EFFECT OF FOLIAR SPRAYS OF GIBBERELLIC ACID AND BORON ON GROWTH, YIELD AND QUALITY OF CABBAGE (*Brassica oleracea* var. *Capitata* L.) CV. GOLDEN ACRE

A

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ABSTRACT

EFFECT OF FOLIAR SPRAYS OF GIBBERELLIC ACID AND BORON ON GROWTH, YIELD AND QUALITY OF CABBAGE (*Brassica oleracea* var. *Capitata* L.) CV. GOLDEN ACRE

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A B S T R A C T

An experiment was carried out at Regional Horticultural Research Station, Block-E, Plot No.-1, Navsari Agricultural University, Navsari-396450 during *rabi* season of the year 2003-04. The experiment included twenty treatments consisting of gibberellic acid at 0, 50, 75, 100 and 125 mg l^{-1}, boron at 0, 0.10, 0.15 and 0.20 per cent and their combinations. The experiment was laid out in Factorial Randomized Block Design (FRBD) with three replications. Plants were sprayed twice at 10 and 20 days after transplanting.

The results revealed that foliar application of G_4 (125 mg l^{-1}) and boron (0.20%) were found more beneficial for vegetative characters viz., plant height, plant spread, number of non-wrapping leaves per plant, days taken for head formation and its maturity, head diameter, fresh weight of shoot and root, shoot/root ratio as well as yield and yield attributes viz., fresh

weight of head, volume of head and yield (q/ha) and also quality characters viz., total soluble solids and compactness of head.

From the economic point of view foliar spray of gibberellic acid at 125 mg l^{-1} gave the maximum net gain of Rs. 101011 but, cost benefit ratio was maximum in 50 mg l^{-1} GA (1:5.53). In case of boron 0.20 per cent gave the maximum net gain of Rs. 101689.40 with cost benefit ratio 1:7.75.

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CERTIFICATE

This is to certify that the thesis entitled **EFFECT OF FOLIAR SPRAYS OF GIBBERELLIC ACID AND BORON ON GROWTH, YIELD AND QUALITY OF CABBAGE (*Brassica oleracea* var. *Capitata* L.) CV. GOLDEN ACRE** submitted by **SHRI. RAJENDRA SINGH RATHORE** in partial fulfilment of the requirement for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **HORTICULTURE** of the Navsari Agricultural University is a record of bona fide research work carried out by him under my guidance and supervision and the thesis has not previously formed the basis for the award of any degree, diploma or other similar title.

Place : Navsari.

Date : 8th October, 2004

(P.B. Parmar)

Major Advisor

DECLARATION

This is to declare that the whole of the research work submitted in this thesis for the partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE) in HORTICULTURE** is the result of investigation done by the undersigned under the direct guidance and supervision of **Dr. P. B. PARMAR,** Professor and Head, Department of Horticulture, N. M. College of Agriculture, Navsari Agricultural University, Navsari and that no part of the work has been submitted for any other degree so far.

Place : Navsari.

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Date : 8th October , 2004

(Rajendra Singh Rathore)

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ABBREVIATIONS

@	:	At the rate of
B	:	Boron
CBR	:	Cost Benefit Ratio
Cm	:	Centimeter
Cv.	:	Cultivar
DAT	:	Days After Transplanting
g	:	Gram
GA_3	:	Gibberellic Acid
ha	:	Hectare
Kg	:	Kilogram
Mg^{-1}	:	Milligram Per Litre
ml	:	Millilitre
mm	:	Millimeter
ppm	:	Parts Per Million
q	:	Quintal
sq	:	Square centimeter
^{o}c	:	Degree Celcius
%	:	Per cent

INTRODUCTION

I. INTRODUCTION

Cabbage (*Brassica Oleracea* var. *Capitata* L.) is the most important member of the genus *Brassica* grown in the world and in fact is one of the most important vegetable crop. It is the native of Western Europe and the Northern Shore of Mediterranean region. It was introduced by Portuguese. Its popularity grew during the British rule.

Cabbage is more nutritious than cauliflower and knol-knol and is rich source of Vit.A, Vit.B, and Vit. C. It also contains minerals including phosphorus, potassium, calcium and sulphur besides traces of iron, iodine, copper. It also contain, fairly good amount of carbohydrates, protein and fibers. Cabbage is grown for its head, which is used for salad, boiling, cooking currying, pickling and dehydration purposes. It neutralizes acidity, improve digestion and appetite. Area under cabbage cultivation was around 0.27 million hectares with the production of 507 million tonnes in India during 2001-2002 (Anon.,2003). In Gujarat state cabbage, occupies an area about 10381 hectares with total head production of 179674 metric tonnes during 2002-2003 (Anon., 2004).

Cultivar Golden Acre is very popular among the farmers in the vicinity of all big cities in Gujarat owing to its earliness, round and compact head. The yield of cabbage per hectare in India is very low (16.5t) in comparison to European countries (25.21t) and it in true with Gujarat in comparison to

other states. There are several factors responsible for low yield of this crop in India. This may be attributed to the absence of proper knowledge of the cultivation techniques especially about its nutritional requirement. The importance of trace element in crop production has long been recognized and considerable amount of research work has been carried out on this aspect in many countries of the world. However, not much work has been conducted on these aspects in India and especially in Navsari district of Gujarat. Infect research information pertaining to the trace element nutrition of crops in India is still very meager and most of the research work on crop nutrition has been restricted to the study of the role of major elements.

A recent development concept in crop production is the use of growth regulators to modify and control plant growth and development. The appropriate time and amount of chemical application are very important in order to achieve the desired effect with indigenous growth regulators. A number of growth regulators have been tried in past on cabbage crop in different parts of the country in different ways and for different purposes. The great possibilities for maximizing the yield of vegetable crops by use of growth regulators have been emphasized by various research workers. El-Queshi *et al.* (1988) and Yadav *et al.* (2000) reported that increased vegetative growth and yield of spinach and cabbage with higher concentration of GA_3.

GA_3 is involved in the regulation of growth through both cell division and enlargement.

There is lack of details systematic study on the use of growth regulators and micro-nutrients for increasing growth, yield and quality of cabbage. The efficiency of plant growth regulators and micro-nutrients also varies with the climatic conditions. Recommendations for the practical use of these substances under one set of conditions may not be applicable to another set of conditions. This is particularly true in case of Gujarat because there is no information available on this aspect for the humid climatic conditions of the state.

Keeping all the points in view an investigation was conducted to evaluate the different concentrations of gibberellic acid and boron on growth, yield and quality of cabbage, cv. 'Golden Acre' at Regional Horticultural Research Station, Navsari Agricultural University, Navsari-396 450, during the *Rabi* season of 2003-2004 with the following objectives.

1. To study the effect of foliar application of GA_3 on growth, yield and quality of cabbage.

2. To determine the effect of foliar application of boron on growth, yield and quality of cabbage.

3. To find out the best concentration combination of GA_3 and boron on growth, yield and quality of cabbage.

4. To work out the economics of different treatments.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

One of the development in scientific agriculture has been the use of plant growth regulators and micro-nutrients, which have brought about a sort of revolution in growing of some horticultural crops. These, if applied in a suitable manner and proper concentration, regulate growth and fruitfulness in vegetable and other crops.

The work done on cabbage and other important vegetable crops treated with varying levels of gibberellic acid and boron in context of its growth, yield and quality have been reviewed in this chapter.

2.1 Effect of gibberellic acid

Chhonkar and Singh (1963) observed that two sprays of GA 5 ppm, 2nd and 3rd week after transplanting increased yield by 210 per cent over control in cabbage.

Sharma and Rathore (1964) conducted the experiment on cabbage varieties viz., 'Golden Acre' and Pride of India, proved that 75 ppm GA had increased the specific gravity of head, dry matter percentage in head, earlier head formation and the maximum number of inner leaves per head.

Singh and Saimbhi (1968) observed that foliar spray of GA at 50 and 100 ppm, 2nd and 4th week after transplanting in Chinense cabbage had increased yield significantly.

Chauhan and Singh (1970) observed early head formation and maturity of the cabbage by application of 5 ppm GA twice at 2nd and 3rd week after transplanting. Two sprays of 15 ppm GA had given the maximum inner leaves and compactness of head as well as twice spray of 50 ppm GA had given maximum diameter of head.

Chauhan and Bordia (1971) reported that spraying of 50 ppm GA is effective for the maximum weight of head in cabbage.

Chhonkar and Sengupta (1972) reported that foliar spray of GA 5 ppm had increased the plant growth, head formation and early maturity of cabbage head.

Prasad and Chaturvedi (1973) sprayed GA_3 at 5, 10 and 15 ppm on transplanted knol-khol at 4 to 5 leaf stage and observed that GA_3 at 10 ppm had given the better growth and yield.

Prasad and Sewak (1973) reported that the maximum enlargement of knol-khol had been increased with 5 and 10 ppm GA_3 treatment.

Nair *et al.* (1974) observed that the yield has been improved by GA at 5, 10 and 15 ppm in tomato.

Mehta and Mathai (1975) reported a case of poor fruit set and yield when tomato plant was treated with GA 10 and 25 ppm.

Sinha (1977) reported that when roots of cabbage seedlings were immersed in solution of GA at 5 and 10 ppm for 2 hrs. before transplanting, the recovery after transplanting was accelerated as compared to water immersed.

Bisaria and Bhatnagar (1978) working on brinjal crop reported that foliar application of GA_3 at 0, 10, 25, 50, 100 and 200 ppm had promoted the vegetative growth at all concentrations.

Mapelli *et al.* (1978) reported that the GA has been responsible for enlargement, which in turn had increased plant height and also the fresh and dry weight of cabbage.

Badawi and Sahhar (1980) observed that increased in growth, maximum edible head weight in cabbage when sprayed with GA 50 ppm after four weeks of transplanting.

Salesh and Abdul (1980) reported that GA application had increased plant height and fresh and dry weight of tomato.

Sengupta and Malik (1981) treated seedlings of cauliflower with 1 ppm GA_3 for 24 hrs prior to transplanting had hardened the seedlings and increased the spread of plant.

Suryanarayan and Rao (1981) reported that treatment with GA + agromin had given the yield of 64.42 q/ha as compared to control 57.61 q/ha in okra.

Durnam and Jones (1982) reported that GA had enhanced cell expansion of letutce hypocotyl.

Midam *et al.* (1982) recorded that foliar spray of 5 and 20 ppm GA_3 had increased plant height of pea.

Gonzalez and Marx (1983) reported that single spray of 20 ppm GA_3 two weeks before harvest had increased yield of autumn spinach.

Wu *et al.* (1983) reported that GA at 100 ppm had increased plant height, leaf area and stem fresh and dry weight of one month old tranplanted tomato plants cv. CL 143-0-10-3.

Lilov and Dowchew (1984) observed that GA_3 at 20, *40 and 100 mg* l^{-1} *had reduced yield as compared to control in* tomato.

Mishriky (1984) reported that application of GA_3 at 25 and 50 ppm had increased plant height, plant weight, weight of petioles per plant, weight of leaves per plant and ratio of petiole weight to whole plant weight. The length and width of the petiole was also increased in celery plant.

Shaheen and El-Sayed (1984) found that GA at 100 ppm had increased plant height, leaf area and stem fresh and dry weight in squash.

Maurya *et al.* (1985) reported that the maximum yield (87.39 q/ha) was obtained from plants treated with 2 per cent urea and 50 ppm GA_3 in okra over (64.97 q/ha) in control.

Zayed *et al.* (1985) reported that when GA_3 at 50 ppm was applied at the beginning of flowering and fortnight later had increased plant height in hot pepper.

Muthoo *et al.* (1987) found that foliar spray of GA_3 was best for vegetative and curd growth and increased the fresh weight and dry weight of leaves and curd in cauliflower.

Patil *et al.* (1987) noticed that the maximum head yield (28.83 t/ha) of cv. Golden Acre was obtained under GA_3 50 ppm after one month of transplanting while, the yield of control was only 16.18 t/ha.

El-Queshi *et al.* (1988) recorded the maximum plant height (39.00 cm) and fresh and dry weight of leaves (122.4 and 9.2 g/10 plant, respectively) were obtained under 50 ppm GA_3 spray in spinach.

Islam (1988) applied different growth regulators thirty days after transplanting in cabbage cv. Hercules. The highest yield was observed under GA_3 at 20 ppm, whereas CCC (Chloromequat) had negative effect on the indices studied.

Mishriky *et al.* (1988) observed that the application of GA_3 on pea plant at 50, 100 and 200 ppm 30 days after sowing and again 15 days later significantly had increased stem length, number of leaves per plant, fresh and dry weight and early and total yield, but 50 ppm GA_3 application was found most effective.

Booij (1989) reported that 10 and 20 ppm GA_{4+7} had increased curd diameter as a consequences of earlier curd initiation in cauliflower.

Maheshwari *et al.* (1989) reported that 100 ppm of GA_3 had been optimum concentration for plant growth in capsicum.

