EFFECT OF PLANTING TIME AND PLANT GROWTH REGULATOR ON GROWTH AND YIELD OF CAULIFLOWER (*Brassica oleraceae* var. *botrytis* sub. var. *cauliflora* cv. Shirajuki)

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This is to certify that the thesis entitled **"Effect of Planting Time and Plant Growth Regulator on Growth and Yield of Cauliflower (*Brassica oleraceae* var. *botrytis* sub. var. *cauliflora*)"** submitted to the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of ***MASTER OF SCIENCE in HORTICULTURE***, embodies the result of a piece of bona fide research work carried out by ***MD. ABU TAHER***, being Registration No. ***03-01097*** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

I further certify that any help or source of information, received during the course of this investigation has been duly acknowledged.

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BY

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ABSTRACT

The experiment was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during the period from October 2007 to March 2008 to determine the effect of planting time and growth regulators on the growth and yield of cauliflower. The experiment consisted of two factors; Factor A : Planting Time - 3 levels such as P_1: Early planting at 1 November; P_2: Mid planting at 15 November and P_3: Late planting at 1 December; Factor B: Plant growth regulators - 4 levels, such as H_0- No Hormone (control); H_1: 10 ppm IAA (Indole-3 Acetic Acid); H_2: 70 ppm GA_3 (Gibberelic Acid) and H_3: 10 ppm IAA + 70 ppm GA_3. The experiment was laid out following Randomized Complete Block Desgin (RCBD) with three replications. In case of planting time highest plant height at harvest (63.82 cm), curd diameter (22.82 cm), marketable yield per hectare (28.11 t/ha) was recorded from P_2 and the lowest was recorded from P_3. In case of growth regulators highest plant height at harvest (63.25 cm), curd diameter ()22.65 cm, marketable yield per hectare (29.88 t/ha) was recorded from H_3 and the lowest was recorded from H_0. Combination of planting time and growth regulators the highest plant height at harvest (67.46 cm), curd diameter (25.75 cm), marketable yield per hectare (31.03 t/ha) was recorded from P_2H_3 and the lowest was recorded from P_3H_0. The highest benefit cost ratio (2.20) was noted from the combination P_2H_3 and the lowest (1.59) was obtained from P_3H_0. From economic point of view, it is apparent from the above results that the combination of P_2H_3 was more profitable rest of the combination.

LIST OF ABBREVIATED TERMS

ABBREVIATION	Elaboration
AEZ	Agro-Ecological Zone
et al.	and others
BBS	Bangladesh Bureau of Statistics
cm	Centimeter
°C	Degree Celsius
DAT	Days After Transplanting
etc	*et cetra*
FAO	Food and Agriculture Organization
ha	Hectare
hr	Hour
kg	Kilogram
m	Meter
MOP	Muriate of Potash
%	Percent
RCBD	Randomized Complete Block Design
SAU	Sher-e-Bangla Agricultural University
m^2	Square meter
TSP	Triple superphosphate
UNDP	United Nations Development Program

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CHAPTER I

INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis* sub var. *cauliflora*) is a cole crop belongs to the family Brassicaceae. It was introduced in India in the year of 1822 (Swarup and Chatterjee, 1972). Cauliflower is a very tasty and much popular vegetable in Bangladesh as well as all over the world. 100 g edible part of cauliflower contains 89% moisture, 8.0 g carbohydrate, 2.3 g protein, 40 IU carotene, 0.13 mg B_1, 0.11 mg B_2, 50 mg vitamin C, 30 mg calcium and 0.8 mg iron and also contains 30 calorie (Rashid, 1999). Edible part of cauliflower is commonly known as 'Curd'.

Vegetable consumption in Bangladesh is very low, only 32 g per person per day against the minimum recommended quantity of 200g per day (FAO, 1986). The total vegetable production in Bangladesh is far below the requirement. In 2003-2004 cauliflower covered an area of 30,900 hectares with a total production of 101,485 metric tones (BBS, 2004). The success or failure of cauliflower production is largely depends upon climate, especially temperature and this relationship is very intensive and complex. The life cycle of cauliflower is divided into three stages based on the effect of temperature; they are vegetative growth stage, curd initiation stage and reproductive stage. The suitable temperature for growth stages ranging from 20 ± 5^0C. The best temperature for curd growth and development is 15^0C to 20^0C.

Planting time is one of the important factors for the successful production of cauliflower. As a seasonal crop, cauliflower needs to plant in optimum time to return the maximum yield and benefit. Nichols and Heydecker (1967) reported that early planting produced the largest curd and maximum yield in compared to the late planting. Malformation of curd also been reported in case of too early planting and late planting reduces curd size (Katharine, 1963).

Many experiments have been carried out in developed country to investigate the effect of bio-chemical substances on the yield and quality of cauliflower. Reports so far been made indicated a promising results on yield and quality of cauliflower and other crops due to the use of bio-chemical substances, such as Napthaline acetic acid (NAA), Gibberelic acid (GA_3), Indole acetic acid (IAA) etc. (Voronova and Kozakov, 1983; Senthelhas *et al.*, 1987; Tadzhiryan, 1990; Tomar *et al.*, 1991). In addition it is generally accepted that a biochemical processes are affected by a single chemical or a mixture of chemicals is not only different for between species but also for cultivars within the species and due to climatic regions (Hardy, 1979). However, recently done preliminary trials indicate possibility of yields increase of Cauliflower in Bangladesh with the use of biochemical (Islam *et al.*, 1993; Biswas and Mondal, 1994). Plant height, curd formation and curd size of Cauliflower can be increased with foliar application of plant growth regulators. Several experiments were conducted to increase the yield of cauliflower. GA_3 and IAA have a positive role on curd formation and curd size of cauliflower (Sharma and Mishra, 1989).

At present Plant Growth Regulators (PGRs) are widely used in horticultural crop production all over the world. Plant Growth Regulators (PGRs) play a vital role in growth and development of cauliflower. Some plant growth regulators like Auxin, Gibberellins, Cytokinin etc. are involved with the physiological activities in plants. IAA one of the PGRs plays an important role in cell division, promoting cell elongation, callus formation which enhance plants vegetative growth. Gibberellins are also important PGR, control plant growth and development with the most interesting with respect to the photoperiodic control of flowering. The cauliflower plant showed that GA_3 at 100 ppm produced the tallest plants, the largest curds and highest curd yields (Vijay and Ray, 2000).

Considering the background stated above, the present study was undertaken to investigate the effect of planting time and plant growth regulator with the following objectives-

i. To find out the appropriate planting time of cauliflower in relation to yield contributing characters and yield

ii. To know the combined effect of planting time and plant growth regulators for ensuring the maximum growth and higher yield of cauliflower.

CHAPTER II

REVIEW OF LITERATURE

Cauliflower is one of the most popular vegetable and received much attention to the researcher of different countries including Bangladesh. Like many other vegetables the growth and yield of cauliflower are influenced by planting time and growth regulators. A number of experiments have been conducted throughout the growing regions but research findings regarding the effect of planting time and growth regulators on growth and yield and of cauliflower under Bangladesh condition is very limited. The literature related to the present study are reviewed in this chapter under the following headings.

2.1 Effect of planting time on growth and yield of cauliflower

An experiment was conducted by Ara *et al.*, (2009) at the Regional Agricultural Research Station, Ishurdi, Pabna during the period from April to December 2007. Two lines of cauliflower Viz, CL026 and CL0134 and four dates of planting cauliflower viz; 1 May, 1 June, 1 July and 1 August were included in this study. The trail was laid out in Factorial Randomized Complete Block Design with three replications. Planting dates significantly influenced the growth and yield of cauliflower lines at one month interval during 1 May to 1 August at the Regional Agricultural Research Station, Ishurdi, Pabna during 2007-2008 in summer season to delineate yield potentialities of cauliflowers. Plant height, number of leaves per plant, weight of whole plant, weight of marketable curd per plant and yield t/ha were also significantly differed among the planting dates. Weight of marketable curd per plant (419.61 g) was obtained from as earlier August planting in summer season. Significantly highest yield (17.56 t/ha) was obtained from the line CL0134 when combination with as earlier August planting.

An experiment was conducted by Cebula *et al.*, (2005) in Poland during 2002-04 to determine the dependence between the pattern of weather conditions and the vegetative growth, as well as the cropping course, of white and green cauliflower cultivars planted for autumn harvesting. For the white cauliflower, the late cultivar Planita F_1 and the early cultivar Farras F_1 were used. For the green cauliflower, cultivars Trevi F_1 and Panther F1 were used. Plants of late cultivars were planted in the second half of June, which is the usual time for autumn cultivars, whereas the early ones in the first half of July, the time used following the harvesting of certain forecrops. During vegetation, measurements were taken of plant height and diameter as well as number of formed leaves. The times of initial curd formation as well as consecutive harvests were also recorded. The weather conditions included daily measurements of maximal, minimal and average air temperature, as well as totals of atmospheric rainfalls. Intensive vegetative growth (height and diameter of plants, as well as number of formed leaves) was proved for both cauliflower types in full summer (end of July, August) until first curd harvesting. By using the delayed planting time, it became possible to move harvesting to a later time in autumn. The cultivars of green cauliflower were harvested a bit later than the white cultivars. However, in all years of the experiment, for both planting times, full harvest of curds was possible. The analysis of harvesting dynamics against the weather conditions in particular years, at certain periods, showed the visible effect of temperature on accelerating or delaying the cropping of both cauliflower types.

A field experiment was conducted in Cooch Behar, West Bengal, India during the 1996/97 and 1997/98 winter seasons by Jana and Mukhopadhyay (2003) to determine the effect of sowing date (15 August, 31 August and 15 September) and cultivar (Early Kunwari, First Crop, Kartika, Aghani and Improved Japanese) on the growth and curd yield of cauliflower. Seeds sown on 15 August gave the maximum plant height, leaf length, number of leaves, curd initiation, curd maturity, net curd weight and curd yield. Seeds sown on 31 August gave the highest leaf width. Improved Japanese gave the maximum plant height, leaf length, curd initiation and curd maturity. First Crop gave the highest leaf width while Aghani gave the highest net curd weight and curd yield. Comparative data on the interaction of sowing dates and cultivars on the growth and curd yield of cauliflower are also tabulated.

Jana and Mukhopadhyay (2002) conducted an experiment in West Bengal, India during 1996-98 to determine the effects of different sowing dates (15 August, 31 August and 15 September) and cultivars (Early Kunwari, First Crop, Kartika, Aghani and Improved Japanese) on the growth and yield of cauliflower. Seed sowing on 15 August produced the highest seed yield attributing characters and seed yield (483.24 kg/ha), whereas delay in sowing reduced seed yield due to the reduction in the yield attributing characters. The 1000-seed weight and germination percentage of the produced seeds increased with early sowing. Aghani recorded highest seed yield (493.04 kg/ha).

An experiment was conducted by Gautam *et al.* (2001) in Jorhat, Assam, India during 1993-95 to determine the effect of different sowing dates (15 and 30 July, and 14 August), seed production methods (plants left in situ; and without scooping the curds) and cultivars (Pusa Katki, Pusa Deepali, Selected Early Dawn, Early Chinese Prince and Heavy Silver Plate) on the growth and seed yield of early cauliflower. The 15 July sowing recorded the maximum seed yield (4.5 q/ha). Yield significantly declined with delay in sowing irrespective of the cultivars. Scooping curds significantly increased the seed yield in Pusa Deepli and Heavy Silver Plate, while the rest did not respond to scooping. All cultivars differed significantly from each other in terms of seed yield. Selected Early Dawn recorded the highest yield (4.6 q/ha).

Dutta (1999) conducted an experiment to study the effect of dates of planting on the performance of different groups of cauliflower. Among the nine cultivars 3 early, 3 mid season and 3 late season cultivar were planted on 3 dates at 10 days interval (1, 11 and 21 September; 11, 21 and 31 October; and 15 and 25 November and 5 December, respectively). Planting time exhibited a significant effect on days to curd formation, curd size, curd weight and yield. An increase in size and weight of curd associated with a rise in yield was registered by the gradual delay in planting time in early and mid season cultivars while all these characters were superior in late cultivars at the mid planting date. The highest yield in early cultivars (117.0 q/ha) was obtained from the delayed planting on 21 September, in mid-season cultivars (129.6 q/ha) it was obtained from the delayed planting on 31 October, and in late cultivars, maximum yield of 68.3 q/ha was recorded with the medium late planting on 25 November.

Gautam *et al.* (1998) carried out a study at Jorhat (Assam, India) during 1993 and 1994 to determine the effect of sowing (15 and 30 July and 14 August) and five cultivars (Pusa Katki, Pusa Deepali, Selected Early Dawn, Early Chinese Prince and Heavy Silver Plate) on the growth and yield of early cauliflower. Sowing on 15 July gave the maximum curd yield (78.48 q/ha) which was significantly declined with each delay in sowing time. Early-sown crops resulted in longer duration and produced taller plants with more number of leaves, higher plant spread, more leaf size index as well as the lowest percentage of abnormal curds than late-sown crops and finally attributed to higher curd yield. Among the cultivars, 'Heavy Silver Plate' exhibited the highest curd yield with an average yield of 81.15 q/ha of marketable curd.

Csizinszky (1996) conducted and experiment to find out the effect of plant timing and nitrogen and observed that marketable yield of cauliflower was highest in the January planting with N at 294 kg/ha, when 71% of the plants had marketable size and desirable quality curds.

Ghanti and Mallik (1995) conducted an experiment where six early cauliflower cultivars were transplanted during different summer months at Bidhan Chandra Krishi Viswavidyalaya in the plains of West Bengal in 2 consecutive years. Their findings revealed that stems were longest in August-transplanted crops and in early market and hot season. The most compact curds were recorded for crops transplanted in September and in Early Patna No. 1 and Pusa Katki.

An experiment was conducted by Ahmed and Hussain (1985) in the horticulture farm of the Bangladesh Agricultural University, Mymensingh to find out the influence of time of planting on the performance of three local cauliflower cultivars. They found that early planting took longer period for curd initiation than that of late planting. Higher vegetative growth and curd yield were also obtained from earlier planting.

Nichols and Heydecker (1967) carried out an experiment to find out the effect of planting time with seven varieties of early summer cauliflowers. They raised the seedlings of three varieties from mid-January and planted them at fortnight interval starting from 26 March. Thus there were three dates of planting. All the cultivars took shorter time to mature in case of late planting compared to early planting. The earliest planting produced the largest curds.

Kathrine (1963) conducted an experiment to find out the effect of planting time with cornish cauliflowers at Rosewarne experimental Horticulture station and observed that late planting reduces curd size and yield. Too early planting is likely to result with malformed curds.

Mounsey (1961) carried out a study to find out the effect of day length during germination of cauliflower and reported that different day length during germination had a remarkable effect on blindness, yield, quality and date of maturity of the heads. About 12.5 hours day length gave the best result and in the Holland districts of Lincolnshire, showing on 20 September is preferable to sowing on 15 October when the day length is about 10.5 hours.

