EFFECT OF PLANT GROWTH REGULATORS ON GROWTH CURD YIELD AND SEED PRODUCTION OF CAULIFLOWER

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BY

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CERTIFICATE

This is to certify that the thesis entitled, **"EFFECT OF PLANT GROWTH REGULATORS ON GROWTH CURD YIELD AND SEED PRODUCTION OF CAULIFLOWER "** submitted to the Faculty of Agriculture, Department of Horticulture and Postharvest Technology, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka-1207 in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (M.S)** in **HORTICULTURE** embodies the result of a price of bona fide research work carried out by **MAHMUDUL ISLAM KHAN ZIA** Registration No. **23946/00187** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.

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

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ABBREVIATIONS AND ACORONYMS

BARI	: Bangladesh Agricultural Research Institute
BRRI	: Bangladesh Rice Research Institute
BBS	: Bangladesh Bureau of Statistics
BCR	: Benefit cost ratio
BINA	: Bangladesh Institute of Nuclear Agriculture
CCC	: Cycocel
DMRT	: Duncan's Multiple Range Test
2,4-D	: 2,4-Dichlorophenoxy Acetic Acid
et al.	: And Others (at elli)
FAO	: Food and Agricultural Organization
GA_3	: Gibberellic Acid
HRC	: Horticulture Research Center
IBA	: Indole Butyric Acid
i.e.	: That is
LSD	: Least Significant Difference
Max	: Maximum
Min	: Minimum
Mo	: Molybdenum
No.	: Number
NOA	: Beta-naphthoxy Acetic Acid
NAA	: Naphthalene Acetic Acid
ppm	: Parts Per Million
PGR	: Plant Growth Regulator
RCBD	: Randomized Complete Block Design
SAU	: Sher-e-Bangla Agricultural University
t/ha	: Tons Per Hectare
RH	: Relative Humidity
viz.	: Namely
wt	: Weight

DEDICATED TO
MY
BELOVED PARENTS

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The Author

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EFFECT OF PLANT GROWTH REGULATORS ON GROWTH CURD YIELD AND SEED PRODUCTION OF CAULIFLOWER

By

Mahmudul Islam Khan Zia

ABSTRACT

Two field experiments were conducted at the farm of the Horticulture Research Center (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during the period from October 2004 to March 2005. The objectives of the research work were to study the curd yield and seed production of BARI Fulkapi-1 as influenced by different levels of Gibberellic acid (GA_3) and Ethrel. Both the experiments were laid out in a randomized complete block design (RCBD). The field experiment had three replications. There were five concentrations of GA_3 (50, 75, 100, 125 and 150 ppm) in the first experiment and three concentration of both GA_3 and Ethrel (300, 350, 400 and 50, 75, 100 ppm) in the second experiment.

For curd initiation the maximum time (85.00 days) was required in plants treated with 150 ppm GA_3 while the minimum time (80.00 days) was required with 50 ppm GA_3. The maximum number of leaves (26) were obtained in 125 ppm GA_3 and the minimum (23) in 50 ppm GA_3 and control treatment. The maximum curd weight with leaves (2.20 kg), marketable curd weight (1.50 kg), curd length (27 cm), curd breadth (240cm), yield per plot (20.20 kg) and yield per hectare (57.71 tons) were recorded by 150 ppm GA_3 and control treatment showed the lowest performance. For curd production, the highest BCR value of 2.90 was observed in 150 ppm GA_3.

The highest plant height (115 cm) was recorded in 350 ppm GA_3 while lowest was (84.00 cm) recorded in 100 ppm Ethrel. The maximum number of pods per plant (2850), pod length (7.50 cm), seeds per pod (16.30), seed weight per plant (38.53 g), 1000 seed weight (4.97 g), seed yield (1.57 t/ha) and percentages of seed germination (97.50) were found in 350 ppm GA_3 . 350 ppm GA_3 also had the highest BCR value of 8.02 indicating the economic viability of using growth regulator in seed production of cauliflower.

Chapter 1

INTRODUCTION

INTRODUCTION

Cauliflower (*Brassica oleraceae* var. botrytis L) is one of the most important cole crops and popular winter vegetables in many countries of the world including Bangladesh. The leading cauliflower producing countries of the world are China, Pakistan and India in respect of yield per hectare of land. It is highly nutritious vegetable, rich in Vitamin A, C and minerals like calcium, iron and iodine (Haque, 1999).

Vegetable consumption in Bangladesh is very low, only 32 g per person per day against the minimum recommended quantity of 200 g per day (FAO, 1986). The total vegetable production in Bangladesh is far below the requirement. In 2003-2004 cauliflower covered an area of 30900 hectares with a total production of 101485 metric tonnes (BBS, 2004). The average yield per hectare of cauliflower is far below than it's actual yield potentially. The yield of cauliflower depends on variety, cultivation methods, climatic conditions as well as edaphic factors etc. Among the different modern techniques of cauliflower curd production now a days the role of plant growth regulators is considered to be an important tool. Application of GA_3 (50 mg/L + Urea 1%) have been reported to enhance curd yield in cauliflower (Mishra and Singh, 1986).

Quality seed of cauliflower is also an important factor for higher yield of the crop per unit area of land. So, the seed production of this crop is also felt to be an outstanding issue to the personnel involved in cauliflower improvement and development.

The climatic conditions of Bangladesh are not much congenial for quality seed production of cauliflower. Seed production of cauliflower is well in areas where the temperature during flowering and seed setting stage remains the range of 15.5-26.6°C (FAO, 1961). The subtropics of sub-tropical areas having mild winter of around 10°C mean minimum temperature can be said the best place for cauliflower seed production all over the world including Bangladesh (Shinohara, 1984). Some of the early cauliflower cultivars are reported to produce seeds in certain areas of the country

especially near Tangail (Ahmed and Hussain, 1977). Cauliflower seed requirement in Bangladesh is around 6 tonnes per annum. In 1993, 4.7 tonnes of seeds were imported and the rest quantity was locally produced (FAO, 1993). Not only the yield of cauliflower is low, its seeds yield is also very poor, about 344 kg per hectare on an average (Rahman *et al.*, 1996).

BARI Fulkapi-1 produces seed in the Eastern and Northern part of the country. But the seed yield is quite low. The use of plant growth regulators in vegetable seed production has been reported in increasing the seed yield of cauliflower. Mangal *et al.*,(1980) reported that GA_3 at 50-250 mg/L improved seed yield. Singh *et al.*, (1976) also obtained increase in seed yields in variety Snowball-16 variety with Ethepon or CCC sprays. Considering the above facts, the present studies were undertaken to maximize cauliflower curd and seed production under Bangladesh conditions using the different plant growth regulators with the following objectives:

1. To find out the optimum dose of GA_3 to have higher curd yield.
2. To find out the optimum dose of the GA_3 and Ethrel for increased seed yield of cauliflower.
3. To determine the relative cost and returns of curd and seed production of cauliflower.

Chapter 2

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Cauliflower is one of the most popular vegetables of many countries of the world as well as in Bangladesh. Considerable interest has been developed recently regarding the benefit from the use of plant growth regulators of cauliflower. GA_3 and Ethrel have been known to play a vital role in increasing the growth, yield and quality of cauliflower. A great deal of research work has been reported on the uses of plant growth regulators (GA_3 and Ethrel) in different vegetable including cauliflower and the results already achieved are of outstanding importance. The present study was undertaken to asses the effects of GA_3 and Ethrel on curd yield and seed production of cauliflower. However, a brief review has been presented in this chapter.

2.1 Effect of GA_3 on the growth and yield of cauliflower

Muthoo *et al.*, (1987) found 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 amongst the individual treatments, gibberrellic acid proved to be the best for the vegetative growth and molybdenum proved to be the best for growth of curd and yield of cauliflower (q/ha) followed by naphthalene acetic acid. The effect of treatment combination $G_2 N_2 M_2$ (100 ppm GA_3, 120 ppm NAA and 0.2% molybdenum) gave best result for all parameters of growth and yield.