Ghimire *et al.* (1991) obtained the highest seed yield and 1000-seed weight of cabbage cv. Pride of India when crop was sprayed with 200 ppm GA_3 at one and two months after transplanting.

Sharma *et al.* (1992) sprayed brinjal cv. Pusa Purple Long with GA_3 30 ppm and reported the maximum number of fruits and marketable yield per plant.

El-Asdoudi and Ouf (1993) conducted an experiment on tomato cv. Cormello and sprayed three times with GA_3 10, 15, 25, 50 and 100 ppm at 15 days intervals and obtained the maximum and early yield with three sprays of 100 ppm GA_3, whereas 15 ppm had given the maximum total yield, while three sprays of 50 ppm GA_3 produced the tallest plants.

Singh (1995) reported enhanced germination of seed and induced flowering with GA_3 5 and 10 ppm in tomato.

Dharmendra *et al.* (1996) recorded the maximum yield in cabbage cv. Pride of India with spraying GA_3 at 50 ppm followed by NAA at 50 ppm, respectively.

Tomar and Ramgiry (1997) reported that plants treated with GA_3 had showed significantly greater plant height, number of branches per plant, number of fruits per plant and yield as compared to control in chilli.

Belakar *et al.* (1998) reported that GA_3 and CCC had increased fruit solid content in chilli.

Kumar *et al.* (2000) reported the tallest plants, the largest curd and maximum curd yield of cauliflower cv. Pant Subhra under foliar spray of GA_3 at 100 ppm.

Yadav *et al.* (2000) reported that two sprays of 100 ppm GA_3 at 30 and 60 days after transplanting was found to be optimum and most economical dose for achieving better growth and yield of cabbage under semi-arid condition of Jobner.

2.2 Effect of boron

Branchley (1927) assigned first place to boron among the trace elements in the amount of observational and fundamental research on its relation with plants. There is still interest in boron among research workers as an essential plant nutrient. The essentiality of boron to higher green plants was decisively accepted after the experimental work done by (Sommer, 1927).

Alexender (1960) observed the better growth of cauliflower on sand culture with 0.03 ppm boron.

Takano *et al.* (1960) reported that the application of 100, 200 and 300 g boron/acre had increased the growth characters of Chinese cabbage and cauliflower.

Jurkevic (1963) noticed an increase in the yield of tomato crop by 0.03 per cent boron foliar spray.

Park and Song (1965) reported that the foliar spray of 0.5 and 1.5 ppm boron or added to the nutrition solution at concentrations of 1.5 and 4.5 ppm resulted in resumption of growth of Chinese cabbage with in 2 weeks and had a considerable increase in the number of leaves.

Alekseeva and Knjazeva (1968) soaked the seeds of several cabbage varieties for 24 hr. in solution of boron and in water before direct sowing. The treatment had increased the yield by 15-20 per cent as compared to control.

Ashour and Fouly (1970) conducted field experiment on tomato plants. They found that foliar application of boron with growth regulators like GA and CCC and individually had increased the vegetative parts and yield per plant.

Singh and Randhawa (1970) conducted an experiment on muskmelon cultivar Haramadhu. Plants were sprayed at 2,4 and 6 leaf stage with iron (1,2 and 3 ppm), boron (2,4 and 6 ppm) and Ca (10, 20 and 30 ppm). Plant growth had been promoted by B while Ca and fruit yield has been significantly increased by 4 ppm boron application as compared to control.

Verma *et al.* (1973) recorded the maximum plant height, number of leaves and higher yield of tomato plants which were grown in sand culture with 1 ppm foliar spray of boron.

Maurya and Lal (1975) studied the response of onion plants to 0, 1, 2 and 3 ppm boron solution spray. The maximum number of leaves and bulb weight were observed with 1 ppm

boron whereas, plant height was maximum in response to 2 ppm boron spray.

Mehrotra *et al.* (1975) carried out three year trial on pot grown cauliflower with the foliar application of borax which had increased the size and weight of curd.

Ilooda *et al.* (1981) sprayed the plants of muskmelon cv Harmadhu with Ca at 10 and 30 ppm and 2.5 and 7.5 ppm B at 2 and 6 leaf stage resulted in highest yield.

Mishra and Singh (1984) recorded the highest yield (301.48 q/ha) with N at 1 per cent + GA_3 at 50 ppm when applied 15 and 45 days after transplanting in cauliflower and also reported that spraying of 50 ppm GA_3 with 1.0 per cent N and 0.1 per cent B significantly increased growth characters of cabbage.

Shelp and Shattuck (1987) reported that different concentrations of boron (0.0, 0.25, 1.0 2.5 and 12.5 mg/l) increased the optimum plant height, head yield and the maximum fresh weight harvest index at 1.0 mg B/l in cauliflower cv. White Top.

Baghel and Sarnaik (1988) observed that number of leaves, plant height, bulb diameter, bulb fresh weight, per cent TSS, dry matter content and bulb yield was significantly increased with a combined application of Zn 0.5 and B 0.2 per cent applied to the foliage. Foliage spray gave 17.07 per cent higher yield than the control with the soil application being slightly less effective (15.65% over the control).

Kotur and Kumar (1989) reported that yield of marketable curds in cauliflower increased from 0.4 t/ha in control to the highest yield of 9.1 t/ha at application of 1.6 kg boron/ha and thereafter the curd yield was decreased with higher doses of boron.

Panigrahi *et al.* (1990) reported that application of 0.2 per cent boron to seedling as a root dip alongwith soil application of 1 kg B/ha had resulted in the highest seed yield (2.05 q/ha) and 97 per cent increase in cauliflower diameter as compared to control.

Dixit *et al.* (1997) reported that the head yield ranged from 28.50 t/ha (2.0 mg B/kg + no Ca) to 40.25 t/ha (0.5 mg B/kg + 40 mg Ca/kg). The highest B rate tended to reduce yields compared with applying no. B.B. contents in the harvested produce increased as B rate increased.

Ghosh and Hasan (1997) reported that application of borax at 15 kg/ha resulted in the maximum number of leaves per plant, largest curd and the higher yield in cauliflower.

Kotur (1997) reported that the increasing level of B (0.0125 and 0.125 per cent) as boric acid, each applied thrice by foliar spray had significantly increased curd size and yield of cauliflower.

Sharma and Sharma (1999) reported that direct application of borax at 18 kg/ha as soil application or foliar spray

of 0.3 per cent borax solution enhanced the yield in cauliflower, cabbage and khol rabi by 16.1, 12.1 and 11.5 per cent respectively over control.

Kumar *et al.* (2002) reported that molybdenum (0.5 kg/ha) and boron (10 kg/ha) application had significantly increased curd diameter, weight and yield by 14 and 32 per cent respectively in the absence of FYM, in cauliflower cv. Pusa Snowball-1.

Sharma (2002) obtained the maximum plant height, number of branches per plant, number of seeds per pod, seed yield per plant, per hectare, 10-seed weight and per cent seed germination when 25 kg borax/ha had been applied through soil application in cauliflower cv. 'Pusa Snowball K-1'.

MATERIALS AND METHODS

III. MATERIALS AND METHODS

The details of materials used, experimental methods and techniques were adopted during the course of this investigation are given below:

3.1 Experimental site

The experiment was conducted at the Regional Horticultural Research Station, Block-E, Plot-No. 1, Navsari Agricultural University, Navsari-396450 during *rabi* season 2003-04.

3.2 Soil characteristics

The soil of Navsari Campus is heavy deep black, moderately drained, clayey in nature and rich in organic matter and potassium, having good water holding capacity. The soil cracks heavily on drying after irrigation. It falls under inceptisol order of Jalalpur series as classified by the Soil Survey Officer Department of Agriculture, Gujarat State (Desai and Patel, 1970). Keeping in view the physical and chemical properties of soil the experimental yield was determined. The soil samples, from the surface of 0 to 30 cm strata were drawn randomly before transplanting of the crop and composite sample was prepared and then analyzed for physico-chemical properties. The soil characteristics data presented in Table-3.1 and 3.2.

Table-3.1 : Physical properties of the soil

Sr. No.	Particulars	Value (%) 0-30 cm	Methods
1	Coarse sand	0.69	International Pipette method (Piper, 1956).
2	Fine sand	9.17	
3	Silt	24.94	
4	Clay	65.20	
5	Texture	Clayey	

Table-3.2 : Chemical characteristics of the soil

Sr. No.	Particulars	Value at 0-30cm depth	Methods employed
1	Soil pH (1:2.5 soil: water ratio)	7.7	Blackman's pH meter (Jackson, 1967)
2	Total Nitrogen (%)	0.052	Modified Kjeldahl's method (Jackson, 1967)
3	Available Nitrogen (kg/ha)	160.60	Alkaline permanganate method (Jackson, 1967)
4	Available Phosphorus (kg/ha)	40.02	Olsen's method (Olsen *et al.*, 1954)
5	Available Potash (kg/ha)	384.50	Flame photo meter (Jackson, 1967)

3.3 Location

Navsari Campus of Navsari Agricultural University where the investigation was carried out is located on 20°57' N and 72°57 E and longitude and has an altitude of about 10 meters above the mean sea level. This location is about 13 km away from Dandi seashore.

3.3.1 Climate and weather

The climate of this area is typically tropical characterized by fairly hot summer, moderately and cold winter with humid and warm monsoon. The rainfall of this region is heavy and is normally received from June to September. Most of the precipitation is received from south-west monsoon concentrating in the months of July and August. The annual mean precipitation of this area is 1210.4 mm in 50 rainy days and grouped under South Gujarat heavy rainfall zone.

The winter commences from October onwards and ends by the middle of February. The temperature falls down from the beginning of November. December and January are the coldest months of the year. The summer season commences from the middle of February and ends by the first week of June. April and May are the hottest months of summer. The minimum and maximum temperature ranges between 13.0 and 34.9°C, respectively.

The mean weekly meteorological data on maximum and minimum temperature, relative humidity and sunshine hours during the course of investigation were recorded at the Meteorological observatory of N.M. College of Agriculture, Navsari Agricultural University, Navsari-396450 which are presented in Appendix-I.

3.4 Experimental details

3.4.1 Title

The effect of foliar sprays of gibberellic acid and boron on growth, yield and quality of cabbage (*Brassica oleracea* var. *Capitata* L.) cv. 'Golden Acre'.

3.4.2 Treatments

Total twenty treatment combinations involving two factors, viz.,

1. Gibberellic acid at five levels
2. Boron at four levels

3.4.2.1 Treatment details

(a) Gibberellic acid levels : Five

G_0	Control
G_1	50 mg l^{-1}
G_2	75 mg l^{-1}
G_3	100 mg l^{-1}
G_4	125 mg l^{-1}

(B) Boron levels : Four

B_0	Control
B_1	0.10%
B_2	0.15%
B_3	0.20%

Table-3.3 : Treatment of different combinations

Sr. No.	Treatment combinations	Levels of gibberellic acid (mg l^{-1})	Levels of boron (%)
1	G_0B_0	00	0.00
2	G_0B_1	00	0.10
3	G_0B_2	00	0.15
4	G_0B_3	00	0.20
5	G_1B_0	50	0.00
6	G_1B_1	50	0.10
7	G_1B_2	50	0.15
8	G_1B_3	50	0.20
9	G_2B_0	75	0.00
10	G_2B_1	75	0.10
11	G_2B_2	75	0.15
12	G_2B_3	75	0.20
13	G_3B_0	100	0.00
14	G_3B_1	100	0.10
15	G_3B_2	100	0.15
16	G_3B_3	100	0.20
17	G_4B_0	125	0.00
18	G_4B_1	125	0.10
19	G_4B_2	125	0.15
20	G_4B_3	125	0.20

3.4.3 Experimental design

The factorial randomized block design (FRBD) was adopted.

(1) Total no. of treatment combinations : 20

(2) Total no. of plots : 60

3.4.4 Details of experiment plot

(1) Size of Plot : Gross : 2.40 x 3.6 m

Net : 1.20 x 2.40 m

(2) Total experimental area: 661.50 sq. m.

(3) Crop and Variety : Cabbage cv. 'Golden Acre'

(4) Spacing : 60 x60 cm

(5) No. of replications : Three

3.5 Cultivation details

3.5.1 Land preparation

The experimental area was ploughed twice with the *mould board plough followed* by a planking. The FYM was applied uniformly @ 20 t/ha and again the field was ploughed with cultivator to bring it to good tilth and followed by a planking.

3.5.2 Planting materials

Four week old seedlings with 5-6 leaf stage were used for planting of cabbage (*Brassica oleracea* var. *Capitata* L.) cv. 'Golden Acre'.

3.5.2.1 Nursery/raising of seedlings

The seeds were sown on the raised beds in middle of October, 2003 in lines at a distance of 5-8 cm between row and 3-4 cm between two plants. The size nursery bed was 8.0 x 1.0 m, 50 kg of well rotten FYM, 300 g of murate of potash and 250 g of Urea were applied before seed sowing and was covered properly to ensure quick germination. Irrigation and plant protection measures were given as and when required.

