</sub> in D<sub>2</sub> at second picking were on par with each other.

Interaction between dates of sowing at same or different levels of chemicals exhibited significant differences for germination percentage. The treatment combination D<sub>1</sub>T<sub>7</sub> recorded significantly higher germination percentage (94.7, 93.0 and 88.6 at first, second and third pickings, respectively) compared to any other combinations and control. This was followed by D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub>, D<sub>1</sub>T<sub>3</sub>, D<sub>1</sub>T<sub>1</sub> and D<sub>1</sub>T<sub>2</sub> which were on par each other at first picking except D<sub>1</sub>T<sub>2</sub> in second picking.

### 4.3.2 Germination rate index

The results on the germination rate index as influenced by dates of sowing and chemicals under different pickings are presented in Table 14.

May sowing (D<sub>1</sub>) had significantly highest germination rate index (20.98, 19.67 and 19.03 at first, second and third pickings respectively) compared to June sowing (D<sub>2</sub>) (15.60, 14.32 and 13.64, respectively).

Chemicals showed significant influence on germination rate index (GRI) as compared to control. Among the chemicals, T<sub>7</sub> recorded higher GRI (21.65, 20.64 and 20.08 at first, second and third pickings respectively) compared to other chemicals and control (15.44, 14.13 and 13.56, respectively). This was followed by T<sub>4</sub> and T<sub>6</sub> which were on par with each other at third picking. The T<sub>6</sub> was followed by T<sub>3</sub>, T<sub>1</sub> and T<sub>2</sub>, however T<sub>6</sub>, T<sub>3</sub> and T<sub>1</sub> were on par with each other at first picking, but T<sub>1</sub> and T<sub>2</sub> were on par with each other at second and third pickings.

Interaction between chemicals at same date of sowing differed significantly with respect to GRI. The T<sub>7</sub> at both D<sub>1</sub> and D<sub>2</sub> recorded significantly higher GRI as compared to any other combinations. This was followed by T<sub>4</sub>, T<sub>6</sub>, T<sub>3</sub> and T<sub>1</sub> however, these were on par with each other in D<sub>1</sub> at both first and second pickings.

The interactions of dates of sowing at same or different levels of chemicals also exhibited significant effect on germination rate

**Table 14. Germination rate index of cotton as influenced by Dates of sowing and chemicals at different pickings**

Treatments	First picking		Second picking			Third picking			
	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean
T <sub>1</sub>	20.79	16.58	18.68	19.57	14.18	16.87	18.56	14.07	16.31
T <sub>2</sub>	20.61	15.41	18.01	18.92	14.04	16.48	18.39	13.55	15.97
T <sub>3</sub>	20.93	16.76	18.84	19.66	14.67	17.16	19.28	14.54	16.91
T <sub>4</sub>	21.52	18.44	19.98	20.69	17.30	18.99	19.40	15.76	17.58
T <sub>5</sub>	20.01	12.02	16.01	18.64	11.23	14.93	18.13	11.14	14.63
T <sub>6</sub>	21.52	16.80	19.16	19.91	15.83	17.87	19.32	14.79	17.05
T <sub>7</sub>	22.95	20.34	21.65	22.82	18.45	20.64	22.58	17.59	20.08
T <sub>8</sub>	20.56	13.08	16.82	18.84	12.88	15.86	18.21	11.68	14.94
T <sub>9</sub>	19.95	10.93	15.44	17.94	10.32	14.13	17.45	9.67	13.56
Mean	20.98	15.60	18.29	19.67	14.32	16.99	19.03	13.64	16.34
For comparing the means of	SEm±		CD (0.05)	SEm±		CD (0.05)	SEm±		CD (0.05)
Dates of sowing (D)	0.08	0.49		0.02	0.14		0.10	0.60	
Chemicals (C)	0.21	0.62		0.22	0.62		0.22	0.63	
C at same level of D	0.30	0.87		0.30	0.88		0.31	0.89	
D at same or different levels of C	0.30	0.86		0.29	0.83		0.31	0.89	

D<sub>1</sub> = 20.5.99  
D<sub>2</sub> = 10.6.99

T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha  
T<sub>2</sub> = Boron @ 5kg/ha  
T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)  
T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2mM

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM  
T<sub>9</sub> =Control

index. The D<sub>1</sub>T<sub>7</sub> recorded significantly higher GRI (22.95, 22.82 and 22.58 at first, second and third pickings respectively) compared to other treatments and control (19.95, 17.94 and 17.45 respectively). However, D<sub>1</sub>T<sub>7</sub> was followed by D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub>, D<sub>1</sub>T<sub>3</sub> and D<sub>1</sub>T<sub>1</sub> were on par with each other at first and third pickings, however in second picking D<sub>1</sub>T<sub>2</sub> and D<sub>1</sub>T<sub>6</sub> were on par with each other.

### 4.3.3 Shoot length

The data on shoot length of seedlings as influenced by dates of sowing and chemicals at different pickings are presented in Table 15.

May sowing (D<sub>1</sub>) showed significantly more shoot length (10.06, 9.32 and 8.41 cm at first, second and third pickings, respectively) compared to June (D<sub>2</sub>) sowing (7.84, 7.21 and 6.49 cm, respectively).

Shoot length was significantly influenced by chemicals as compared to other treatments and control. Among the chemicals, T<sub>7</sub> recorded significantly higher shoot length (10.13, 9.72 and 8.94 cm at first, second and third pickings, respectively) compared to other chemicals and control (7.10, 6.68 and 5.80 cm, respectively), except T<sub>4</sub> and which were on par with each other at first picking, but only T<sub>4</sub> and T<sub>6</sub> were on par with each other at second and third pickings. These were followed by T<sub>3</sub> and T<sub>1</sub> which were on par with each other at second and third pickings.

**Table 15. Shoot length (cm) of cotton as influenced by dates of sowing and chemicals at different pickings**

Treatments	First picking			Second picking			Third picking		
	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean
T <sub>1</sub>	10.01	7.84	8.92	9.10	6.97	8.03	8.60	6.50	7.55
T <sub>2</sub>	9.75	7.41	8.58	8.93	6.74	7.83	7.84	6.39	7.11
T <sub>3</sub>	10.41	8.47	9.44	9.14	7.15	8.14	8.68	6.53	7.60
T <sub>4</sub>	11.04	8.79	9.91	10.38	8.33	9.36	9.60	7.12	8.36
T <sub>5</sub>	9.37	7.02	8.19	8.75	6.33	7.54	7.30	6.15	6.72
T <sub>6</sub>	11.02	8.71	9.87	10.36	8.28	9.32	9.58	6.71	8.14
T <sub>7</sub>	11.25	9.02	10.13	10.58	8.86	9.72	10.36	7.52	8.94
T <sub>8</sub>	9.54	7.19	8.36	8.84	6.69	7.76	7.46	6.19	6.82
T <sub>9</sub>	8.14	6.07	7.10	7.82	5.55	6.68	6.24	5.36	5.80
Mean	10.06	7.84	8.95	9.32	7.21	8.27	8.41	6.49	7.45
For comparing the means of	SEm± CD (0.05)			SEm± CD (0.05)			SEm± CD (0.05)		
Dates of sowing (D)	0.01	0.08		0.04	0.22		0.02	0.14	
Chemicals (C)	0.11	0.33		0.09	0.27		0.08	0.23	
C at same level of D	0.16	0.46		0.13	0.38		0.11	0.32	
D at same or different levels of C	0.15	0.44		0.13	0.37		0.11	0.31	

D<sub>1</sub> = 20.5.99  
D<sub>2</sub> = 10.6.99

T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha  
T<sub>2</sub> = Boron @ 5kg/ha  
T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)  
T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2mM

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM  
T<sub>9</sub> =Control

Interaction between chemicals at same date of sowing found to be significant. The T<sub>7</sub> at both D<sub>1</sub> and D<sub>2</sub> recorded significantly higher shoot length compared to any other combinations except T<sub>4</sub> and T<sub>6</sub> in D<sub>1</sub> at first and second and also in D<sub>2</sub> at first picking were on par with each other. This was followed by T<sub>3</sub>, T<sub>1</sub>, T<sub>2</sub> and T<sub>8</sub> however, these were on par with each other in D<sub>1</sub> at second picking except T<sub>2</sub> and T<sub>8</sub> in D<sub>1</sub> at first and third pickings which were on par with each other.