Srivastava (1960) conducted an experiment and stated that formation of good size head of cauliflower depended upon the number of leaves, their size and ability to store carbohydrates and other nutrients within a particular temperature range. The greater the number and larger the leaves, the bigger was the size of head. He further mentioned that production of large heads depended entirely upon planting seedlings at proper time and also on their care and nourishment.

Barbara and Mounsey (1957) studied the effects of different sowing and planting dates on blindness, yield and quality of early summer cauliflower and reported that early sowing increased weight of crop per plot, size of head, firmness of curd, the number of perfectly shaped curd and other characters. Though planting date was less effective than sowing date, early planting tended to produce the highest yield per plot, but the little effect on quality.

2.2. Effect of Growth Regulators on growth and yield of cauliflower

The growth and flowering response of a cold-requiring cauliflower (*Brassica oleracea* var. botrytis cv. '60 day') to a range of temperatures under 10 h photoperiod and to growth regulator application were investigated by Guo *et al.* (2004). Endogenous gibberellin (GA_3) concentrations were also assessed under these treatments. Flowering and growth of the inflorescence stalk were correlated with plant developmental stage at the time of a vernalizing cold treatment. Temperature and its duration also affected flowering and inflorescence development. The most effective temperature for inflorescence induction was 10^0C. Flowering did not occur in non-vernalized plants (25^0C) even though they had been treated with GA_3. Application of GA_3 promoted inflorescence stalk elongation greatly in vernalized plants (10^0C), but less so in partially vernalized plants (15 or 20^0C). Paclobutrazol sprayed at the 8-9 leaf stage significantly suppressed inflorescence stalk length and slightly delayed flower bud formation and anthesis. Vernalization at 10^0C increased endogenous GA_3 content in both leaves and the inflorescence stalk irrespective of GA_3 treatment.

Vijay and Ray (2000) carried out an experiment that thirty day old cauliflower (cv. Pant Subhra) seedlings that were transplanted into experimental plots treated with 50 or 100 ppm GA_3, 5 or 10 ppm IBA, or 200 ppm NAA at 15 and 30 days of growth. The results clearly revealed that GA_3 at 100 ppm produced the tallest plants, the largest curds and highest curd yields.

Dharmender *et al.*, (1996) conducted an experiment to find out the effect of GA_3 or NAA (both at 25, 50 or 75 ppm) on the yield of cabbage (cv. Pride of India) in the field at Jobner, Rajstan, India. They recorded the highest yield following treatment with GA_3 at 50 ppm followed by NAA at 50 ppm (557.54 and 528.66 q/ha respectively). They also reported that combination and higher concentrations of plant growth regulators proved less effective and were uneconomic in comparison to control.

Dharmender *et al.*, (1996) studied GA_3 alone or in combination with NAA (both at 25, 50 or 75 ppm) on the growth of cabbage (cv. Pride of India) in the field of Horticulture Farm S. K. A. College of Agriculture. Jobnner, Rajstan, India during rabi (winter) 1993-94. The best growth parameter like as plant height, plant spread, number of leaves, leaf area and days of maturity was observed following treatment with GA_3 at 50 ppm followed by NAA at 50 ppm. GA_3 at 75 ppm reduced the mean number of days required to start head formation. The highest chlorophyll content in outer leaves was observed following treatment with NAA at 50 ppm.

Aditya and Fordham (1995) carried out an experiment in the field and greenhouse to study the effects of cold exposure and GA_3 during early growth stages on the date of flowering of the tropical cauliflower cv. Early Patnai and the temperate cv. Lawyna. Flowering in cv. Early Patnai was advanced by approximately 25 days following vernalization (1 week at 10^0C) of 3 week old plants. They reported that one week old plants failed to respond to this treatment suggesting juvenile phase lasting up to about the 6 leaf stage in this cultivar.

Islam *et al.*, (1993) determined the effective concentration of NAA and GA_3 for promoting growth, yield and ascorbic acid content of cabbage. They used 12.5, 25, 50 and 100 ppm of both the NAA and GA_3 and applied in three different methods i.e. seedling soaked for 12 hours, spraying at 15 and 30 days of transplanting. They found that ascorbic acid content increased up to 50 ppm when sprayed twice with both the growth regulator, while its content was declined afterwards. They also added that two sprays with 50 ppm GA_3 was suitable both for higher yield and ascorbic acid content of cabbage.

Reddy (1989) reported that exogenous application of GA_3 and Urea either alone or in combination enhanced curd size as well as yield. Greatest plant height at curd formation (58.2 cm), curd diameter at maturity (26.8 cm) and increase yield over the control (164%) were obtained with two application of GA_3.

Sharma and Mishra (1989) stated that plant height, curd formation and curd size of cauliflower can increase with foliar application of plant growth regulator. Several experiments were conducted to increase the yield of cauliflower. GA_3 and IAA have a positive effect on curd formation and size of cauliflower.

Muthoo *et al.*, (1987) showed that the foliar application of different concentration of GA_3, NAA and molybdenum increased the average fresh and dry weight of leaves. Curd and yield of cauliflower among the individual treatments, gibberellic acid proved to be the best for the vegetative growth of curd and yield of cauliflower (q/ha) followed by naphthalene acetic acid. The effect of treatment combination $G_2N_2M_2$ (100 ppm GA_3, 120 ppm NAA and 0.2% molybdenum) gave best result for all parameters of growth and yield.

Patil *et al.*, (1987) conducted an experiment in a field trial with the cultivar Pride of India applied GA_3 and NAA each at 25, 50, 75 and 100 ppm one month after transplanting. Both the GA_3 and NAA increased the plant height significantly. The maximum plant height and head diameter and head weight were noticed with

GA_3 at 50 ppm followed by NAA at 50 ppm. Significant increase in number of outer and inner leaves was noticed with both GA_3 and NAA. Head formation and head maturity was 13 and 12 days earlier with 50 ppm GA_3. Maximum number of leaves and maximum yield (23.83 t/ha) were obtained with 50 ppm GA_3.

Pandey and Sinha (1987) reported that photosynthetic area of plant increased when treated with gibberellic acid and naphthalene acetic acid.

Mishra and Singh (1986) conducted an experiment with all possible combinations of the levels of nitrogen (0, 0.5, and 1.0 per cent), boron (0, 0.1, 0.2 per cent) and GA_3 (0, 25, and 50 ppm) in the form of Urea, boric acid, and GA_3 were sprayed on snowball-16 cauliflower respectively. Results revealed that there was significant increase in growth characters namely plant height, diameter of stem, number of leaves per plant, weight of plant, curd yield and nitrogen content in stem and leaves due to N, B and GA_3 applications. However, length of stem was increased only by GA_3 spray.

Islam (1985) conducted an experiment at the Bangladesh Agricultural University Farm, Mymensingh with applying various growth regulators (CCC, GA_3, NAA and IBA) at 30 days after transplanting of 32 day old seedlings, CCC decreased the plant height, size of loose leaves, diameter of cabbage of head and finally the yield. GA_3 increased the plant height, number of loose leaves per plant, size of leaf and finally the yield.

Yabuta *et al*. (1981) reported that application of GA_3 had significantly increased marketable weight, petiole length, and number of leaves, leaf area and height of many leafy vegetables.

Abdalla *et al*. (1980) conducted an experiment with cauliflower varieties and the plants were treated with different concentration of IBA (5-40 ppm), GA_3 (10-80 ppm) or NAA (120-160 ppm) 4 weeks after twice more at fortnightly intervals. NAA at 160 ppm gave the best result with regard to curd diameter, weight and color. Similar results were obtained from plants treated with GA_3 at 80 ppm and NAA at 40 ppm.

Badawi and Sahhar (1979) conducted a study at the experimental station of the Faculty of Agriculture, Cairo University, Egypt. They sprayed 0, 50, 100, and 200 ppm GA_3 and 0, 10, 20, and 40 ppm IBA after 4 and 8 weeks of transplanting to determine the extent of stimulating effect of different concentrations of GA_3 and IBA on cabbage.

Chauhan and Bordia (1971) carried out an experiment using Drumhead variety of cabbage to assess the effects of Gibberellic acid (GA_3) at 5, 10, 25, 50, 100 ppm, Beta-napthoxy-acetic acid (NOA) at 5, 10, 25, 50, 100 ppm and 2,4-Dichlorophenoxy acetic acid (2,4-D) at 0.25, 0.5, 1.0, 2.0, 2.5 ppm as pre-sowing seed treatment on growth and yield of cabbage and mentioned that none of the treatments affected the height of the plants and the time taken for head formation. Maximum weight of head (1.72 kg) was obtained with 50 ppm GA_3 as against 0.81 kg under control.

Chhonkar and Singh (1965) conducted an experiment in Rabi season of 1962-63 with GA_3 at 5 ppm and 10 ppm after two and three weeks of transplanting. They reported that 5 ppm GA_3 induced larger number of inner leaves in heads, earlier head formation by 16 days, increased head diameter, improved compactness and significantly increased the yield and quality of heads.

In cabbage, Chhonkar and Jha (1963) observed that IAA and IBA at lower concentration were very effective in promoting early recovery and higher percentage of seedling establishment.

Denisova and Lupinovich (1962) found that GA_3 application brought about rapid vegetative growth, which subsequently helped in the early formation of large and compact heads. The probable cause of this may be increased nutrient transport from root to the aerial parts and increased rate of photosynthesis and accelerated transport of photosynthates by GA_3.

Anderson *et al.*, (1948) found increased growth in cauliflower by the application of GA_3 with NAA. This was found to have significant effect due to synergistic action.

CHAPTER III

MATERILAS AND METHODS

3.1 Experimental Site

The experiment was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during the period from October 2007 to March 2008. The experimental site was previously used as vegetable garden and recently developed for research work. The location of the site in $23^0 74'$ÓN latitude and $90^0 35'$E longitude with an elevation of 8.2 meter from sea level (Anon., 1989).

3.2 Climate

The climate of the experimental site is subtropical, characterized by heavy rainfall during the months from April to September (Kharif season) and scanty rainfall during the rest of the year (Rabi season). The total rainfall of the experimental site was 80 mm during the period of the experiment. The average maximum and minimum temperature were 29.45°C and 13.86°C, respectively during the experimental period. Rabi season in characterized by plenty of sunshine. The maximum and minimum temperature, humidity rainfall and soil temperature during the study period were collected from the Bangladesh Meteorological Department (climate division) and have been presented (Appendix I).

3.3 Soil

The soil of the experimental area belongs to the Modhupur Tract (UNDP, 1988). The analytical data of the soil sample collected from the experimental area were determined in the SRDI, Soil Testing Laboratory, Khamarbari, Dhaka. The experimental site was a medium high land and pH of the soil was 5.6. The morphological characters of soil of the experimental plots as indicated by FAO (1988) are presented in Appendix II.

3.4 Plant Materials

Seed of Cauliflower *Brassica oleracea* var. *botrytis* sub-var. *cauliflora* cv. Shirajuki was used in the experiment. The seeds were collected from Siddique bazar seed market with authentic lebelled.

3.5 Treatment of the experiment

The experiment was designed to study the growth and yield performance of cauliflower with different planting time and plant growth regulators. The experiment consisted of two factors were as follows:

Factor A: Planting time - 3 levels

i. P_1: Early planting at 1 November
ii. P_2: Mid planting at 15 November
iii. P_3: Late planting at 1 December

Factor B: Plant growth regulators - 4 levels

i. H_0: No Hormone (Control)
ii. H_1: 10 ppm IAA (Indole-3 Acetic Acid)
iii. H_2: 70 ppm GA_3 (Gibberelic Acid)
iv. H_3: 10 ppm IAA + 70 ppm GA_3

There were altogether 12 treatments combination such as P_1H_0, P_1H_1, P_1H_2, P_1H_3, P_2H_0, P_2H_1, P_2H_2, P_2H_3, P_3H_0, P_3H_1, P_3H_2 and P_3H_3.

3.6 Experimental design and layout

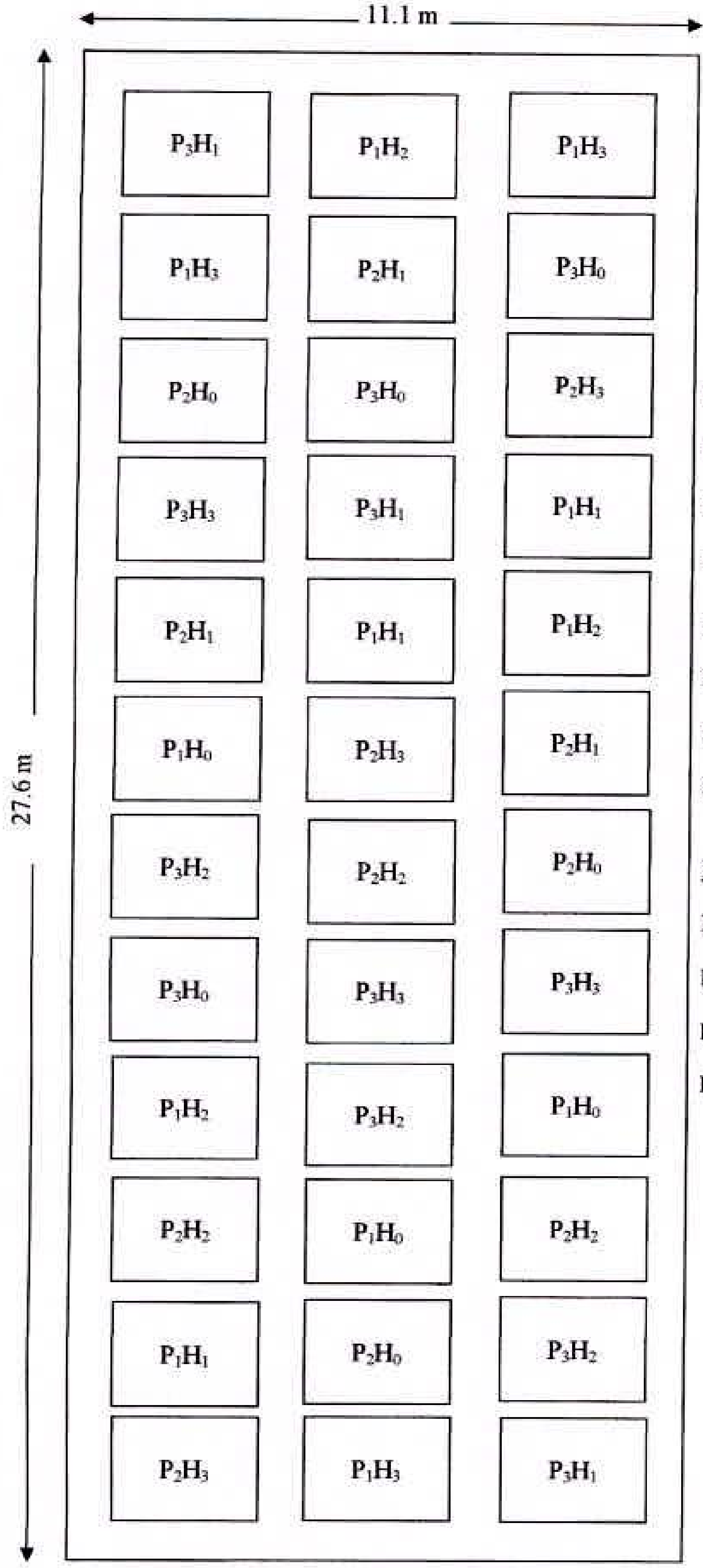
The two factors experiment was laid out following Randomized Complete Block Desgin (RCBD) with three replications. An area of 27.6 m × 11.1 m was divided into three equal blocks. Each block was divided into 12 plots where 12 treatments were allotted at random. Thus there were 36 unit plots altogether in the experiment. The size of each plot was 2.7 m × 1.8 m. The distance between two blocks and two plots were kept 1 m and 0.5 m respectively. A layout of the experiment has been shown in Figure 1.