3.5.3 Fertilizers application

The half of the nitrogen was applied in the form of Urea before transplanting as a basal dose and remaining half dose was applied one month after transplanting as a top dressing. The phosphorus and potash were applied @ 37.5 kg/ha each as a basal dose in the form of Single Super Phosphate and murate of potash.

3.5.4 Transplanting of seedlings

Four weeks old healthy uniform seedlings with 5-6 leaf stage were used for transplanting. Transplanting was done at vapsa condition of soil in the middle of November with distance of 60 cm row to row and 60 cm plant to plant in late afternoon to avoid wilting. The beds were irrigated immediately after transplanting.

3.5.5 Hand weeding

Weeding was done with the help of *Khurpi* for three times at an interval of 15 days after transplanting.

3.5.6 Earthing up

After first weeding operation, earthing up was done manually for giving support to the plant.

3.5.7 Irrigation

A light irrigation after transplanting and then subsequent irrigations within 7 to 8 days interval were given to avoid the cracking of upper surface of the soil. At the time of head formation the crop was irrigated at close intervals, i.e. after every 6 days.

3.5.8 Application of different treatments

3.5.8.1 Application of gibberellic acid

Different concentration of GA_3 i.e. 50, 75, 100 and 125 mg l^{-1} were prepared. For this purpose 50, 75, 100 and 125 mg l^{-1} of gibberellic acid was weighted separately dissolved in a 8-10ml alcohol and the volume was raised upto one litre with distilled water. Two foliar sprays of these concentrations were done at 10 DAT and 20 DAT. The spraying consisted of the complete spraying of individual plants with the help of the hand sprayer and teepol as a sticking agent was also added to the solution.

3.5.8.2 Application of boron

For application of boron, boric acid was used at different concentrations i.e. 0.10, 0.15 and 0.20 per cent. For this purpose 0.1, 0.15 and 0.2 g of boric acid was dissolved in one

litre distilled water. Two foliar sprays of these concentrations were done at 10 and 20 DAT.

In case of treatment combinations of Gibbrellic acid and Boric acid, first Gibbrellic acid was sprayed, after 24 hours boric acid was sprayed on the plants according to the treatment combinations. In case of control the spray was done with distilled water with teepol as a sticking agent.

3.5.9 Plant protection measures

Heliothis and diamondback moth infested the cabbage crop, so two sprays of insecticide viz., monocrotophos at the rate of 12 ml in ten litres of water were given for its control.

3.5.10 Harvesting

Cabbage heads were harvested when they become compact and fully matured. The head was considered to be matured for harvesting if sufficient hard with pressing with thumb. The upper most leaf gave prominent shiny appearance at maturity.

3.6 Observations

Five plants were randomly selected in each net plot and were tagged for recording the following observations.

3.6.1 Observations on vegetative growth characters:

3.6.1.1 Plant height (cm)

Height of the plant was measured from the ground level to the tip of the plant with the help of meter scale.

3.6.1.2 Plant spread (cm^2)

Spread of plant was measured with scale from two sides, then averaged it, thereafter, plant spread as circle area was calculated.

3.6.1.3 Number of non-wrapping leaves per plant

After harvesting the plant, number of fully opened leaves were counted on the plant. The results were expressed as mean number of non-wrapping leaves per plant.

3.6.1.4 Days taken for head initiation after transplanting

The number of days required for initiation of head were counted and recorded from the date of transplanting.

3.6.1.5 Days taken for complete maturity of head

The number of days were recorded from the date of transplanting to the date of harvesting of fully developed heads for at complete maturity.

3.6.1.6 Head diameter (cm)

The head diameter was measured with measuring tape, by measuring two way axial circumference of each cabbage head. Then it was converted and expressed into diameter of head in cm.

3.6.1.7 Fresh weight of shoot (g) per plant

The root portion of the uprooted plants was cut with the help of knife and the shoot portion was separately weighed.

3.6.1.8 Fresh weight of root (g)per plant

The left over portion alongwith roots was weighed and recorded.

3.6.1.9 Shoot / root ratio

The shoot and root portion were weighed separately and the shoot and root ratio was calculated by the following formula.

$$\text{Ratio} = \frac{\text{Fresh weight of shoot (g)}}{\text{Fresh weight of root (g)}}$$

3.6.2 Yield and yield attributes

3.6.2.1 Fresh weight of head (g)

Weight of head after removing unfolded leaves was recorded.

3.6.2.2 Volume of head (ml)

The volume of the head was taken by water displacement method.

3.6.2.3 Yield per hectare (q)

It was calculated by dividing the yield per bed (kg) with net area of bed (m^2) and multiplied with 10000.

3.6.3 Quality characters

3.6.3.1 Total soluble solids (%)

The head leaves were chopped and crushed with the help of mixer and the extracted juice was placed on refractometer and the data were recored.

3.6.3.2 Compactness of head (%)

Compactness of head was calculated by formula suggest by Pearson (1931).

$$Z = \frac{C}{W^3} \times 100$$

Where,

Z = An index of compactness

C = The net weight of head (g)

W = The diameter of the head (cm)

3.7 Statistical analysis

The data collected for all the characters were subjected to the statistical analysis by adopting 'Analysis' of variance technique as described by Panse and Sukhatme (1985) for the Factorial Randomized Block design (FRBD).

3.8 Economics

The gross realization in term of rupees per hectare was worked out by taking into consideration the prevailing market price of the cabbage head under each treatment during the year 2003-04. Likewise, the cost of cultivation was worked out by considering the expenses incurred for cultural operations from preparatory tillage to harvesting including the cost of inputs viz., seeds, manures, fertilizers, insecticides, irrigation growth substances (GA_3, Boron) etc. under each treatment. The cost of

cultivation was then deducted from the gross realization to work out the net profit under each treatment. The cost benefit ratio (CBR) was calculated on the basis of the formula given below:

$$CBR = \frac{\text{Net realziation (Rs.)}}{\text{Total expenditure (Rs.)}}$$

EXPERIMENTAL RESULTS

IV. EXPERIMENTAL RESULTS

Results of the field experiment entitled "Effect of foliar sprays of gibberellic acid and boron on growth, yield and quality of cabbage (*Brassica oleracea* var. *Capitata* L.) cv. Golden Acre" was carried out during *rabi* of 2003-04 at the Regional Horticultural Research Station, Block-E, Plot No. 1, Navsari Agricultural University, Navsari-396450. The data recorded during the experimentation were statistically analysed and results of each characters are presented in this chapter.

4.1 Vegetative growth characters

4.1.1 Plant height (cm)

The mean data on plant height (cm) recorded as affected by gibberellic acid and boron treatment alongwith statistical inference are presented in Table 4.1.

The data (Table-4.1) indicated that gibberellic acid significantly influenced the plant height. Significantly the maximum plant height (30.82 cm) was observed in G_4 (125 mg l^{-1}) treatment, while significantly the minimum plant height (23.86 cm) was noted in control (G_0). However, treatments G_1, G_2 and G_3 were at par with each other. Boron significantly influenced the plant height. The maximum plant height (29.95 cm) was observed in B_3 (0.20%) treatment followed by B_2 (27.39 cm) treatment. The minimum plant height (25.56 cm) was observed under control (B_0) which was at par with B_1 (0.10%) and B_2 (0.15%) treatments.

Table 4.1 : Effect of gibberellic acid and boron on plant height (cm) and plant spread (cm^2) of cabbage cv. 'Golden Acre'.

Treatments	Plant height (cm)	Plant spread (cm^2)
(A) Gibberellic acid (G)		
G_0 (Control)	23.86	1940.70
G_1 (50 mg l^{-1})	26.99	2104.83
G_2 (75 mg l^{-1})	27.38	2160.82
G_3 (100 mg l^{-1})	28.19	2224.08
G_4 (125 mg l^{-1})	30.82	2372.10
S.Em±	0.83	49.54
C.D. at 5%	2.37	141.58
(B) Boron (B)		
B_0 (Control)	25.56	2020.65
B_1 (0.10%)	26.89	2084.05
B_2 (0.15%)	27.39	2173.22
B_3 (0.20%)	29.95	2364.10
S.Em±	0.74	44.31
C.D. at 5%	2.12	126.63
(C) Interaction (G x B)		
S.Em±	1.66	99.09
C.D. at 5%	NS	NS
C.V. %	10.45	7.94

The interaction effect of gibberellic acid and boron for plant height was found non-significant.

4.1.2 Plant spread (cm^2)

Plant spread was statistically analysed and is presented in Table 4.1.

The data illustrated in Table 4.1 showed that different levels of gibberellic acid significantly influenced plant spread. The maximum plant spread (2372.10 cm^2) was observed in G_4 (125 mg l^{-1}) treatment. Significantly the minimum plant spread (1940.70 cm^2) was observed under control (G_0). However, treatments G_1 (50 mg l^{-1}), G_2 (75 mg l^{-1}) and G_3 (100 mg l^{-1}) were at par with each other. Boron significantly influenced the plant spread. The maximum plant spread (2364.10 cm^2) was recorded in B_3 (0.20%) followed by B_2 (2173.22 cm^2) treatment. The minimum plant spread (2020.65 cm^2) was observed under control (B_0) which was at par with B_1 (2084.05 cm^2) treatment.

The interaction effect of gibberellic acid and boron for plant spread were found non-significant.

4.1.3 Number of non-wrapping leaves

Number of non-wrapping leaves per plant was statistically analysed and presented in Table 4.2.

Number of non-wrapping leaves per plant were significantly influenced under different gibberellic acid levels.

Table 4.2 : Effect of gibberellic acid and boron on number of non-wrapping leaves per plant of cabbage cv. 'Golden Acre'.

Treatments	No. of non-wrapping leaves per plant
(A) Gibberellic acid (G)	
G_0 (Control)	16.82
G_1 (50 mg l^{-1})	17.99
G_2 (75 mg l^{-1})	18.21
G_3 (100 mg l^{-1})	18.90
G_4 (125 mg l^{-1})	20.89
S.Em±	0.57
C.D. at 5%	1.62
(B) Boron (B)	
B_0 (Control)	16.39
B_1 (0.10%)	18.33
B_2 (0.15%)	18.68
B_3 (0.20%)	20.86
S.Em±	0.51
C.D. at 5%	1.44
(C) Interaction (G x B)	
S.Em±	1.13
C.D. at 5%	NS
C.V. %	10.57

The maximum number of non-wrapping leaves per plant (20.89) were recorded in treatment G_4 (125 mg l^{-1}) which was followed by G_3 (18.90) treatment. The minimum number of non-wrapping leaves (16.82/plant) were recorded under control (G_0) which was at par with G_1 (50 mg l^{-1}) and G_2 (75 mg l^{-1}) treatment. Boron significantly influenced the number of non-wrapping leaves. The maximum number of non-wrapping leaves per plant (20.86) were recorded in treatment B_3 (0.20%) and the minimum number of non-wrapping leaves per plant (16.39) were recorded under control (B_0). However, treatment B_1 (0.10%) and B_2 (0.15%) were at par with each other.

The interaction effect of gibberellic acid and boron for number of non-wrapping leaves per plant were found to be non-significant.

4.1.4 Days taken for head initiation after transplanting

Mean data on days taken for head initiation after transplanting as affected by gibberellic acid and boron treatments alongwith statistical inference are presented in Table 4.3.

The data (Table 4.3) indicated that gibberellic acid significantly influenced the days taken for head initiation after transplanting. The minimum days taken for head initiation (32.41 days) were observed in G_4 (125 mg l^{-1}) treatment which was followed by G_3 (100 mg l^{-1}) and G_2 (75 mg l^{-1}) and the maximum G_0 being (37.08 days) which was at par with G_1 (35.52 days) treatment.

Table 4.3 : Effect of gibberellic acid and boron on days to head initiation and days to head maturity after transplanting of cabbage cv. 'Golden Acre'.

Treatments	Days to head initiation after transplanting (days)	Days to head maturity after transplanting (days)
(A) Gibberellic acid (G)		
G_0 (Control)	37.08	68.51
G_1 (50 mg l^{-1})	35.52	65.63
G_2 (75 mg l^{-1})	34.80	64.32
G_3 (100 mg l^{-1})	34.82	64.33
G_4 (125 mg l^{-1})	32.41	59.89
S.Em±	0.71	1.32
C.D. at 5%	2.04	3.77
(B) Boron (B)		
B_0 (Control)	36.29	67.05
B_1 (0.10%)	35.50	65.00
B_2 (0.15%)	34.95	64.58
B_3 (0.20%)	32.95	60.89
S.Em±	0.63	1.18
C.D. at 5%	1.82	3.37
(C) Interaction (G x B)		
S.Em±	1.43	2.64
C.D. at 5%	NS	NS
C.V. %	7.09	7.09

Boron significantly influenced the days taken for head initiation after transplanting. The minimum days taken for head initiation (32.95 days) were observed in B_3 (0.20%) treatment. The maximum days taken for head initiation (36.29 days) were observed under control (B_0) which was at par with B_1 (0.10%) and B_2 (0.15%) treatments.

