EFFECT OF GROWTH REGULATORS AND FERTILIZER MANAGEMENT PRACTICES ON THE FLOWERING, FRUIT SET AND YIELD OF BITTER GOURD (*Momordica charantia* L.)

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CERTIFICATE

This is to certify that thesis entitled, "**Effect of Growth Regulators and Fertilizer Management Practices on the Flowering, Fruit set and Yield of Bitter gourd"** submitted to the Department of Horticulture & Post harvest Technology, 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 bonafide research work carried out by **Mohammad Abdul Momin** Registration No. **27620/00765** under my supervision and guidance. No part of the thesis has been submitted for any other degree of diploma.

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

Dated:
Dhaka, Bangladesh.

.....
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DEDICATED
TO
MY BELOVED PARENTS

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LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABBREVIATIONS AND ACRONYMS

BADC	=	Bangladesh Agricultural Development Corporation
BARC	=	Bangladesh Agricultural Research Council
BARI	=	Bangladesh Agricultural Research Institute.
BAU	=	Bangladesh Agricultural University
SAU	=	Sher-e-Bangla Agricultural University
SRDI	=	Soil Resources and Development Institute
BCR	=	Benefit cost ratio
DAT	=	Days after transplanting
FAO	=	Food and Agricultural Organization
LSD	=	Least Significant Difference
NPK	=	Nitrogen, Phosphorus and Potassium
PGR	=	Plant Growth Regulator
CV%	=	Percentage of coefficient of variance
Max	=	Maximum
Min	=	Minimum
MP	=	Muriate of Potash
NS	=	Not Significant
Ppm	=	Parts per million
Rh	=	Relative humidity
t/ha	=	Ton per hectare
TSP	=	Triple Super Phosphate

et al = And others

EFFECT OF GROWTH REGULATORS AND FERTILIZER MANAGEMENT PRACTICES ON THE FLOWERING, FRUIT SET AND YIELD OF BITTER GOURD *(Momordica charantia L.)*

ABSTRACT

A field experiment was conducted to examine the effect of growth regulators (IAA and Ripen-15) and fertilizer management practices on the flowering, fruit set and yield of bitter gourd (Hybrid Corolla- Penta Green) during April to July 2007 at the Horticulture farm of Sher-e-Bangla Agricultural University, Dhaka. The experiment was considered of two factors. Factor A: Different plant growth regulators viz. control (H_0), IAA (H_1), Ripen-15 (H_2) and IAA+Ripen-15 (H_3) and Factor B: Fertilizer management practices viz. control (F_0), organic manure (F_1) and inorganic manure (F_2). It was laid out in the two factors Randomized Complete Block Design (RCBD) with three replications. The data obtained for different characters were statistically analyzed to find out the significance of the PGR's and fertilizer management practices. The tallest plant at 1st flowering time (163.90 cm), the lowest ratio of male and female flower (3.08), the maximum fruit weight (129.10 gm) were recorded from the application of IAA+Ripen-15 (H_3) but the maximum number of fruit (18.26) and highest yield per hactare (21.89) was found from application of Ripen-15 (H_2) and the minimum was recorded in control condition. The tallest plant at 1st flowering (160.72 cm), the lowest ratio of male and female flower (3.06), the maximum number of branches (11.86), nodes (26.33), female flowers (23.72), fruits (16.35), maximum fruit weight (119.92 gm) per plant and the highest yield (19.11 t/ha) were recorded from the application of inorganic fertilizer (F_2) and the minimum was recorded in control condition. Interaction effect between plant growth regulators and fertilizer management practices showed a statistically significant variation incaseof most of the recorded characters. The combination of Ripen-15 and inorganic fertilizer (H_2F_2) gave the highest gross return (Tk. 510,000) which is closely followed by combination of Ripen-15 and organic fertilizer (H_2F_1). The lowest gross return (Tk. 208,000) was obtained in the control condition where no plant growth

regulator as well as no fertilizer was applied. The combination of Ripen-15 and inorganic fertilizer (H_2F_2) gave highest benefit cost ratio (2.47) and the lowest benefit cost ratio (0.61) was obtained in combination of control conditions (H_0F_0).