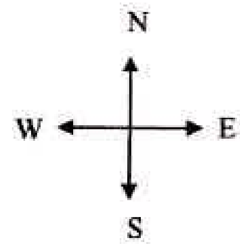
3.7 Seed bed preparation, seed germination and raising of seedlings

The 3 m × 1 m in size seed bed was selected. Seed beds were prepared with a mixture of sand, soil and compost. It was raised 15 cm from ground level. Seeds were sown on three different times. First at 1 October, 2007 second at 15 October, 2007 and third at 1 November 2007. Germination of seeds were completed within seven days.

3.8 Land preparation

The land which was selected to conduct the experiment was opened 20 October 2007 with the help of a power tiller and then it was kept open to sun for 7 days to further ploughing. Afterwards it was prepared by ploughing and cross ploughing followed by laddering. Deep ploughing was done to have good tilth which was





Plot size: 2.7 m × 1.8 m

Plant spacing: 60 cm × 45 cm

Plot spacing: 50 cm

Between replication: 1.0 m

Factors A:

P_1: Early planting on 1 November

P_2: Mid planting on 15 November

P_3: Late planting on 1 December

Factors B:

H_0: No Hormone (Control)

H_1: 10 ppm IAA (Indole-3 Acetic Acid)

H_2: 70 ppm GA_3 (Gibberelic Acid)

H_3: 10 ppm IAA + 70 ppm GA_3

Figure 1. Layout of the experimental plot

necessary for getting better yield of the crop. The weeds and stubbles were removed after each laddering. Simultaneously the clods were broken and the soil was made until good tilth.

3.9 Manuring and fertilization

Manures and fertilizers were applied according to the experimental plot considering the recommended fertilizer doses for cauliflower production per hectare by BARI (2005).

Table 1. Dose and method of application of fertilizers in cauliflower field

Fertilizers and Manures	Dose/ha	Application (%)			
		Basal	10 DAT	30 DAT	50 DAT
Cowdung	20 tonnes	100 (Entire)	--	--	--
Urea	300 kg	--	33.33	33.33	33.33
TSP	200 kg	100 (Entire)	--	--	--
MP	250 kg	50 (½ portion)	16.67	16.67	16.67

The total amount of cowdung, TSP and half of MP was applied as basal dose at the time of land preparation. The rest of MP and total amount of Urea was applied equally in three installments at 10, 30 and 50 day after transplanting.

3.10 Transplanting of seedling and after care

Healthy and uniform sized 30 days old cauliflower seedlings were transplanted to the main field at three different times. First transplanting was done at 1 November 2007, second at 15 November 2007 and third at 1 December 2007. The spacing was maintained at 60 cm × 45 cm. Moderate watering was needed after transplanting. Shading was provided to the newly transplanted seedlings for three days with banana stem from scorching sunlight. After seedling establishment, the soil around the base of each seedling was pulverized and new ones from the same stock were used to replace in case of damaged cauliflower seedlings.

3.11 Preparation and application of growth regulators

Growth regulators Indole-3 acetic acid (IAA) and Gibberellic acid (GA_3) were prepared as per the following procedure and spraying was done by using hand sprayer covering whole plant at 25 days after transplanting of cauliflower seedlings.

3.11.1. IAA solution

10 ppm IAA solution was prepared by dissolving 10 mg IAA powder with 10 ml Ethyle Alcohol and the volume was made 1000 ml by adding distilled water in a volumetric flask.

3.11.2. GA_3 solution

To prepare 70 ppm GA_3 solution 70 mg granules are measured by an electrical balance and dissolved into 1000 ml distilled water.

3.12. Intercultural operation

3.12.1. Weeding

Weeding was done three times in those plots at the 10, 30 and 50 DAT followed by fertilizer application.

3.12.2. Irrigation

Light irrigation was given just after transplanting the seedlings. A week after transplanting the requerement of irrigation was envisaged through visual estimation. Wherever the plants of a plot had shown the symptom of wilting the plots were irrigated on the same day with a hosepipe until the entire plot was properly wet.

3.12.3. Insects and Diseases

The birds attacked the crop at tender stage. Alluminium foil was used to protect the crop from birds.

3.12.4. Earthing Up

It was done 15 days after transplanting for each planting around the base of each plant.

3.13. Harvesting

Randomly selected five plants were harvested from each plot for recording data to achieve the goal of experiment.

3.14. Data collection

Data were recorded on the following parameters from the sample plants during the course of experiment. Randomly selected five plants were sampled from each unit plot for the collection of data.

3.14.1. Plant height

Plant height was measured in centimeter (cm) by a meter scale at 30, 40, 50, 60 days after transplanting (DAT) and at harvest from the point of attachment of the leaves to the ground level up to the tip of the leaf.

3.14.2. Number of leaves per plant

Number of leaves of five randomly selected plants were counted at 30, 40, 50, 60 DAT and at harvest. All the leaves of each plant were counted separately. Only the smallest young leaves at the growing point of the plant were excluded from counting. The average number of leaves of five plants gave number of leaves per plant.

3.14.3. Leaf length

Leaf length of five randomly selected plants was measured in centimeter (cm) at 30, 40, 50, 60 DAT and harvest. It was measured from the base of the petiole to the tip of the largest leaf of each plant with a meter scale.

3.14.4. Leaf breath

Leaf breath of from the widest central and two terminal portion of the lamina with a meter scale and average breath was recorded in centimeter (cm) at 30, 40, 50, 60 DAT and at harvest.

3.14.5. Days from transplanting to curd initiation

Days required from transplanting to curd initiation were counted when curds of the plants were started to its initiation.

3.14.6. Days from transplanting to 50% curd initiation

Days required from transplanting to 50% curd initiation were counted when curds of the plants were emerged about 50% of the total plants.

3.14.7. Days from transplanting to harvest

Days required from transplanting to curd harvest were counted from the difference between transplanting to harvest of curd.

3.14.8. Root length (cm)

Root length was measured from collar region to the tip of the root by using meter scale. It was expressed in centimeter (cm).

3.14.9. Stem length

Stem length was measured from the collar region to the base of curd in centimeter from five randomly selected plants at each plot at harvest.

3.14.10. Stem diameter

Stem diameter was measured by measuring circumference of the stem and converted it into diameter and expressed in centimeter randomly 5 selected plants at each plot at harvest.

3.14.11. Curd weight with leaf

Root portion of cauliflower plant was separated from the stem and the rest portion of the plant was weighted by using a weighing balance then it was expressed in kilogram.

3.14.12. Pure curd height

Curd height was measured with a measuring scale placing it horizontally. It was measured in centimeter.

3.14.13. Pure curd weight/plant

As pure curd weight only the weight of curd was measured and recorded with the help of weighing balance excluding all the leaves and stem. It was expressed in kilogram.

3.14.14. Curd diameter

Curd diameter was measured in centimeter by using a measuring scale. Measurement was taken from two opposite directions.

3.14.15. Marketable curd weight per plant

Marketable curd weight was recorded after harvesting of curd when the leaves around the curd were pruned. It was measured with weighing balance and expressed in kilogram.

3.14.16. Marketable yield per hectare

It consisted of only quality curd that was ready for marketing. It was expressed in ton per hectare by converting the total yield of curd per plant of marketable weight of curd.

3.15. Statistical analysis

The data collected from the experimental plots were statistically analyzed using MSTAT-C program. The mean values for all the treatments was calculated and the analysis of variance for most of the characters was accomplihsed by 'Duncan's Multiple Ranges Test' (DMRT) at 5% level of probabilty (Gomez and Gomez, 1984).

3.16. Economic analysis

The cost of production was analyzed in order to find out the most economic treatment of planting time and growth regulators. All input cost included the cost for lease of land and interests on running capital in computing the cost of production. The interests were calculated @ 13% in simple rate. The market price of cauliflower was considered for estimating the cost and return. Analyses were done according to the procedure of Alam *et al.* (1989). The benefit cost ratio (BCR) was calculated as follows:

$$\text{Benefit cost ratio (BCR)} = \frac{\text{Gross return per hectare (Tk.)}}{\text{Total cost of production per hectare (Tk.)}}$$

CHAPTER IV

RESULTS AND DISCUSSION

The experiment was carried out to determine the effect of planting time and growth regulators on the growth and yield of cauliflower. Data on different growth parameter and yield was recorded. The analysis of variance (ANOVA) of the data on different growth parameter and yield are presented in Appendix III-VIII. The results have been presented and discussed, and possible interpretations are given under the following headings:

4.1 Plant height

Plant height of cauliflower showed significant variation due to different planting time at 30, 40, 50, 60 DAT and at harvest (Appendix III). The tallest plant 27.30, 42.17, 53.12, 60.67 and 63.82cm was recorded from P_2 (mid planting at 15 November) and the shortest plant 24.85, 37.56, 47.41, 52.38 and 53.03 cm was observed from P_3 (late planting on 1 December) at 30, 40, 50, 60 DAT and at harvest, respectively (Table 2). Optimum planting time ensured suitable condition for the vegetative growth of plant for that tallest plant was produced from that planting time compare to the early and late planting. Early planting also lead to favorable vegetative growth than the late planting. Ara *et al.*, (2009) reported that plant height significantly differed among different planting dates.

Table 2. Effect of planting time and growth regulators on plant height of cauliflower

Treatment	Plant height (cm)				
	30 DAT	40 DAT	50 DAT	60 DAT	Harvest
Planting time					
P_1	25.68 b	40.66 b	51.14 b	57.75 b	59.17 b
P_2	27.30 a	42.17 a	53.12 a	60.67 a	63.82 a
P_3	24.85 c	37.56 c	47.21 c	52.38 c	53.03 c
$LSD_{(0.05)}$	0.470	0.733	0.298	1.753	1.872
Significance level	**	**	**	**	**
Growth regulators					
H_0	24.34 d	36.89 d	45.75 d	50.16 c	52.64 c
H_1	26.50 b	41.35 b	52.07 b	59.10 ab	61.49 a
H_2	25.68 c	39.94 c	50.75 c	57.44 b	57.62 b
H_3	27.25 a	42.34 a	53.38 a	61.03 a	63.25 a
$LSD_{(0.05)}$	0.543	0.847	1.010	2.024	2.162
Significance level	**	**	**	**	**
CV(%)	6.14	9.16	5.05	6.64	7.77

DAT: Days after transplanting

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

P_1: Early planting on 1 November

P_2: Mid planting on 15 November

P_3: Late planting on 1 December

H_0: No Hormone (control)

H_1: 10 ppm IAA (Indole-3 Acetic Acid)

H_2: 70 ppm GA_3 (Gibberelic Acid)

H_3: 10 ppm IAA + 70 ppm GA_3

A significant variation was recorded on plant height of cauliflower due to the application of different hormones at 30, 40, 50, 60 DAT and at harvest (Appendix III). At 30, 40, 50, 60 DAT and at harvest the longest plant 27.25, 42.34, 53.38, 61.03 and 63.25 cm was found from H_3 (10 ppm IAA + 70 ppm GA_3) and the shortest plant 24.34, 36.89, 45.75, 50.16 and 52.64 cm was obtained from H_0 (no hormone) respectively (Table 2). Application of hormone produced the tallest plant compare to the control condition. IAA as growth hormone lead to vegetative growth than the GA_3 as flowering hormone but the combination of IAA and GA_3 as growth and flowering hormone leads to the maximum vegetative growth. Vijay and Ray (2000) reported that 100 GA_3 ppm produced the tallest plants.

Combined effect of planting time and growth regulators showed significant variation in terms of plant height of cauliflower under the trial at 30, 40, 50, 60 DAT and at harvest (Appendix III). The tallest plant 28.77, 44.63, 56.46, 65.23 and 67.46 cm was found from the treatment combination of P_2H_3 (mid planting at 15 November × 10 ppm IAA + 70 ppm GA_3) whereas the shortest plant 23.42, 32.41, 40.67, 43.00 and 44.31 cm was recorded from P_3H_0 (late planting at 1 December × no hormone) at 30, 40, 50, 60 DAT and at harvest, respectively (Table 3).

Table 3. Combined effect of planting time and growth regulators on plant height of cauliflower

Treatment	Plant height (cm)				
	30 DAT	40 DAT	50 DAT	60 DAT	Harvest
P_1H_0	24.01 ef	37.86 f	47.35 f	52.45 e	53.11 c
P_1H_1	25.60 cd	40.63 cd	51.11 cd	57.65 cd	59.19 b
P_1H_2	25.91 cd	41.33 c	52.23 bc	59.18 bc	59.38 b
P_1H_3	27.21 b	42.82 b	53.85 b	61.72 ab	65.00 a
P_2H_0	25.59 cd	40.39 cde	49.23 de	55.02 de	60.49 b
P_2H_1	28.63 a	44.04 ab	55.65 a	64.10 a	66.56 a
P_2H_2	26.19 c	39.62 de	51.14 cd	58.32 bcd	60.78 b
P_2H_3	28.77 a	44.63 a	56.46 a	65.23 a	67.46 a
P_3H_0	23.42 f	32.41 g	40.67 g	43.00 f	44.31 d
P_3H_1	25.28 cd	39.37 def	49.46 de	55.55 cde	58.72 b
P_3H_2	24.93 de	38.88 ef	48.87 ef	54.83 de	51.81 c
P_3H_3	25.77 cd	39.56 de	49.83 de	56.14 cde	57.29 b
$LSD_{(0.05)}$	0.940	1.466	1.750	3.506	3.744
Significance level	**	**	**	**	**
CV(%)	6.14	9.16	5.05	6.64	7.77

DAT: Days after transplanting

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

4.2 Number of leaves per plant

Number of leaves per plant of cauliflower varied significantly due to different planting time at 30, 40, 50, 60 DAT and at harvest (Appendix IV). At the different days after transplanting (DAT) and harvest, the maximum number of leaves per plant 13.00, 15.82, 18.25, 22.92 and 24.06 was observed in P_2 (mid planting at 15 November) which was closely followed 12.25, 15.17, 17.57, 21.74 and 22.28 by P_1 (early planting at 1 November) at 30, 40, 50 and 60 DAT and at harvest, respectively. Again, at the same DAT the minimum number of leaves per plant 11.12, 14.38, 16.24, 19.17 and 20.36 was found from P_3 (late planting at 1 December), respectively (Table 4). Ara *et al.* (2009) reported that number of leaves per plant significantly differed among different planting dates.