The interaction effect of gibberellic acid and boron for days taken for head initiation after transplanting were found to be non-significant.

4.1.5 Days taken for head maturity

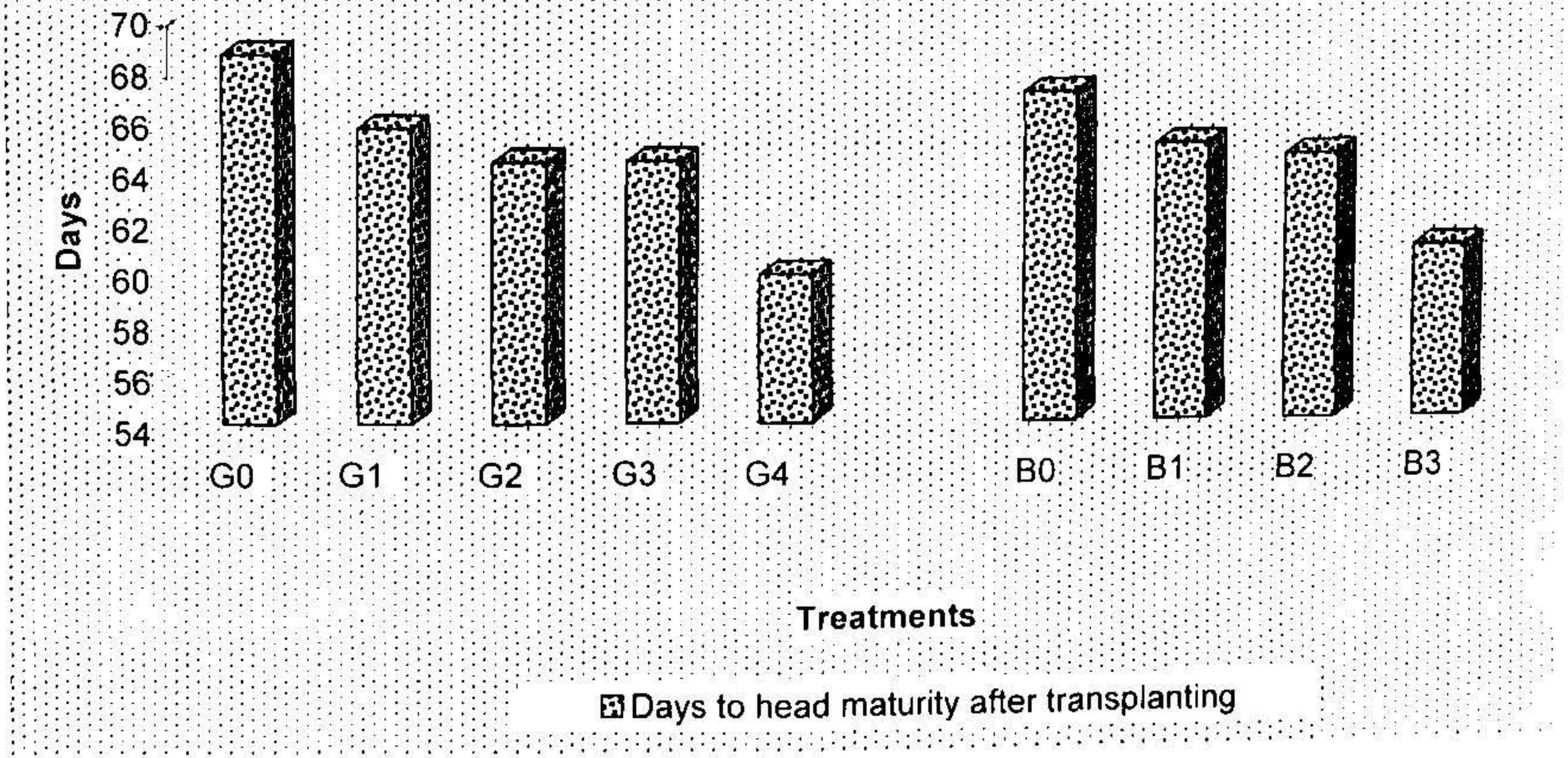
The mean data on days taken for head maturity as affected by gibberellic acid and boron treatments alongwith statistical inference are presented in Table 4.3 and graphically depicted in Fig. 1.

The mean data (Table 4.3) indicated that gibberellic acid significantly influenced the days taken for head maturity. Significantly the minimum days taken for head maturity (59.89 days) were observed in G_4 (125 mg l^{-1}) treatment and the maximum days (68.51) were recorded under control which was at par with G_1 (65.63 days) while, G_3, G_2 and G_1 treatments were at par with each other. Boron significantly influenced the days taken for head maturity. The minimum days taken for head maturity (60.89 days) were observed in B_3 (0.20%) treatment. The maximum days taken for head maturity (67.05 days) were

Table 4.4 : Effect of gibberellic acid and boron on head diameter (cm) of cabbage cv. 'Golden Acre'.

Treatments	Head diameter (cm)
(A) Gibberellic acid (G)	
G_0 (Control)	12.47
G_1 (50 mg l^{-1})	13.76
G_2 (75 mg l^{-1})	13.96
G_3 (100 mg l^{-1})	14.37
G_4 (125 mg l^{-1})	16.00
S.Em±	0.47
C.D. at 5%	1.35
(B) Boron (B)	
B_0 (Control)	13.04
B_1 (0.10%)	14.11
B_2 (0.15%)	14.21
B_3 (0.20%)	15.10
S.Em±	0.42
C.D. at 5%	1.21
(C) Interaction (G x B)	
S.Em±	0.95
C.D. at 5%	NS
C.V. %	11.67

Fig.-1: Effect of gibberellic acid and boron on days to head maturity after transplanting of cabbage cv. 'Golden Acre'



observed under control (B_0) which was at par with B_1 (65.00 days) and B_2 (64.58 days).

The interaction effect of gibberellic acid and boron for days taken for head maturity were found to be non-significant.

4.1.6 Head diameter (cm) /plant

Head diameter was statistically analzyed and are presented in Table 4.4 and graphically in Fig. 2.

A Perusal to the data (Table 4.4) revealed that foliar spray of gibberellic acid at all levels had significant effect on head diameter. The maximum (16.00 cm) head diameter was observed in G_4 (125 mg l^{-1}) treatment. Significantly the minimum head diameter was observed in control (12.47 cm) which was at par with G_1 (13.76 cm) treatment. Boron also significantly influenced the head diameter. Significantly the maximum head diameter (15.10 cm) was observed in B_3 (0.20%) treatment while the minimum was in control i.e. B_0 (13.04 cm) which was at par with B_1 (14.11 cm) and B_2 (14.21 cm).

The interaction effect between gibberellic acid and boron levels on head diameter was found to be non-significant.

4.1.7 Fresh weight of shoot (g)/plant

The data on fresh weight of shoot was statistically analyzed and presented in Table 4.5.

The mean data (Table 4.5) indicated that gibberellic acid significantly influenced the fresh weight of shoot

Table 4.5 : Effect of gibberellic acid and boron on fresh weight of shoot and root of cabbage cv. 'Golden Acre'.

Treatments	Fresh weight of shoot (g)/plant	Fresh weight of root (g)/plant	Shoot/root ratio
(A) Gibberellic acid (G)			
G_0 (Control)	2166.82	30.50	71.13
G_1 (50 mg l^{-1})	2393.62	30.52	78.67
G_2 (75 mg l^{-1})	2476.88	31.01	79.99
G_3 (100 mg l^{-1})	2599.95	32.00	81.65
G_4 (125 mg l^{-1})	2758.35	33.56	82.60
S.Em±	69.24	0.95	2.18
C.D. at 5%	198.22	NS	6.23
(B) Boron (B)			
B_0 (Control)	2351.56	30.79	76.22
B_1 (0.10%)	2455.36	31.51	78.07
B_2 (0.15%)	2499.04	31.42	79.83
B_3 (0.20%)	2610.53	32.33	81.11
S.Em±	61.93	0.85	1.95
C.D. at 5%	177.30	NS	NS
(C) Interaction (G x B)			
S.Em±	138.48	1.90	4.36
C.D. at 5%	NS	NS	NS
C.V. %	9.67	10.45	9.57

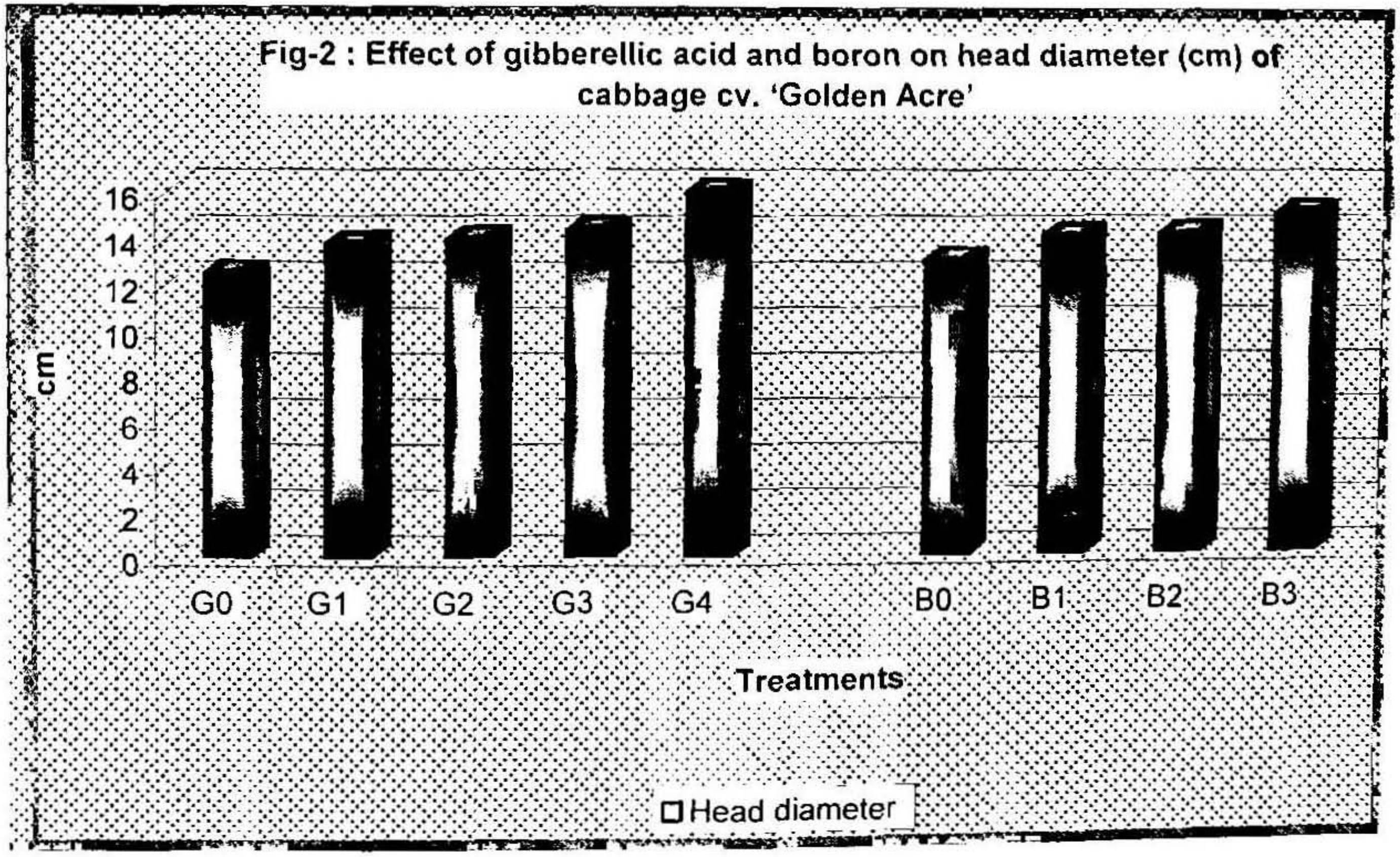


Fig-2 : Effect of gibberellic acid and boron on head diameter (cm) of cabbage cv. 'Golden Acre'
cm
16
14
12
10
8
6
4
2
0
G0
G1
G2
G3
G4
B0
B1
B2
B3
Treatments
Head diameter

Significantly the maximum fresh weight of shoot (2758.35 g) was observed in G_4 (125 mg l^{-1}) treatment which was at par with G_3 (2599.95g). The minimum fresh weight of shoot (2166.82g) was noticed in control (G_0). Boron significantly influenced the fresh weight of shoot. Significantly the maximum fresh weight of shoot (2610.53 g) was noticed in B_3 (0.20%) treatment which was at par with B_2(2499.04g) and the minimum fresh weigh of shoot (2351.56 g) was observed in control (B_0) which was at par with B_1 (2455.36 g) and B_2(2499.04g).

The interaction effect between gibberellic acid and boron levels on fresh weight of shoot was found to be non-significant.