Anderson *et al.*, (1946) also found the increased growth in cauliflower by the application of molybdenum. Combination of molybdenum with GA_3 and NAA was found to have significant effect due to synergistic action. These results are supported by the findings of El-Habbasha and Behairy (1977) in onion.

Singh (1957) found maximum growth of tomato seedling when treated with 0.1 ppm NAA at the time of transplanting.

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

Chhonkar and Singh (1959) recorded the increased yield of tomato by seedling treatment with growth substances.

Chhonkar and Singh (1963) found that gibberellic acid has been used in different vegetables in recent years by many investigators and plant responses have been reported the potentiality of this plant growth regulator was ascertained for the furtherance of vegetable production, a number of methods of application have been tried on various vegetables.

Radwan (1955) reported the whole plant spray with GA_3 superior to preplanting dip in tobacco.

Simao *et al.* (1958) reported that, application of GA_3 has increased the leaf size and number of lettuce. Jauhari *et al.* (1960) noted increase in number of leaves in spinach with the use of GA_3. A universal response of marked elongation of stem by GA_3 was observed by Bukovac and Wittwer (1956) in a number of plants.

Apart from the effects on the morphological characters earlier flowering and fruiting was noted by Johnson (1958) in tomato with GA_3. Belik *et al.*, (1961) reported increased yield of cabbage and Mukherjee and Datta (1962) recorded improvement in quality of tomato and brinjal fruits by GA_3 application to plants.

Jauhri *et al.*, (1960) found that seedling treatment with GA_3 markedly reduced the transplanting shock and quite apparently influenced the early establishment of seedlings. Substantial increase in the number of leaves with GA_3 treatments is in

conformity with the findings. This might have been due to invigoration of physiological process of plants and stimulatory effects with GA_3 to form new leaves at faster rates.

Denisova and Lupinovich (1962) found that GA_3 applications brought about rapid vegetable 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.

Brian *et al.*, (1954) found that GA_3 failed to induce root growth in proportion to vegetative growth. The views expressed by Pirone (1958) that GA_3 applications created improper balance between top and root growth on account of under stress of the aerial growth on underground parts, causing temporary deficiency of nutrients, particularly nitrogen, seems to be the responsible cause in this case.

Mishra and Singh (1986) found that all possible combinations of three levels of nitrogen (0, 0.5 and 1.0 per cent), boron (0, 0.1 and 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 plants height, diameter of stem, number of leaves per plant, weight of plant, curd yield and nitrogen content in the stem and the leaves due to N, B and GA_3 application. However, length of stem was increased only by GA_3 spray.

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

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

Booij (1988) applied GA_{4+7} at a concentration of 10-12 ppm in various times up to 31 days after transplanting which increased curd diameter and earlier curd initiation. He also added that multiple applications (2-4) of GA_{4+7} could be used to control the growing period of cauliflower.

Chhonkar and Singh (1965) conducted an experiment in the Rabi season of 1962-63 with GA_3 at 5 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.

Chauhan and Singh (1970) found that 2 sprays of 15 ppm GA_3 at 2 and 3 weeks after cabbage transplanting increased earliness, yield and quality.

Chauhan and Bordia (1971) carried out an investigations suing Drumhead variety of cabbage to assess the effects of Gibberellic acid (GA_3) at 5, 10, 15, 25, 50, 100 ppm, Beta-naphthoxy-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 the 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.

Zee (1978) applied Gibberellic acid once or twice as 10 or 20 ppm spray on seedling of cabbage at transplanting or 10 or 20 days after transplanting, plants reached edible

maturity 53 days after transplanting when treated with 20 ppm GA_3. Plant fresh weight and dry weight were considerably enhanced by a 20 ppm GA_3 spray applied 10 days after transplanting. Transplanting 30 days after sowing delayed harvest and reduced plant weight, regardless of GA_3 treatment.

Badawi and Sahhar (1979) conducted an experiment 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. In most cases, treatments showed a decline in both diameter and height of the edible head. The highest edible head weight (5.21 kg) was obtained with GA_3 (50 ppm) applied 4 weeks after transplanting.

Kato and Sooen (1980) observed that leaf petiole epinasty in cabbage appeared to be controlled by the hormone balance at the apical region of the stem. They also reported that applied NAA induced a downward movement in the wrapper leaves of decapitated plants and the plants with entire heads and in the leaves of young seedlings but GA_3 induced the upward movement of leaves.

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

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

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

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 NAAA 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 were 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.

Islam *et al.*, (1993) to determine the effective concentration of NAA and GA_3 for promoting growth, yield and ascorbic acid content of cabbage. They used 12.5, 25, 50, 100 ppm of both the NAA and GA_3 and applied in three different methods i.e. seedlings 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 regulators, 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.

Drarmender *et al.*, (1996) studied that GA_3 alone or in combination with NAA (both at 25, 50 or 75 ppm) on the growth of cabbage (cv. Pride of India) was investigated in the field at Horticulture Farm S.K.A. College of Agriculture, Jobner, Rajasthan, India during rabi (winter) 1993-94. The best growth (plant height, plant spread, number of leaves, leaf area and days to 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.

Dharmender *et al.*, (1996) the effect of GA_3 or NAA (both at 25, 50 or 75 ppm) on the yield of cabbage (cv. Pride of India) was investigated in the field at Jobner, Rajasthan, India. The highest yield was observed following treatment with GA_3 at 50 ppm followed by NAA at 50 ppm (557.54 and 528.66 q/ha, respectively). Combination and higher concentrations of plant growth regulators proved less effective and were uneconomic in comparison to the control.

2.2 Effect of GA_3 and Ethrel on cauliflower seed yield

Mangal *et al.*, (1980) found that the role of growth regulators in well established in the improvement of seed germination, promotion of plant growth, flowering, sex modification, induction of male sterility, fruit set and parthenocarpy, fruit maturity and ripening, weed control, control of apical dominance, fruit set and grain filling of pods. However very scattered information is available on the effect of growth regulators on the seed production of various vegetable crops.

Sinha (1973) reported a significantly higher seed yield in cauliflower varity snow ball-16 when the plants were sprayed with 250 ppm Ethrel at full bloom stage. Similarly application of GA_3 at 50, 100 and 250 ppm also increased the seed yield in cauliflower. However, the treatment delayed the seed maturity.

Dodds and Senca (1970) produced higher number of seeds producing plants in four cultivars of cauliflower when the plant stem along with leaf pedicle were dipped in a solution of 100 cc 95% alcohol + 100 cc water and 400 mg IBA.

Thomas (1976) reported that N-6 benzyladenine (BA) and N-4 pyridyle N^1 phenyle urea had same effect on lateral bud development on brussels seedlings. Both chemicals increased flowering of young plants and produced higher seed yield. The application of gibberellins improved the plant development and seed yield in cabbage and cauliflower.

Kruzilin and Svedskaza (1963) reported that when vermilized seedling of cabbage were treated with GA_3, there was good development of flower stalk bud flowers did not develop properly.

Marrewi and Van (1976) reported an increase in bolting and flowering by three applications of GA_3 at 250 or 500 ppm on slow bolting cultivars of Kohlrabi.

Singh *et al.*, (1976) found that the effect of Ethrel and ccc was studied on growth and seed production of cauliflower (var. Snowball-16) at Govt. Hill Fruit Research Station, Chaubattia (2000 m A. S. L) Ranikhet (V. P), during 1973-74. The plant height and length of primary branches were significantly reduced by Ethrel and ccc applications. The lower concentrations of Ethrel (150 and 300 ppm) and higher concentrations of ccc (1500 and 2000 ppm) increased the number of siliqua. The seed yield was not influenced by ccc applications, however, Ethrel at 150 ppm concentration brought about significant increase in yield over control. Higher concentrations of Ethrel adversely affected the yield.