Number of leaves per plant of cauliflower differed significantly at 30, 40, 50, 60 DAT and at harvest due to the application of different hormones (Appendix IV). At 30, 40, 50, 60 DAT and at harvest, the maximum number of leaves per plant 13.80, 15.77, 18.32, 22.72 and 23.74 was recorded from H_3 (10 ppm IAA + 70 ppm GA_3) which was followed 13.07, 15.43, 17.77, 21.97 and 22.92 by H_1 (10 ppm IAA). Again, the minimum number of leaves per plant (10.16, 14.33, 16.04, 19.07 and 19.90) was found from H_0 (no hormone) for the same DAT, respectively (Table 4). Dharmender *et al.* (1996) reported highest number of leaves following treatment with 50 GA_3 ppm followed by at 50 ppm NAA. Patil *et al.* (1987) reported significant increase in number of outer and inner leaves was noticed with both GA_3 and NAA.

Table 4. Effect of planting time and growth regulators on number of leaves per plant of cauliflower

Treatment	Number of leaves per plant				
	30 DAT	40 DAT	50 DAT	60 DAT	Harvest
Planting time					
P_1	12.25 b	15.17 b	17.57 b	21.74 b	22.28 b
P_2	13.00 a	15.82 a	18.25 a	22.92 a	24.06 a
P_3	11.12 c	14.38 c	16.24 c	19.17 c	20.36 c
$LSD_{(0.05)}$	0.584	0.269	0.242	0.609	0.757
Significance level	**	**	**	**	**
Growth regulators					
H_0	10.16 d	14.33 d	16.04 d	19.07 c	19.90 c
H_1	13.07 b	15.43 b	17.77 b	21.97 b	22.92 ab
H_2	11.47 c	14.96 c	17.28 c	21.34 b	22.36 b
H_3	13.80 a	15.77 a	18.32 a	22.72 a	23.74 a
$LSD_{(0.05)}$	0.675	0.311	0.280	0.704	0.874
Significance level	**	**	**	**	**
CV(%)	5.69	12.10	10.65	8.38	7.02

DAT: Days after transplanting

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Statistically significant variation was recorded due to combined effect of planting time and growth regulators in terms of number of leaves per plant of cauliflower at 30, 40, 50, 60 DAT and at harvest (Appendix IV). The maximum number of leaves per plant (14.90, 16.47, 19.10, 24.43 and 25.87) was observed from P_2H_3 (mid planting at 15 November × 10 ppm IAA + 70 ppm GA_3) at 30, 40, 50, 60 DAT and at harvest, respectively while the minimum number of leaves per plant (9.27, 13.50, 14.33, 16.17 and 17.93) was recorded from P_3H_0 (late planting at 1 December × no hormone) at 30, 40, 50, 60 DAT and at harvest, respectively (Table 5).

4.3 Leaf length

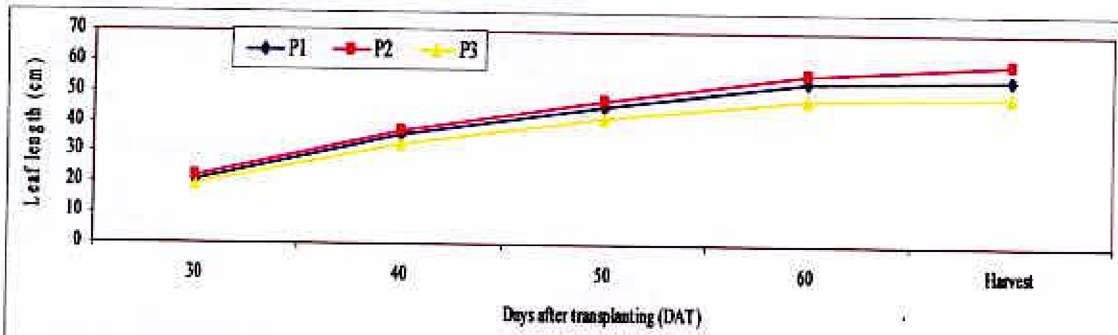
Planting time showed statistically significant variation for leaf length of cauliflower at 30, 40, 50, 60 DAT and at harvest (Appendix V). At the different days after transplanting (DAT) and at harvest the longest leaf 22.15, 37.40, 47.39, 56.32 and 59.83 cm was obtained from P_2 (mid planting at 15 November) which was closely followed 20.62, 35.96, 45.38, 53.59 and 55.08 cm by P_1 (early planting at 1 November) at 30, 40, 50 and 60 DAT and at harvest, respectively. On the other hand, at the same DAT the shortest leaf 19.61, 32.73, 41.50, 48.06 and 48.91 cm was found from P_3 (late planting at 1 December), respectively (Figure 2). Csizinszky (1996) reported highest leaf length for optimum time of planting.

Table 5. Combined effect of planting time and growth regulators on number of leaves per plant of cauliflower

Treatment	Number of leaves per plant				
	30 DAT	40 DAT	50 DAT	60 DAT	Harvest
P_1H_0	10.10 ef	14.50 fg	16.67 ef	19.90 e	20.00 f
P_1H_1	12.50 b	15.10 de	17.50 cd	21.77 cd	22.00 de
P_1H_2	12.30 bc	15.23 de	17.70 c	22.07 bc	22.97 cd
P_1H_3	14.10 a	15.83 bc	18.40 b	23.23 ab	24.13 bc
P_2H_0	11.10 cde	15.00 def	17.13 de	21.13 cde	21.77 de
P_2H_1	14.50 a	16.37 ab	18.97 a	23.97 a	25.60 ab
P_2H_2	11.50 bcd	15.47 cd	17.80 c	22.13 bc	23.00 cd
P_2H_3	14.90 a	16.47 a	19.10 a	24.43 a	25.87 a
P_3H_0	9.27 f	13.50 h	14.33 g	16.17 f	17.93 g
P_3H_1	12.20 bc	14.83 ef	16.83 ef	20.17 e	21.17 ef
P_3H_2	10.60 de	14.17 g	16.33 f	19.83 e	21.10 ef
P_3H_3	12.40 b	15.00 def	17.47 cd	20.50 de	21.23 ef
$LSD_{(0.05)}$	1.168	0.538	0.485	1.219	1.515
Significance level	**	**	**	**	**
CV(%)	5.69	12.10	10.65	8.38	7.02

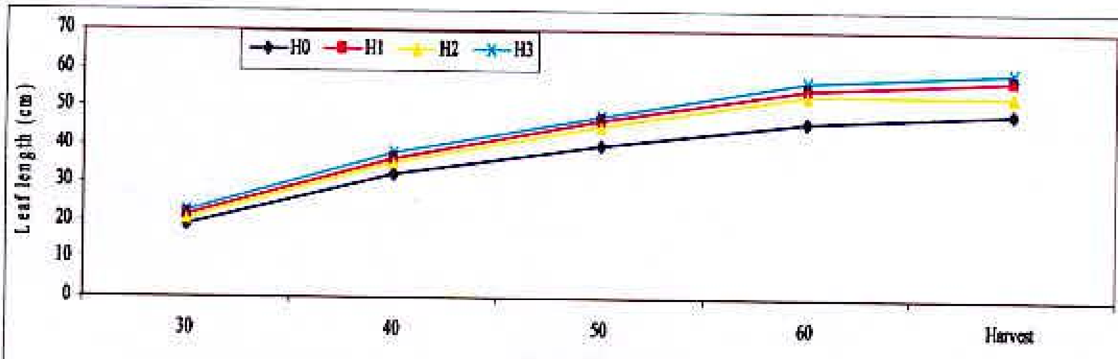
DAT: Days after transplanting

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability



P_1: Early Planting (1 November) P_2: Mid Planting (15 November) P_3: Late Planting (1 December)

Figure 2. Effect of planting time on leaf length of cauliflower



H_0: No Hormone (Control) H_1: IAA 10 ppm H_2: 70 ppm GA3 H_3: 10 ppm IAA + 70 ppm GA3

Figure 3. Effect of growth regulators on leaf length of cauliflower

Leaf length of cauliflower showed significant variation due to application different hormones at 30, 40, 50, 60 DAT and at harvest (Appendix V). At 30, 40, 50, 60 DAT and at harvest the longest leaf 22.23, 37.61, 47.67, 56.87 and 59.30 cm was obtained from H_3 (10 ppm IAA + 70 ppm GA_3) which was followed 21.41, 36.51, 46.39, 54.81 and 57.32 cm by H_1 (10 ppm IAA). Again, the shortest leaf 19.09, 32.12, 39.99, 45.86 and 48.55 cm was observed from H_0 (no hormone) for the same DAT, respectively (Figure 3). Sharma and Mishra (1989) reported that GA_3 and IAA have a positive effect on vegetative growth of cauliflower.

Combined effect of planting time and growth regulators showed statistically significant variation on leaf length of cauliflower at 30, 40, 50, 60 DAT and at harvest (Appendix V). The longest leaf 23.83, 39.88, 50.58, 60.89 and 63.64 cm was found from P_2H_3 (mid planting on 15 November × 10 ppm IAA + 70 ppm GA_3) at 30, 40, 50, 60 DAT and at harvest, respectively and the shortest leaf 18.02, 27.48, 34.63, 38.52 and 40.00 cm was obtained from P_3H_0 (late planting at 1 December × no hormone) at 30, 40, 50, 60 DAT and at harvest, respectively (Table 6).

4.4 Leaf breadth

Leaf breadth of cauliflower differ significantly due to use of different planting time at 30, 40, 50, 60 DAT and at harvest (Appendix VI). At the different days after transplanting (DAT) and at harvest, the highest leaf breadth 10.24, 14.45, 17.21, 18.65 and 19.24 cm was obtained from P_2 (mid planting 15 November) which was closely followed 9.60, 13.91, 16.53, 17.74 and 17.88 cm by P_1 (early planting on 1 November) at 30, 40, 50 and 60 DAT and at harvest, respectively whereas, at the same DAT, the lowest leaf breadth 9.10, 12.80, 15.18, 15.91 and 16.12 cm was recorded from P_3 (late planting on 1 December), respectively (Figure 4). Mid planting time ensured suitable condition for the vegetative growth than the early and late planting. Early planting also lead to favorable vegetative growth with highest leaf breadth than the late planting. Ahmed and Hussain (1985) reported higher vegetative growth obtained from earlier planting which was disagreed to the present study.

Significant variation was recorded for leaf breadth of cauliflower due to the application of different hormones at 30, 40, 50, 60 DAT and at harvest (Appendix VI). At 30, 40, 50, 60 DAT and at harvest the highest leaf breadth 10.37, 14.50, 17.30, 18.75 and 19.07 cm was recorded from H_3 (10 ppm IAA + 70 ppm GA_3) which was followed 10.00, 14.14, 16.85, 18.12 and 18.51 cm by H_1 (10 ppm IAA). On the other hand, the lowest leaf breadth 8.77, 12.59, 14.71, 15.30 and 15.97 cm was recorded from H_0 (no hormone) which was closely followed 9.44, 13.65, 16.38, 17.58 and 17.44 cm by H_2 (70 ppm GA_3) for the same DAT, respectively (Figure 5). Dharmender *et al.* (1996) reported highest plant spread following treatment with 50 ppm GA_3 followed by 50 ppm NAA.

Table 6. Combined effect of planting time and growth regulators on leaf length of cauliflower

Treatment	Leaf length (cm)				
	30 DAT	40 DAT	50 DAT	60 DAT	Harvest
P_1H_0	18.81 ef	33.24 f	41.70 f	48.21 e	49.05 c
P_1H_1	20.62 cd	35.92 cd	45.33 cd	53.54 cd	54.96 b
P_1H_2	20.91 c	36.58 c	46.33 c	54.95 bc	55.36 b
P_1H_3	22.13 b	38.12 b	48.16 b	57.65 ab	60.94 a
P_2H_0	20.45 cd	35.65 cde	43.63 de	50.86 de	56.59 b
P_2H_1	23.61 a	39.15 ab	49.87 ab	59.66 a	62.36 a
P_2H_2	20.73 cd	34.92 de	45.48 cd	53.89 cd	56.73 b
P_2H_3	23.83 a	39.88 a	50.58 a	60.89 a	63.64 a
P_3H_0	18.02 f	27.48 g	34.63 g	38.52 f	40.00 d
P_3H_1	19.99 cd	34.46 def	43.98 de	51.24 cde	54.64 b
P_3H_2	19.70 de	34.15 ef	43.14 ef	50.42 de	47.67 c
P_3H_3	20.73 cd	34.85 de	44.27 de	52.07 cde	53.33 b
$LSD_{(0.05)}$	0.971	1.471	1.805	3.577	3.746
Significance level	**	**	**	**	**
CV(%)	9.76	5.46	6.38	8.01	9.05

DAT: Days after transplanting

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

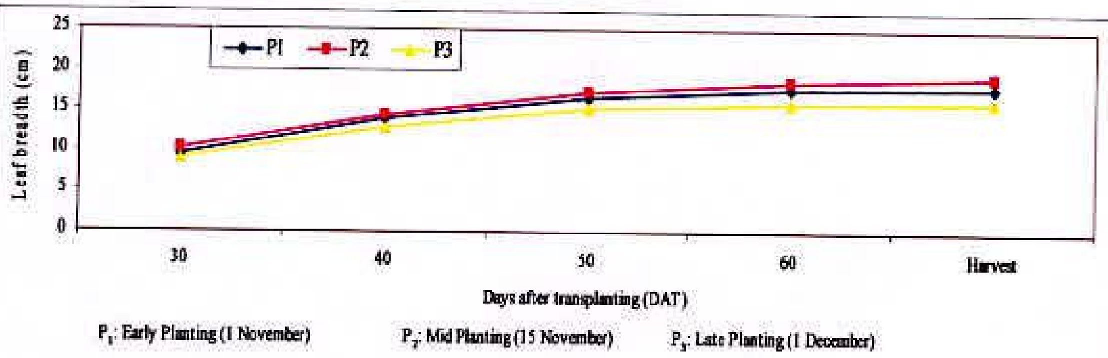


Figure 4. Effect of planting time on leaf breadth of cauliflower

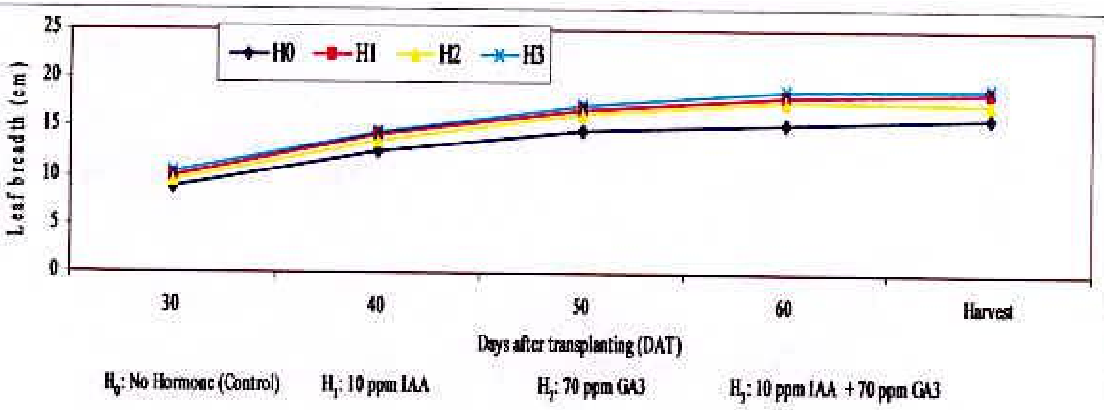


Figure 5. Effect of growth regulators on leaf breadth of cauliflower

A statistically significant differences was recorded due to combined effect of planting time and growth regulators for leaf breadth of cauliflower at 30, 40, 50, 60 DAT and at harvest (Appendix VI). The highest leaf breadth 11.07, 15.30, 18.28, 20.07 and 20.37cm was found from P_2H_3 (mid planting 15 November × 10 ppm IAA + 70 ppm GA_3) at 30, 40, 50, 60 DAT and at harvest, respectively. The lowest leaf breadth 8.26, 11.00, 12.87, 12.89 and 13.62 cm was obtained from P_3H_0 (late planting at 1 December × no hormone) at 30, 40, 50, 60 DAT and at harvest, respectively (Table 7).