4.1.8 Fresh weight of root (g)/ plant

The fresh weight of root was statistically analyzed and presented in Table 4.5.

A perusal to the data (Table 4.5) revealed that foliar spray of gibberellic acid at all levels had non-significant effect on fresh weight of root. The maximum (33.56 g) fresh weight of root was observed in G_4 (125 mg l^{-1}) followed by G_3 (32.00 g), G_2 (31.01 g) and G_1 (30.52 g). The minimum fresh weight of root observed in control i.e. G_0 (30.50 g). The effect of boron on fresh weight of root was found to be non-significant. The maximum and minimum fresh weight of root was observed in B_3 (32.33 g) and B_0 (30.79 g), respectively.

The interaction effect between gibberellic acid and boron levels on fresh weight of root was found to be non-significant.

4.1.9 Shoot/root ratio

The shoot/root ratio was statistically analyzed and presented Table 4.5.

The mean data (Table 4.5) indicated that gibberellic acid significantly influenced the shoot/root ratio. Significant the maximum shoot/root ratio (82.60) was observed in G_4 (125 mg l^{-1}) treatment which was at par with G_3 (81.65),G_2 (79.99)and G_1 (78.67)and the minimum shoot/root ratio (71.13) was observed in control (G_0). The effect of boron on shoot/root ratio was found to be non-significant. The maximum shoot/root ratio was noticed in B_3 (81.11) and minimum under control (76.22).

The interaction effect between gibberellic acid and boron levels on shoot/root ratio was found to be non-significant.

4.2 Yield and yield attributes

4.2.1 Fresh weight of head (g)

The data on fresh weight of head as affected by gibberellic acid and boron treatment along with statistical inference are presented in Table 4.6 and graphically in Fig. 3.

The mean data (Table 4.6) indicated that gibberellic acid significantly influenced the fresh weight of head. Significantly the maximum fresh weight of head (1466.48 g) was

observed in G_4 (125 mg l^{-1}) treatment. Significantly the minimum fresh weight of head (1155.52 g) was noticed in control (G_0). However, treatment G_3, G_2 and G_1 were at par with each other. Boron significantly influenced the fresh weight of head. The maximum fresh weight of head (1404.66g) was recorded in B_3 (0.20%) treatment which was at par with B_2 (1320.52 g) and B_1 (1311.25 g) treatment and the minimum fresh weight of head (1155.52 g) was noted in control (B_0) which was at par with B_1 and B_2 treatments.

The interaction effect between gibberellic acid and boron levels on fresh weight of head was also found to be non-significant.

4.2.2 Volume of head (ml)

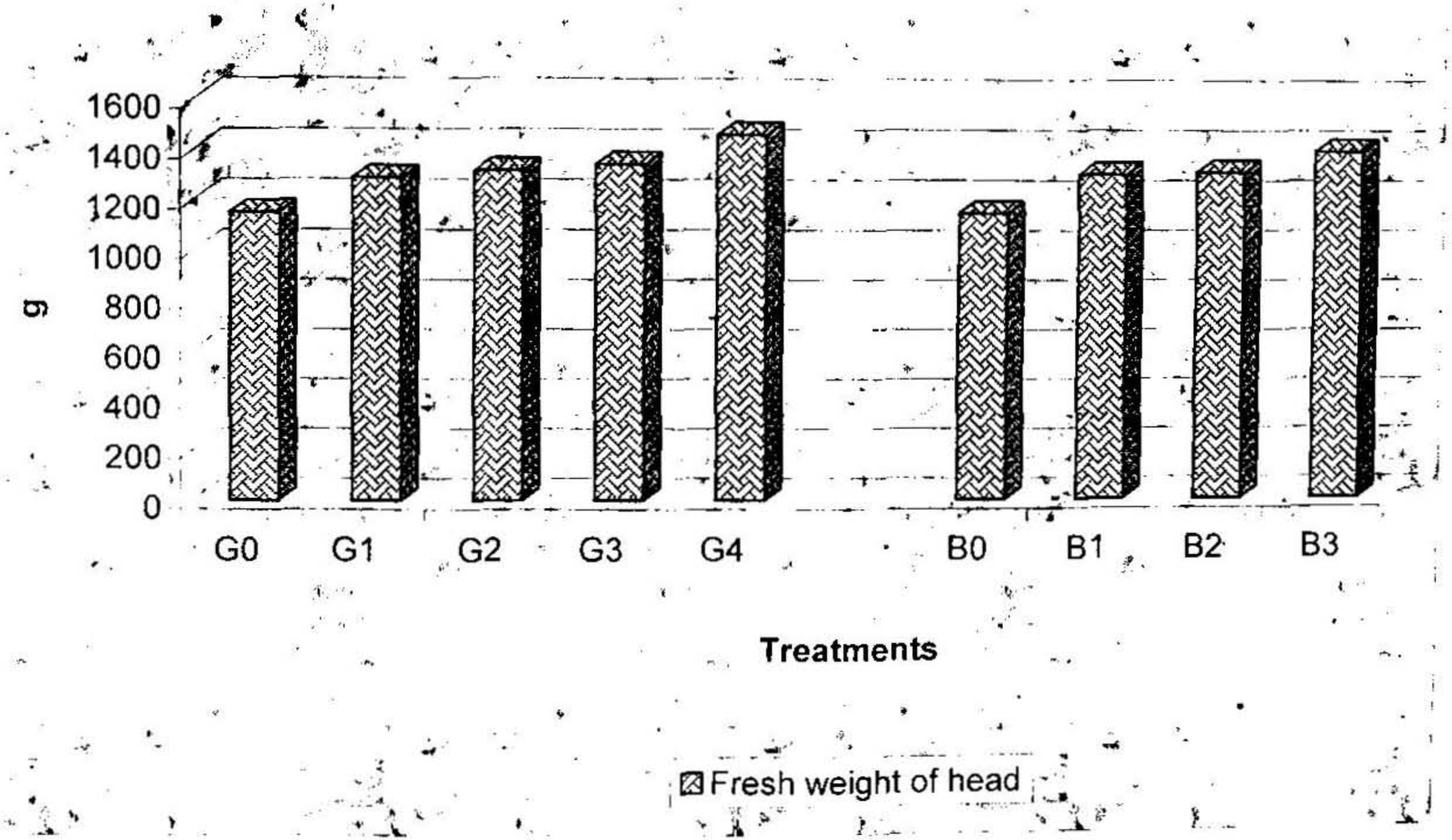
The volume of head was statistically analysed and is presented in Table 4.6.

The mean data (Table 4.6) indicated that gibberellic acid significantly influenced the volume of head. Significantly the maximum volume of head (1311.29 ml) was observed in G_4 (125 mg l^{-1}) treatment. Significantly the minimum volume of head (1013.93 ml) was noted in control (G_0). However, treatment G_3, G_2 and G_1 were at par with each other. Boron significantly influenced volume of head. Significantly the maximum volume of head (1268.96 ml) was recorded in B_3 (0.20%) treatment and the minimum volume of head (1094.96 ml) was observed in control (B_0) which was at par with B_1 (1158.74 ml) and B_2 (1166.81 ml) treatment.

Table 4.6 : Effect of gibberellic acid and boron on yield and yield attributes of cabbage cv. 'Golden Acre'.

Treatments	Fresh weight of head (g)/plant	Volume of head (ml)plant	Yield (q/ha)
(A) Gibberellic acid (G)			
G_0 (Control)	1155.52	1013.93	236.88
G_1 (50 mg l^{-1})	1294.79	1155.91	261.46
G_2 (75 mg l^{-1})	1323.43	1172.99	265.32
G_3 (100 mg l^{-1})	1349.69	1207.71	273.17
G_4 (125 mg l^{-1})	1466.48	1311.29	304.14
S.Em±	39.87	36.17	9.03
C.D. at 5%	113.93	103.37	25.83
(B) Boron (B)			
B_0 (Control)	1155.52	1094.96	247.67
B_1 (0.10%)	1311.25	1158.74	268.13
B_2 (0.15%)	1320.52	1166.81	269.95
B_3 (0.20%)	1404.66	1268.96	287.02
S.Em±	35.66	32.35	8.08
C.D. at 5%	101.91	92.46	23.10
(C) Interaction (G x B)			
S.Em±	79.74	72.34	18.07
C.D. at 5%	NS	NS	NS
C.V. %	10.47	10.68	11.67

Fig-3 : Effect of gibberellic acid and boron on yield and yield attributes of cabbage cv. 'Golden Acre'



The interaction effect between gibberellic acid and boron levels on volume of head was also fund to be non-significant.

4.2.3 Yield (q/ha)

Calculated yield per hectare was statistically analyzed and are presented in Table 4.6 and graphically depicted in Fig. 4.

The data illustrated in Table 4.6 showed that different levels of gibberellic acid significantly influenced yield per hectare. The maximum yield (304.14 q/ha) was recorded in G_4 (125 mg l^{-1}) treatment. The minimum yield (236.88 q/ha) was recorded under control (G_0) which was at par with G_1 (261.46 q/ha) treatment. However, treatment G_3 (273.17 q/ha), G_2 (265.32 q/ha) and G_1 (261.46 q/ha) were at par with each other. Boron significantly influenced yield per hectare. The maximum yield (287.02 q/ha) was recorded in B_3 (0.20%) treatment which was at par with B_2 (0.15%) and B_1 (0.10%). The minimum yield (247.67 q/ha) was recorded under control (B_0) which was at par with B_1 (268.13 q/ha) and B_2 (269.95 q/ha).

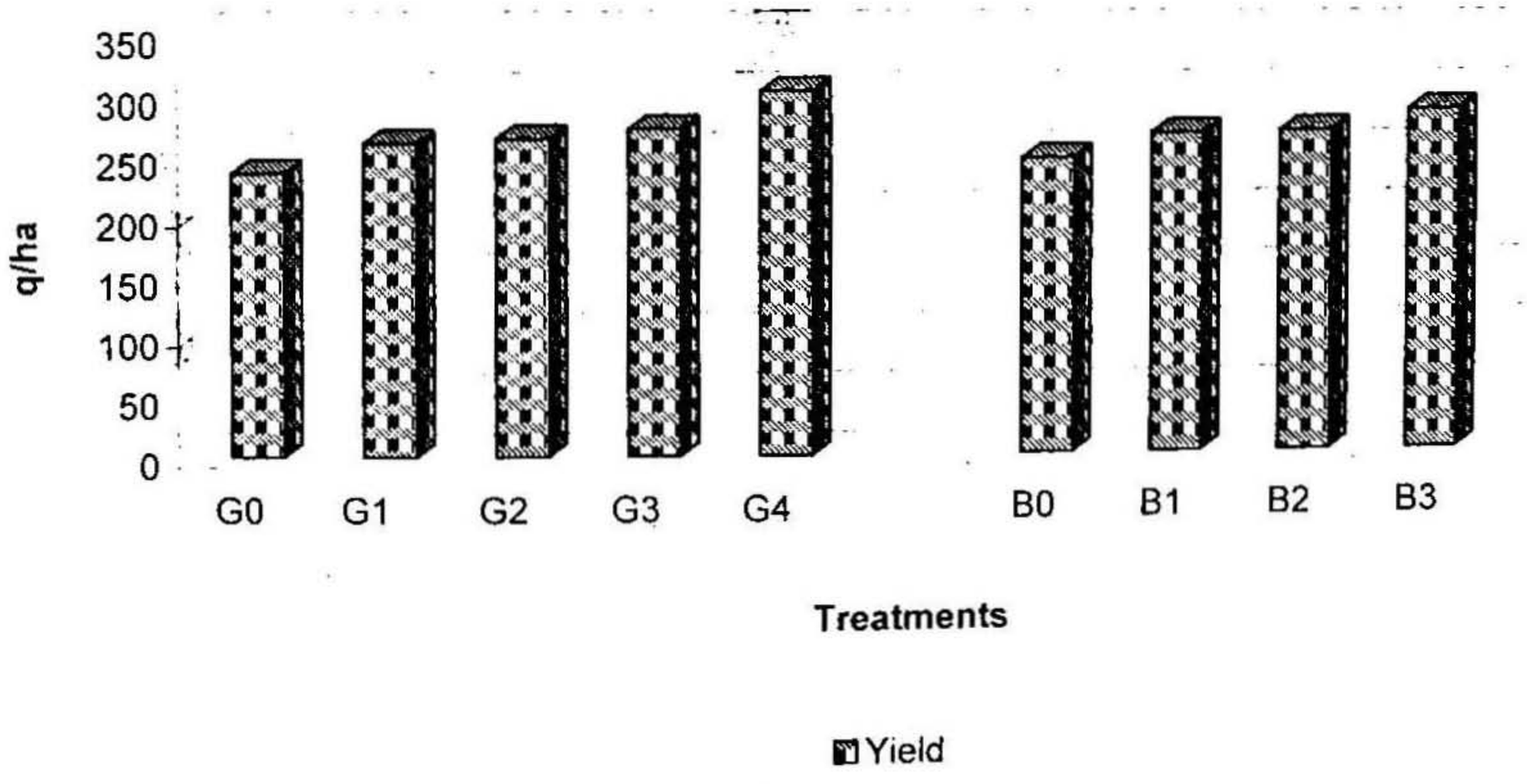
The interaction effect of gibberellic acid and boron yield per hectare were found to be non-significant.