Srivastava (1960, 1965, 1966) reported the beneficial effects of GA_3, NOA and other plant growth regulators as pre-sowing seed treatments of many vegetable crops. He concluded that the application of GA_3, OR 2,4-D at appropriate concentrations as pre-sowing seed treatment may be quite beneficial in obtaining increased yield.

Chapter 3

MATERIALS AND METHODS

MATERIALS AND METHODS

The present research work was carried out at the Horticulture Research Center, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur during the period from October 2004 to March 2005 to study the effect of plant growth regulator on curd yierd and the seed production potential of BARI Fulkapi-1 (*Brassica oleraceae* var. botrytis L.). This chapter deals with the materials and methods of the investigation and is envisaged below through the following sub-heading:

3.1 Soil

The land was medium high with good drainage facilities. The soil of the experimental area belongs to the Grey Terrace Soil Tract. The texture of the soil was silt loam having pH 6.4 with an organic matter content of 1.88%.

3.2 Climate

The area is characterized by hot and humid climate. The average rainfall of the locality during the experimental period was 59.67 mm. The mean monthly maximum, minimum and average temperature were 29.08^{o}C, 17.82^{o}C and 23.45^{o}C respectively. The average relative humidity was 72.54% during October 2004 to March 2005. The detailed meteorological data in respect of monthly temperature, relative humidity recorded during the period of the present study have been presented in Appendix-I.

3.3 Land Preparation

The selected land for the experiment was first opened on one week before laying out the experimental plots. The land was well prepared with the tractor followed by laddering until good tilth. All weeds and stubbles were removed. The individual plots were made by making ridges (20 cm height) around each plot to restrict the lateral runoff of irrigation water.

3.4 Layout and design of the experiment

Both the experiments were laid out in a Randomized Complete Block Design with three replications. The unit plot size was 3.5 x 1 m. Thirty day old seedlings were transplanted in the main field on 10th November 2004 following 60 x 50 cm plot spacing.

3.5 Manuring and Fertilization

Fertilizers were applied at the rate of 15 ton cowdung, 240 kg urea, 150 kg TSP, 220 kg MP, 5 kg Boron and 2 kg Molybdenum per hectare, Cowdung, TSP, boron, molybdenum and 50% MP were applied during final land preparation urea and the rest MP were applied as top dressing in three equal installments at 15, 30 and 45 days after transplanting. In case of seed production one additional installment of urea and MP were applied.

3.6 Treatments

a) Curd Yield

i) GA_3 -50 ppm (G_1)

ii) GA_3 -75 ppm (G_2)

iii) GA_3 -100 ppm (G_3)

iv) GA_3 -125 ppm (G_4)

v) GA_3 -150 ppm (G_5)

vi) Control treatment (G_0)

b) Seed production

i) Control treatment-(G_0)

ii) GA_3 -300 ppm (G_1)

iii) GA_3 -350 ppm (G_2)

iv) GA_3 -400 ppm (G_3)

v) Ethrel-50 ppm (E_1)

vi) Ethrel-75 ppm (E_2)

vii) Ethrel-100 ppm (E_3)

3.7 Planting material

The cauliflower seeds (BARI Fulkapi-1) were collected from the farm of Horticulture Research Center of the Bangladesh Agricultural Research Institute, Joydebpur, Gazipur for experimental purpose.

3.8 Raising of Seedling

Seeds were sown in plastic trays filled with vermiculite on the 10th October 2004. After sowing seeds were covered with thin layer of vermiculite. The entire seed tray was then covered with a sheet of newspaper preserve moisture until germination. Complete germination of seeds took place within 5 days of sowing. Nine days old seedlings were transplanted individually in polythylene bags filled with equal proportion of sand, soil and cowdung. Seedlings were left under shade for 2 to 3 days and then brought to the sunlight. After three days these seedlings were gradually exposed to sunlight.

3.9 Transplanting of seedling and after care

Healthy and uniform sized 30 days aged seedling were transplanted in the experimental plots on 10th November, 2004 at a spacing 60 cm x 50 cm. Each plots had 2 rows of 14 plants. Before transplanting of seedlings polybags were removed each seedling to facilitate growth of root from basal media so that then can easily be established in the field. At the time of remove polybags care was taken to protect the earth ball bagged soil. There were no need of irrigation immediately after transplanting because of moderate rainfall on 10th November 2004. So sufficient soil moisture was present for seedling establishment. After seedling establishment, the soil around the base of each seedling was pulverized and new ones from the same stock replaced the damaged seedlings.

3.10 Preparation and application of GA_3 and Ethrel

Gibberellic acid in different concentrations viz. 50, 75, 100, 125, 150, 300, 350 and 400 ppm and Ethrel in different concentrations viz. 50, 75, 100 ppm were prepared following the procedure mentioned below and spraying was done dyring noon by using

3.13 Staking

The flowering plants were staked with bamboo stick and tied well so that the plants do not be lodged.

3.14 Pest and disease control

The birds attacked the crop during growing period (Bulbuli birds). The aluminium foil was used against the birds to protect the crop. Spraying was done with Nogos to control hairy caterpillar and Dimecron was applied in seed crop cauliflower to avoid the infestation of Aphids.

3.15 Crop management

Among 14 plants of a plot, 6 randomly selected plants were kept for seed production. Damaged and old leaves from the plants were removed after flowering.

3.16 Seed crop

When 70% of the pod turned to yellow, the seed stalks were cut and dried under shade. The seeds were then threshed, dried and preserved in dry airtight containers. Harvesting of seed crop was done on 26 to 30 March, 2005.

3.17 Collection of data

a) Effect of plant growth regulator (GA_3) on curd yield and yield contributing characters of cauliflower

The data pertaining to the following characters were recorded from randomly selected 5 (five) plant from each plot. These data were collected during the harvesting time.

i) Days to curd initiation

The period required for curd initiation from transplanting was recorded for all treatments.

ii) Number of leaves per plant

The number of leaves per plant was counted on different dates after transplanting.

iii) Biggest leaf length

The length of the biggest leaf was measured with a meter scale and expressed in centimeter (cm).

iv) Curd weight with leaves

The curd weight with leaves was recorded with the help of a weighing balance just after maturity of the curd. It was expressed in kilogram (kg).

v) Marketable curd weight

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

vi) Curd length

Curd length was measured with a measuring scale placing it horizontally. It was measured in centimeter (cm).

vii) Curd breadth

Curd breadth was measured with a measuring scale placing it vertically at the widest point of the curd. It was expressed in centimeter (cm).

viii) Yield per plot

The yield of cauliflower per unit plot was recorded by weighing all the cauliflower curds from each unit plot separately excluding roots and outer leaves and it was measured in kilogram (kg).

ix) Yield per hectare

The yield per hectare was calculated by converting from the per plot yield data to per hectare and was expressed in ton (t).

b) Effect of plant growth regulator (GA_3 and Ethrel) on seed yield and yield contributing characters of cauliflower

The data pertaining to the following characters were recorded from randomly selected five plants of each plot from the remaining fourteen plants:

i) Plant height

The plant height was measured with the help of a meter scale from the ground level to the top of the longest leaf and was recorded in centimeter (cm).

ii) Number of pods per plant

Number of pods per plant was counted after harvesting of mature flower stalk with mature pods.

iii) Pod length

Pod length was measured with a meter scale putting it along the pod. It was expressed in centimeter (cm).

iv) No. of seeds per pod

Number of seeds per pod was counted after harvesting of the mature pod.

v) Seed yield per plant

All the seeds were collected from a flowering stalk after maturity and weight was taken with a weighing balance to measure seed yield per plant. It was expressed in gram (g).

vi) 1000 seed weight

One thousand seeds for each treatment was weighed to record 1000 seed weight. It was expressed in gram (g).

vii) Seed yield (t/ha)

Seed yield for each treatment was recorded with a weighing balance and was calculated in ton per hectare from the unit plot yield.

viii) Percentage of seed germination

Seed germination test was conducted for each treatments and the result was expressed in percentage.