4.5 Days from transplanting to curd formation

Days from transplanting to curd formation of cauliflower differ significantly for different planting time (Appendix VII). The minimum 39.58 days from transplanting to curd formation was found from P_2 (mid planting on 15 November) which was followed 42.25 days by P_3 (late planting on 1 December), while the maximum 46.58 days from transplanting to curd formation was noted from P_1 (early planting on 1 November) (Table 8). Optimum planting time leads to maximum vegetative growth that trend to reproductive growth. Dutta (1999) reported that planting time exhibited a significant effect on days to curd formation.

Statistically significant variation was recorded on days from transplanting to curd formation of cauliflower due to the application of different hormones (Appendix VII). The minimum 40.22 days from transplanting to curd formation was found

Table 7. Combined effect of planting time and growth regulators on leaf breadth of cauliflower

Treatment	Leaf breadth (cm)				
	30 DAT	40 DAT	50 DAT	60 DAT	Harvest
P_1H_0	8.68 ef	12.97 f	15.32 g	16.07 e	16.13 c
P_1H_1	9.63 c	13.89 cd	16.51 cde	17.73 cd	17.83 b
P_1H_2	9.69 c	14.11 c	16.85 c	18.16 bc	18.02 b
P_1H_3	10.40 b	14.66 b	17.45 b	19.01 ab	19.53 a
P_2H_0	9.37 cd	13.79 cd	15.94 ef	16.94 cde	18.16 b
P_2H_1	10.94 a	15.09 ab	18.04 a	19.70 a	20.07 a
P_2H_2	9.58 c	13.64 cde	16.58 cd	17.91 bcd	18.36 b
P_2H_3	11.07 a	15.30 a	18.28 a	20.07 a	20.37 a
P_3H_0	8.26 f	11.00 g	12.87 h	12.89 f	13.62 d
P_3H_1	9.42 cd	13.43 def	15.98 def	16.93 cde	17.64 b
P_3H_2	9.05 de	13.21 ef	15.70 fg	16.68 de	15.94 c
P_3H_3	9.66 c	13.55 de	16.17 def	17.16 cde	17.31 b
$LSD_{(0.05)}$	0.425	0.445	0.557	1.112	0.995
Significance level	**	**	**	**	**
CV(%)	12.61	10.91	6.02	8.77	5.31

DAT: Days after transplanting

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

from H_3 (10 ppm IAA + 70 ppm GA_3) which was statistically identical 41.33 to H_2 (70 ppm GA_3). On the other hand, the maximum 45.67 days from transplanting to curd formation was found from H_0 (no hormone) which was closely followed 44.00 by H_1 (10 ppm IAA) (Table 8).

Combined effect of planting time and growth regulators showed significant variation in terms of days from transplanting to curd formation (Appendix VII). The minimum 38.00 days from transplanting to curd formation was observed from P_2H_3 (mid planting on 15 November × 10 ppm IAA + 70 ppm GA_3) where as the maximum 49.67 days from transplanting to curd formation was recorded from P_1H_0 (early planting on 1 November × no hormone) (Table 9). Combination of IAA and GA_3 leads to maximum vegetative and reproductive growth and the ultimate results was the earlier curd formation. Dharmender *et al.* (1996) reported 75 ppm GA_3 reduced the mean number of days required to start head formation.

4.6 Days from transplanting to 50% curd formation

Days from transplanting to 50% curd formation of cauliflower differed significantly on different planting time (Appendix VII). The minimum days (45.42) from transplanting to 50% curd initiation was recorded from P_2 (mid planting at 15 November) and the maximum 51.92 days from transplanting to 50% curd formation was found from P_1 (early planting on 1 November) (Table 8). Ahmed and Hussain (1985) reported that early planting took longer period for curd initiation than that of late planting.

Table 8. Effect of planting time and growth regulators on yield contributing characters of cauliflower

Treatment	Days from transplanting to curd initiation	Days from transplanting to 50% curd initiation	Days from transplanting to harvest	Stem length (cm)	Stem Diameter (cm)
Planting time					
P_1	46.58 a	51.92 a	66.67 a	10.00 b	1.49 b
P_2	39.58 c	45.42 c	61.75 c	11.42 a	1.66 a
P_3	42.25 b	47.75 b	63.67 b	9.16 c	1.30 c
$LSD_{(0.05)}$	1.346	1.434	1.614	0.377	0.027
Significance level	0.01	0.01	0.01	0.01	0.01
Growth regulators					
H_0	45.67 a	50.33 a	67.56 a	9.52 c	1.25 d
H_1	44.00 b	48.44 b	65.56 b	10.40 b	1.63 b
H_2	41.33 c	48.22 b	63.00 c	9.61 c	1.36 c
H_3	40.22 c	46.44 c	60.00 d	11.25 a	1.69 a
$LSD_{(0.05)}$	1.554	1.656	1.864	0.435	0.031
Significance level	**	**	**	**	**
CV(%)	9.71	10.50	11.98	10.36	6.27

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Table 9. Interaction effect of planting time and growth regulators on yield contributing characters of cauliflower

Treatment	Days from transplanting to curd initiation	Days from transplanting to 50% curd initiation	Days from transplanting to harvest	Stem length (cm)	Stem Diameter (cm)
P_1H_0	49.67 a	52.33 a	69.00 a	9.12 ef	1.29 f
P_1H_1	46.00 bc	52.67 a	65.33 ab	9.43 def	1.68 c
P_1H_2	46.67 b	51.33 ab	68.67 a	10.07 cd	1.34 f
P_1H_3	44.00 bcd	51.33 ab	64.00 b	11.40 b	1.66 c
P_2H_0	42.67 d	47.33 cd	67.33 ab	10.59 c	1.42 e
P_2H_1	42.33 d	43.67 e	65.33 ab	12.56 a	1.76 b
P_2H_2	35.33 f	45.67 de	56.33 c	9.74 de	1.60 d
P_2H_3	38.00 ef	45.00 de	58.00 c	12.80 a	1.86 a
P_3H_0	44.67 bcd	51.33 ab	66.67 ab	8.84 f	1.04 h
P_3H_1	43.67 cd	49.00 bc	66.00 ab	9.22 ef	1.45 e
P_3H_2	42.00 d	47.67 cd	64.00 b	9.03 ef	1.14 g
P_3H_3	38.67 e	43.00 e	58.00 c	9.55 def	1.56 d
$LSD_{(0.05)}$	2.692	2.868	3.228	0.754	0.054
Significance level	**	**	**	**	**
CV(%)	9.71	10.50	11.98	10.36	6.27

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Days from transplanting to 50% curd formation of cauliflower showed significant variation due to application of different hormones (Appendix VII). The minimum 46.44 days from transplanting to 50% curd formation was observed from H_3 (10 ppm IAA + 70 ppm GA_3) which was followed by H_2 (70 ppm GA_3) and H_1 (10 ppm IAA) that was 48.22 and 48.44 days, respectively whereas, the maximum 50.33 days from transplanting to 50% curd formation was observed from H_0 (no hormone) (Table 8). Sharma and Mishra (1989) curd formation of cauliflower can increase with foliar application of plant growth regulator.

Significant differences were recorded due to formation effect of planting time and growth regulators in terms of days from transplanting to 50% curd formation (Appendix VII). The minimum 43.00 days from transplanting to 50% curd formation was obtained from P_3H_3 (late planting at 1 December × 10 ppm IAA + 70 ppm GA_3) where as the maximum 52.33 days from transplanting to 50% curd formation was recorded from P_1H_0 (early planting at 1 November × no hormone) (Table 9).

4.7 Days from transplanting to harvest

Statistically significant variation was recorded for days from transplanting to harvest of cauliflower for different planting time (Appendix VII). The minimum 61.75 days from transplanting to harvest was found from P_2 (mid planting on 15 November) and the maximum 66.67 days from transplanting to harvest was foud from P_1 (early planting on 15 November) (Table 8). Ahmed and Hussain (1985) reported that early planting took longer period for curd formation than that of late planting.

A significant variation was found due to application of different hormones on days from transplanting to harvest of cauliflower (Appendix VII). The minimum 60.00 days from transplanting to harvest was found from H_3 (10 ppm IAA + 70 ppm GA_3) while the maximum 67.56 days from transplanting to harvest was observed in H_0 (no hormone) (Table 8). Dharmender *et al.* (1996) reported minimum days of maturity following treatment with 50 ppm GA_3 followed by 50 ppm NAA.

Combined effect of planting time and growth regulators in terms of days from transplanting to harvest showed statistically significant differences (Appendix VII). The minimum 56.33 days from transplanting to harvest was recorded from P_2H_2 (mid planting on 15 November × 70 ppm GA_3) while the maximum 69.00 days from transplanting to harvest was obtained from P_1H_0 (early planting on 1 November × no hormone) (Table 9).

4.8 Root length

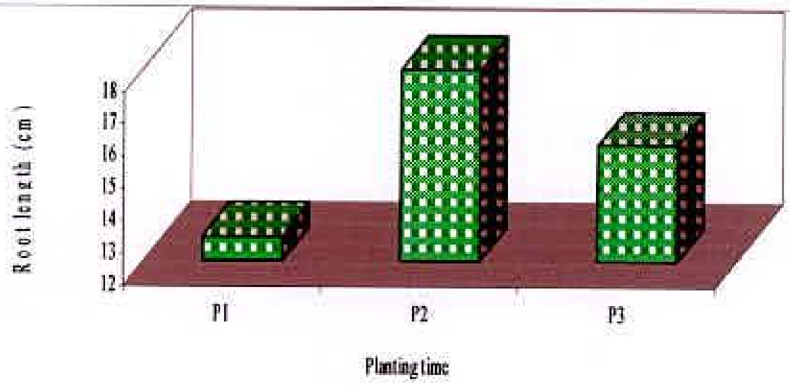
Due to use of different planting time showed significant influence on root length of cauliflower (Appendix VII). The longest root length 17.96 cm was found from P_2 (mid planting on 15 November) and the shortest root length 12.78 cm was obtained from P_1 (early planting on 1 November) (Figure 6). Ahmed and Hussain (1985) reported that early planting took longer period for growth and development than that of late planting.

Significant variation was recorded on root length of cauliflower due to the application of different hormones (Appendix VII). The longest root length 16.30 cm was observed from H_3 (10 ppm IAA + 70 ppm GA_3) which was statistically identical (15.47 cm, 15.33 cm) to H_0 (no hormone) and H_1 (10 ppm IAA). Again, the lowest root length (14.71 cm) was recorded from H_2 (70 ppm GA_3) (Figure 7).

Root length showed statistically significant variation due to the combined effect of planting time and growth regulators (Appendix VII). The longest root length 19.99 cm was recorded from P_2H_3 (mid planting on 15 November × 10 ppm IAA + 70 ppm GA_3) where as the lowest root length 12.14 cm was found from P_1H_1 (early planting on 1 November × 10 ppm IAA) (Figure 8).

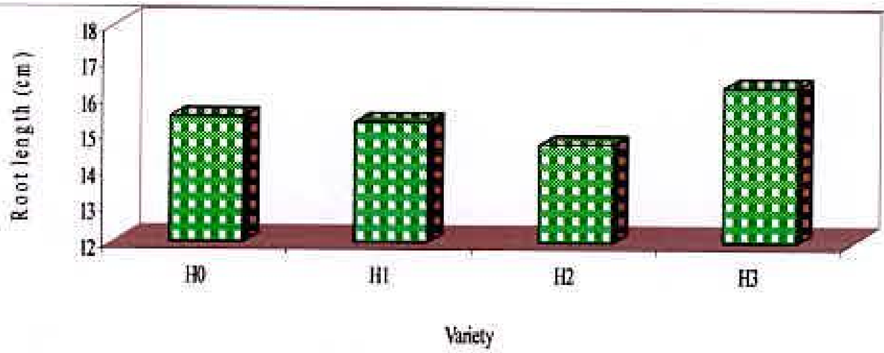
4.9 Stem length

Planting time showed statistically significant variation on stem length of cauliflower (Appendix VII). The longest stem length (11.42 cm) was obtained from P_2 (mid planting on 15 November) which was closely followed 10.00 cm by P_3 (late planting on 1 December) and the lowest stem length 9.16 cm was found from P_1 (early planting at 1 November) (Table 8). Ghanti and Mallik (1995) reported that stems were longest in August-transplanted crops for in early market.