Interaction of dates of sowing at same or different levels of chemicals also differed significantly with respect to shoot length. The treatment combination D<sub>1</sub>T<sub>7</sub> gave significantly higher shoot length (11.25, 10.58 and 10.36 cm at first, second and third pickings respectively) compared to other combinations. These were followed by D<sub>1</sub>T<sub>3</sub>, D<sub>1</sub>T<sub>1</sub>, D<sub>1</sub>T<sub>2</sub> and D<sub>2</sub>T<sub>7</sub>, but these were on par with each other at second picking however in first and third pickings only D<sub>1</sub>T<sub>3</sub> and D<sub>1</sub>T<sub>1</sub> were on par each other.

### **4.3.3 Root length**

The data on root length of seedling as influenced by dates of sowing and chemicals at different pickings are given in Table 16.

May sowing (D<sub>1</sub>) showed significantly more root length (14.26, 12.46 and 11.00 cm at first, second and third pickings respectively) compared to June sowing (12.27, 10.68 and 9.65 cm respectively).

**Table 16. Root length (cm) of cotton as influenced by dates of sowing and chemicals at different pickings**

Treatments	First picking			Second picking			Thrd picking		
	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean
T <sub>1</sub>	13.65	12.03	12.84	12.14	10.37	11.25	10.32	10.14	10.23
T <sub>2</sub>	13.40	11.09	12.24	12.07	9.83	10.95	10.30	9.64	9.97
T <sub>3</sub>	15.30	14.07	14.68	13.38	10.71	12.04	11.14	10.37	10.75
T <sub>4</sub>	16.28	14.34	15.31	13.85	13.11	13.48	12.47	10.76	11.61
T <sub>5</sub>	12.61	10.35	11.48	10.65	9.02	9.84	9.88	8.29	9.09
T <sub>6</sub>	15.81	14.14	14.97	13.59	12.43	13.01	12.25	10.39	11.32
T <sub>7</sub>	16.49	14.70	15.59	15.06	13.59	14.32	12.93	11.38	12.15
T <sub>8</sub>	13.18	10.62	11.90	11.42	9.34	10.38	10.17	8.93	9.55
T <sub>9</sub>	11.59	9.12	10.35	9.98	7.77	8.87	9.54	6.97	8.26
<b>Mean</b>	<b>14.26</b>	<b>12.27</b>	<b>13.26</b>	<b>12.46</b>	<b>10.68</b>	<b>11.57</b>	<b>11.00</b>	<b>9.65</b>	<b>10.33</b>
<b>For comparing the means of</b>	SEm± CD (0.05)			SEm± CD (0.05)			SEm± CD (0.05)		
<b>Dates of sowing (D)</b>	0.07	0.42		0.02	0.12		0.03	0.16	
<b>Chemicals (C)</b>	0.07	0.21		0.08	0.23		0.09	0.27	
<b>C at same level of D</b>	0.11	0.30		0.11	0.33		0.13	0.38	
<b>D at same or different levels of C</b>	0.12	0.35		0.11	0.31		0.13	0.36	

D<sub>1</sub> = 20.5.99  
D<sub>2</sub> = 10.6.99

T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha  
T<sub>2</sub> = Boron @ 5kg/ha  
T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)  
T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2mM

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM  
T<sub>9</sub> =Control

With respect to chemicals, T<sub>7</sub> significantly recorded higher root length (15.59, 14.32 and 12.15 cm at first, second and third pickings, respectively) compared to other chemicals and control, (10.35, 8.87 and 8.26 cm respectively). This was followed by T<sub>4</sub>, T<sub>6</sub>, T<sub>3</sub>, T<sub>1</sub> and T<sub>2</sub> at all pickings however, T<sub>1</sub> and T<sub>2</sub> were on par with each other at third picking.

The interaction between chemicals at same date of sowing differed significantly with respect to root length. The T<sub>7</sub> at D<sub>1</sub> and D<sub>2</sub> recorded significantly higher root length compared to any other combinations except T<sub>4</sub> in D<sub>1</sub> at first picking were on par with each other. This was followed by T<sub>4</sub>, T<sub>6</sub> and T<sub>3</sub> however, T<sub>4</sub> and T<sub>6</sub> in D<sub>1</sub> at both second and third pickings and T<sub>4</sub>, T<sub>6</sub> and T<sub>3</sub> in D<sub>2</sub> at first picking were on par with each other.

Among the interaction of dates of sowing at same or different levels of chemicals found to be significant. The D<sub>1</sub>T<sub>7</sub> recorded higher root length (16.49, 15.06 and 12.93 cm at first, second and third pickings respectively) compared to other combinations and control (11.59, 9.98 and 9.54 cm, respectively), except D<sub>1</sub>T<sub>4</sub> which was on par with each other at first picking. In second and third pickings D<sub>1</sub>T<sub>7</sub> was followed D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub> and D<sub>2</sub>T<sub>7</sub>, however these were on par with each other at picking, except D<sub>2</sub>T<sub>7</sub> in third picking. These were followed by D<sub>1</sub>T<sub>3</sub> in all pickings, however D<sub>2</sub>T<sub>4</sub> and D<sub>2</sub>T<sub>7</sub> were on par with each other at second and third pickings respectively.

#### 4.3.5 Dry weight of ten seedlings (mg)

The data on ten seedling dry weight as influenced by dates of sowing and chemicals at different pickings are given in Table 17.

Significant difference was obtained due to dates of sowing for dry weight of seedling. May sowing (D<sub>1</sub>) recorded higher seedling dry weight (346.9, 321.0 and 288.6 mg at first, second and third pickings, respectively) than June (D<sub>2</sub>) sowing (210.0, 191.5 and 163.8 mg, respectively).

Chemicals also influenced the seedling dry weight significantly over control. T<sub>7</sub> recorded significantly maximum seedling dry weight (339, 329 and 300 mg at first, second and third pickings, respectively) compared to other chemicals and control (220, 202 and 163 mg, respectively). However, T<sub>7</sub> was followed T<sub>4</sub> and T<sub>6</sub>, but these were on par with each other at second and third pickings. The next best chemicals were T<sub>3</sub> and T<sub>1</sub>, but these were also on par with each other at second and third pickings. Then these were followed T<sub>2</sub> and T<sub>8</sub> but, these were on par with each other at second and third pickings.

Interaction between chemicals at same date of sowing found to be significant with respect to seedling dry weight. The T<sub>7</sub> at both D<sub>1</sub> and D<sub>2</sub> recorded significantly higher seedling dry weight as compared to any other combinations, except T<sub>4</sub> in D<sub>2</sub> at both first and third pickings were on par with each other. This was followed by T<sub>6</sub> and T<sub>3</sub> however, these were on par with each other in D<sub>1</sub> at first picking.