3.18 Statistical analysis

The observation (data) for various growth and yield contributing characters were statistically analyzed to find out the significance of variation resulting from the experimental treatments. The mean for all the treatments were calculated and the analysis of variance for each of the characters under study was done by F (variance ratio) test for Randomized Complete Block Design (RCBD). The treatment means were compared by Duncan's New Multiple Range Test (DMRT) at 5% level of significance (Gomez and Gomez, 1984).

3.19 Economic analysis

Economic analysis was done with a view to comparing the cost and benefits under different levels of GA_3 and Ethrel. All input costs and interests on fixed cost (land) and running capital were considered for computing the cost of production. The interests were calculated @ 13% for 6 months. Cost and return analysis was done in details according to the procedure of Alam *et al.* (1989).

Chapter 4

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

This chapter comprises the presentation and discussion of the results obtained due to the execution of the effects of different plant growth regulators (GA_3 and Ethrel) on curd and seed yield and yield attributes of cauliflower (BARI Fulkapi-1). The analysis of variance for different characters are given in Appendix II and III. The results are presented in Table 1 to 4 and Figure 1 to 2 and necessary discussions have been made under the following sub-headings.

4.1 Effect of plant growth regulator (GA_3) on curd yield and yield contributing characters of cauliflower

The impact of Plant Growth Regulator (PGR) on curd yield (Figure 1) and yield components of cauliflower was significant (Table 1 & 2). Most of the plant characters such as days to curd initiation, no. of leaves per plant, biggest leaf length, curd weight with leaves, marketable curd weight, curd size (length and breadth), yield per plot and yield(t/ha) were significantly influenced by different levels of PGR (GA_3).

4.1.1 Days to curd initiation

Significant difference was noted on days required from seed sowing to curd initiation by different concentrations of gibberellic acid (Table 1). Maximum days (85.00) were required in GA_3 150 ppm which was followed by control treatment (84.10) and minimum days were required (80.00) in GA_3 50 ppm which was followed by GA_3 75 ppm (81.50) (Table 1). Haque (1999) reported that days to first curd initiation in cauliflower ranged from 83.33 to 84.87.

4.1.2 Number of leaves per plant

There had a significant influence of the different levels of GA_3 on the number of leaves/plant in cauliflower (Table 1). It revealed that the cauliflower plants receiving 125 ppm GA_3 produced the maximum (26) number of leaves/plant. The number of leaves produced by the application of GA_3 75 ppm and GA_3 150 ppm were statistically similar to that of GA_3 125 pm. But it was also observed that there had not have any statistical variation in respect to the no. of leaves/plant due to the application of GA_3

Table-1. Effect of plant growth regulator (GA_3) on curd yield and yield attributes of cauliflower

Treatment	Days to curd initiation	No. of leaves per plant	Biggest leaf length (cm)	Curd weight with leaves (kg)	Marketable curd weight (kg)
G_1	80.00 d	23.00 c	51.00 bc	1.70 c	1.00 c
G_2	81.50 cd	25.00 ab	53.00 b	1.80 bc	1.10 bc
G_3	83.00 bc	24.00 bc	59.00 a	1.85 bc	1.10 bc
G_4	82.75 bc	26.00 a	60.00 a	2.00 ab	1.35 ab
G_5	85.00 a	25.00 ab	60.00 a	2.20 a	1.50 a
G_0	84.10 ab	23.00 c	48.00 c	1.60 c	0.90 c
Level of significance	**	*	**	**	*
CV (%)	3.06	3.29	3.29	7.30	13.72

Means followed by the common letters did not differ at 5% level of probability as per DMRT.
* = 5% level of significance
** = 1% level of significance
NS = Non significant
G_1 = GA_3 50 ppm
G_2 = GA_3 75 ppm
G_3 = GA_3 100 ppm
G_4 = GA_3 125 ppm
G_5 = GA_3 150 ppm
G_0 = Control treatment

Table 2. Effect of plant growth regulator (GA_3) on curd yield and yield attributes of cauliflower

Treatment	Curd size		Yield per plot (kg)
	Length (cm)	Breadth (cm)	
G_1	12.00 c	18.00 c	13.50 bc
G_2	13.00 c	17.33 c	14.80b
G_3	13.00 c	19.00 bc	14.90 b
G_4	15.00 b	21.00 b	18.20 a
G_5	17.00 a	24.00 a	20.20 a
G_0	12.00 c	17.00 c	12.60 c
Level of significance	**	**	**
CV (%)	6.48	7.69	7.50

Means followed by the common letters did not differ at 5% level of probability as per DMRT.
* = 5% level of significance
** = 1% level of significance
NS = Non significant
G_1 = GA_3 50 ppm
G_2 = GA_3 75 ppm
G_3 = GA_3 100 ppm
G_4 = GA_3 125 ppm
G_5 = GA_3 150 ppm
G_0 = Control treatment

50 ppm, GA_3 75 ppm and GA_3 100 ppm (Table 1). On the other hand, it was observed that the lowest number (23) of leaves per plant was produced in control. It was statistically identical to that of GA_3 50 ppm. Roy (2002) found 24 no. of leaves in cabbage due to the application of different growth regulators. This is almost similar to the present findings.

4.1.3 Biggest leaf length

There was a significant influence of the different levels of GA_3 on the biggest leaf length in cauliflower (Table 1). The highest length (60 cm) was measured by the application of GA_3 125 ppm and GA_3 150 ppm. The lowest leaf length (48 cm) was measured in the control treatment. The highest leaf length produced by the application of GA_3 100 ppm was statistically similar to those of GA_3 125 ppm and GA_3 150 ppm (Table 1).

4.1.4 Curd weight with leaves (kg)

The different levels of GA_3 influenced the weight of curd with leaves significantly (Table 1). The maximum curd weight with leaves (2.20 kg) was obtained in GA_3 150 ppm. The weight of curd with leaves produced by the application of GA_3 125 ppm was statistically similar to that of GA_3 150 ppm. But it was also observed that there had not have any statistical variation in respect to the weight of curd with leaves due to the application of GA_3 125 ppm, GA_3 100 ppm and GA_3 75 ppm (Table 1). On the other hand, it was observed that the minimum weight of curd with leaves was produced in control treatment (1.60 kg).

4.1.5 Marketable curd weight (kg)

Marketable curd weight of cauliflower increased significantly due to different levels of GA_3 (Table 1). The highest weight of curd (1.5 kg) was recorded due to the highest dose of GA_3 150 ppm. The weight of marketable curd produced by the application of GA_3 125 ppm was statistically similar to that of GA_3 150 ppm. But it was also observed that there were no statistical variation in respect to the marketable curd weight. due to

the application of GA_3 75 ppm, GA_3 100 ppm and GA_3 125 ppm. On the other hand, it was observed that the lowest weight of marketable curd was recorded in control treatment (0.90 kg). It was statistically identical to that of GA_3 50 ppm (Table 1). On the contrary it was observed that curd weight of cauliflower due to varying doses of GA_3 varied from 0.90 to 1.5 kg. It indicates that there is a positive effect of GA_3 on marketable curd weight of cauliflower.