4.3 Quality characters

4.3.1 Total soluble solids (%)

The data on total soluble solids was statistically analyzed and presented in Table 4.7.

Fig.-4: Effect of gibberellic acid and boron on yield (q/ha) of cabbage cv. 'Golden Acre'



The data illustrated in Table 4.7 showed that different levels of gibberellic acid significantly influenced TSS (%). The maximum TSS (8.42%) was observed in G_4 (125 mg l^{-1}) treatment which was at par with G_3 (7.91%) treatment. The minimum TSS (7.44%) was recorded under control (G_0) which was at par with G_1 (7.53%), G_2 (7.66%) and G_3 (7.91%) treatment. The effect of boron on TSS was found to be non-significant. The maximum and minimum TSS was observed B_3 (8.02%) and B_0 (7.62%), respectively.

The interaction effect of gibberellic acid and boron levels on TSS were found to be non-significant.

4.3.2 Compactness of head (%)

Compactness of head was statistically analyzed and are presented in Table 4.7

The data illustrated in Table 4.7 showed that different levels of gibberellic acid significantly influenced compactness of head. Significantly the maximum compactness of head (63.75%) was observed in G_4 (125 mg l^{-1}) treatment. Significantly the minimum compactness of head (50.23%) was observed under control (G_0). However, treatment G_1 (56.29%), G_2 (57.54%) and G_3 (58.68%) were at par with each other. Boron significantly influenced the compactness of head. Significantly the maximum compactness of head (61.06%) in B_3 (0.20%) treatment which was at par with B_2 (57.41%) and B_1 (57.41%) treatment. Significantly

Table 4.7 : Effect of gibberellic acid and boron on quality of cabbage cv. 'Golden Acre'.

Treatments	T.S.S. (%)	Compactness of head / plant(%)
(A) Gibberellic acid (G)		
G_0 (Control)	7.44	50.23
G_1 (50 mg l^{-1})	7.53	56.29
G_2 (75 mg l^{-1})	7.66	57.54
G_3 (100 mg l^{-1})	7.91	58.68
G_4 (125 mg l^{-1})	8.42	63.75
S.Em±	0.25	1.73
C.D. at 5%	0.71	4.95
(B) Boron (B)		
B_0 (Control)	7.62	53.71
B_1 (0.10%)	7.74	57.41
B_2 (0.15%)	7.79	57.41
B_3 (0.20%)	8.02	61.06
S.Em±	0.22	1.55
C.D. at 5%	NS	4.43
(C) Interaction (G x B)		
S.Em±	0.50	3.47
C.D. at 5%	NS	NS
C.V. %	11.12	10.48

the minimum compactness of head (53.71%) was observed under control (B_0) which was at par with B_1 and B_2.

The interaction effect of gibberellic acid and boron levels for compactness of head were found to be non-significant.

4.4 Economics

The details of gross income, expenditure considering cost of all chemicals, net return and cost benefit ratio under different treatments is presented in Table 4.8.

Foliar spray of gibberellic acid at 125 mg l^{-1} gave the maximum net gain of Rs. 101011 but, cost benefit ratio was maximum in 50 mg l^{-1} GA (1:5.53). In case of boron 0.20 per cent gave the maximum net gain of Rs. 101689.40 with cost benefit ratio 1:7.75.

Table 4.8 : Details of net realization (Rs/ha) for evaluation of gibberellic acid and boron

Treatments	Yield (q/ha)	Gross realization (Rs/ha)	Cost of cultivation (Rs/ha)	Net realization (Rs/ha)	CBR
(A) Gibberellic acid (G)					
G_0 (Control)	236.88	71064	12945.00	58119.00	1:4.49
G_1 (50 mg l^{-1})	261.46	104584	16025.00	88559.00	1:5.53
G_2 (75 mg l^{-1})	265.32	106128	17565.00	88563.00	1:5.04
G_3 (100 mg l^{-1})	273.17	109268	19105.00	90163.00	1:4.72
G_4 (125 mg l^{-1})	304.14	121656	20645.00	101011.00	1:4.89
(B) Boron (B)					
B_0 (Control)	247.67	74301	12945.00	61356.00	1:4.74
B_1 (0.10%)	268.13	107252	13031.80	94220.20	1:7.23
B_2 (0.15%)	269.95	107980	13075.20	94904.80	1:7.26
B_3 (0.20%)	287.02	114808	13118.60	101689.40	1:7.75

Rate of inputs

GA_3 : 120 Rs/g Boron : 250 Rs/kg

Selling price

Control : 300 Rs/q Others : 400 Rs/q

Plate-1

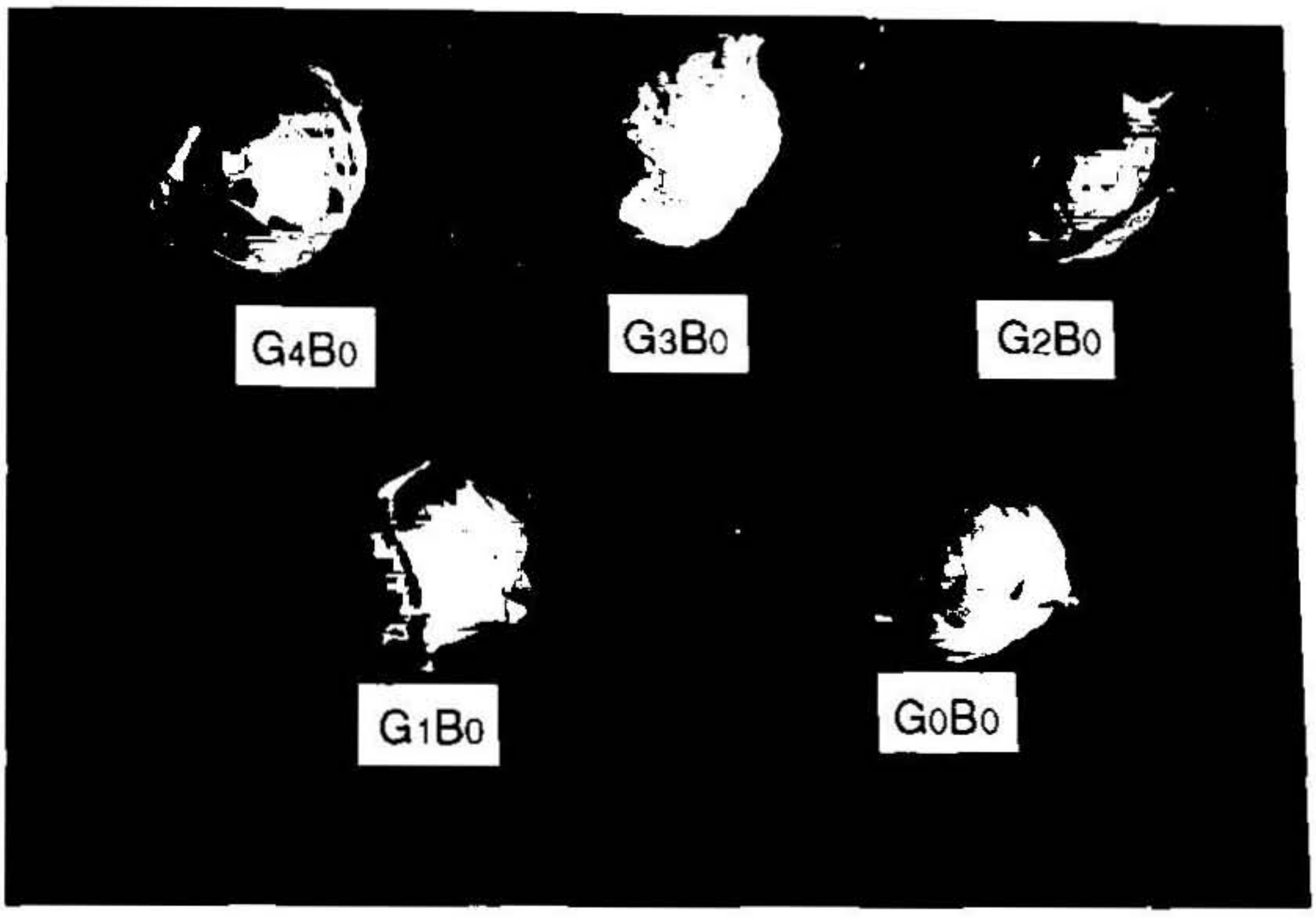


Plate-1-2 : Showing the effect of various treatment combinations (Gibberellic acid x Boron) on head diameter