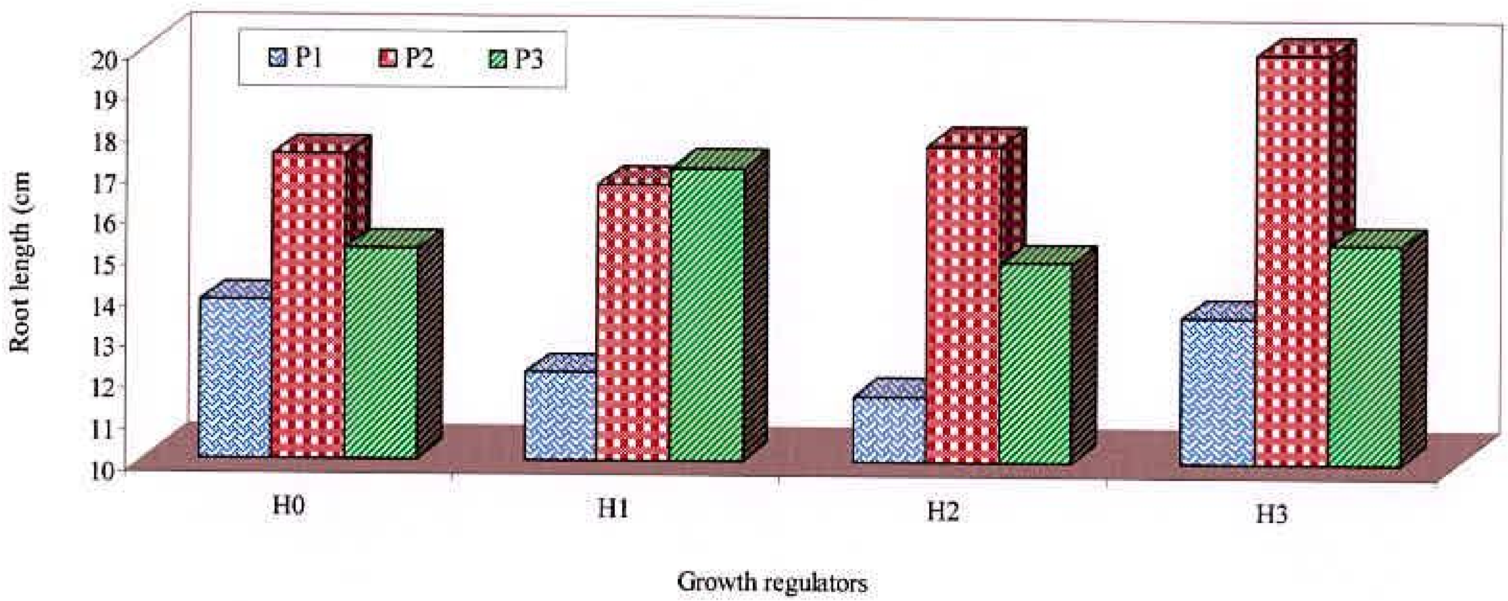
P₁: Early Planting (1 November) P₂: Mid Planting (15 November) P₃: Late Planting (1 December)

Figure 6. Effect of planting time on root length of cauliflower



H_0: No Hormone (Control) H_1: 10 ppm IAA H_2: 70 ppm GA_3 H_3: 10 ppm IAA + 70 ppm GA_3

Figure 7. Effect of growth regulators on root length of cauliflower



P_1: Early Planting (1 November)
P_2: Optimum Planting (15 November)
P_3: Late Planting (1December)

H_0: No Hormone (Control)
H_1: 10 ppm IAA
H_2: 70 ppm GA_3
H_3: 10 ppm IAA + 70 ppm GA_3

Figure 8. Interaction effect of planting time and growth regulators on root length of cauliflower

A significant variation was recorded on stem length due to application of different hormones (Appendix VII). The longest stem length 11.25 cm was recorded from H_3 (10 ppm IAA + 70 ppm GA_3) and the lowest (9.52 cm) was observed from H_0 (no hormone) which was statistically similar 9.61 cm to H_2 (70 ppm GA_3) (Table 8).

Significant differences were recorded due to combined effect of planting time and growth regulators in terms of stem length (Appendix VII). The longest stem 12.80 cm was obtained from P_2H_3 (mid planting on 15 November × 10 ppm IAA + 70 ppm GA_3) where as the shortest stem 9.03 cm was recorded from P_3H_2 (late planting at 1 December × 70 ppm GA_3) (Table 9).

4.10 Stem diameter

Stem diameter of cauliflower showed significant variation due to different planting time (Appendix VII). The highest stem diameter 1.66 cm was recorded from P_2 (mid planting on 15 November) and the lowest stem diameter (1.30 cm) was found from P_3 (late planting on 1 December) (Table 8).

Stem diameter of showed significant differences due to the application of different hormones (Appendix VII). The highest stem diameter 1.69 cm was recorded from H_3 (10 ppm IAA + 70 ppm GA_3) which was closely followed 1.63 cm by H_1 (10 ppm IAA). On the other hand, the lowest stem diameter 1.25 cm was recorded from H_0 (no hormone) (Table 8).

Combined effect of planting time and growth regulators in terms of stem diameter showed statistically significant variation (Appendix VII). The highest stem diameter 1.86 cm was obtained from P_2H_3 (mid planting on 15 November × 10 ppm IAA + 70 ppm GA_3) where as the lowest stem diameter (1.04 cm) was found from P_3H_0 (late planting on 1 December × no hormone) (Table 9).

4.11 Curd weight with leaf

Curd weight with leaf of cauliflower differed significantly due to different planting time (Appendix VIII). The highest curd weight with leaf 2.15 kg was obtained from P_2 (mid planting on 15 November) and the lowest curd weight with leaf 1.54 kg was recorded from P_3 (late planting on 1 December) (Table 10). Dutta (1999) reported that planting time exhibited a significant effect on curd weight with leaf.

Curd weight with leaf of cauliflower showed statistically significant variation due to the application of different hormones (Appendix VIII). The highest curd weight with leaf 2.06 kg was observed from H_3 (10 ppm IAA + 70 ppm GA_3) which was closely followed 1.98 kg by H_1 (10 ppm IAA). The lowest curd weight with leaf 1.59 kg was found from H_0 (no hormone) (Table 10). Sharma and Mishra (1989) stated that curd size of cauliflower can increase with foliar application of plant growth regulator.

Table 10. Effect of planting time and growth regulators on yield contributing characters and yield of cauliflower

Treatment	Curd weight with leaf (kg)	Pure curd height (cm)	Curd Diameter (cm)	Marketable yield (kg/plant)	Marketable yield (t/ha)
Planting time					
P_1	1.94 b	12.23 c	21.98 a	1.08 b	27.05 b
P_2	2.15 a	15.09 a	22.82 a	1.12 a	28.11 a
P_3	1.54 c	13.75 b	17.58 b	1.04 c	25.98 c
$LSD_{(0.05)}$	0.060	0.660	0.961	0.027	0.569
Significance level	**	**	**	**	**
Growth regulators					
H_0	1.59 d	12.42 b	18.86 c	0.94 d	23.47 d
H_1	1.98 b	14.33 a	21.62 a	1.12 b	27.89 b
H_2	1.88 c	13.03 b	20.06 b	1.08 c	26.95 c
H_3	2.06 a	14.97 a	22.65 a	1.20 a	29.88 a
$LSD_{(0.05)}$	0.069	0.762	1.110	0.031	0.657
Significance level	**	**	**	**	**
CV(%)	9.68	6.69	5.46	8.48	8.48

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Statistically significant variation was recorded due to combined effect of planting time and growth regulators for curd weight with leaf (Appendix VIII). The highest curd weight with leaf 2.42 kg was obtained from the treatment combination of P_2H_3 (mid planting on 15 November × 10 ppm IAA + 70 ppm GA_3) where as the lowest curd weight with leaf 1.31 kg was observed from P_3H_0 (late planting 1 December × no hormone) (Table 11).

4.12 Pure curd height

Statistically significant variation was recorded on pure curd height of cauliflower due to different planting time (Appendix VIII). The maximum pure curd height 15.09 cm was recorded from P_2 (mid planting 15 November) and the minimum pure curd height 12.23 cm was found from P_1 (early planting on 1 November) (Table 10).

Due to the application of different hormones showed significant variation on pure curd height of cauliflower (Appendix VIII). The maximum pure curd height 14.97 cm was recorded from H_3 (10 ppm IAA + 70 ppm GA_3) which was statistically identical 14.33 cm with H_1 (10 ppm IAA). The minimum pure curd height 12.42 cm was recorded from H_0 (no hormone) which was statistically similar 13.03 cm to H_2 (70 ppm GA_3) (Table 10). Vijay and Ray (2000) reported that GA_3 at 100 ppm produced the largest curds.

Table 11. Combined effect of planting time and growth regulators on yield contributing characters and yield of cauliflower

Treatment	Curd weight with leaf (kg)	Pure curd height (cm)	Curd Diameter (cm)	Marketable yield (kg/plant)	Marketable yield (t/ha)
P_1H_0	1.62 ef	10.39 g	18.67 efg	0.98 e	24.58 e
P_1H_1	1.92 cd	13.36 def	21. 35 cd	1.05 d	26.17 d
P_1H_2	2.03 c	11.18 g	22.85 bc	1.10 cd	27.60 c
P_1H_3	2.20 b	13.98 cdef	25.05 a	1.19 ab	29.87 ab
P_2H_0	1.86 d	14.24 bcde	21.55 cd	0.96 e	24.08 e
P_2H_1	2.32 ab	15.64 ab	24.19 ab	1.22 a	30.40 a
P_2H_2	2.01 c	14.73 abcd	19.81 de	1.08 d	26.95 cd
P_2H_3	2.42 a	15.78 a	25.75 a	1.24 a	31.03 a
P_3H_0	1.31 g	12.64 f	16.35 h	0.87 f	21.75 f
P_3H_1	1.71 e	14.00 cdef	19.30 ef	1.08 d	27.12 cd
P_3H_2	1.59 ef	13.19 ef	17.52 fgh	1.05 d	26.31 d
P_3H_3	1.55 f	15.16 abc	17.14 gh	1.15 bc	28.74 b
$LSD_{(0.05)}$	0.120	1.319	1.922	0.054	1.137
Significance level	**	**	**	**	**
CV(%)	9.68	6.69	5.46	8.48	8.48

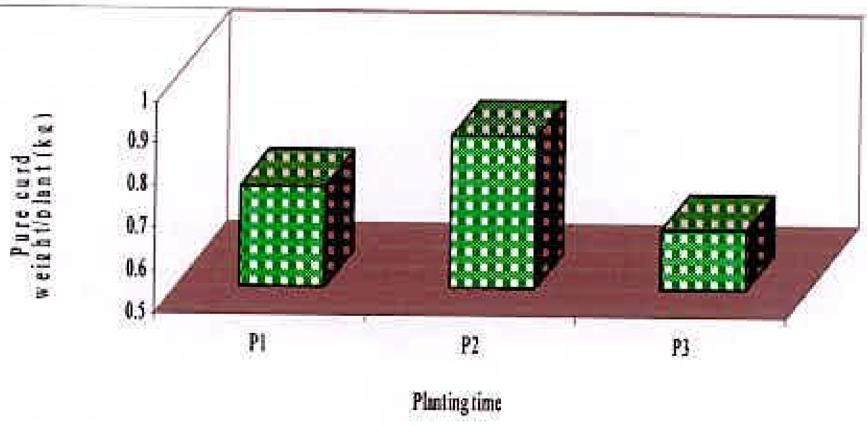
In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Statistically significant differences were recorded due to combined effect of planting time and growth regulators for pure curd height (Appendix VIII). The maximum pure curd height 15.78 cm was found from the treatment combination of P_2H_3 (mid planting on 15 November × 10 ppm IAA + 70 ppm GA_3) where as the minimum pure curd height (10.39 cm) was found from P_1H_0 (early planting on 1 November × no hormone) (Table 11).

4.13 Pure curd weight

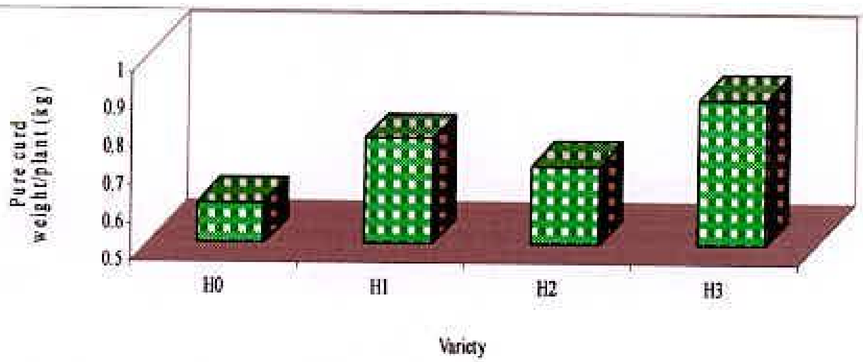
Pure curd weight of cauliflower showed statistically significant variation due to different planting time (Appendix VIII). The highest pure curd weight 0.86 kg was recorded from P_2 (mid planting on 15 November) which was closely followed 0.74 kg by P_1 (early planting on 15 November) and the lowest pure curd weight 0.64 kg was obtained from P_3 (late planting on 1 December) (Figure 9). Dutta (1999) reported that planting time exhibited a significant effect on curd weight.

Significant variation was recorded on pure curd weight of cauliflower due to the application of different hormones (Appendix VIII). The highest pure curd weight 0.89 kg was observed from H_3 (10 ppm IAA + 70 ppm GA_3) which was closely followed 0.78 kg by H_1 (10 ppm IAA), while, the lowest pure curd weight (0.61 kg) was observed from and H_0 (no hormone) which was closely followed (0.71 kg) with H_2 (GA_3 at 70 ppm) (Figure 10). Vijay and Ray (2000) reported that GA_3 at 100 ppm produced the highest curd yields.