INTRODUCTION

Bitter gourd (*Momordica charantia L.*) is a tropical and subtropical vine of the family Cucurbitaceae. It is widely grown for edible fruit, which is among the most bitter of all vegetables. The original home of the species is not known, other than that it is a native of the tropics. It is widely grown in South and Southeast Asia, China, and Africa. The herbaceous tendril-bearing vine grows to 5 m. It bears simple, alternate leaves 4-12 cm across, with 3-7 deeply separated lobes. Each plant bears separate yellow male and female flowers. (Rashid, 2004)

Bitter gourd is usually grown under kitchen garden as a summer vegetable. But at present it is also being grown as commercial crop near the urban areas. Moreover, it can also be grown in any type of soil having good drainage system. From nutritional point of view, bitter gourd can be considered as nutrition rich fruit vegetable. It contains considerable amount of water (83-92%), carbohydrates (4.0-10.5%), protein (1.5-2.0%), fat (0.2-1.0%), minerals (0.5-1.0%) and fiber (0.8-1.7 %) (Gopalan *et al*, 1982). Ripe fruits are rich in vitamin- A. Among all cucurbits vegetables bitter gourd contains maximum amount of minerals and vitamins. Due to high keeping quality (Banerjee and Mangal, 1986), it has also export potentiality.

The fruit has a distinct warty looking exterior and an oblong shape. It is hollow in cross-section, with a relatively thin layer of flesh surrounding a central seed cavity filled with large flat seeds and pith. Seeds and pith appear white in unripe fruits, ripening to red; they are not intensely bitter and can be removed before cooking. However, the pith will become sweet when the fruit is fully ripened, and the pith's color will turn red. The pith can be eaten uncooked in this state, but the flesh of the gourd will be far too tough to be eaten anymore. Red and sweet bitter gourd pith is a popular ingredient in some special Southeast Asian style salad. The flesh is crunchy and watery in texture, similar to cucumber, chayote or green bell

pepper. The skin is tender and edible. The fruit is most often eaten green. Although it can also be eaten when it has started to ripen and turn yellowish.
The fully ripe fruit turns orange and mushy, is too bitter to eat, and splits into segments which curl back dramatically to expose seeds covered in bright red pulp. (Gopalan *et al,* 1982).
Bitter gourd comes in a variety of shapes and sizes. The typical Chinese phenotype is 20 to 30 cm long, oblong with bluntly tapering ends and pale green in color, with a gently undulating, warty surface. The bitter gourd more typical of India has a narrower shape with pointed ends, and a surface covered with jagged, triangular "teeth" and ridges. Coloration is green or white. Between these two extremes are any numbers of intermediate forms. Some bear miniature fruit of only 6 - 10 cm in length, which may be served individually as stuffed vegetables. These miniature fruit are popular in Southeast Asia as well as India. Bitter gourds are seldom mixed with other vegetables due to the strong bitter taste, although this can be moderated to some extent by salting and then washing the cut gourd before use.

Bitter gourds have been used in various Asian traditional medicine systems for a long time. Like most bitter-tasting foods, bitter gourd stimulates digestion. While this can be helpful in people with sluggish digestion, dyspepsia, and constipation, it can sometimes make heartburn and ulcers worse. The fact is that bitter gourd is also a demulcent and at least mild inflammation modulator, however, means that it rarely does have these negative effects, based on clinical experience and traditional reports. (Abascal and Yarnell , 2005). Though it has been claimed that bitter gourd’s bitterness comes from quinine, no evidence could be located supporting this claim. Asians, as well as Panamanians and Colombians traditionally regard bitter gourd, as useful for preventing and treating malaria.