**Table 17. Dry weight of ten seedlings (mg) of cotton as influenced by dates of sowing and chemicals at different pickings**

Treatments	First picking			Second picking			Third picking		
	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean
T <sub>1</sub>	349	209	278	320	188	254	295	156	225
T <sub>2</sub>	344	181	262	291	158	224	264	123	193
T <sub>3</sub>	357	224	291	329	192	260	301	159	230
T <sub>4</sub>	391	267	329	358	250	304	326	230	278
T <sub>5</sub>	307	152	229	282	139	210	248	120	183
T <sub>6</sub>	366	264	315	353	244	298	323	224	273
T <sub>7</sub>	404	275	339	398	261	329	365	236	300
T <sub>8</sub>	314	167	240	289	155	222	254	213	187
T <sub>9</sub>	289	151	220	269	135	202	222	105	163
<b>Mean</b>	<b>346.9</b>	<b>210.0</b>	<b>279.5</b>	<b>321.0</b>	<b>191.5</b>	<b>256.3</b>	<b>288.6</b>	<b>163.8</b>	<b>226.2</b>
<b>For comparing the means of</b>	SEm± CD (0.05)			SEm± CD (0.05)			SEm± CD (0.051)		
<b>Dates of sowing (D)</b>	1.19 7.27			0.57 3.46			0.17 1.01		
<b>Chemicals (C)</b>	2.28 6.57			2.31 6.64			2.26 6.51		
<b>C at same level of D</b>	3.22 9.29			3.26 9.39			3.20 9.21		
<b>D at same or different levels of C</b>	3.27 9.41			3.13 9.01			3.02 8.69		

D<sub>1</sub> = 20.5.99  
D<sub>2</sub> = 10.6.99

T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha  
T<sub>2</sub> = Boron @ 5kg/ha  
T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)  
T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2 mM

T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM  
T<sub>9</sub> =Control

The interaction between dates of sowing at same or different levels of chemicals were found to be significant with respect to seedling dry weight. D<sub>1</sub>T<sub>7</sub> recorded significantly more seedling dry weight (404, 398 and 365 mg at first, second and third pickings respectively) compared to other combinations and control (289, 269 and 222 mg, respectively). However, this was followed by D<sub>1</sub>T<sub>4</sub> and D<sub>1</sub>T<sub>6</sub>, but these were on par with each other at second and third pickings. These were followed by D<sub>1</sub>T<sub>3</sub> and D<sub>1</sub>T<sub>1</sub> were also on par with each other at all pickings.

#### 4.3.4 Seedling vigour index

The results on the seedling vigour index as influenced by dates of sowing and chemicals are presented in Table 18 and Fig.4.

Vigour index was significantly influenced by different dates of sowing. Significantly May sowing (D<sub>1</sub>) recorded higher vigour index (2201, 1908, and 1566 at first, second and third pickings respectively) over June sowing (1681, 1426 and 1167, respectively).

All the chemicals, showed significant effect on vigour index. The T<sub>7</sub> recorded significantly higher vigour index (2289, 2032 and 1646 at first, second and third pickings, respectively) compared to other chemicals and control (1476, 1230 and 972 respectively), except T<sub>4</sub> which was on par with each other at second and third pickings. These were followed by T<sub>6</sub>, T<sub>3</sub>, T<sub>1</sub>, T<sub>2</sub> however only T<sub>1</sub> and T<sub>2</sub> were on par with each other at second picking. These were followed by T<sub>8</sub> and T<sub>5</sub>, but these were on par with each other at first and second pickings.

**Table 18. Seedling vigour index of cotton as influenced by dates of sowing and chemicals at different pickings**

Treatments	First picking			Second picking			Third picking		
	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean	D <sub>1</sub>	D <sub>2</sub>	Mean
T <sub>1</sub>	2129	1695	1912	1855	1381	1618	1514	1192	1353
T <sub>2</sub>	2076	1548	1812	1827	1343	1585	1439	1143	1291
T <sub>3</sub>	2348	1856	2102	1966	1431	1713	1639	1298	1468
T <sub>4</sub>	2523	1968	2245	2253	1722	1987	1938	1324	1631
T <sub>5</sub>	1957	1462	1709	1677	1241	1459	1339	1013	1176
T <sub>6</sub>	2423	1943	2183	2099	1712	1905	1775	1311	1543
T <sub>7</sub>	2606	1973	2289	2290	1744	2032	1957	1335	1646
T <sub>8</sub>	2007	1470	1738	1707	1243	1475	1346	1095	1220
T <sub>9</sub>	1736	1216	1476	1471	990	1230	1152	793	972
Mean	2201	1681	1941	1908	1426	1667	1566	1167	1366
For comparing the means of	SEm± CD (0.05)			SEm± CD (0.05)			SEm± CD (0.05)		
Dates of sowing (D)	5.94	36.13	8.88	54.02	6.57	39.95	11.15	32.12	
Chemicals (C)	14.36	41.37	15.91	45.83	15.77	45.42	15.77	45.42	
C at same level of D	20.31	58.50	22.50	64.82	15.77	45.42	15.77	45.42	
D at same or different levels of C	20.04	57.75	22.99	66.25	16.25	46.82	16.25	46.82	

D<sub>1</sub> = 20.5.99  
 D<sub>2</sub> = 10.6.99  
 T<sub>1</sub> = ZnSO<sub>4</sub> @ 10kg/ha  
 T<sub>2</sub> = Boron @ 5kg/ha  
 T<sub>3</sub> = ZnSO<sub>4</sub>+ Boron (10+5kg/ha)  
 T<sub>4</sub> = T<sub>3</sub>+ GA<sub>3</sub> @ 50ppm  
 T<sub>5</sub> = T<sub>3</sub>+ Acetyl salicylic acid @ 2 mM  
 T<sub>6</sub> = ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1%  
 T<sub>7</sub> = T<sub>6</sub>+ GA<sub>3</sub> @ 50ppm  
 T<sub>8</sub> = T<sub>6</sub>+ Acetyl salicylic acid @ 2mM  
 T<sub>9</sub> = Control

## LEGEND

- T<sub>1</sub> : ZnSO<sub>4</sub> @ 10 kg per ha (soil application)
- T<sub>2</sub> : Boron @ 5 kg per ha (soil application)
- T<sub>3</sub> : ZnSO<sub>4</sub> + Boron @ 10 + 5 kg per ha (soil application)
- T<sub>4</sub> : ZnSO<sub>4</sub> + Boron @ 10 + 5 kg per ha (soil application) + GA<sub>3</sub>  
@ 50 ppm (foliar application)
- T<sub>5</sub> : ZnSO<sub>4</sub> + Boron @ 10 + 5 kg per ha (soil application) + Acetyl  
salicylic acid @ 2 mM (foliar application)
- T<sub>6</sub> : ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1% (foliar application)
- T<sub>7</sub> : ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1% + GA<sub>3</sub> @ 50 ppm  
(foliar application)
- T<sub>8</sub> : ZnSO<sub>4</sub> @ 0.1% + Boron @ 0.1% + Acetyl salicylic acid @ 2mM  
(foliar application)
- T<sub>9</sub> : Control