4.1.6 Curd length

Curd length of cauliflower was significantly affected due to different level of GA_3 (Table 2). It revealed that the cauliflower plants receiving GA_3 150 ppm produced the highest curd length (17 cm) while the lowest was found in control and GA_3 50 ppm treatment (12 cm). The curd length of the treatments GA_3 75 ppm and GA_3 100 were similar to that of control and GA_3 50 ppm. It was also observed that with the increase in concentration of GA_3, the curd size in respect of length increases with the exception of GA_3 50 ppm. But it is statistically similar to other treatments except GA_3 125 ppm and GA_3 150 ppm (Table 2). It indicated that the application of GA_3 influences greatly to increase the size of cauliflower in respect of curd length.

4.1.7 Curd breadth

The analysis of variance revealed a significant variation due to the application of different concentrations of GA_3 on cauliflower curd breadth (Table 2). It ranged from 17.00 to 24.00 cm. The highest curd breadth was measured in GA_3 150 ppm treatment while the lowest was found in control treatment (17.00 cm). The curd breadth of he treatment s GA_3 50 ppm, GA_3 75 ppm and GA_3 100 ppm were statistically similar to that of control. It was also observed that with the increase in concentration of GA_3, the curd size in respect of breadth increases with the exception of GA_3 50 ppm. But it is statistically similar to other treatments except GA_3 150 ppm (Table 2). It indicated that the application of GA_3 influences much to increase the size of the cauliflower curd which is excepted to the grower to boost production of cauliflower per unit of land.

4.1.8 Yield per plot (kg)

Application of GA_3 significantly influenced the curd yield per plot (Table 2). The highest yield per plot (20.20 kg) was produced by the plants grown with the GA_3 150 ppm, which was identical to GA_3 125 ppm. While the lowest yield per plot (12.60 kg) was found in control treatment. The curd yield per plot of the treatment GA_3 50 ppm was statistically similar to that of control (Table 2).

4.1.9 Yield per hectare

The yield of cauliflower per hectare was significantly influenced by the different levels of GA_3 (Figure 1). The highest yield (57.71 t/ha) was recorded in GA_3 150 ppm and the lowest yield (36 t/ha) was recorded in the plants having no treatments i.e. the control treatment, which was identical to GA_3 50 ppm (Figure 1). Besides this, GA_3 150 ppm treated plots stimulated quick cell division and cell enlargement and contributed to good results, Mishra *et al.*, (1986) reported that GA_3 (50 mg / L) + urea (1%) have also been enhanced curd yield in cauliflower.

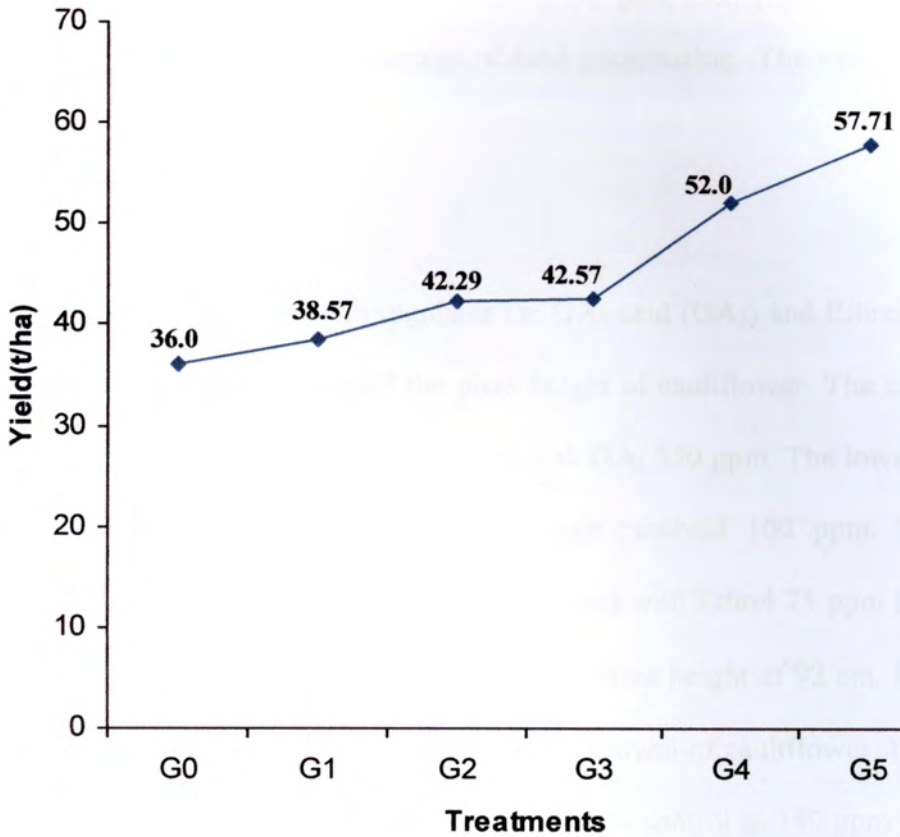

Figure 1.Effect of plant growth regulator (GA_3) on curd yield of Cauliflower

Where,
G_1= GA_3 50 ppm
G_2= GA_3 75 ppm
G_3= GA_3 100 ppm
G_4= GA_3 125 ppm
G_5= GA_3 150 ppm
G_0= Control treatment

4.2 Effect of plant growth regulator (GA_3 and Ethrel) on seed yield and yield contributing characters of cauliflower

The impact of PGR (Plant Growth Regulator) on seed yield of cauliflower was significant (Table 3, 4 and Figure 2). Most of the characters were plant height, number of pods per plant, pod length, number of seeds per pod, seed yield per plant, 1000 seed weight, seed yield (ton/ha), percentage of seed germination. The results are presented in Table 3, 4 and Figure 2.

4.2.1 Plant height (cm)

Different levels of plant growth regulator i.e. GA_3 acid (GA_3) and Ethrel concentration (Table 3) significantly influenced the plant height of cauliflower. The maximum plant height (115 cm) was obtained when treated with GA_3 350 ppm. The lowest plant height (84 cm) was recorded from the plants which received 100 ppm. Ethrel. It was statistically identical to the height of plants treated with Ethrel 75 ppm (86 cm). When the plants were treated with Ethrel 50 ppm gave plant height of 92 cm. It might be due to the fact that Ethrel suppressed the vegetative growth of cauliflower. It was observed that with the increase in concentration of GA_3 from control to 350 ppm increased plant height (96 to 115 cm). But when the plant received GA_3 400 ppm (Table 3) reduced the plant height. It indicated that the application of GA_3 and Ethrel influences the plant height of cauliflower. The findings of the present study are in agreement with reports of Singh *et al.*, (1976) in which there had a significant influence of Ethrel on plant height of cauliflower.

Table 3. Effect of plant growth regulator (Gibberellic acid & Ethrel) on seed yield and yield attributes of cauliflower

Treatment	Plant height (cm)	Number of pods per plant	Pod length (cm)	Number of seeds per pod
G_0	96.00 cd	1820.00 d	4.57 f	11.60 c
G_1	110.00 b	2730.00 ab	6.95 b	15.50 ab
G_2	115.00 a	2850.00 a	7.50 a	16.30 a
G_3	100.00 c	2310.00 c	6.00 d	15.00 ab
E_1	92.00 d	2120.00 cd	5.40 e	12.00 c
E_2	86.00 e	2256.00 c	6.20 cd	14.50 ab
E_3	84.00 e	2440.00 bc	6.50 bc	13.98 b
Level of significance	**	**	**	**
CV (%)	3.40	8.15	4.31	7.53

Means followed by the common letters did not differ at 1% level of probability as per DMRT.
* = 5% level of significance
** = 1% level of significance
NS = Non significant
G_0 = Control treatment
G_1 = GA_3 300 ppm
G_2 = GA_3 350 ppm
G_3 = GA_3 400 ppm
E_1 = Ethrel 50 ppm
E_2 = Ethrel 75 ppm
E_3 = Ethrel 100 ppm