Laboratory tests suggest that compounds in bitter gourd might be effective for treating HIV infection. As most compounds isolated from bitter gourd that impact HIV have either been proteins or glycoprotein lectins, neither of which are well-

absorbed, it is unlikely that oral intake of bitter gourd will slow HIV in infected people. It is possible oral ingestion of bitter gourd could offset negative effects of anti-HIV drugs, if a test tube study can be shown to be applicable to people. In one preliminary clinical trial, an enema form of a bitter gourd extract showed some benefits in people infected with HIV (Zhang 1992).

The other realm showing the most promise related to bitter gourd is as an immunomodulator. One clinical trial found very limited evidence that bitter gourd might improve immune cell function in people with cancer, but this needs to be verified and amplified in other research. Some claim bitter gourd as "a cure for diabetes", although outside of anecdotal stories scientific evidence for this claim is limited. Studies so far demonstrate improvement but not cure in some diabetic parameters. (Baldwa et al., 1977)

In Bangladesh, vegetables are grown in 0.2 million hectares of land which is about 1% of the cultivated. Winter vegetables are usually grown in 58.96% of the total land area while 41.04% area is covered by summer vegetables (BBS, 2005). Vegetables become rare during summer season. Besides, there are lean periods at the end of winter and summer seasons when there is always a scarcity of vegetables in this country. The nutritional problems and vegetable scarcity in Bangladesh during that gap period can be reduced to some extent through improvement of production technology of cucurbitaceous crops like bitter gourd.

The role of plant growth regulators in various physiological and biochemical process in plant is well known from its identification. Growth regulators are known to have an effect on the produced of earliest flower, yield (Gedam *et al*., 1998), ratio of male/female flower (Bisaria, 1974), number of fruits, weight of fruit (Gopalkrishman and Choudhury, 1978). Initiation of flower bud, development of flowers and fruits are controlled by physiological process. In many agricultural plants, these processes can often be used to alter by proper application of plant growth substances. Exogenous application of growth

regulators has sifted the sex expression towards femaleness by increasing the production of female flower and suppressing that of male flowers in bitter gourd (Parkash, 1974). Ethephon has been most effective including early female flowers at lower nodes and suppresses the male flower production in bitter gourd (Kalia and Dhillon, 1964).

The cultivation of bitter gourd requires an ample supply of plant nutrient. Use of organic manures and fertilizers is essential for its proper growth and development. Organic manure improves soil structure as well as increases its water holding capacity. Moreover, it facilitates aeration in soil. Vegetable consumers appreciate recently organic farming as it enhances quality of the produce. *(Rashid, 2004)*

Considering the above facts, the present experiment has been undertaken with the following objectives:

1. To asses the response of plant growth regulators (Ripen-15 and Indole 3-Acetic Acid) on the flowering, fruit set and yield of bitter gourd.
2. To asses the response of organic and inorganic fertilizer on the flowering, fruit set and yield of bitter gourd.
3. To find out the interaction of IAA and Ripen-15 on the flowering, growth and yield of bitter gourd.
4. To find out the interaction effect among fertilizer management practices (organic and inorganic) and plant growth regulators, on the flowering fruit set and yield of bitter gourd.

CHAPTER II
REVIEW OF LITERATURE

Studies on bitter gourd are very limited. However, research works on bitter gourd and other members of the Cucurbitaceae family and other related crops in respect of fertilizer management, plant growth regulators, time of sowing; plant spacing, vine pruning, fruit retention, etc. have been carried out in different parts of the world. Literatures related to the present study have been reviewed below.

2.1 Effect of Plant Growth Regulators

Ameena, M and S.George (2002) was conducted an experiment to assess the allelopathic effect of aqueous extracts of purple nutsedge (Cyperus rotundus) on the germination and seedling growth of bitter gourd (Momordica charantia). In petri plate bioassays, the aqueous extracts of nutsedge dry plant parts inhibited the germination and seedling growth of bitter gourd.