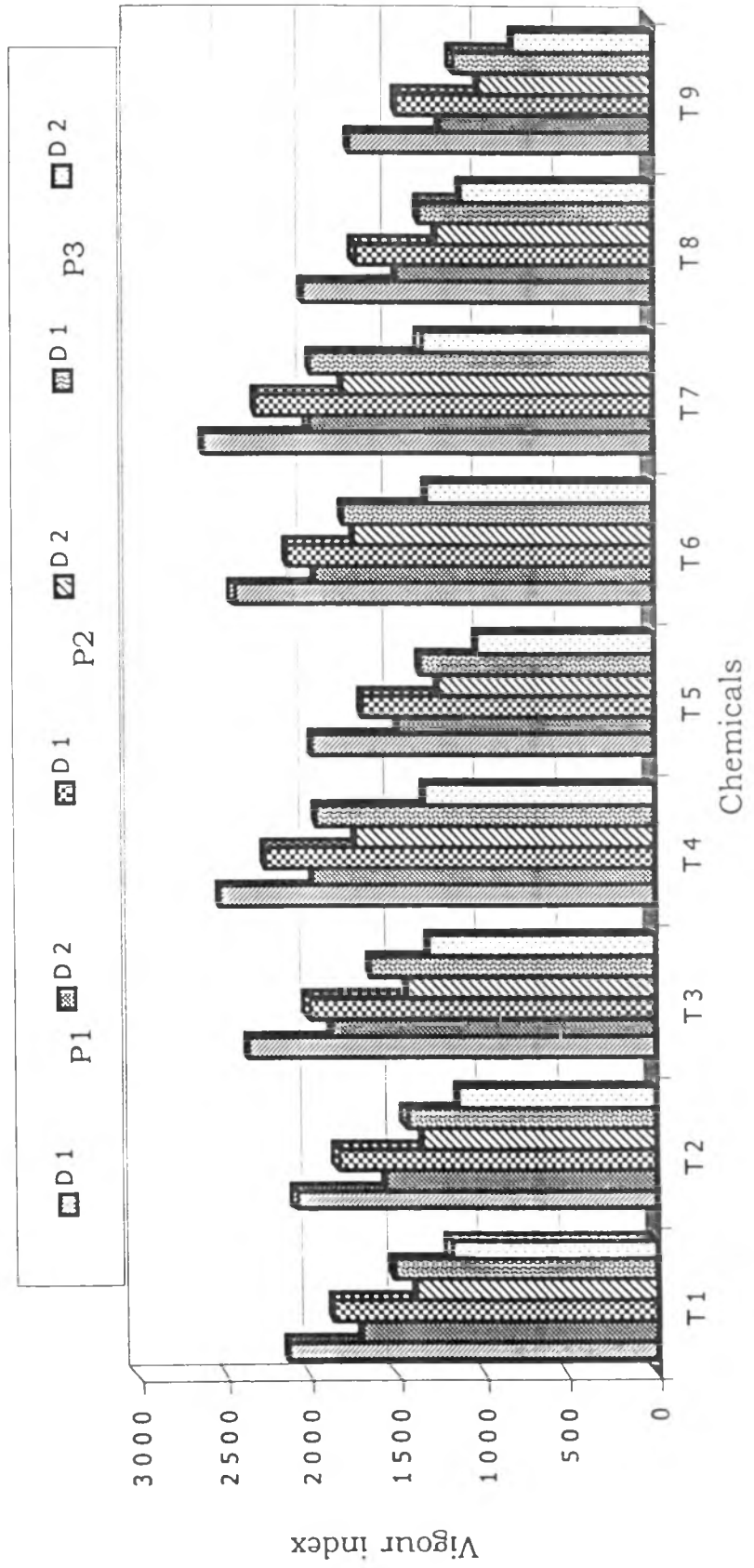


Fig. 4. Vigour index of cotton as influenced by dates of sowing and chemicals

Interaction between chemicals at same date of sowing differed significantly with respect to vigour index. The T<sub>7</sub> at D<sub>1</sub> and D<sub>2</sub> recorded significantly higher vigour index compared to any other combinations, except T<sub>4</sub> in D<sub>1</sub> at both second and third pickings and T<sub>4</sub> and T<sub>6</sub> in D<sub>2</sub> at all pickings were on par with other. This was followed by T<sub>3</sub> and T<sub>1</sub> however, these were on par with each other in D<sub>2</sub> at second picking.

Among the interaction of dates of sowing at same or different levels of chemicals showed significant effect on vigour index. The combination of D<sub>1</sub>T<sub>7</sub> recorded significantly more vigour index (2606, 2290 and 1957 at first, second and third pickings respectively) compared to any other combinations except, D<sub>1</sub>T<sub>4</sub> which was on par with each other at second and third pickings. This was followed by D<sub>1</sub>T<sub>6</sub>, D<sub>1</sub>T<sub>3</sub>, D<sub>1</sub>T<sub>1</sub> and D<sub>1</sub>T<sub>2</sub>, however only D<sub>1</sub>T<sub>1</sub> and D<sub>1</sub>T<sub>2</sub> which were on par with each other at first and second pickings.

# *DISCUSSION*

## V. DISCUSSION

With increase in population, the demand for cotton is also increasing, and hence the production has to be augmented to meet this increasing demand. Unfortunately, there are several problems associated with growth and development of cotton, which ultimately limit the yield of cotton. Square and boll drying is one of the major problems associated with the performance of cotton which limit the yield considerably (20-25% loss). The productivity of male parent SB (YF)-425 of DCH-32 hybrid (Jayalaxmi) is low mainly because of premature drying of squares and bolls and it has become difficult to meet even the minimum demand of the total seed requirement for seed production. To increase seed production in this male parent (SB (YF)-425), it is imperative to minimize yield losses arising due to square and boll drying using some cultural practices, plant growth regulators and nutrients. It is known that, among the cultural practices, suitable time of sowing is the most important from the point of high yields and the plant growth regulators and nutrients are known to modify the source-sink relationship and increase the translocation and photosynthetic efficiency resulting in increased square and boll retention and boll set per cent.

With this view, an experiment was conducted at Main Research Station, Dharwad, during *kharif* 1998-99 to study the effect of dates of sowing and application of chemicals on seed yield and quality of cotton cv. SB (YF)-425 (*G. barbadense*). The results obtained on these aspects are discussed in this chapter.

## **5.1 Effect of dates of sowing**

### **5.1.1 Effect of dates of sowing on growth parameters**

Effect of dates of sowing on various morphological characters such as plant height and number of leaves indicated that the dates of sowing differed significantly with respect to above parameters. Between dates of sowing, the better response was noticed in May sowing compared to June sowing. May sowing (D<sub>1</sub>) recorded significantly higher plant height (66.3, 93.6, 120.2 and 156.8 cm at 60, 90, 120 and 150 DAS, respectively) compared to June sowing (D<sub>2</sub>) (54.9, 70.9, 98.2 and 130.6 cm at 60, 90, 120 and 150 DAS, respectively). An increase in plant height may be due to coincidence of favourable weather conditions, such as temperature, light and humidity during different stages of crop growth. The reduction in plant growth and dry matter production with late planting (June) compared to early planting (May) was due to low temperature prevailing at later stages of growth as it was noticed by Prabhakar (1981) in Varalaxmi cotton.

Number of leaves per plant was significantly higher at all stages in May sowing (27.3, 39.4, 53.7 and 64.6) compared to June sowing (18.6, 28.6, 48.1 and 59.0) at 60, 90, 120 and 150 DAS, respectively. The increase in number of leaves per plant in May sowing might be due to higher plant height, which provided more space to bear higher number of leaves.

### 5.1.2 Effect of dates of sowing on seed yield and yield attributes

June sowing significantly took more number of days to 50 per cent flowering (78.15) compared to May sowing (71.18). Such a delay in 50 per cent flowering in June sowing was due to prevailing adverse climatic conditions like low temperature, heavy rainfall and short day conditions. These adverse climatic conditions might have extended the vegetative phase of the cotton plant due to slow growth. Eid *et al.* (1993) also noticed the number of days from sowing to 50 per cent flowering was decreased when sowing of cotton cv. Giza 75 was delayed from January to April.

May sowing (D1) recorded significantly more number of squares per plant (18.6, 29.2, 41.1 and 46.6) compared to June sowing (D2) (6.5, 15.5, 25.5 and 29.7 at 60, 90, 120 and 150 DAS, respectively). The increased number of squares in May sowing may be attributed to increase in plant height and also due to coincidence of favourable weather conditions, such as temperature, light and humidity during different stages of crop growth. Such increase in the number of squares per plant with early sown crop had been reported by Jain *et al.* (1981) in cotton. The June sown crop suffered more shedding of reproductive parts due to adverse climatic conditions, such as heavy rainfall during August and September months coupled with prevalence of cold weather, as evidenced by lower accumulation of dry matter in reproductive parts in late sowing.