Plate-2

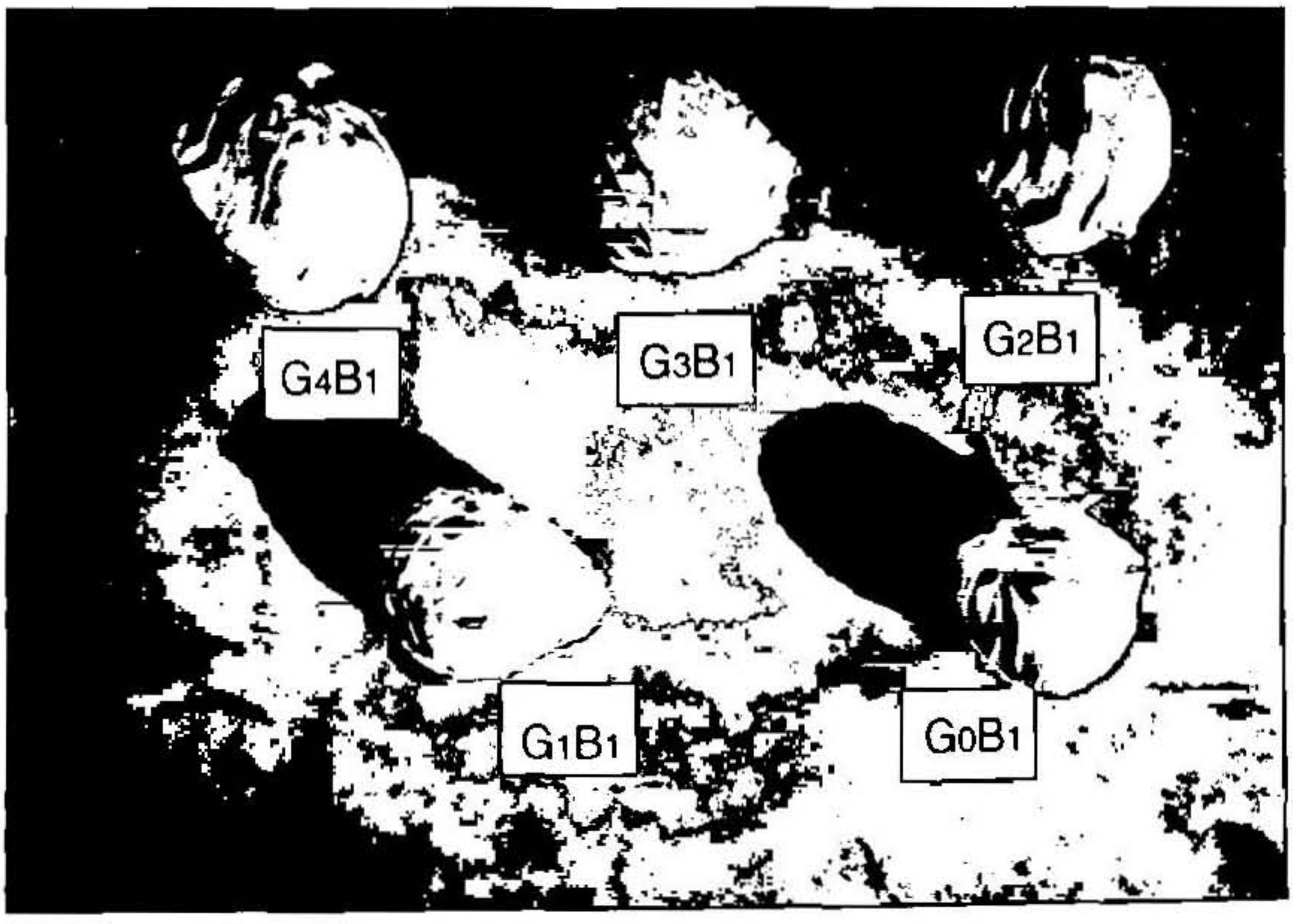


Plate-3

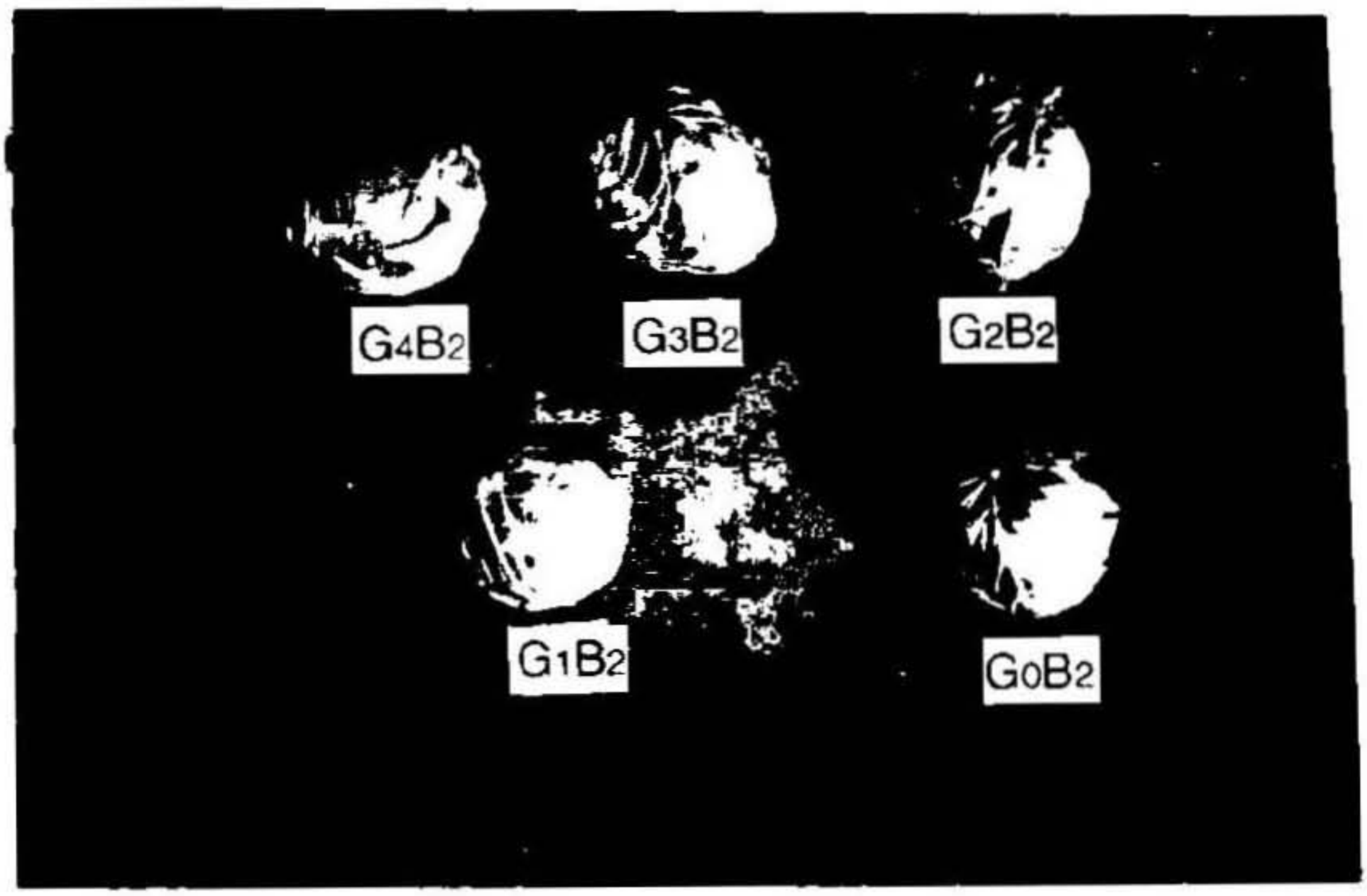


Plate-3. : Showing the effect of various treatment combinations (Gibberellic acid x Boron) on head diameter

DISCUSSION

V. DISCUSSION

An effort has been made in this chapter to discuss critically the important findings of the present study on the "Effect of foliar sprays of Gibberellic acid and Boron on growth, yield and quality of cabbage (*Brassica oleracea* var. *Capitata* L.) cv. Golden Acre" alongwith probable reasons for the treatment behaviour. The discussion, for the sake of convenience, has been made under the following headings.

5.1 Effect on vegetative growth characters

5.2 Effect on yield and yield attributes

5.3 Effect on quality characters

5.4 Effect on economics

5.1 Effect on vegetative growth characters

5.1.1 Height of plant, plant spread and number of non-wrapping leaves per plant

5.1.1.1 Effect of gibberellic acid

In the present investigation results revealed that foliar application of different concentrations of gibberellic acid significantly increased all the growth parameters viz. height of plant, plant spread and number of non-wrapping leaves per plant at harvest. Significantly gibberellic acid treatment G_4 (125 mgl^{-1}) was found to be the best in respect to rest of treatments.

The possible reason for increase in vegetative growth characters might be due to increased osmotic uptake of water and nutrients under the influence of gibberellic acid which would have maintained a constant swelling force against softening of cell walls. (Feucht and Watson, 1958). Gibberellic acid promotes vegetative growth by way of cell division and cell elongation.

The increase in number of unfolded leaves per plant and plant spread might be due to the activity of gibberellic acid at the apical meristem resulting in more nucleoprotien synthesis responsible to increasing leaf initiation and expansion (Simao *et al.*, 1960). The results are in the conformation with the findings of Sengupta and Malik (1981), Mishra and Singh (1984), Muthoo *et al.* (1987) in cauliflower Mehrotra *et al.* (1970), Protsko and Goldban (1973) and Wu *et al.* (1983) in tomato; Chhonkar and Sengupta (1972) in cabbage; Prasad and Chaturvedi (1973) in khol rabi; Durnam and Jones (1982) in lettuce; Mishriky (1984) in celery and Shaheen and El-sayed (1984) in squash.

5.1.1.2 Effect of boron

In present investigation increasing concentration of boron significantly increased vegetative growth characters, , but B_3 treatment (0.20%) was found to be the best in respect to rest of the treatments. This increase in vegetative growth of cabbage plant may be attributed due to physiological role of boron and its involvement in the nitrogen and protein metabolism, synthesis of pectin, in maintaining the correct water relation with in the plant.

resynthesis of adenosine tri-phosphate (ATP) and in the translocation of sugar. Similar, findings were reported by Shelp and Shattuck (1987), Ghosh and Hasan (1997) in cauliflower; Ashour and Fouly (1970) and Verma *et al.* (1973) in tomato; Singh and Randhawa (1970) in muskmelon; Maurya and Lal (1975), Baghel and Sarnaik (1988), Mukhopadhyay and Chattopadhyay (1999) in onion and Maurya *et al.* (1977) in radish.

5.1.1.3 Effect of interaction

In present investigation, the results revealed that the combined effect of gibberellic acid and boron treatment combination with respect to vegetative growth parameters were found to be non-significant

5.1.2 Days taken for head initiation and complete maturity of head

5.1.2.1 Effect of gibberellic acid

The results of the present studies in preceding chapter revealed that foliar application of different concentrations of gibberellic acid had significant effect on days to head formation and complete maturity of head. The minimum days required from transplanting to start of head formation were observed in G_4 (125 mg l^{-1}) treatment, whereas maximum days were required in control. Likewise, the minimum days required for complete maturity of head were in observed in G_4 treatment (125 mg l^{-1}) and maximum days were recorded in control.

The reduction in time taken for complete maturity of head by GA_3 treatment may be due to accelerated nutrient transport from root to the aerial parts resulting in better growth of the plant. Thus, enhancing the accumulation of food material into head (Denisova and Lupinovich, 1962). The other possible reason might be an increased rate of photosynthesis and rapid translocation and photosynthates towards the head by gibberellic acid treatment (Alvin, 1960). Suggestion of North (1958) that auxin activity of leaves which is enhanced by GA_3 application leads to early heading in cabbage also supported the present findings. Similar, findings were also reported by Chhonkar and Sengupta (1972) in cabbage, Booij (1989) in cauliflower, Stambera (1984) in lettuce and Verzilov and Mihetleva (1968) in tomato.

5.1.2.2 Effect of boron

The foliar application of boron had significantly affected the days taken for head formation and complete maturity of head. The results revealed that the minimum days required from transplanting to initiation of head formation were observed in B_3 (0.20%) treatment and maximum days were noticed under control.

Likewise, the minimum days for complete maturity of head were observed in B_3 (0.20%) treatment and maximum days were recorded in control.

The advance head formation and maturity of head might be due to the physiological role of boron and rapid translocation of photosynthates toward the head which might have developed advanced head. The results were in closed findings of Park and Song (1965) in Chinese cabbage; Chakraborty (1976) and Shelp and Shattuck (1987) in cauliflower; Ashour and Fouly (1970) in tomato.

5.1.2.3 Effect of interaction

The results of present investigation revealed that combined effect of gibberellic acid on boron and days taken for head formation and complete maturity of head were found to be non-significant.

5.1.3 Diameter of head

5.1.3.1 Effect of gibberellic acid

The results revealed that the foliar application of gibberellic acid significantly affected the diameter of head. In present studies maximum diameter was noticed under G_4 treatment (125 mg l^{-1}) and the minimum diameter was observed in control.

The increased in head diameter may be due to profound effect of gibberellic acid on cell division, cell elongation and cambial activity. Another possible reason might be because of large accumulation of carbohydrates owing to better photosynthesis by the plant (Alvin, 1960) resulting in greater

diameter. The positive effect of gibberellic acid spray in increasing diameter, in the present investigation, is in conformity with the findings of Chauhan and Singh (1970) in cabbage; Sengupta and Malik (1981) and Muthoo *et al.* (1987) in cauliflower and Mishriky (1984) in celery.

5.1.3.2 Effect of boron

The foliar application of boron had significantly increased the diameter of head. The maximum diameter of head was observed in B_3 (0.20%) treatment, while minimum diameter was noticed under control.

Such increased in diameter of head as a result of foliar application of boron might be attributed to better vegetative growth of boron treated plant as compared to control. Another reason is that boron play an important role in nitrogen metabolism which increase the growth characteristics. The present findings are in agreement with the results obtained by Takano *et al.* (1960) in Chinese cabbage; Mehrotra *et al.* (1975), Prasad and Singh (1988) and Panigrahi *et al.* (1990) in cauliflower; Ashour and Fouly (1970) in tomato; Singh and Randhawa (1970) in muskmelon and Baghel and Sarnaik (1988) in onion.

5.1.3.3 Effect of interaction

The results revealed that interaction between gibberellic acid and boron with respect to diameter of head was found to be non-significant.

5.1.4 Fresh weight of shoot and root per plant

5.1.4.2 Effect of gibberellic acid

The results in preceding chapter revealed that application of different concentrations of gibberellic acid significantly increased the fresh weight of shoot. The maximum fresh weight of shoot was observed under G_4 (125 mg l^{-1}) treatment, while minimum fresh weight was noticed in control. The possible explanation for the increased in fresh weight of shoot by foliar application of gibberellic acid may be that GA_3 improves the rate of photosynthesis and increase the accumulation of photosynthates (Alvin, 1960). The present findings can be supported by the work of Badawi and Sahhar (1980) in cabbage; Muthoo *et al.* (1987) in cauliflower and Prasad and Chaturvedi (1973) in Knol- Khol.

The fresh weight roots had non-significant effect at all concentration of gibberellic acid.

5.1.4.3 Effect of boron

The application of boron significantly increased the fresh weight of shoot over all the treatments, but B_3 (0.20%) treatment was found to be best. The possible explanation for the increase in head weight by boron treatment may be due to its physiological role in nitrogen metabolism which results in more vegetative growth of plant. The another reason might be due to that boron plays an important role in which reaction in cells and

regulate the intake of water into cell which results in better translocation of nutrients from root to shoot.

However, in present investigation application of boron had no significant effect on fresh weight of root.

This findings are in close agreement with those of Alexender (1960), Mehrotra *et al.*, (1975), Chakraborty (1976), Shelp and Shattuck (1987), Prasad and Singh (1988) and Panigrahi *et al.* (1990) in cauliflower.

5.1.4.4 Effect of interaction

The results revealed that the interaction effect between gibberellic acid and boron treatment combinations with respect to fresh weight of shoot and root were found to be non-significant.

5.1.5 Effect of shoot root ratio

5.1.5.1 Effect of gibberellic acid

In present investigation all the concentrations of gibberellic acid application significantly increased the shoot root ratio, but the maximum shoot root ratio was found under G_4 (125 mg l^{-1}) treatment, while minimum was noted under control.

5.1.5.2 Effect of boron

In the present investigation boron application had shown non-significant effect on shoot root ratio.

5.1.5.3 Effect of interaction

The results revealed that the interaction effect between gibberellic acid and boron treatment combination with respect to shoot root ratio of plants were found to be non-significant.

5.2 Yield characters

5.2.1 Fresh weight of head

5.2.1.1 Effect of gibberellic acid

A perusal of data presented in the preceding chapter showed that foliar application of gibberellic acid had significant effect on fresh weight of head per plant.