Wang, Q.M. and Q.M. Wang (2001) conducted an experiment on the effect of CPPU (forchlorfenuron) application on growth and endogenous phytohormone contents of M. charantia cv. Kaihua Changbai was determined. Application of CPPU to the ovary at anthesis within the concentration of 10-50 mg/litre accelerated fruit growth by increasing the length, diameter and fresh weight of fruits, while 100 mg/litre inhibited fruit growth. HPLC analysis showed that the endogenous ZT (zeatin) content of fruit was lowered and the endogenous ABA (abscisic acid) content was improved by CPPU treatments at the concentration of 20 and 100 mg/litre, and that the endogenous contents of IAA and GA3 (gibberellic acid) were significantly improved by application of CPPU at 20 mg/liters, reaching a peak value 6 days after anthesis.

Al-Masoum and Al-Masri (1999) reported that Cucumber cv. Beit Alpha was grown in a greenhouse in 1996-97 and ethephon applied at 250 ppm, 350 ppm and

450 ppm at the seedling stage (2-4 true leaves). Data were collected on the total yield, early yield, late yield, number of female flowers, number of male flowers, days to the first male flowers, days to first female flowers, number of nodes to the first female flower, number of nodes to the first male flower and plant height. All the cases positive result was found from ethephon treated plants. Ethephon induced femaleness (pistillate flowers) on the main stem that led to greater fruit production.

Gedam *et al.* (1998) conducted an experiment in 1992 where bitter gourd plants were sprayed 40, 55, 70, 80 and 100 days after sowing with 15, 25 and 35 ppm GA_3, 50, 100 and 150 ppm NAA, 50, 100 and 150 ppm Ethephon, 100, 200, 200 and 300 ppm Maleic Hydrazide, 2, 4 and 6 ppm boron and with water (control). GA_3 at 35 ppm produced the earliest female flower and NAA at 50 ppm produced the earliest male flower. Fruit maturity was the earliest in plants treated with 50 ppm NAA or 4 ppm boron. Fruit and seed yields were also the highest in these treatments.

Susmita, D *et all*.(1998) reported that foliar application of silver nitrate (50 mg/litre; an inhibitor of ethylene-induced plant responses) reduced the vegetative phase and extended the flowering phase of Momordica charantia L. Silver nitrate promoted female flowering, fruit setting, and fruit development. It also increased the length, girth, weight and quality of fruits.

The effects of NAA (25 and 100 ppm) and Maleic hydrazide (50 and 100 ppm), applied at the 2-true leaf stage, and sowing date (15 day intervals from 10 September to 25 October) on the growth of *Lagenaria siceraria* (cv. Kiyari Lao) was investigated by Baruah and Das (1997) during rabi 1994-95 in India. They observed that plants sprayed with NAA at 25 ppm and MH at 50 ppm produced the best yields (5.48 and 4.86 kg/plant, respectively. Yield decreased with later sowing dates from 5.49 to 2.62 kg/plant.

Tomar and Ramgiry (1997) conducted an experiment and found that plants treated with GA_3 showed significantly greater plant height, number of branches/plant, number of fruit/plant and yield than untreated controls. GA_3 treatment at the seedling stage offered valuable scope for obtaining higher commercial tomato yields.

Islam (1995) conducted a trial with different concentrations of GA_3 like 0, 10, 25, 50 and100 ppm. He stated that application of GA_3 was effective in improving the yield and yield components of bitter gourd when applied at low concentration of 10 ppm. The inhibitory effect of GA_3 applied at the rate of 100 ppm was observed on production of fruits with lesser number of filled seeds, dry matter of seeds, weight of 100 seeds, seed yield and percent seed vigor index. Irrespective of concentration, the application of GA_3 reduced the total number of staminate flowers. The ratio between the staminate and pistillate flowers as well as fruit setting was low. The number, length, diameter and weight of fruits were not influenced by GA_3 application.

Suresh and Pappiah (1991) conducted a trial with bitter gourd cv. MDU 1, where N and P_2O_5 were applied at 0, 40 and 80 and 0, 30 and 60 kg/ha, respectively and maleic hydrazide was sprayed at 0, 100 and 200-ppm solution. The highest yield was obtained with 80 kg N/ha, 30 kg P_2O_5/ha and 200 ppm MH.