May sowing (D<sub>1</sub>) recorded significantly more number of flowers per plant (3.97, 9.16, 13.48 and 18.27) compared to June sowing (D<sub>2</sub>) (3.12, 7.77, 12.47 and 17.26) at 70, 100, 130 and 160 DAS, respectively. The increased number of flowers per plant in May sowing may be attributed to sowing the crop early had overcome the effect of reduced and prolonged seedling emergence, produced earliness particularly in short growing season. Such adverse effect of late planting on flowering and number of flowers per plant was also reported by Galanopoulou *et al.* (1980) in cotton.

The number of matured bolls per plant is one of the important yield components which differed significantly due to dates of sowing. Significantly more number of matured bolls per plant was recorded in May sowing (8.05) compared to June sowing (6.68) at first picking. The increased number of bolls in May sowing might be due to fairly good plant structure as evidenced by higher plant height and more number of leaves per plant as compared to June sowing. Higher number of leaves might have helped in production of higher amount of photosynthates and its accumulation in reproductive parts. Bilbro and Roy (1973) noticed that cotton planted on 20<sup>th</sup> April gave highest yield and late plantings decreased the yields. This was expected because, with the late planting dates, growth, fruiting and maturation periods coincided with low temperature and reduced growing season, which resulted in poor crop performance. Misra and Malik (1979) also reported higher number of matured bolls under 12<sup>th</sup> May sown crop followed by

29<sup>th</sup> May and 15<sup>th</sup> June sown crop due to longer period of crop growth. Singh *et al.* (1969), Jain *et al.* (1981), Nehra *et al.* (1981), Dhoble *et al.* (1988), Ishwar Singh and Chouhan (1993) and Brar *et al.* (1996) in cotton also reported similar increase in number of matured bolls per plant.

The mean boll weight was also reduced due to delay in sowing. Higher boll weight was recorded in May sowing (4.35 g) compared to June sowing (3.44 g). It was observed that the May sowing recorded higher number of leaves per plant, that might have enhanced the area for photosynthesis and the efficient utilization of solar energy. The synthesized photosynthates might have translocated to reproductive parts (bolls). Decreased mean boll weight in June sowing, may be due to reduced growth of crop in delayed sowing as evidenced by less number of leaves per plant resulting in decreased accumulation of amount of photosynthates in bolls, might have leading to lesser boll weight in late sown crop, the results are in agreement with the findings of Khan *et al.* (1970), Galanopoulou *et al.* (1980), Ishwar Singh and Chouhan (1993) in cotton.

The availability of photosynthetic metabolites in early sown crop was more which might have helped to attain higher seed cotton weight per boll, number of seeds per boll and their development and also inturn increased seed weight per boll. May sowing (D<sub>1</sub>) being early in the present study recorded significantly higher seed cotton (kapas) weight per boll. Similar results were also reported by Malik and Malik (1986)

who observed that the number of seeds and seed weight per boll were higher in early sowing.

Significantly higher 100 seed weight was recorded in May sowing (8.24 g) as compared to June sowing (7.61 g). The increase in hundred seed weight may be attributed to the favourable climatic conditions, better synthesis and translocation of photosynthates from source (leaves) to sink (seeds), which might have enhanced the individual seed weight. These results are in line with the findings of Gadagi *et al.* (1990) in cotton.

In the present investigation seed yield per hectare significantly differed due to dates of sowing. May sowing produced higher seed yield (228.2 kg/ha) compared to June sowing (179.7 kg/ha). Increase in seed yield in May sowing was mainly due to favourable weather conditions, such as temperature, light and humidity during different growth stages of the crop, specially during flowering and boll development stages. Decrease in seed yield in June sowing may be due to the adverse climatic conditions such as low temperature, heavy rainfall and short day conditions. Similarly, Jain *et al.* (1981) reported that crop planted late after May reached the reproductive phase in first the half of October, coinciding with the cold weather, which affected the boll formation and development adversely, resulting in poor yields. Various research workers (Singh and Singh, 1974; Misra and Malik, 1979; Galanopoulou *et al.*, 1980; Nehra *et al.*, 1981; Prabhakar, 1981; Shrivastava *et al.*, 1982; Ishwar Singh and Chouhan, 1993; Brar and

Singh, 1994; Brar *et al.*, 1996) have also reported decreased yields due to delay in sowing.

### **5.1.3 Effect of dates of sowing on seed quality parameters**

May sowing recorded significantly higher germination percentage (90.3) compared to June sowing (83.5). The higher germination percentage in May sowing might be due to proper seed development which is evident through higher 100 seed weight and which in turn during germination might have supplied adequate food reserves for the resumption of embryonic plant growth.

The seedling vigour was significantly higher in May sowing (2201) compared to June sowing (1681). The increase in seedling vigour might be due to increased shoot and root length of the seedling and germination percentage. As the seedling vigour index is a product of sum of shoot and root length of the seedling and germination percentage, cumulative effect of these might have resulted in higher vigour values.

## **5.2 Effect of application of chemicals**

### **5.2.1 Effect of application of chemicals on growth parameters**

Effect of growth regulators and nutrients on morphological characters such as plant height and number of leaves per plant indicated that these differed significantly with respect to treatments. Among the growth regulators and nutrients treatments, ZnSO<sub>4</sub> (0.1%) + boron (0.1%) + GA<sub>3</sub> (50 ppm) followed by ZnSO<sub>4</sub> (10 kg/ha) + boron (5 kg/ha) + GA<sub>3</sub> (50 ppm); ZnSO<sub>4</sub> (0.1%) + boron (0.1%) and ZnSO<sub>4</sub>

(10 kg/ha) + boron (5 kg/ha) responded better than any other treatments.

Application of ZnSO<sub>4</sub> (0.1%) + boron (0.1%) + GA<sub>3</sub> (50 ppm) recorded significantly higher plant height (69.1, 92.8, 119.8 and 154.1 cm at 60, 90, 120 and 150 DAS, respectively) compared to other treatments and control. An increase in plant height is mainly attributed to increase in both cell division and cell elongation in apical meristem leading to increased length of inter nodes and also due to the production of growth promoting hormones by zinc. On the contrary, the growth inhibitors (Acetyl salicylic acid) are known to inhibit the growth and development by inhibiting or reducing auxin content in growing tissues by antagonising them. Thus they exert an inhibitory effect by suppressing the cell division and cell elongation at the meristematic region of the growing point. The increase in height of the plant height due to zinc, boron and GA<sub>3</sub> spray is in conformity with the results of Tsui (1948), Berger (1949), Bhat and Ramanujam (1971), Oosterhuis (1976), Dippenaar (1989) and Thakar Singh *et al.* (1997) in cotton.

The reduction in height of the plants sprayed with growth inhibitors or retardants may be due to slowing down of cell division and reduction in cell elongation because of inhibitory effect of Acetyl salicylic acid in the biosynthetic pathway of gibberellins in the plant body.

The number of leaves per plant was significantly influenced by chemicals at 60, 90, 120 and 150 DAS as compared to control (19.2, 30.2, 41.3 and 52.3, respectively). Among chemicals, ZnSO<sub>4</sub> (0.1%) +

boron (0.1%) in combination with GA<sub>3</sub> (50 ppm) recorded the maximum number of leaves per plant (26.6, 37.8, 59.6 and 70.6, respectively). The increase in number of leaves due to chemical spray might be due to increased plant height. These growth regulators and nutrients increased the activity of meristematic cells which in turn increased the plant height, which has provided more space to bear higher number of leaves on the plant.