In the present investigation foliar spray of gibberellic acid G_4 (125 mg l^{-1}) showed maximum fresh weight of head, while minimum was observed in control. The possible explanation for the increase in head weight by gibberellic acid treatment might be due to rapid and better nutrient transports form roots to the aerial parts of the plant. (Denisova and Lupinovich, 1962). Another reason might be that gibberellic acid improves the ratio of photosynthesis and increase the accumualtion of photosynthates (Alvin, 1960 and Zhong and Kato, 1988). The present findings can be supported by the work at Chhonkar and Singh (1963), Badawi and Sahhar (1980) in cabbage; Prasad and Chaturvedi (1973) in Khol-Khol; Singh and Saimbhi (1968) in Chinese cabbage; Wu *et al.* (1983) and Bugibee and White (1984) in tomato; Shaheen and El-Sayed (1984) in squash; El-Queshi *et*

al. (1988) in spinach; Mishriky *et al.* (1988) in pea and Muthoo *et al.* (1987) in cauliflower.

5.2.1.2 Effect of boron

A perusal of the data showed that boron had significant effect on fresh weight of head in present studies. The maximum fresh weight of head was found in G_4 (125 mg l^{-1}) treatment and minimum was noticed under control.

The increase in fresh weight may due to its physiological role in nitrogen metabolism which enhance the growth of leaves. The another reason may be due to that boron tends to keep calcium in soluble form within the plant, which is an essential constituents of cell wall. The increase in fresh weight of head per plant by boron treatment was also supported by Mehrotra *et al.* (1975), Shelp and Shattuck (1987), Prasad and Singh (1988) and Ghosh and Hasan (1997) in cauliflower; Jurkevic (1963) and Ashour and Fouly (1970) in tomato; Maurya and Lal (1975) and Baghel and Sarnaik (1988) in onion.

5.2.1.3 Effect of interaction

The combined effect of gibberellic acid and boron on fresh weight of head were found to be non-significant.

5.2.2 Volume of head

5.2.2.1 Effect of gibberellic acid

In present investigation the volume of head was significantly increased by the foliar application of gibberellic

acid at all concentrations. The maximum volume was recorded in G_4 (125 mg l^{-1}) treatment, while the minimum was observed under control.

The probable reason for the increase in head weight and diameter as discussed earlier in this chapter. The present findings are also in conformity with those of Badawi and Sahhar (1980), Chauhan and Singh (1970) in cabbage; Muthoo *et al.* (1987), Mishriky *et al.* (1988) and Booij (1989) in cauliflower and Durnam and Jones (1982) in lettuce.

5.2.2.2 Effect of boron

The volume of head was significantly increased by the foliar spray of different concentrations of boron. All the levels of boron had significantly increased the volume of head over control as the concentration of boron was increased, but B_3 (0.20%) had found to be best over rest of treatments.

The probable reason for the increase in volume of head might be due to the increase of head weight and diameter discussed earlier in this chapter. The present findings are in the conformity with those of Mehrotra *et al.* (1975), Shelp and Shattuck (1987), Prasad and Singh (1988), Panigrahi *et al.* (1990), Ghosh and Hasan (1997) and Kotur (1997) in cauliflower

5.2.2.3 Effect of interaction

A perusal of the related data showed that combined effect of gibberellic acid and boron had non-significant effect on volume of head.

5.2.3 Yield (q/ha)

5.2.3.1 Effect of gibberellic acid

In present studies revealed that folair application of gibberellic acid had significant effect on head yield. The maximum head yield was recorded in G_4 (125 mg l^{-1}) treatment which was significantly higher than other treatments and control. The higher yield in gibberellic acid treated plants may be due to greater phloem activity of the plant leading to a greater accumulation of carbohydrates resulting in maximum weight of head. The increase in head weight was ultimately responsible for greater yield of head per hectare. These findings are in close conformity with Chhonkar and Singh (1963) in cabbage; Singh and Saimbhi (1968) in Chinese cabbage; Paul and Kedar (1980-81) in cauliflower; Prasad and Chaturvedi (1973) in Khol-Khol; Verzilov and Mihetleva (1968), Nair *et al.* (1974) and El-Asdoudi and Ouf (1993) in tomato and Maurya and Lal (1987) in onion.

5.2.3.2 Effect of boron

The results on yield of head per hectare suggest that the foliar spray of boron at different concentrations significantly increased the yield of heads/ha. The maximum yield was recorded in B_3 treatment (0.20%) as compared to minimum in control. The increased in yield might be due to increased in the size and weight of head by foliar spray of boron as discussed earlier in this chapter. Similar increase in yield of cabbage due to foliar

spray of boron was reported by Alekseeva and Kanjazeva (1968), Shelp and Shattuck (1987) and Sharma and Sharma (1999).

Similar results were also observed by Mehrotra *et al.* (1975), Chakraborty (1976), Mishra and Singh (1984), Prasad and Singh (1988), Kotur and Kumar (1989), Ghosh and Hasan (1997) and Sharma and Sharma (1999) in cauliflower.

5.2.3.3 Effect of interaction

The combined effect of different concentrations of gibberellic acid and boron was found to be non-significant.

5.3 Quality characters

5.3.1 Total soluble solids content (%)

5.3.1.1 Effect of gibberellic acid

The data presented in the preceding chapter shows that foliar application of gibberellic acid at different concentrations had significant effect. The maximum increase in TSS (%) was recorded in G_4 (125 mg l^{-1}) treatment, while the minimum TSS (%) was noticed under control.

5.3.1.2 Effect of boron

In present investigation, the data revealed that the foliar application of boron at different concentration had non-significant effect on TSS (%) in head .

5.3.1.3 Effect of interaction

The combined effect of gibberellic acid and boron had non-significant effect on TSS (%) in head.

5.3.2 Compactness

5.3.2.1 Effect of gibberellic acid

5.3.1.1 Effect of gibberellic acid

The compactness of head was significantly influenced by different concentrations of gibberellic acid spray. The maximum compactness was recorded in G_4 treatment (125 mg l^{-1}) while minimum compactness was observed in G_0 treatment (control).

The studies revealed that the foliar application of gibberellic acid significantly increased the compactness of head, while the heads in control were found to be less compact. The probable reason for increase in compactness of head might be due to increase in head size and diameter which results in increase in compactness.

5.3.1.2 Effect of boron

The foliar spray of boron at different concentrations had significant effect on compactness of head. The maximum compactness of head was recorded in B_3 treatment (0.20%), while minimum compactness was observed in (Control) indicating that

foliar application of boron at higher levels significantly increased compactness of head. The probable reason might be due to increase in size and volume of head which results increase in compactness.

5.3.1.3 Effect of interaction

In present investigation the results revealed that the combined effect of gibberellic acid and boron treatment combinations with respect to head compactness were found to be non-significant.

5.4 Economics

Looking to the different treatment of GA and boron, cost benefit ratio (CBR) was observed to be the maximum (1:7.75) under foliar spray of boron at 0.2 per cent with the net gain at Rs. 101689.40. In case of gibberellic acid G_4 at 125 mg l^{-1} gave net gain of Rs. 101011 but CBR was maximum in G_1 at 50 mg l^{-1} (1:5.53) with net gain of Rs. 88559.

In present investigation, the production was higher at G_4 125 mg l^{-1}, and boron at 0.20 per cent, consequently these treatments gave higher gross realization.

SUMMARY AND CONCLUSIONS

VI. SUMMARY AND CONCLUSION

The present investigation on "Effect of foliar sprays of gibberellic acid and boron on growth, yield and quality of cabbage (*Brassica oleracea* var. *Capitata* L.) cv. Golden Acre" was conducted at Regional Horticultural Research Station, Block-E, Plot No.-1, Navsari Agricultural University, Navsari during the year 2003-04. The experiment was laid out in factorial randomized block design (FRBD) with twenty treatments viz., gibberellic acid G_0 (0), G_1 (50 mg l^{-1}), G_2 (75 mg l^{-1}), G_3 (100 mg l^{-1}), G_4 (125 mg l^{-1}), and Boron B_0 (0.0%), B_1 (0.10%), B_2 (0.15%), B_3 (0.20%).

The salient features of the results obtained are epitomized below :

6.1 Effect of gibberellic acid

1. Plant height, plant spread and number of non-wrapping leaves were significantly influenced by different level of gibberellic acid. Significantly the maximum plant height, plant spread and number of non-wrapping leaves were observed in G_4 125 mg l^{-1} (30.82 cm, 2372.10 cm^2 20.89 leaves, respectively).

2. Significantly the minimum days required for head initiation and maturity of head were observed in G_4 (32.41 days and 59.89 days, respectively).

3. Gibberellic acid significantly influenced the head diameter. The maximum head diameter was observed in GA_4 (16.00 cm), while minimum under control (12.47 cm).

4. Fresh weight of shoot and shoot/root ratio were significantly influenced by the foliar application of gibberellic acid. Both were maximum in 125 mg l^{-1} (2758.35g and 82.60 %, respectively). While, fresh weight of root was non-significant with different gibberellic acid treatment.

5. Yield and yield attributes were significantly influenced by the foliar spray of gibberellic acid. The maximum fresh weight of head, volume of head and yield were observed under G_4 i.e. 125 mg l^{-1} (1466.48 g, 1311.29 ml and 304.14 q/ha, respectively).

6. Quality characters were also significantly influenced by different level of gibberellic acid. The maximum TSS (8.42%) and compactness of head (63.75%) were observed in G_4 (125 mg l^{-1}).

7. The maximum net realization of Rs. 101011.00 per ha. was obtained with 125 mg l^{-1} gibberellic acid (G_4), but cost benefit ratio was maximum in G_1 (1:5.53).

6.2 Effect of boron

1. Plant height, plant spread and number of non-wrapping leaves were significantly influenced by different level of

boron. The maximum plant height, plant spread and number of non-wrapping leaves were observed in B_3 0.20 per cent (29.95 cm, 2364.10 cm^2 and 20.68 leaves, respectively).

2. Significantly the minimum days required for head initiation and maturity of head after transplanting were observed in B_3 (32.95 days and 60.89 days, respectively).

3. Boron levels significantly influenced the head diameter. The maximum head diameter was observed in B_3 (15.10cm) while, minimum in B_0 i.e. control (13.04 cm).

4. Fresh weight of shoot was significantly influenced by different levels of boron. The maximum fresh weight of shoot (2386.71 g) was observed in B_3 (0.20%). Fresh weight of root and shoot/root ratio were non-significant with different levels of boron.

5. Yield and yield attributes were significantly influenced by the foliar sprays of boron. Significantly, the maximum fresh weight of head (1404.68 g), volume of head (1268.96 ml) and yield (287.02 q/ha) were observed under B_3 (0.20%).

6. Compactness of head was significantly influenced by different levels of boron. The maximum compactness (61.05%) was observed in B_3 (0.20%). TSS (%) was non-significant with foliar spray of different levels of boron.

7. The highest net realization of Rs. 101689.40 per ha and cost benefit ratio (1:7.75) was obtained with 0.20 % boron (B_3).

CONCLUSION

From the above summarized experimental results, it can be concluded that under south Gujarat agroclimatic condition, the maximum yield of cabbage (*Brassica oleracea* var. *Capitata* L.) cv. 'Golden Acre' could be obtained by foliar spray of gibberellic acid (125 mg l^{-1}) and boron (0.2%) individually.

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*Original not seen

APPENDICES

Appendix-I: Mean weekly meteorological data recorded at the meteorological observatory of Navsari Agricultural University, Navsari during the course of investigation

Month	Standard week	Dates	Temperature (°C)		Relative humidity (%)		Sunshine (hr.)
			Max.	Min.	Max.	Min.	
Oct. 2003	40	1-7	33.1	24.1	90	53	8.2
	41	8-14	34.4	25.4	89	57	8.0
	42	15-21	35.4	21.7	86	39	9.7
	43	22-28	35.3	18.4	75	36	9.6
	44	29-4	35.2	21.8	75	42	9.8
Nov. 2003	45	5-11	34.6	19.7	84	37	9.5
	46	12-18	33.3	19.2	81	40	9.3
	47	19-25	32.6	19.2	86	60	8.3
	48	26-2	32.0	18.8	89	59	8.9
Dec. 2003	49	3-9	32.8	16.4	89	49	8.6
	50	10-16	32.0	15.5	83	41	8.8
	51	17-23	29.7	13.7	82	34	8.5
	52	24-31	28.8	13.9	86	42	9.0
Jan., 2004	1	1-7	28.0	15.8	65	36	8.4
	2	8-14	30.9	15.4	71	37	8.5
	3	15-21	31.6	15.3	55	25	9.8
	4	22-28	31.8	13.4	81	27	9.2
	5	29-4	30.2	13.5	81	40	9.4

CERTIFICATE

This is to certify that I have no objection to supply one copy of any part of this thesis at a time to any scientist through reprographic process, if necessary for rendering reference service in a library or documentation centre.

Place : Navsari.

Date : 8th October, 2004

(Rajendra Singh Rathore)