Arora *et al.* (1988) stated that in 2 season field trials with cv. *Lagenaria cylindrica (Lagenaria aegyptiaca)* Pusa Chikni, the plants were sprayed with 5 different growth regulators at the 2 and 4 true leaf stages. The total yield (av. 2.39 kg/plant) was the highest in plants treated with Ethrel (ethephon) at 100 ppm. The average control yield was 0.69 kg/plant.

Sreeramulu (1987) found that ethrel 100 g/l increased the number of pistillate flowers and also hastened the appearance of the female flower compared to the

control in sponge gourd. It also delayed the appearance of the first staminate flower and also decreased the total number of male flowers.

Verma *et al*. (1984) found that ethrel 100 ppm delayed the appearance of first male and female flowers. MH 200 ppm and Boron 3 ppm and 4 ppm produced the earliest female flowers but at a higher node, while ethrel 100 ppm induced the first staminate and pistillate flower at the lowest nodes at 6.5 and 9.5 respectively. Boron 4 ppm also proved superior to all the other chemicals in producing the maximum fruits and yield. Ethrel and MH 100 ppm did not response much. One local and exotic varieties of bitter gourd was treated with 0.1% and 0.2% of potassium naphthalene (knap). The number of fruits per plant and average weight of fresh fruit increased significantly following treatment with 0.1% knap in both varieties.

Irshad Ahmad and Gupta (1981) found that the minimum ratio of male to female flower was reached at 1000 ppm of cycocel in case of smooth gourd and at 1500 ppm in bottle gourd and bitter gourd. Nodes per female flower as well as days to flower were minimum at 1000 ppm in bitter gourd and 1500 ppm in smooth gourd and bottle gourd. Earliest node for first female flower was observed at 1000 ppm in smooth gourd and bitter gourd but at 1500 ppm in bottle gourd.

An investigation to study the influence of various chemicals (Ethrel, NAA, Cycocel, MH, PCPA, Ascorbic acid and Boron) on the growth, flowering and yield of bitter gourd was conducted. PCPA at 100 ppm improved plant growth significantly. The treatment of CCC at 250 and 500 ppm produced female flowers about 12 days earlier in comparison to control plant. Maximum fruit yield per plant (3123 gm) was produced under Cycocel 250 ppm followed by Ascorbic acid 25 ppm and Cycocel 250 ppm (Mangal *et al*., 1981)

Saleh and Abdul (1980) conducted an experiment with GA_3 (25 and 50 ppm), which were applied 3 times in June to early July. They reported that GA_3 stimulated plant growth. It reduced the total number of flowers per plant, but increased the total yield compared to the control. GA_3 also improved fruit quality.

Gopalkrishman and Choudhury (1978) reported that in contrast with TIBA, GA in general produced the largest number of male flowers; GA at the lowest concentration of 10 ppm produced more number of female flowers in first year. In the first year MH 100 ppm to 600 ppm as well as NAA and IAA at 50 ppm to 150 ppm induced a reduction in the mean number of female flowers. Treatment with TIBA at 50 ppm, 100 ppm and 200 ppm excelled all the other treatments in producing a favorable female to male flower ratio. TIBA from 50 ppm to 200 ppm gave a significant increased in the number of fruits and weight of fruits of watermelon.

Pandey *et al.* (1976) stated that the effects were compared of seed soaking for 24 hrs in solutions of 2, 4-D at 1.5 ppm, MH and NAA, each at 200 ppm and GA_3 at 50 ppm and foliar spraying with 2, 4-D at 0.5-1.0 ppm, applied at the 2 true leaf and 4-5 true leaf stages. The number of pistillate flowers of *Lagenaria cylindrica (Lagenaria aegyptiaca)* was increased by seed treatment with MH and NAA at 200 ppm and by spraying with NAA at 100 and 150 ppm, MH at 100-200 ppm and GA_3 at 10 ppm; staminate flower numbers were decreased by MH at 200 ppm, NAA at 100 ppm and GA_3 at 10 ppm. The ratio of pistillate: staminate flower numbers was increased by all treatments except 2, 4-D and GA_3 at 25 and 50 ppm. Fruit set was enhanced by all treatments except GA_3 at 50 ppm and 2, 4-D. Yields were increased by seed treatment with NAA at 200 ppm and by spraying with NAA and MH at 150 and 200 ppm respectively.