### **5.2.2 Effect of application of chemicals on seed yield and yield attributes**

The foliar Application of ZnSO<sub>4</sub> (0.1%) + boron (0.1%) + GA<sub>3</sub> (50 ppm) recorded significantly less number of days (71.33) to 50 per cent flowering as compared to other treatments and control (77.50). Early flowering in GA<sub>3</sub> spray might be due to increase in the endogenous gibberellin levels inducing early flowering in the present study. The delayed flowering in the plants which received growth inhibitors might be due to reduced synthesis of endogenous gibberellins, which effectively blocking the synthesis of gibberellins.

Number of squares per plant increased significantly by chemicals at 60, 90, 120 and 150 DAS as compared to control (9.9, 15.8, 25.7 and 32.6, respectively). Among the chemicals, maximum number of squares per plant was recorded in GA<sub>3</sub> (50 ppm) in combination with ZnSO<sub>4</sub> (0.1%) and boron (0.1%). Increase in the number of squares per plant were more with the treatment of GA<sub>3</sub> (50 ppm) may be due to the better development of sinks and redistribution of photosynthates to the

developing sinks. Thus, the plants treated with GA<sub>3</sub> appeared to be vigorous with higher number of reproductive parts per plant may be because of more retention of reproductive parts. These results are in line with reports of Bhardwaj *et al.* (1975) and He *et al.* (1983) in cotton.

Number of flowers per plant also increased significantly by chemicals compared to control. Among the chemicals, maximum number of flowers per plant was recorded in ZnSO<sub>4</sub> (0.1%) + boron (0.1%) + GA<sub>3</sub> (50 ppm). This increase in number of flowers per plant could be attributed to the redistribution of photosynthates to the developing sinks that have developed much better due to GA<sub>3</sub> application. Thus, the plants sprayed with GA<sub>3</sub> seems to be reduced the shedding of reproductive parts which inturn retained higher number of flowers. The above results are in conformity with the findings of He *et al.* (1983) in cotton.

Application of ZnSO<sub>4</sub> (0.1%) + boron (0.1%) + GA<sub>3</sub> (50 ppm) significantly increased the number of matured bolls per plant compared to control (11.17) and other treatments. The increase in number of matured bolls per plant in the present study is mainly due to the action of GA<sub>3</sub>. GA<sub>3</sub> was applied to cotton at the beginning of square formation followed by at beginning of anthesis. This had pronounced effect on retention of bolls and decreased the boll shedding. Hence, it was evidenced with increase in number of bolls and these results are in conformity with the findings of Kosmidou-Demetropoulou (1985), Livingston *et al.* (1992) in cotton by GA<sub>3</sub>, Lu and Shi (1986), Sharma *et*

*al.* (1988), Gomaa (1991), Braud *et al.* (1969) and Wankhade *et al.* (1994) in cotton by boron and Raja Rajeshwari (1996) in cotton by both zinc and boron.

Application of ZnSO<sub>4</sub> (0.1%) + boron (0.1%) in combination with GA<sub>3</sub> (50 ppm) significantly increased the boll weight (4.24 g) as compared to control (3.02 g) and other chemicals. The increase in weight of the boll in the present study was mainly attributed to the increase in number of leaves per plant which might have enhanced the photosynthetic area for efficient translocation of these photosynthates to reproductive parts (bolls). Further, these results indicated that there was better establishment of translocation of nutrients from source (leaf) to sink (boll) due to spray of GA<sub>3</sub>. Such an increase in boll weight due to GA<sub>3</sub>, zinc and boron spray was reported by Silva *et al.* (1982), Lu and Shi (1986), Sharma *et al.* (1988), Livingston *et al.* (1992) and Raja Rajeshwari (1996) in cotton.

Seed cotton weight per boll was also influenced by application of chemicals. Significantly higher seed cotton weight per boll was recorded in ZnSO<sub>4</sub> (0.1%) + boron (0.1%) + GA<sub>3</sub> (50 ppm) as compared to other treatments and control. The increase in seed cotton weight depends upon the accumulation of photo assimilates and efficient partitioning in different parts of the plant. The seed cotton weight was strongly influenced by different growth regulators and nutrients indicating the role of these chemicals in increasing the seed cotton

weight through their effect on various morpho-physiological and bio-chemical traits.

Significantly maximum number of seeds per boll was recorded in ZnSO<sub>4</sub> (0.1%) + boron (0.1%) + GA<sub>3</sub> (50 ppm) as compared to other treatments and control. The increase in the number of seeds per boll might be due to proper development of fertilized ovules through efficient translocation of photo synthates from source (leaves) to reproductive parts (bolls). This might have helped to better filling up of fertilized ovules (seeds) and also due to enhanced synthesis of carbohydrates, proteins and their transport to the site of seed formation there by increased the number of seeds in the boll.

Seed weight per boll was significantly influenced by chemicals compared to control. However, maximum seed weight per boll was recorded in the chemicals, such as GA<sub>3</sub> (50 ppm) in combination with ZnSO<sub>4</sub> (0.1%) and boron (0.1%). These sprays might have increased the seed weight per boll in this study due to better development of individual seed and more number of seeds per boll.

Among the chemicals, maximum hundred seed weight was recorded in the treatment of ZnSO<sub>4</sub> (0.1%) + boron (0.1%) + GA<sub>3</sub> (50 ppm). An increase in hundred seed weight might be due to increase in the individual seed weight. Similar findings on increase in the hundred seed weight was reported by Kashyap *et al.* (1988) in cotton crop sprayed with zinc.

In the present study, significantly higher seed yield per hectare was recorded in GA<sub>3</sub> (50 ppm) along with ZnSO<sub>4</sub> (0.1%) and boron (0.1%) as compared to control, followed by GA<sub>3</sub> (50 ppm) along with soil application of ZnSO<sub>4</sub> (10 kg/ha) and boron (5 kg/ha), foliar spray of ZnSO<sub>4</sub> (0.1%) + boron (0.1%) and soil application ZnSO<sub>4</sub> (10 kg/ha) + boron (5 kg/ha). This increase in the seed yield may be attributed to enhanced yield attributes such as higher number of harvested bolls per plant, higher mean boll weight, higher seed weight per boll, more number of seeds per boll and hundred seed weight. Several research workers viz., Baluch *et al.* (1970), Bharadwaj and Sharma (1971), Venkatakrisnan and Pothiraj (1991), Pothiraj *et al.* (1995) and Hansen *et al.* (1996), have also reported the increased seed yield in cotton due to micro nutrients.

### **5.2.3 Effect of application of chemicals on seed quality parameters**

The maximum germination percentage was recorded by GA<sub>3</sub> (50 ppm) in combination with ZnSO<sub>4</sub> (0.1%) and boron (0.1%). Increase in seed germination percentage in GA<sub>3</sub> spray may be due to increased 100 seed weight, which might have supplied adequate food reserves to resume embryo growth and in addition, to release enzymes responsible for degradation of macro molecules into micro molecules to be utilized in growth promoting processes. Such an increase in germination percentage due to chemical spray was also reported by Sharma *et al.* (1984) in cotton with GA<sub>3</sub> spray.

Speed of germination was also significantly influenced by chemicals spray as compared to control. Higher speed of germination was recorded by GA<sub>3</sub>. An increase in speed of germination is in conformity with the observations made by Sharma *et al.* (1984) in cotton.

Seedling vigour index was significantly influenced by chemicals as compared to control and maximum vigour index was recorded by GA<sub>3</sub>. The increase in vigour index due to chemicals might be due to increased germination percentage, shoot and root length of the seedling.

### **5.3 Interaction effect of dates of sowing and application of chemicals**

The plant growth and development is a complex phenomenon resulting from interaction with several factors. The yield can be manipulated by taking advantage of their combined actions. In the present study, two factors viz., dates of sowing and application of chemicals were taken and results obtained from the combined effect of these two factors are discussed.