Table 4. Effect of plant growth regulator (Gibberellic acid & Ethrel) on seed yield and yield attributes of cauliflower

Treatment	Seed yield per plant (g)	1000 seed weight (g)	% of seed germination
G_0	26.50 e	2.95 de	89.25 e
G_1	36.24 ab	4.72 a	91.00d
G_2	38.53 a	4.97 a	97.50 a
G_3	31.12 cd	4.00 b	94.35 b
E_1	28.42 de	2.86 e	92.17 cd
E_2	30.47 cd	3.45 cd	93.33 bc
E_3	32.98 bc	3.90 bc	94.50 b
Level of significance	**	**	**
CV (%)	6.47	7.61	3.02

Means followed by the common letters did not differ at 1% level of probability as per DMRT.
* = 5% level of significance
** = 1% level of significance
NS = Non significant
G_0 = Control treatment
G_1 = GA_3 300 ppm
G_2 = GA_3 350 ppm
G_3 = GA_3 400 ppm
E_1 = Ethrel 50 ppm
E_2 = Ethrel 75 ppm
E_3 = Ethrel 100 ppm

4.2.2 Number of pods per plant

There had a pronounced variation among the pods per plant obtained through the applicaton of different levels of PGR (Table 3). The highest number of pods (2850) per plant was produced in plants treated with GA_3 350 ppm. The second highest number of pods (2730) per plant was found in GA_3 300 ppm and the control plants produced 1820 pods per plant (Table 3). It might be due to the fact the optimum GA_3 dose helped higher flower production and fertilization. On the other hand, it was also observed that the number of pods per plant due to the application of different doses of Ethrel as well as the GA_3 400 ppm were also found not to differ significantly from each other. Further, it could be noted that the influence of Ethrel was found to be less than the influence of GA_3 on the production of number of pods per plant. It might be due to the characteristics of GA_3 and Ethrel respectively.

4.2.3 Pods length

There had a significant influence of different levels of GA_3 and Ethrel on the pod length of cauliflower (Table 3). The highest pod length (7.50 cm) was recorded from the plants treated with GA_3 350 ppm followed by GA_3 300 ppm (6.95 cm) and the lowest (4.57 cm) from control. It was observed that with the increase in concentration of GA_3, the pod length was gradually increased except GA_3 400 ppm. But the increase in concentration of Ethrel, there is a sharp increase in pod length of cauliflower (Table 3). Singh *et al.*, (1976) obtained significant influence of Ethrel on the siliqua length of cauliflower which ranged from 4.8 cm to 6.8 cm.

4.2.4 Number of seeds per pod

The number of seeds per pod was influence significantly due to the different levels of plant growth regulators i.e. GA_3 and Ethrel (Table 3). The maximum seeds per pod (16.30) was recorded from the plants receiving GA_3 350 ppm. The number of seeds per pod produced by

the application of GA_3 300 ppm, GA_3 400 ppm and Ethrel 75 ppm were statistically similar to that of GA_3 350 ppm. On the other hand, it was observed that the lowest number of seeds per pod (11.6) was produced in control, which was identical to Ethrel 50 ppm (12)(Table 3). The number of seeds per pod in cauliflower varied from as low as 9.00 to as high as 14.4 due to the application of different levels of Ethrel. The findings is in close proximity to the findings of the present study.

4.2.5 Seed yield per plant

Remarkable variation was observed in seed yield per plant due to varied levels of PGR i.e. GA_3 and Ethrel (Table 4). GA_3 350 ppm treated plants produced the highest (38.53 g) seeds per plant followed by GA_3 300 ppm and the lowest (26.5 g) in control (Table 4). It might be due to higher to pods per plant which consequently conferred higher seed weight/plant. The findings of the present study also corroborates with the findings of Singh *et al* (1976).

4.2.6 1000 seed weight (g)

Analysis of variance revealed a significant variation as regards to the 1000 seed weight due to different levels of plant growth regulators i.e. GA_3 and Ethrel (Table 4). The maximum 1000 seed weight (4.97 g) was obtained from GA_3 350 ppm which was also identical to GA_3 300 ppm and the minimum 1000 seed weight (2.86 g) was recorded from Ethrel 50 ppm which was identical to control treatment (2.95 g) (Table 4). Haque (1999) found 1000 seed weight of cauliflower varying from 2.39 g to 3.00 g due to the different organic fertilizer use. But the 1000 seed weight in the present investigation is much higher than the findings of Haque (1999) which might be due to the positive effect of the PGR.

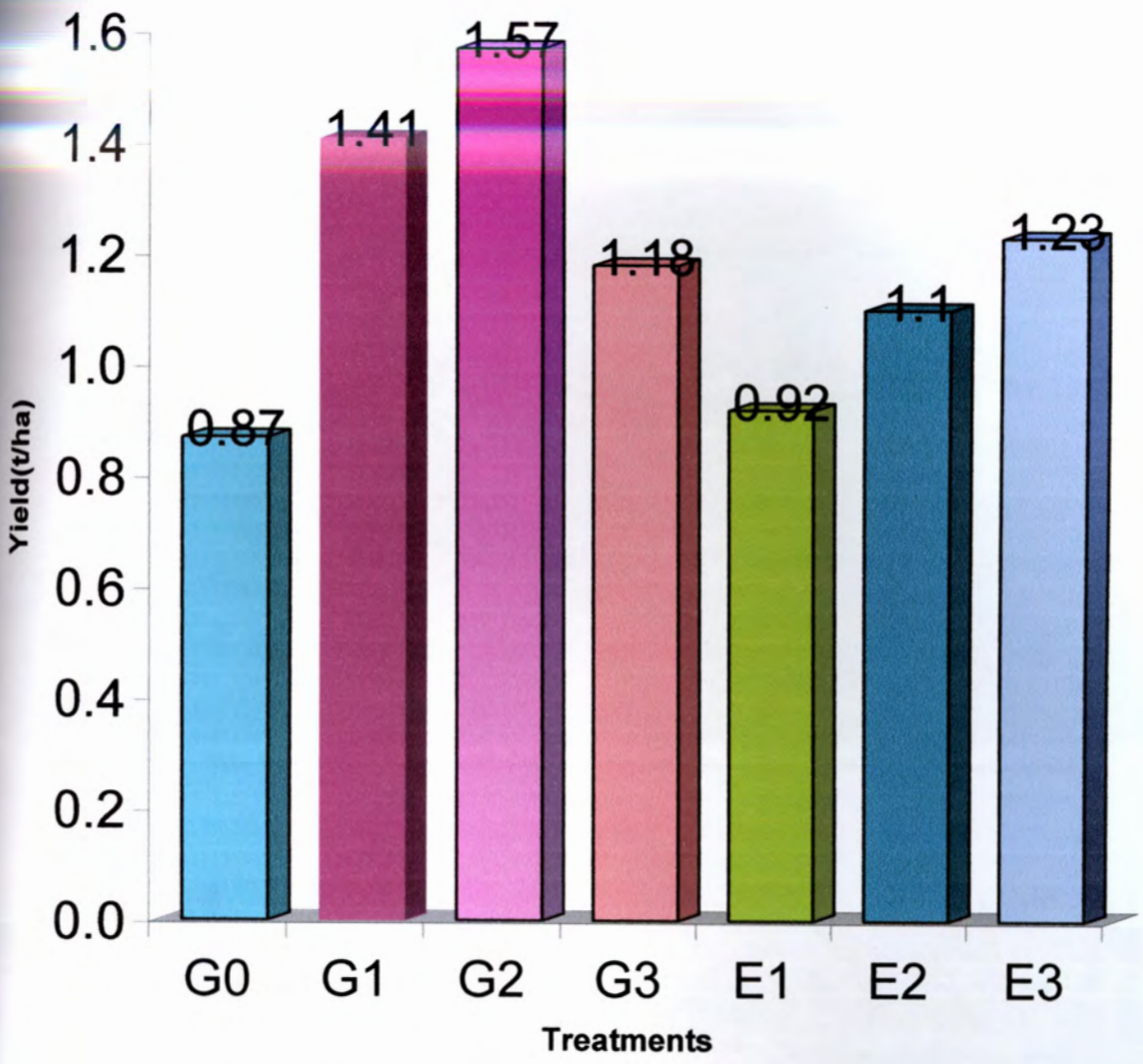

Figure 2. Effect of plant growth regulator (GA_3 and Ethrel) on seed yield of cauliflower