Bisaria (1974) found that foliar spray of NAA 100 ppm increased the number of female flower per plant and the sex ratio is reduced in cucurbits.

Patnaik *et al.* (1974) reported that application of Cycocel in 1000 ppm concentration produced maximum number of pistillate flowers, while 500 ppm produced the maximum number of staminate flowers. Fruit yield was observed to be highest in the treatment of 100 ppm Cycocel followed by 2000 ppm and 500 ppm. Ethrel was found to be toxic to the plants and yield was markedly reduced with its application.

In India, Kaushik *et al.* (1974) carried out an experiment with the application of GA_3 at 1, 10 or 100 mg/l on tomato plants at 2-leaf stage and then at weekly interval until 5 leaf stage. They reported that GA_3 increased the number and weight of fruits per plant at higher concentration.

Pandey and Singh (1973) found that soil application of up to 100 kg/N increased the number of pistillate and staminate flower and the yield; the sex ratio was not affected in bottle gourd. Maleic hydrazide approximately doubled the proportion of female flowers and also increased yield. Combined application of N and maleic hydrazide gave a further increased in the proportion of female flowers and the highest yield.

Ravindran (1971) reported that bitter gourd seedlings were sprayed with ethral at concentrations ranging from 200 ppm to 600 ppm. Stunting, growth retardation and pollen sterility were induced in proportion to the dose applied and the production of male flowers was significantly reduced.

McMurray and Miller (1969) found that cucumber seedlings treated with ethephon at concentrations of 120 ppm, 180 ppm and 240 ppm increased the number of pistillate flowers. The staminate to pistillate flower ratio was approximately 10:1. But in case of ethephon treated plants, the staminate to pistillate flower ratio ranged from 1:6 to 1:14, depending on the concentration of ethephon used.

Irving *et al.* (1968) found that TIBA at 25 ppm was particularly effective in promoting the femaleness in cucumber. The increased TIBA stimulation of female flowers ranged from 100 to 200 percent. TIBA also increased the number of female flowers but lowered the male and female ratio.

Choudhury *et al*. (1967) reported that NAA 100 ppm, IAA 100 ppm and 200 ppm and MH 50 ppm and 200 ppm were equally effective in suppressing the male flowers and increasing the number of female flowers in cucumber. The effects subsequently increased the percentage of fruit set and ultimately the yield.

Singh and Upadhaya (1967) studied the effect of IAA and NAA on tomato and reported that the regulators activated growth, increased the fruit set, size and yield of fruit and induced parthenocarpic fruit. The chemicals could be applied on seeds, roots, whole plants or flowers, but foliar application was very effective for increasing the size of fruit and the yield.

The ratio of male and female flower reduced when maleic hydrazide at 150 ppm was sprayed on the plant of bitter gourd reported by Prasad and Tyagi, 1963.
Choudhury and Pahatak (1959) reported the effects of growth regulators on sex expression of cucumber. They observed that MH 200 ppm and NAA 100 ppm significantly increased number of female flowers and MH 600 and 800 ppm, NAA 100 ppm and IAA 200 ppm greatly suppressed the number of male flower over control. All treatments increased the female to male flower ratio when compared with the control.

2.2 Effect of Fertilizers

Bacha, M.R. *et all*.(2005) conducted an Experiment on the effects of P rate (0, 30, 40, 50 or 60 kg/ha as P2O5) and sowing date (15 May, 30 May, 20 June and 5 July) on the growth and yield of bitter gourd (Momordica charantia cv. Land Race) were studied in Mingora, Pakistan, during 2001-02. The increase in the rate

of P2O5 rate resulted in early germination, flowering and harvesting, but had no effect on growth and yield. Early sowing had favourable effect on germination, plant growth, fruit size and yield. Among the sowing dates, 15 May resulted in the greatest germination (59.7%), plant height (262.7 cm) and total yield (34.0 t/ha). The lowest number of days to first picking was obtained with the application of 60 kg P/ha and sowing on 20 June (51.7). P at 0 kg/ha and sowing on 30 May gave the highest number of fruits per plant (40.0). Sowing on 15 May is optimum for bitter gourd production in the region.