#### **5.3.1 Interaction effect of dates of sowing and application of chemicals on growth parameters.**

May sowing (D<sub>1</sub>) coupled with spray of ZnSO<sub>4</sub> (0.1%) + boron (0.1%) in combination with GA<sub>3</sub> (50 ppm) put up significantly maximum plant height. The increase in plant height might be due to favourable weather conditions viz., temperature, light and humidity prevailed during crop growth and that zinc and boron are very important in the

production of growth promoting hormones and important in cell division and forms an essential component of cell wall respectively, and also increase in cell division and cell elongation activity due to application of GA<sub>3</sub>.

On the contrary to this, the growth inhibitors (acetyl salicylic acid) produced significantly less plant height. A similar trend was noticed at all stages of plant growth. The reduction in plant height in dates of sowing coupled with growth inhibitors spray may be due to the reducing or inhibiting auxin synthesis in growing tissues by antagonising them and exert an inhibitory effect by suppression of cell division and cell elongation at the meristematic region of the growing point (Kene and Sontakey, 1995) in sunflower.

The D<sub>1</sub>T<sub>7</sub> gave significantly maximum plant height, whereas D<sub>1</sub>T<sub>7</sub> was followed by D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub> and D<sub>1</sub>T<sub>3</sub> at all stages of plant growth.

The T<sub>7</sub> at both D<sub>1</sub> and D<sub>2</sub> gave significantly more number of leaves per plant at all stages of plant growth. The treatment combination of D<sub>1</sub>T<sub>7</sub> recorded significantly higher number of leaves per plant. Increase in number of leaves per plant may be because of increased plant height and increased number of branches per plant.

### **5.3.2 Interaction effect of dates of sowing and chemicals on seed yield and yield attributes.**

Number of squares and flowers per plant are important yield deciding components which differed significantly with dates of sowing and chemicals interactions. Significantly more number of squares and

flowers per plant were recorded in treatment combination of D<sub>1</sub>T<sub>7</sub> followed by D<sub>1</sub>T<sub>4</sub>, whereas it was least in D<sub>2</sub>T<sub>9</sub>. The increase in number of squares and flowers per plant may be due to increase in plant height and also due to favourable weather conditions. The June sown crop showed more shedding of reproductive parts due to adverse climatic conditions and with respect to chemicals, might be due to better development of sinks and redistribution of photosynthates to developing sinks (squares and flowers) inturn more retention of reproductive parts. Similar results also reported by Jain *et al.* (1981), Bharadwaj *et al.* (1975) and He *et al.* (1983) in cotton.

Other yield components like number of matured bolls per plant, boll weight, seed cotton yield per bolls, number of seeds per boll, seed weight per boll and 100 seed weight differed significantly due to interaction of dates of sowing and chemicals. Treatment combination of D<sub>1</sub>T<sub>7</sub> followed by D<sub>1</sub>T<sub>4</sub> gave significantly higher values of the above parameters. The increase in the yield attributed may be due to fairly good plant structure as evidenced by higher plant height and more number of leaves in these treatments which helped in production of higher amount of photosynthates and its accumulation in reproductive parts.

Seed yield per hectare differed significantly due to interaction of dates of sowing and chemicals. Significantly higher seed yield was recorded in the treatment combination of D<sub>1</sub>T<sub>7</sub> and it was closely followed by D<sub>1</sub>T<sub>4</sub>. This increase in seed yield in cotton in May

sowing was mainly due to coincidence of favourable weather conditions and also increase in yield attributes per boll and per plant. Thus, it indicates that D<sub>1</sub>T<sub>7</sub> treatment combination was best for getting higher seed yield as compared to any other combination. Like wise, many research workers viz., Prabhakar (1981), Ishwar Singh and Chouhan (1993), Venkatakrishan and Pothiraj (1991) and Hansen *et al.* (1996) were also reported similar results in cotton.

### **5.3.3 Interaction effect of dates of sowing and chemicals on seed quality**

The treatment combination D<sub>1</sub>T<sub>7</sub> followed by D<sub>1</sub>T<sub>4</sub>, D<sub>1</sub>T<sub>6</sub> and D<sub>1</sub>T<sub>3</sub> gave significantly higher germination percentage. This is because of increase in 100 seed weight in these combinations, which in turn during germination might have supplied adequate metabolites to resume embryo growth. Similar observations were made by Sharma *et al.* (1984) in cotton with application of GA<sub>3</sub>.

The D<sub>1</sub>T<sub>7</sub> gave significantly higher values for seedling vigour index. The increase in seedling vigour index might be due to increase in shoot and root length and higher germination values as recorded in this combination.

## **5.4 Practical application of results**

Based on the results obtained from field and laboratory studies, the following recommendations can be made from this investigation.

1. May sowing gave higher seed yield (228 kg/ha) by 21.26 per cent as compared to sowing in June. Hence, May sowing is advisable under irrigated condition to get higher seed yield.
2. Foliar application of ZnSO<sub>4</sub> (0.1%) + boron (0.1%) + GA<sub>3</sub> (50 ppm) may be advocated to get higher yield.
3. Supply of micronutrients, zinc and boron along with growth regulators may also be advocated to get higher yield.

#### **5.5 Future line of work**

1. Investigations on varying doses of application of growth regulators and nutrients at critical stages of the plant need to be taken up.
2. It is well documented that various growth regulators and nutrients have profound effect in growth, seed yield and quality in cotton. The application of nutrients other than zinc and boron, in combination with growth regulators may be initiated to exploit the basic mechanism involved in seed yield and quality improvement.
3. Biochemical changes in seeds may be quantified due to growth regulators and nutrients to know the basic concept of seed development leading to enhanced seed quality.
4. There is a need to standardize the dosage, concentration, stage of spray and number of sprays required to increase the yield potential in different parental lines of cotton.

# *SUMMARY*

## VI. SUMMARY

Investigations on the effect of dates of sowing and chemical application on seed yield and quality of SB (YF)-425 was carried out on medium black soil at Main Research Station, Dharwad during the year 1998-99. The salient results of the experiment are summerized below.

1. May sowing recorded significantly highest plant height (156.8 cm) compared to June sowing (130.6 cm). Significantly higher number of leaves (64.6) and squares (46.6) per plant were recorded in May sowing compared to June sowing (59.0 and 29.7, respectively).
2. Significantly higher number of flowers (18.3) per plant were recorded in May sowing compared to June sowing (17.3) June sowing took more number of days to 50 per cent flowering (78.1) compared to May sowing (71.2).
3. May sowing recorded significantly higher number of matured bolls per plant, mean boll weight, seed cotton weight, number of seeds and seed weight per boll and hundred seed weight compared to June sowing. Significantly higher seed yield (228.2 kg/ha) was recorded in May sowing compared to June sowing (179.7 kg/ha).
4. Seed quality parameters such as germination percentage, germination rate index, shoot and root length, seedling dry weight and seedling vigour index were significantly higher in May sowing compared to June sowing.
5. Among the chemicals, growth regulators and nutrients significantly influenced plant height and number of leaves per

plant. Foliar application of ZnSO<sub>4</sub> (0.1%) + boron (0.1%) + GA<sub>3</sub> (50 ppm), ZnSO<sub>4</sub> (10 kg/ha) + boron (5 kg/ha) + GA<sub>3</sub> (50 ppm) and ZnSO<sub>4</sub> (0.1%) + boron (0.1%) significantly increased the plant height and number of leaves per plant while, soil application of ZnSO<sub>4</sub> (10 kg/ha) + boron (5 kg/ha) + foliar application of acetyl salicylic acid (2 mM) and ZnSO<sub>4</sub> (0.1%) + boron (0.1%) + acetyl salicylic acid (2 mM) decreased the plant height and leaves per plant.