Where,
G_0= Control treatment
G_1= GA_3 300 ppm
G_2= GA_3 350 ppm
G_3= GA_3 400 ppm
E_1= Ethrel 50 ppm
E_2= Ethrel 75 ppm
E_3= Ethrel 100 ppm

Plate 1: Photograph of Cauliflower Seed Production Plot Where no hormone was sprayed

Plate 2: Photograph of Cauliflower Seed Production Plot Where 350 ppm GA3 was applied

4.2.7 Seed yield (t/ha)

Marked variation was found in seed yield (t/ha) due to varied levels of plant growth regulators i.e. GA_3 and Ethrel (Figure 2). Seed yield was found to be maximum (1.57 t/ha) in plants treated with GA_3 350 ppm and the lowest (0.87 t/ha) in control which was identical to Ethrel 50 ppm (Figure 2). It might be due to higher number of pods and seed yield per plant. Mongal *et al.*, (1980) reported that GA_3 at 50-250 ppm improved seed yield.

4.2.8 Percentage of seed germination (%)

Analysis of variance revealed significant variation as regards to the parameter percentage of germination of the seeds of cauliflower due to the different concentrations of Gibberellic acid and Ethrel (Table 4). However, the percent germination of seeds differed from as low as 89.25 to as high as 97.50. It was also observed that the quality of seed was the highest in GA_3 350 ppm while it was the lowest in control treatments (Table 4). The percent germination of seeds in cauliflower was about more than 90%. It indicated that there were minor influence of the seed quality due to the application of gibberellic acid and Ethrel from the practical point of view although it was statistically significant. Singh (1976) found 83% germination of cauliflower seeds due to the application of Ethrel @ 150 ppm.

4.3 Economic analysis

The details of economic analysis have been presented in Appendices iv, v, vi, vii, viii, ix.

The variation in cost of production was noticed due to different levels of Gibberellic acid (Table 5). The production cost of curd was the highest (Tk. 79475/ha) when 150 ppm GA_3 was applied. It might be due to the use of higher levels of GA_3. The lowest cost of production (Tk. 68494/ha) was found when no Gibberellic acid was applied. The highest gross return (Tk. 230840/ha) was obtained from the 150 ppm GA_3 application while the lowest (Tk. 144000/ha) in the control treatment. It was evident that the highest net return (Tk. 151365/ha) was obtained from the 150 ppm GA_3 application. The plant which received no GA_3 showed negative net return. The maximum (2.90) benefit cost ratio (BCR) was recorded in 150 ppm while the lowest (2.10) was found in control treatment.

The total cost of production of cauliflower seed per hectare ranged from Tk. 74928 to 100311 (Table 6). Among all the treatments, the variation was due to the cost of different levels of Gibberellic acid and Ethrel (Table). The highest cost of production (Tk. 100311/ha) was found in 400 ppm GA_3 and the lowest cost of production (Tk. 74928/ha) was found in control treatment. The treatment of 350 ppm GA_3 gave the highest gross return (Tk. 785000/ha) and net return (Tk. 687228/ha). On the other hand, the lowest gross return (Tk. 435000/ha) and net return (Tk. 360072/ha) were recorded from the control treatments. The benefit cost ratio (BCR) was found to be the highest (8.02) in 350 ppm GA_3 while the lowest benefit cost ratio (5.80) was recorded in control treatment.

Table 5. Economic analysis of cauliflower curd yield as influenced by different levels of Gibberellic acid

Treatment	Total cost of production (Tk/ha)a	Yield (ton/ha)	Gross return (Tk/ha)b	Net return (Tk/ha)	BCR
G_1	72385	38.57	154280	81895	2.13
G_2	74157	42.29	169160	95003	2.28
G_3	75930	42.57	170280	94350	2.24
G_4	77704	52.00	208000	130296	2.67
G_5	79475	57.71	230840	151365	2.90
G_0	68494	36.00	144000	75506	2.10

a. Details shown in Appendix iv, v, viii.

b. Considering market price of cauliflower Tk. 4000 per ton

Table 6. Economic analysis of cauliflower seed production as influenced by different levels of Gibberellic acid and Ethrel

Treatment	Total cost of production (Tk/ha)a	Yield (ton/ha)	Gross return (Tk/ha)b	Net return (Tk/ha)	BCR
G_0	74928	0.87	435000	360072	5.80
G_1	94224	1.41	705000	610776	7.48
G_2	97772	1.57	785000	687228	8.02
G_3	100311	1.18	590000	489689	5.88
E_1	76633	0.92	460000	383367	6.00
E_2	77092	1.10	550000	472908	7.13
E_3	77448	1.23	615000	537552	7.94

a. Details shown in Appendix vi, vii, ix.

b. Considering market price of cauliflower seed Tk. 500 per kg.

Chapter 5

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

A field experiment was conducted with BARI Fulkapi-1 cauliflower at the farm of the Horticulture Research Center (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during the period from October, 2004 to March, 2005 to find out the effect of different plant growth regulators (GA_3 and Ethrel) to increase yield on curd and seeds of cauliflower. Two experiments were conducted and both were laid out in a randomized complete block design (RCBD) with three replications. For the field experiment, the size of unit plot was 3.5 x 1 m and 14 plants were accommodated in each plot with a spacing of 60 x 50 cm. Seedlings were planted in the field on 10th November, 2004. From each plot, 5 plants were randomly selected for collection of data on curd yield and seed production. The treatment of the field experiment comprised of two factors namely (A) five (5) concentrations of GA_3 in curd production experiment and (B) three (3) concentrations of both GA_3 and Ethrel on seed production experiment . Data were statistically analyzed following F-test and DMRT.

The curd yield was recorded from all the plants of a plot. Observations were made on days to curd initiation, number of leaves per plant, biggest leaf length, curd weight with leaves, marketable curd weight, curd length, curd breadth, yield per plot and per hectare.

There was significant difference among the treatment in number of days from seed sowing to curd initiation. The maximum days (85.00) were required in plants treated with GA_3-150 ppm which was followed by control treatment (84.10) and the minimum days (80.00) were required with GA_3-50 ppm which was followed by GA_3-75 ppm (81.50).

Number of leaves was significantly influenced by the different levels of GA_3. The maximum number of leaves (26) were noticed in GA_3-125 ppm and the minimum in GA_3-50 ppm and control treatment. The different levels of GA3 significantly affected biggest leaf length. The biggest leaf length (60 cm) was found in GA_3-125 ppm and GA_3-150 ppm which was followed by GA_3-100 ppm (59 cm) and control treatment was

showed the lowest performance. The different levels of GA_3 influenced the weight of curd with leaves significantly. The maximum curd weight with leaves (2.20 kg) was obtained in GA_3 -150 ppm which was followed by GA_3-125 ppm (2.00 kg) and the minimum curd weight with leaves in control treatment (1.60 kg) which was followed by GA_3-150 ppm (1.70). In respect of marketable curd weight (individually) and curd size (curd length and curd breadth) the treatments showed wide variation among them. Treatment GA_3-150 ppm produced the highest marketable curd weight (1.5 kg) which was followed by GA_3-125 ppm (1.35 kg). The lowest marketable curd yield was obtained in control treatment GA_3 (0.90 kg). In case of curd size, curd length was the highest in GA_3-150 ppm (17 cm) and the lowest was found in control treatment and GA_3-50 ppm. Curd breadth was the greatest in GA_3-150 ppm (24 cm) and the lowest in control treatment of GA_3 (17 cm).