P_1: Early Planting (1 November) P_2: Optimum Planting (15th November) P_3: Late Planting (1 December)

Figure 9. Effect of planting time on pure curd weight/plant of cauliflower



H_0: No Hormone (Control) H_1: 10 ppm IAA H_2: 70 ppm GA_3 H_3: 10 ppm IAA + 70 ppm GA_3

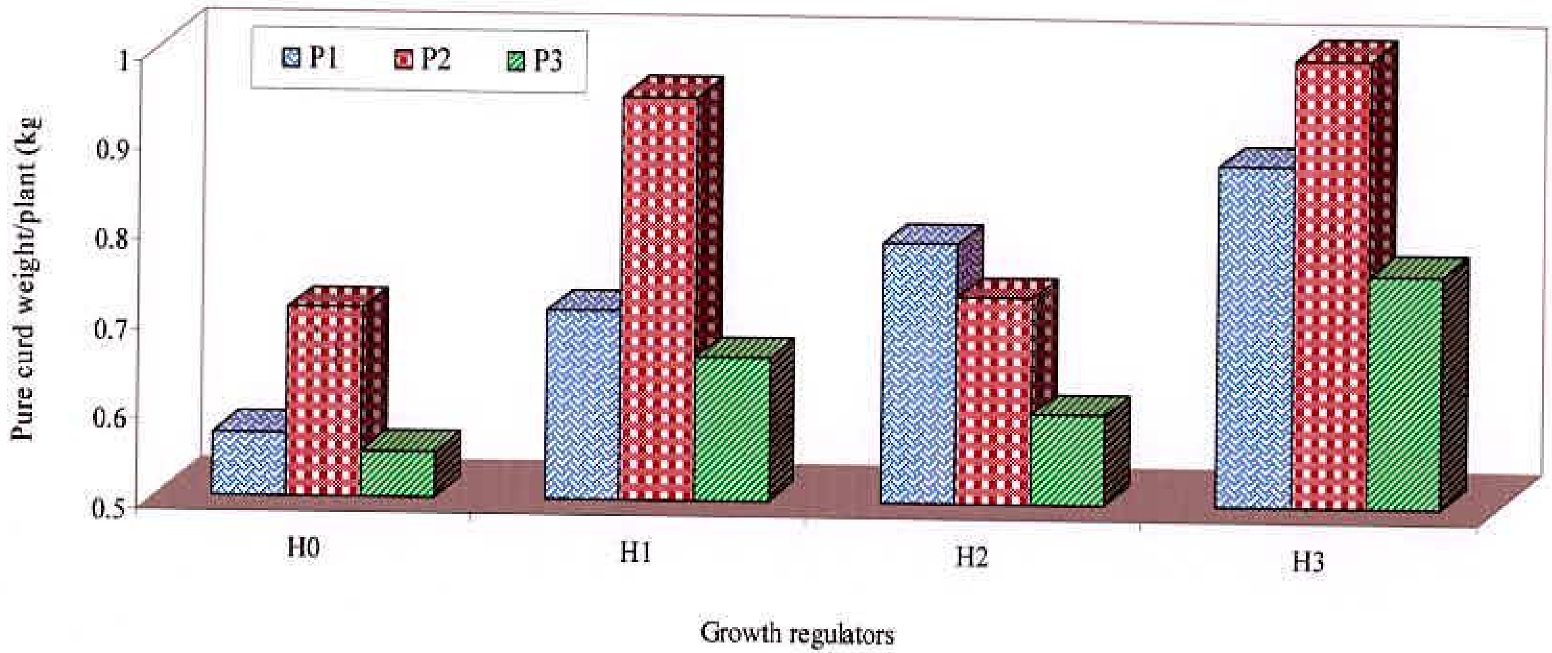
Figure 10. Effect of growth regulators on pure curd weight/plant of cauliflower

Combined effect of planting time and growth regulators showed statistically significant variation was recorded in terms of pure curd weight (Appendix VIII). The highest pure curd weight 1.03 kg was recorded from P_2H_3 (mid planting on 15 November × 10 ppm IAA + 70 ppm GA_3) and the lowest pure curd weight 0.55 kg was observed from P_3H_0 (late planting on 1 December × no hormone) that is presented in Figure 11.

4.14 Curd diameter

Curd diameter of cauliflower differed significantly due to different planting time (Appendix VIII). The maximum curd diameter 22.82 cm was found from P_2 (mid planting at 15 November) which was statistically similar 21.98 cm to P_1 (early planting on 1 November) and the minimum curd diameter 17.58 cm was obtained from P_3 (late planting on 1 December) (Table 10). Ara *et al*. (2009) reported that curd diameter per plant significantly differed among different planting dates.

Curd diameter of cauliflower showed statistically significant due to the application of different hormones (Appendix VIII). The maximum curd diameter 22.65 cm was recorded from H_3 (10 ppm IAA + 70 ppm GA_3) which was statistically identical 21.62 cm with H_1 (10 ppm IAA), whereas, the minimum curd diameter 18.86 cm was recorded from H_0 (no hormone) which was closely followed 20.06 cm by H_2 (70 ppm GA_3) (Table 10). Reddy (1989) reported that curd diameter at maturity 26.8 cm were obtained with the application of GA_3.



P_1: Early Planting (1 November)
P_2: Optimum Planting (15 November)
P_3: Late Planting (1 December)

H_0: No Hormone (Control)
H_1: 10 ppm IAA
H_2: 70 ppm GA_3
H_3: 10 ppm IAA + 70 ppm GA_3

Figure 11. Combined effect of planting time and growth regulators on pure curd weight/plant of cauliflower

A statistically significant difference was observed due to combined effect of planting time and growth regulators in terms of curd diameter (Appendix VIII). The maximum curd diameter 25.75 cm was found from P_2H_3 (mid planting on 15 November × 10 ppm IAA + 70 ppm GA_3) where as the minimum curd diameter 16.35 cm was recorded from the treatment combination of P_3H_0 (late planting on 1 December × no hormone) that is shown in Table 11.

4.15 Marketable yield per plant

Planting time showed statistically significant variation on marketable yield per plant of cauliflower (Appendix VIII). The highest marketable yield per plant 1.12 kg was recorded from P_2 (mid planting on 15 November) which was closely followed 1.08 kg by P_1 (early planting 1 November) and the lowest marketable yield per plant 1.04 kg was obtained from P_3 (late planting on 1 December) that is shown in Table 10. Optimum planting time ensured suitable condition for the vegetative and reproductive growth than the early and late planting and the ultimate results was highest marketable yield of cauliflower. Ara *et al.* (2009) reported that weight of marketable curd per plant significantly differed among different planting dates.

Marketable yield per plant of cauliflower varied significantly due to the application of different hormones (Appendix VIII). The highest marketable yield per plant 1.20 kg was recorded from H_3 (10 ppm IAA + 70 ppm GA_3) which was closely followed 1.12 kg by H_1 (10 ppm IAA) and the lowest marketable yield per plant 0.94 kg was found from and H_0 (no hormone) (Table 10). Combination of

IAA and GA_3 ensured maximum vegetative and reproductive growth that leads to highest marketable yield Vijay and Ray (2000) reported that GA_3 at 100 ppm produced the highest curd yields.

Combined effect of planting time and different hormones showed significant variation on marketable yield per plant (Appendix VIII). The highest marketable yield per plant 1.24 kg was recorded from the treatment combination of P_2H_3 (mid planting on 15 December × 10 ppm IAA + 70 ppm GA_3) which was statistical similar to P_2H_1 1.22 kg and P_1H_3 1.19 kg and the lowest marketable yield per plant 0.87 kg was recorded from P_3H_0 (late planting on 1 December × no hormone) (Table 11).

4.16 Marketable yield per hectare

Marketable yield per hectare of cauliflower varied significantly due to different planting time (Appendix VIII). The highest marketable yield 28.11 t/ha was observed from P_2 (mid planting on 15 November) and the lowest marketable yield 25.98 t/ha was found from P_3 (late planting on 1 December) (Table 10). Similar trends of results also reported by Ara *et al.* (2009). Dutta (1999) reported that highest yield in early cultivars (117.0 q/ha) was obtained from the delayed planting on 21 September, in mid-season cultivars (129.6 q/ha) it was obtained from the delayed planting on 31 October, and in late cultivars, maximum yield of 68.3 q/ha was recorded with the medium late planting on 25 November.

Statistically significant variation was recorded for marketable yield per hectare of cauliflower due to application different hormones (Appendix VIII). The highest marketable yield 29.88 t/ha was found from H_3 (10 ppm IAA + 70 ppm GA_3) which was closely followed 27.89 t/ha by H_1 (10 ppm IAA). The lowest marketable yield 23.47 t/ha was obtained from and H_0 (no hormone) which was closely followed (26.95 ton) by H_2 (70 ppm GA_3) (Table 10). Dharmender *et al.* (1996) recorded the highest yield following treatment with 50 ppm GA_3 followed by 50 ppm NAA 557.54 and 528.66 q/ha respectively.

Marketable yield per hectare showed statistically significant variation was recorded due to combined effect of planting time and different hormones (Appendix VIII). The highest marketable yield 31.03 t/ha was observed from P_2H_3 (mid planting 15 November × 10 ppm IAA + 70 ppm GA_3), while the lowest marketable yield 21.75 t/ha was found from P_3H_0 (late planting on 1 December × no hormone) (Table 11).

4.17 Economic analysis

Input costs for land preparation, ploughing, seedling cost, growth regulators, fertilizer, irrigation and manpower required for all the operations from planting to harvesting of cauliflower were recorded for unit plot and converted into cost per hectare. Price of cauliflower was considered as per market rate of Kowran Bazar, Dhaka. The economic analysis presented under the following headings-

Table 12. Cost and return of cauliflower cultivation as influenced by planting time and growth regulators

Treatment	Cost of production (Tk./ha)	Yield of cauliflower (t/ha)	Gross return (Tk./ha)	Net return (Tk./ha)	Benefit cost ratio
P_1H_0	136,364	24.58	245,800	109,436	1.80
P_1H_1	138,632	26.17	261,700	123,068	1.89
P_1H_2	138,632	27.60	276,000	137,368	1.99
P_1H_3	140,901	29.87	298,700	157,799	2.12
P_2H_0	136,364	24.08	240,800	104,436	1.77
P_2H_1	138,632	30.40	304,000	165,368	2.19
P_2H_2	138,632	26.95	269,500	130,868	1.94
P_2H_3	140,901	31.03	310,300	169,399	2.20
P_3H_0	136,364	21.75	217,500	81,136	1.59
P_3H_1	138,632	27.12	271,200	132,568	1.96
P_3H_2	138632	26.31	263,100	124,468	1.90
P_3H_3	140901	28.74	287,400	146,499	2.04

Price of cauliflower @ tk. 10000/ton as per market rate of Kawran Bazar, Dhaka.

4.17.1 Cost of production

The combination of planting time and growth regulators showed different cost of production under the trial. The highest cost of production Tk. 140901/ha was obtained from the treatment combination of P_2H_3 (mid planting on 15 November × 10 ppm IAA + 70 ppm GA_3) and the second highest cost of production Tk. 138632/ha was found in P_2H_1 (mid planting on 15 November × 10 ppm IAA). The lowest cost of production Tk. 136364/ha was obtained from P_3H_0 (late planting on 1December × no hormone).

4.17.2 Gross return

The combination of planting time and growth regulators showed different gross return under the trial. The highest gross return Tk. 310,300/ha was obtained from the treatment combination of P_2H_3 (mid planting on 15 November × 10 ppm IAA + 70 ppm GA_3) and the second highest gross return Tk. 304,000/ha was found in P_2H_1 (mid planting on 15 November × 10 ppm IAA). The lowest gross return Tk. 217,500/ha was obtained from P_3H_0 (late planting on 1December × no hormone).

4.17.3 Net return

In case of net return different treatment combination showed different levels of net return. The highest net return Tk. 169,399/ha was found from the treatment combination of P_2H_3 and the second highest net return Tk. 165,368/ha was obtained from the combination of P_2H_1. The lowest Tk. 81,136/ha net return was obtained from P_3H_0 (Table 12).

4.17.4 Benefit cost ratio

In the combination of planting time and growth regulators highest benefit cost ratio 2.20 was noted from the treatment combination of P_2H_3 and the second highest benefit cost ratio 2.12 was estimated from the combination of P_1H_3. The lowest benefit cost ratio (1.59) was obtained from P_3H_0 (Table 12). From economic point of view, it is apparent from the above results that the combination of P_2H_3 was more profitable than those of other treatment.

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during the period from October 2007 to March 2008 to find out the effect of planting time and growth regulators on the growth and yield of cauliflower. The experiment consisted of two factors; Factor A : Planting Time - 3 levels such as P_1: Early planting on 1 November; P_2: Mid planting on 15 November and P_3: Late planting on 1 December; Factor B: Plant growth regulators - 4 levels, such as H_0: No hormone (control); H_1: 10 ppm IAA (Indole Acetic Acid); H_2: 70 ppm GA_3 (Gibberelic Acid) and H_3: 10 ppm IAA + 70 ppm GA_3. The experiment was laid out following Randomized Complete Block Desgin (RCBD) with three replications. Data on different yield contributing characters and yield were recorded.

At 30, 40, 50 and 60 DAT and harvest the tallest plant (27.30, 42.17, 53.12, 60.67 and 63.82 cm) was recorded from P_2 and at the same DAT the shortest (24.85, 37.56, 47.41, 52.38 and 53.03 cm) was observed from P_3. The maximum number of leaves per plant (13.00, 15.82, 18.25, 22.92 and 24.06) was observed from P_2 and at the same DAT the minimum (11.12, 14.38, 16.24, 19.17 and 20.36) was found from P_3. The highest leaf length (22.15, 37.40, 47.39, 56.32 and 59.83 cm) was recorded from P_2 and at the same DAT the lowest (19.61, 32.73, 41.50, 48.06 and 48.91 cm) was observed from P_3. The highest leaf breadth (10.24, 14.45, 17.21, 18.65 and 19.24 cm) was observed from P_2 whereas at the same DAT the lowest (9.10, 12.80, 15.18, 15.91 and 16.12 cm) was found from P_3. The minimum days from transplanting to curd formation (39.58) was found from P_2, while the maximum (46.58) was observed from P_1. The minimum days from transplanting to 50% curd formation (45.42) was recorded from P_2 and the maximum (51.92) was found from P_1. The minimum days from transplanting to harvest (61.75) were found from P_2 and the maximum (66.67) were obtained from P_1. The highest root length (17.96 cm) was found from P_2 and the lowest (12.78 cm) was obtained from P_1. The highest stem length (11.42 cm) was obtained from P_2 and the lowest (9.16 cm) was found from P_1. The highest stem diameter (1.66 cm) was recorded from P_2 and the lowest (1.30 cm) was found from P_3. The highest curd weight with leaf (2.15 kg) was obtained from P_2 and the lowest (1.54 kg) was recorded from P_3. The maximum pure curd height (15.09 cm) was recorded from P_2 and the minimum (12.23 cm) was found from P_1. The highest pure curd weight (0.86 kg) was recorded from P_2 and the lowest (0.64 kg) was obtained from P_3. The maximum curd diameter (22.82 cm) was found from P_2 and the minimum (17.58 cm) was obtained from P_3. The highest marketable yield per plant (1.12 kg) was recorded from P_2 and the lowest (1.04 kg) was observed from P_3. The highest marketable yield per hectare (28.11 ton) was observed from P_2 and the lowest (25.98 ton) was found from P_3.