6. The number of squares and flowers per plant were significantly increased by application of growth regulators and nutrients. These increased with all the treatments except ZnSO<sub>4</sub> + boron (10+5 kg/ha) + acetyl salicylic acid (2mM), ZnSO<sub>4</sub> (0.1%) + boron (0.1%) + acetyl salicylic acid (2 mM) and control. Significantly early flowering was noticed with GA<sub>3</sub> (50 ppm) in combination with ZnSO<sub>4</sub> (0.1%) + boron (0.1%) compared to control.
7. The application of growth regulators and nutrients significantly increased the number of matured bolls per plant except ZnSO<sub>4</sub> + boron (10+5 kg/ha) + acetyl salicylic acid (2mM), ZnSO<sub>4</sub> (0.1%) + boron (0.1%) + acetyl salicylic acid (2 mM) and control.
8. The yield and yield components were significantly influenced by the use of growth regulators and nutrients. In general, all the treatments increased the seed yield, boll weight, seed cotton weight per boll, number of seeds per boll, seed weight per boll and hundred seed weight except ZnSO<sub>4</sub> + boron (10+5 kg/ha) + acetyl salicylic acid (2 mM), ZnSO<sub>4</sub> (0.1%) + boron (0.1%) + acetyl

salicylic acid (2 mM) and control. Among the treatments, the highest yield and yield components were recorded in ZnSO<sub>4</sub> (0.1%) + boron (0.1%) + GA<sub>3</sub> (50 ppm) followed by ZnSO<sub>4</sub> + boron (10+5 kg/ha) + GA<sub>3</sub> (50 ppm).

9. Seed quality parameters such as germination percentage, germination rate index, shoot and root length, seedling dry weight and vigour index were significantly higher in ZnSO<sub>4</sub> (0.1%) + boron (0.1%) + GA<sub>3</sub> (50 ppm) followed by ZnSO<sub>4</sub> + boron (10+5 kg/ha) + GA<sub>3</sub> (50 ppm).
10. Among the interactions of dates of sowing and chemicals the T<sub>7</sub> at both D<sub>1</sub> and D<sub>2</sub> gave maximum plant height, number of leaves, squares and flowers per plant at all stages of plant growth.
11. The combination of D<sub>1</sub>T<sub>7</sub> recorded significantly less number of days to 50 per cent flowering while, D<sub>1</sub>T<sub>9</sub> and D<sub>2</sub>T<sub>9</sub> took significantly more number of days to 50 per cent flowering.
12. The D<sub>1</sub>T<sub>7</sub> and D<sub>2</sub>T<sub>7</sub> followed by D<sub>1</sub>T<sub>4</sub> and D<sub>2</sub>T<sub>4</sub> had significantly more number of matured bolls per plant, mean boll weight, seed cotton weight, number of seeds and seed weight per boll and hundred seed weight. The seed yield per ha was significantly higher in D<sub>1</sub>T<sub>7</sub> and D<sub>2</sub>T<sub>7</sub> followed by D<sub>1</sub>T<sub>4</sub> and D<sub>2</sub>T<sub>4</sub>.
13. In general, the seed quality parameters such as germination percentage, germination rate index, shoot and root length, seedling dry weight and vigour index were higher in D<sub>1</sub>T<sub>7</sub> and D<sub>2</sub>T<sub>7</sub> followed by D<sub>1</sub>T<sub>4</sub> and D<sub>2</sub>T<sub>4</sub>.

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# *APPENDICES*

**Appendix 1. Monthly meteorological data for the cropping season and the average 50 years (1950-1999) as recorded at the Meteorological Observatory, Main Research Station, University of Agricultural Sciences, Dharwad (Karnataka)**

Months	Rainfall (mm)		Temperature (°C)				Relative humidity (%)	
	1999-2000	1950-1999	Mean maximum		Mean minimum		1999-2000	1950-1999
			1999-2000	1950-1999	1999-2000	1950-1999		
March	0.0	7.45	36.2	35.76	20.2	18.79	63	56.76
April	14.7	47.52	36.6	37.11	21.1	21.36	65	58.66
May	32.8	86.50	32.2	36.73	21.3	21.45	75	66.99
June	71.8	115.19	28.0	29.50	21.0	21.21	85	81.73
July	113.9	154.52	26.4	27.05	20.8	20.96	89	88.32
August	19.7	101.32	27.1	27.11	20.4	20.65	85	86.83
September	8.8	106.38	28.3	28.73	20.0	20.17	83	83.39
October	161.1	136.62	28.9	30.13	19.8	19.23	79	76.60
November	0.0	35.14	29.6	29.36	16.0	15.33	59	68.57
December	0.0	5.94	28.9	29.15	13.4	13.42	51	64.83
January	0.0	0.10	30.6	29.18	15.1	14.09	48	63.30
February	0.0	0.0	32.2	34.66	15.7	15.96	52	51.44
Total	422.8	796.68	-	-	-	-	-	-

**Appendix II. Physical and chemical properties of soil from experimental site**

	<b>Particulars</b>	<b>Value</b>	<b>Procedure</b>
<b>A</b>	<b>Physical properties</b>		
	Clay (%)	32.70	Hydrometer method (Piper, 1966)
	Silt (%)	9.50	Hydrometer method (Piper, 1966)
	Fine sand (%)	31.24	Hydrometer method (Piper, 1966)
	Caorse sand (%)	26.56	Hydrometer method (Piper, 1966)
<b>B</b>	<b>Chemical properties</b>		
	Total N (kg/ha)	265.00	Modified Kjeldal's method (Jackson, 1967)
	Available P <sub>2</sub> O <sub>5</sub> (kg/ha)	10.80	Olsen's method (Muhr <i>et al.</i> , 1965)
	Available K <sub>2</sub> O (kg/ha)	245.00	Flame photometer (Muhr <i>et al.</i> , 1965)
	Soil pH	6.70	PH meter (Jackson, 1967)

**EFFECT OF DATES OF SOWING AND CHEMICALS ON SEED  
YIELD AND QUALITY OF MALE PARENT SB(YF)-425 COTTON  
(*Gossypium barbadense* L.)**

M.S.ULLAGADDI

2000

P.N.UMAPATHY

Major Advisor

Acc. No. 16-6438

ABSTRACT

A field experiment was conducted at Main Research Station, University of Agricultural Sciences, Dharwad during *kharif* 1999-2000 to find out the effect of dates of sowing and chemicals on seed yield and quality of *barbadense* cotton cultivar SB(YF)-425. The experiment consists of two dates of sowing (main plots) and nine treatments (sub plots) comprising of two plant growth regulators and two micronutrients at different concentrations and different combinations. The experiment was laid out in split plot design with three replications.

The data indicate that the May sowing was found to be best to produce higher yields and high quality seeds as compared to June sowing. Plant height and number of leaves increased significantly due to foliar application of ZnSO<sub>4</sub> (0.1%) and boron (0.1%) in combination with GA<sub>3</sub> (50 ppm). The application of growth regulators and nutrients significantly increased the number of squares, flowers and matured bolls per plant except acetyl salicylic acid which resulted in significantly higher values for these parameters.

The yield and yield components were significantly influenced due to growth regulators and nutrients. Among the treatments, the highest yield and yield components were recorded in RDF + foliar spray of ZnSO<sub>4</sub> (0.1%) + Boron (0.1%) in combination with GA<sub>3</sub> (50 ppm) followed by ZnSO<sub>4</sub> (10 kg/ha) + Boron (5 kg/ha) + GA<sub>3</sub> (50 ppm).

The seed quality parameters were significantly improved by the use of growth regulators and nutrients. Significantly higher germination, shoot length, root length and vigour index were observed in plants sprayed with ZnSO<sub>4</sub> (0.1%) + Boron (0.1%) + GA<sub>3</sub> (50 ppm).