Application of GA_3 played an important role on the curd yield of cauliflower. Different concentrations of GA_3 significantly influenced all the characters recorded. The maximum yield/plot (20.20 kg) and yield/ha (57.71 tons) were recorded from 150 ppm GA_3. The lowest yield/plot (12.60 kg) and yield/ha (36 tons) were recorded in the control treatment.

Significant difference was also observed in seed yield and yield contributing characters of cauliflower. Plant height was significant due to different levels of GA_3 and Ethrel. The highest height (115 cm) was recorded in 350 ppm GA_3 and the lowest was (84.00 cm) in ethral 100 ppm. Number of pods/plant, pod length, no. of seed/pod, seed weight/plant, 1000 seed weight, seed yield (t/ha) and % seed germination had the similar trend. In every case GA_3-350 ppm performed the best, which was followed by GA_3-300 ppm. Control treatment showed the lowest results except for 1000 seed weight in Ethrel 50 ppm. The maximum number of pods per plant (2850), pod length (7.50 cm), seeds per pod (16.30), seed weight/plant (38.53 g), 1000 seed weight (4.97 g), seed yield (1.57 t/ha) and % seed germination (97.50) were given by 350 ppm GA_3. The control showed the lowest performance as regards to the parameter studied.

Pending further verification, it may be concluded that the application of GA_3-150 ppm increase the curd yield of cauliflower with the highest BCR of 2.90. On the other hand, increased concentration namely GA_3-350 ppm significantly increases the seed yield of the crop with the maximum BCR value of 8.02. However, for recommendation, the experiments are to be further carried out to obtain the precise information.

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APPENDICES

Appendix I. Monthly temperature, relative humidity and rainfall during the period October, 2004 to March, 2005.

Month	** Air temperature (°C)			**Humidity (%)	* Rainfall (mm)
	Maximum	Minimum	Average		
October' 04	31.45	23.12	27.28	75.25	174.0
November' 04	29.60	17.68	23.63	68.50	000 .0
December' 04	27.14	14.93	21.03	73.41	000.0
January' 05	24.91	13.02	18.96	72.87	008.8
February' 05	29.15	16.96	23.06	69.07	000.0
March' 05	32.24	21.22	26.73	76.16	175.2

*= Monthly total

**= Monthly Average

Source : Plant Physiology Division. Bangladesh Rice Research Institute, Joydebpur, Gazipur-1701.

Appendix II. Analysis of variance of curd yield and yield attributes of cauliflower

Sources of variation	Degrees of freedom	Mean square								
		Days to curd initiation	Number of leaves per plant	Biggest leaf length (cm)	Curd weight with leaves (kg)	Marketable curd weight (kg)	Curd length (cm)	Curd breadth (cm)	Yield per plot (kg)	Yield (t/ha)
Replication	2	5.167	0.705	1.800	0.174	0.026	2.347	6.722	8.167	22.542
Treatment	5	9.041**	4.400*	80.900**	0.139**	0.151*	11.600**	21.5222**	25.440**	207.609**
Error	10	0.767	0.042	3.300	0.018	0.025	0.785	2.222	1.387	2.142

** = Significant at 1% level

* = Significant at 5% level

NS = Not significant

Appendix III. Analysis of variance of seed yield and yield attributes of cauliflower

Sources of variation	Degrees of freedom	Mean square							
		Plant height (cm)	No. of pods per plant	Pod length (cm)	No. of seeds per pod	Seed yield per plant (g)	1000 seed weight (g)	Yield (t/ha)	% of seed germination
Replication	2	5.476	122242.857	0.094	2.175	14.173	0.093	0.0014	2.200
Treatment	5	407.857**	372955.429**	2.839**	9.220**	53.897**	1.990**	0.189**	21.509**
Error	10	5.476	36992.857	0.070	1.133	4.297	0.085	0.001	0.898

** = Significant at 1% level

* = Significant at 5% level

NS = Not significant

Appendix iv. Labours requirements per hectare for various operations to produce curd yield of cauliflower

Heads of use of labours	No. of labours
Bed preparation	128
Planting and watering	43
Irrigation	42
Weeding	84
Insecticide application	23
Harvesting	15
Fertilizer application	65

Appendix v. Cost of GA_3 and labour for spraying to produce curd yield of cauliflower

Treatment	Cost of GA_3 (Tk/ton)	No. of labours for spraying	Tk/ha	Total cost of GA_3 and labour (Tk/ha)
G_1	3247	15	1050	4297
G_2	4870	15	1050	5920
G_3	6494	15	1050	7544
G_4	8116	15	1050	9167
G_5	9740	15	1050	10790
G_0	-	-	-	-

Source: GA_3 @ Tk. 250/g, which contain 99% GA_3, Indian LOBA company

Appendix vi. Appendix iv. Labours requirements per hectare for various operations to produce seed production of cauliflower

Heads of use of labours	No. of labours
Bed preparation	128
Planting and watering	44
Irrigation	48
Weeding	90
Insecticide application	25
Harvesting	25
Fertilizer application	80

Appendix vii. Cost of GA_3, Ethrel and labour for spraying to produce seed production of cauliflower

Treatment	Cost of GA_3 and Ethrel (Tk/ton)	No. of labours for spraying	Tk/ha	Total cost of GA_3 and labour (Tk/ha)
G_0	-	-	-	-
G_1	19480	20	1400	20880
G_2	22730	20	1400	24130
G_3	25970	20	1400	27370
E_1	102	20	1400	1503
E_2	154	20	1400	1554
E_3	205	20	1400	1605

Source: GA_3 @ Tk. 250/g, which contain 99% GA_3, Indian LOBA company

Ethrel, Ripen-15 @ Tk.150/100 ml which contain 38% Ethrel, National Agri Care, Bangladesh.

Appendix viii. Cost and return in cauliflower curd yield as influenced by different levels of Gibberellic acid

SL NO.	Cost per hectare	Tk.
1	Labour 45 days @Tk. 70 (Details shown in appendix iv)	28000
2	Ploughing (Three times)	3000
3	Cost for lease land Tk. 1200 for season (6 months)	9000
4	Cost of cowdung, urea, TSP, MP, Boron, Molybdenum	12560
5	Cost for insecticide @Tk. 70/50 ml	1630
6	Cost of seedling @ Tk. 300 per 1000 seedling	7800
7	Cost of GA_3 and labour for spraying (Appendix v)	Variable
8	Miscellaneous cost 5% of the total from 1-7	Variable
9	Total input cost (From 1-7)	Variable
10	Interest on running capital 8% for 6 months of the total input cost	Variable
11	Total cost of production (From 1-10)	Variable

Appendix ix. Cost and return in cauliflower seed production as influenced by different levels of Gibberellic acid and Ethrel

SL NO.	Cost per hectare	Tk.
1	Labour 45 days @Tk. 70 (Details shown in appendix iv)	30800
2	Ploughing (Three times)	3000
3	Cost for lease land Tk. 1200 for season (6 months)	9000
4	Cost of cowdung, urea, TSP, MP, Boron, Molybdenum	13175
5	Cost for insecticide @Tk. 70/50 ml	1630
6	Cost of seedling @ Tk. 300 per 1000 seedling	7800
7	Cost of GA_3, Ethrel and labour for spraying (Appendix vii)	Variable
8	Miscellaneous cost 5% of the total from 1-7	Variable
9	Total input cost (From 1-7)	Variable
10	Interest on running capital 8% for 6 months of the total input cost	Variable
11	Total cost of production (From 1-10)	Variable