At 30, 40, 50, 60 DAT and at harvest the longest plant (27.25, 42.34, 53.38, 61.03 and 63.254 cm) was found from H_3 and the shortest (24.34, 36.89, 45.75, 50.16 and 52.64 cm) was recorded from H_0. At 30, 40, 50, 60 DAT and at harvest the maximum number of leaves per plant (13.80, 15.77, 18.32, 22.72 and 23.74) was recorded from H_3, while the minimum (10.16, 14.33, 16.04, 19.07 and 19.90) was found from H_0. At 30, 40, 50, 60 DAT and at harvest the highest leaf length (22.23, 37.61, 47.67, 56.87 and 59.30 cm) was obtained from H_3 again, the lowest (19.09, 32.12, 39.99, 45.86 and 48.55 cm) was observed from H_0. At 30, 40, 50, 60 DAT and at harvest the highest leaf breadth (10.37, 14.50, 17.30, 18.75 and 19.07 cm) was recorded from H_3 and the lowest (8.77, 12.59, 14.71, 15.30 and 15.97 cm) was recorded from H_0. The minimum Days from transplanting to curd formation (40.22) were recorded from H_3 and the maximum (45.67) was found from H_0. The minimum Days from transplanting to 50% curd formation (46.44) were observed from H_3 whereas, the maximum (50.33) was observed from H_0. The minimum Days from transplanting to harvest (60.00) was found from H_3 again, the maximum (67.56) was observed from H_0. The highest root length (16.30 cm) was observed from H_3 again, the lowest (14.71 cm) was recorded from H_2. The highest stem length (11.25 cm) was recorded from H_3 and the lowest (9.52 cm) was observed from and H_0. The highest stem diameter (1.69 cm) was recorded from H_3 and the lowest (1.25 cm) was found from and H_0. The highest curd weight with leaf (2.06 kg) was observed from H_3 and the lowest (1.59 kg) was found from and H_0. The maximum pure curd height (14.97 cm) was recorded from H_3 and the minimum (12.42 cm) was recorded from and H_0. The highest pure curd weight (0.89 kg) was observed from H_3 while, the lowest (0.61 kg) was observed from and H_0. The maximum curd diameter (22.65 cm) was recorded from H_3 whereas, the minimum (18.86 cm) was recorded from and H_0. The highest marketable yield per plant (1.20 kg) was recorded from H_3 and the lowest (0.94 kg) was found from and H_0. The highest marketable yield per hectare (29.88 ton) was found from H_3 and the lowest (23.47 ton) was from H_0.

The longest plant (28.77, 44.63, 56.46, 65.23 and 67.46 cm) was found from P_2H_3 where as the shortest (23.42, 32.41, 40.67, 43.00 and 44.31 cm) was recorded from P_3H_0. The maximum number of leaves per plant (14.90, 16.47, 19.10, 24.43 and 25.87) was observed from P_2H_3 while the minimum (9.27, 13.50, 14.33, 16.17

and 17.93) was recorded from P_3H_0. The highest leaf length (23.83, 39.88, 50.58, 60.89 and 63.64 cm) was found from P_2H_3 and the lowest (18.02 cm, 27.48 cm, 34.63 cm, 38.52 cm and 40.00 cm) was obtained from P_3H_0. The highest leaf breadth (11.07 cm, 15.30 cm, 18.28 cm, 20.07 cm and 20.37 cm) was found from P_2H_3 while, as the lowest (8.26 cm, 11.00 cm, 12.87 cm, 12.89 cm and 13.62 cm) was obtained from P_3H_0. The minimum days from transplanting to curd formation (38.00) was observed from P_2H_3 where as the maximum (49.67) was recorded from P_1H_0. The minimum days from transplanting to 50% curd formation (43.00) was obtained from P_3H_3 where as the maximum (52.33) was recorded from P_1H_0. The minimum days from transplanting to harvest (56.33) was recorded from P_2H_2 while, the maximum (69.00) was obtained from P_1H_0. The highest root length (19.99 cm) was recorded from P_2H_3 where as the lowest (12.14 cm) was found from P_1H_1. The highest stem length (12.80 cm) was obtained from P_2H_3 where as the lowest (9.03 cm) was recorded from P_3H_2. The highest stem diameter (1.86 cm) was obtained from P_2H_3 where as the lowest (1.04 cm) was found from P_3H_0. The highest curd weight with leaf (2.42 kg) was obtained from P_2H_3 where as the lowest (1.31 kg) was observed from P_3H_0. The maximum pure curd height (15.78 cm) was observed from P_2H_3 where as the minimum (10.39 cm) was found from P_1H_0. The highest pure curd weight (1.03 kg) was recorded from P_2H_3 and the lowest (0.55 kg) was observed from P_3H_0. The maximum curd diameter (25.75 cm) was found from P_2H_3 where as the minimum (16.35 cm) was recorded from P_1H_0. The highest marketable yield per plant (1.24 kg) was recorded from P_2H_3 and the lowest (0.87 kg) was recorded from P_3H_0. The highest marketable yield per hectare (31.03 ton) was observed from P_2H_3, while as the lowest (21.75 ton) was found from P_3H_0.

The highest gross return (Tk. 310,300) was obtained from the treatment combination P_2H_3 and lowest (Tk. 217,500) was obtained from P_3H_0. The highest net return (Tk. 169,399) was found from the treatment combination P_2H_3 and lowest (Tk. 81,136) net return was obtained P_3H_0. The highest benefit cost ratio (2.20) was noted from the combination of P_2H_3 and the lowest (1.59) was obtained from P_3H_0. From economic point of view, it is apparent from the above results that the combination of P_2H_3 was more profitable than rest of the combination.

Considering the findings of the present experiment, further studies in the following areas may be suggested:

1. Such study is needed in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability;
2. Another growth hormones and different concentration of hormones may be used for further study.

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APPENDICES

Appendix I. Monthly record of air temperature, rainfall, relative humidity and Sunshine of the experimental site during the period from October 2007 to March 2008

Month	*Air temperature (°c)		*Relative humidity (%)	*Rain fall (mm) (total)	*Sunshine (hr)
	Maximum	Minimum			
October, 2007	29.18	18.26	81	39	7.4
November, 2007	25.8	16.0	78	00	6.8
December, 2007	22.4	13.5	74	00	6.3
January, 2008	24.5	12.4	68	00	5.7
February, 2008	27.1	16.7	67	30	6.7
March, 2008	31.4	19.6	54	11	8.2

* Monthly average,

Source: Bangladesh Meteorological Department (Climate & weather division) Agargoan, Dhaka - 1212

Appendix II. Characteristics of Horticulture Farm soil is analyzed by Soil Resources Development Institute (SRDI), Khamarbari, Farmgate, Dhaka

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Horticulture Garden , SAU, Dhaka
AEZ	Madhupur Tract (28)
General Soil Type	Shallow red brown terrace soil
Land type	High land
Soil series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained

B. Physical and chemical properties of the initial soil

Characteristics	Value
% Sand	27
% Silt	43
% clay	30
Textural class	silty-clay
pH	5.6
Organic carbon (%)	0.45
Organic matter (%)	0.78
Total N (%)	0.03
Available P (ppm)	20.00
Exchangeable K (me/100 g soil)	0.10
Available S (ppm)	45

Source: SRDI

Appendix III. Analysis of variance of the data on plant height of cauliflower as influenced by planting time and growth regulators

Source of variation	Degrees of freedom	Mean square Plant height (cm) at				
		30 DAT	40 DAT	50 DAT	60 DAT	Harvest
Replication	2	0.046	1.054	1.756	2.354	2.508
Planting time (A)	2	18.567**	66.386**	108.589**	212.314**	351.359**
Growth regulators (B)	3	13.946**	50.736**	100.155**	202.928**	201.362**
Interaction (A×B)	6	1.179**	8.499**	8.401**	15.563**	19.241**
Error	22	0.308	0.750	1.068	4.288	4.890

**: Significant at 0.01 level of probability:

Appendix IV. Analysis of variance of the data on number of leaves per plant of cauliflower as influenced by planting time and growth regulators

Source of variation	Degrees of freedom	Mean square Number of leaves per plant				
		30 DAT	40 DAT	50 DAT	60 DAT	Harvest
Replication	2	0.014	0.020	0.021	0.391	1.484
Planting time (A)	2	10.788**	6.325**	12.512**	44.147**	41.088**
Growth regulators (B)	3	24.013**	3.487**	8.485**	22.363**	24.652**
Interaction (A×B)	6	1.163*	0.168*	0.614**	1.389*	2.200*
Error	22	0.476	0.101	0.082	0.518	0.800

**: Significant at 0.01 level of probability: *: Significant at 0.05 level of probability

Appendix V. Analysis of variance of the data on leaf length of cauliflower as influenced by planting time and growth regulators

Source of variation	Degrees of freedom	Mean square Leaf length (cm) at				
		30 DAT	40 DAT	50 DAT	60 DAT	Harvest
Replication	2	0.038	1.580	2.456	2.104	4.246
Planting time (A)	2	19.697**	68.569**	107.375**	212.722**	359.794**
Growth regulators (B)	3	16.399**	50.757**	101.874**	206.223**	203.914**
Interaction (A×B)	6	1.528**	8.596**	9.040**	15.811**	20.564**
Error	22	0.329	0.755	1.136	4.463	4.894

**: Significant at 0.01 level of probability:

Appendix VI. Analysis of variance of the data on leaf breadth of cauliflower as influenced by planting time and growth regulators

Source of variation	Degrees of freedom	Mean square Leaf breadth (cm) at				
		30 DAT	40 DAT	50 DAT	60 DAT	Harvest
Replication	2	0.004	0.090	0.140	0.270	0.122
Planting time (A)	2	3.921**	8.548**	12.819**	23.371**	29.331**
Growth regulators (B)	3	4.402**	6.221**	11.479**	20.302**	16.783**
Interaction (A×B)	6	0.299**	0.932**	0.996**	1.581**	1.471**
Error	22	0.063	0.069	0.108	0.431	0.345

**: Significant at 0.01 level of probability:

Appendix VII. Analysis of variance of the data on yield contributing characters of cauliflower as influenced by planting time and growth regulators

Source of variation	Degrees of freedom	Mean square					
		Days from transplanting to curd initiation	Days from transplanting to 50% curd initiation	Days from curd initiation to harvest	Root length (cm)	Stem length (cm)	Stem Diameter (cm)
Replication	2	0.861	0.445	1.361	0.130	0.011	0.001
Planting time (A)	2	149.778**	130.110**	73.694**	80.849**	15.729**	0.392**
Growth regulators (B)	3	55.361**	22.769**	96.176**	3.822*	5.864**	0.401**
Interaction (A×B)	6	9.778**	11.297**	27.398**	4.465**	2.086**	0.008**
Error	22	2.528	2.869	3.634	1.070	0.198	0.001

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix VIII. Analysis of variance of the data on yield contributing characters and yield of cauliflower as influenced by planting time and growth regulators

Source of variation	Degrees of freedom	Mean square					
		Curd weight with leaf (kg)	Pure curd height (cm)	Pure curd weight/plant (kg)	Curd Diameter (cm)	Marketable yield (kg/plant)	Marketable yield (t/ha)
Replication	2	0.004	0.551	0.0001	0.430	0.001	0.547
Planting time (A)	2	1.161**	24.642**	0.136**	95.100**	0.022**	13.652**
Growth regulators (B)	3	0.370**	12.295**	0.123**	25.214**	0.103**	64.618**
Interaction (A×B)	6	0.051**	0.883*	0.014**	11.078**	0.007**	4.385**
Error	22	0.005	0.607	0.003	1.289	0.001	0.451

**: Significant at 0.01 level of probability; *: Significant at 0.05 level of probability

Appendix IX. Production cost of cauliflower per hectare

A. Input cost

Treatment Combination	Labour cost	Ploughing cost	Seed Cost	Cost of growth regulators	Irrigation	Manure and fertilizers				Insecticide/ pesticides	Sub Total (A)
						Cowdung	Urea	TSP	MP		
P_1H_0	14000.00	8000.00	5000.00	0.00	5000.00	20000.00	3600.00	4800.00	5000.00	6000.00	71400.00
P_1H_1	14000.00	8000.00	5000.00	2000.00	5000.00	20000.00	3600.00	4800.00	5000.00	6000.00	73400.00
P_1H_2	14000.00	8000.00	5000.00	2000.00	5000.00	20000.00	3600.00	4800.00	5000.00	6000.00	73400.00
P_1H_3	14000.00	8000.00	5000.00	4000.00	5000.00	20000.00	3600.00	4800.00	5000.00	6000.00	75400.00
P_2H_0	14000.00	8000.00	5000.00	0.00	5000.00	20000.00	3600.00	4800.00	5000.00	6000.00	71400.00
P_2H_1	14000.00	8000.00	5000.00	2000.00	5000.00	20000.00	3600.00	4800.00	5000.00	6000.00	73400.00
P_2H_2	14000.00	8000.00	5000.00	2000.00	5000.00	20000.00	3600.00	4800.00	5000.00	6000.00	73400.00
P_2H_3	14000.00	8000.00	5000.00	4000.00	5000.00	20000.00	3600.00	4800.00	5000.00	6000.00	75400.00
P_3H_0	14000.00	8000.00	5000.00	0.00	5000.00	20000.00	3600.00	4800.00	5000.00	6000.00	71400.00
P_3H_1	14000.00	8000.00	5000.00	2000.00	5000.00	20000.00	3600.00	4800.00	5000.00	6000.00	73400.00
P_3H_2	14000.00	8000.00	5000.00	2000.00	5000.00	20000.00	3600.00	4800.00	5000.00	6000.00	73400.00
P_3H_3	14000.00	8000.00	5000.00	4000.00	5000.00	20000.00	3600.00	4800.00	5000.00	6000.00	75400.00

P_1: Early planting on 1 November
P_2: Mid planting 15 November
P_3: Late planting on 1 December

H_0: No Hormone (control)
H_1: 10 ppm IAA (Indole Acetic Acid)
H_2: 70 ppm GA_3 (Gibberelic Acid)
H_3: 10 ppm IAA + 70 ppm GA_3

Appendix IX. Contd.

B. Overhead cost (Tk./ha)

Treatment Combination	Cost of lease of land for 6 months (13% of value of land Tk. 8,00000/year	Miscellaneous cost (Tk. 5% of the input cost	Interest on running capital for 6 months (Tk. 13% of cost/year	Sub total (Tk) (B)	Total cost of production (Tk./ha) [Input cost (A)+ overhead cost (B)]
P_1H_0	52000	4641	8323	64964	136364
P_1H_1	52000	4771	8461	65232	138632
P_1H_2	52000	4771	8461	65232	138632
P_1H_3	52000	4901	8600	65501	140901
P_2H_0	52000	4641	8323	64964	136364
P_2H_1	52000	4771	8461	65232	138632
P_2H_2	52000	4771	8461	65232	138632
P_2H_3	52000	4901	8600	65501	140901
P_3H_0	52000	4641	8323	64964	136364
P_3H_1	52000	4771	8461	65232	138632
P_3H_2	52000	4771	8461	65232	138632
P_3H_3	52000	4901	8600	65501	140901

P_1: Early planting on 1 November

P_2: Mid planting on 15 November

P_3: Late planting on 1 December

H_0: No Hormone (control)

H_1: 10 ppm IAA (Indole Acetic Acid)

H_2: 70 ppm GA_3 (Gibberelic Acid)

H_3: 10 ppm IAA + 70 ppm GA_3