Reddy, P.K and P.V.Rao (2004) was conducted field experiment with bitter gourd (M. charantia) in Hyderabad, Andhra Pradesh, India, consisting of 4 levels of vermicompost (0, 10, 20 and 30 t/ha) and 3 levels of N (20, 40 and 80 kg/ha). Application of vermicompost and N significantly increased the vine length, number of branches, number of fruits per vine and fruit yield/ha. Delayed flowering was observed with higher levels of N and Vermicompost. Application of 13.8 t vermicompost and 34.18 kg N (through urea)/ha was found beneficial in improving the yield of bitter gourd.

Rekha and Gopalakrishnan (2001) conducted a field experiment with bitter gourd (*Momordica charantia* L.) cv. Preethi in Thrissur, Kerala, India during kharif 1999. Considering the total yield, marketable yield and size of fruits, the treatment T_7 which received a basal application of 20 tones of dry Cowdung, 2.5 tones of poultry manure, fortnightly drenching of 2.5 tones of cowdung and a fertilizer dose of 70:25:25 kg NPK/ha was found superior to all other treatments. More or less equal fruit yield and fruit size were also recorded in T_5, which received same manures but lacked inorganic fertilizers. This was clearly revealed the possibility of achieving a reasonably good yield by basal application of dry cowdung, top dressing with poultry manure and by drenching cowdung slurry at fortnightly interval.

The influences of N, P and K fertilizers on seed yield and seed quality of bitter gourd were studied by Boonmanop (1997). Bitter gourd was grown and treated with the combination of 3 rates of nitrogen (0, 15 and 30 kg N/rai), 3 rate of phosphorus (0, 10 and 20 kg P_20_5/rai) and 2 rates of potassium (0 and 10 kg K_20/rai) fertilizers. The results showed that N, P and K fertilizers had no significant effects on the first bloom of male and female flower (earliness), total number of fruits, weight per fruit, number of seeds per 7 square meter (6 plants), number of seeds per fruit, total seed weight and 100 seeds weight. However, the high rates of N, P and K gave the highest germination (92.9 %) and germination index (23.2) and the best combination was 30, 20 and 10 kg N, P_20_5 and K_20/rai, respectively.

Isaac and Pushpakumari (1997) conducted a field trial at Department of Agronomy, College of Agriculture, Vellayani, India in 1994-95, where okras were grown with 6 t/ha FYM + chemical fertilizers and 12 t/ha FYM + chemical fertilizers or vermicompost or poultry manure. The effect of picking no, 2, 4 or 6 green fruits/plant was also examined. Fruit and seed yields were highest with FYM + chemical fertilizers, but there was only a marginal benefit in applying the higher rate of FYM. Seed yield declined as more fruits were picked.

The response of bitter gourd cultivars, Tarnab selection and Balsam pear to the application of 0, 60, 80, 100 and 120 kg N/ha was studied by Ali *et al.* (1995) near Peshawar, Pakistan. They found that the highest number of female flowers (36.13) and fruit set (34.49) was recorded with 120 kg N/ha. Individual fruit weight was greater (55.26 g) with 80 kg N but the difference was not significant. The highest yield (24.90 t/ha) was recorded with 80 kg N/ha. The control plants yielded 17.13 t/ha. Differences between cultivars were not significant except for the number of female flowers, fruit per plant and yield per hectare. Tarnab selection produced 35.05 female flowers per plant, 33.98 fruits per plant and 24.77-ton fruit/ha compared with 30.05, 28.66 and 18.85 t/ha, respectively, in Balsam Pear.

Islam (1995) conducted an experiment with five levels of NPK such as 0-0-0, 120-0-0, 120-120-60, 240-0-0 and 240-120-60 kg/ha on bitter gourd seed production. He observed that plots treated with N alone at the rate of 240 kg/ha improved the vegetative growth of bitter gourd as manifested by an increase number and length of vines, diameter of stem, length and diameter of leaves. The inclusion of P and K to N significantly reduced the above parameters, except the number of lateral vines and diameter of stem, which remains unaffected. However, application of NPK significantly increased the number of fruits per plant, size and weight of fruits and the fruit yield compared to plots treated with N alone. The increase in fruit yield due to the application of P and K was 11.35 t/ha at 240 kg N/ha. The same trend of result was noted for seed yield and quality where plants fertilized with 240-120-60 kg/ha produced the highest yield due to greater number of filled seeds per fruit which were bigger and heavier than the seeds produced from other treatments. Moreover, the above treatment produced seeds with the highest percentage of germination (99.00) and seed vigor index (20.03%).

Naik and Srinivas (1992) in trials conducted at the Division of Vegetable Crops, Indian Institute of Horticultural Research, Bangalore, Karnataka, India with cv. Pusa Sawani to observe the influence of nitrogen and phosphorus fertilization on seed crop of okra in the rainy seasons of 1985 and 1986 on a sandy loam soil with low available N and P. N was applied at 50, 100, 150 and 200 kg/ha and P at 30, 60 and 90 kg P_2O_5/ha. Half of the N, all the P and 40 kg K_2O/ha were applied before sowing; the rest of the N was applied as a top dressing 30 days after sowing. The highest seed yields were obtained with 200 kg N/ha (13.00 and 11.25 q/ha in 1985 and 1986 respectively) and 90 kg P_2O_5/ ha (11.89 and 10.71 q/ha during 1985 and 1986 respectively). Other parameters (fruit length, number of fruits/plant, number of seeds/fruit and 1000 seed weight) were also highest with the highest rates of fertilizer application.

Suresh and Pappiah (1991) conducted a trial with bitter gourd cv. MDU 1, where N (0, 40 and 80 kg/ha) P_2O_5 (0, 30 and 60 kg/ha) were applied and Maleic Hydrazide (MH) was sprayed at 0, 100 and 200 ppm solution. The highest yield was obtained with 80 kg N/ha, 30 kg P_2O_5/ha and 200 ppm MH.

Arora and Satish (1989) observed that N and P increase the number of female flower of sponge gourd (*Luffa aegyptiaca*) cv. Pusa Chikni during the summer and rainy seasons. The plants received N at 0-75 Kg/ha and P at 40 Kg/ha. Then highest number of female flower was obtained with N at 50+ P at 20 Kg/ha in summer season and with N at 25 + P at 40 Kg/ha in winter season.

Lingaiah *et al.* (1988) stated that the highest yield of bitter gourd was obtained in coastal region at N: P2O5: K2O at 80:30:20 kg/ha.

Satish *et al.* (1988) stated that in 2 season trials, N at 0, 25, 50 and 75 kg/ha and P at 0, 20, and 40 kg/ha were applied to the cv. Pusa Chikni. Half of the N dose and all P were applied before sowing on 9 March and 9 July and the remaining N was used for top dressing in 2 equal doses at 25 and 50 days after sowing. In both seasons, 50 kg N+20 kg P/ha gave the maximum number of fruits and the greatest weight/plant in the early and total yields. Maximum fruit dry matter content was obtained by applying 25 kg N + 40 kg P/ha in the summer season crop and 40 kg P/ha in the rainy season (July).

Vishnu *et al.* (1987) studied the effect of plant spacing and fertilizers on yield of bottle gourd. It was reported that the average yield was 38537 kg/ha with the full dose of NPK (180:100:100 kg/ha) and 30074 kg/ha with the reduced dose (one third of the full dose).

In a field experiment during 1981-83, application of 3 levels of N, P and K, each at O, 40 and 80 kg/ha, was evaluated by Mishra (1987). It was observed that N did not show a significant effect in increasing the height and number of the main branches and of 100 seed weight, however, P increased plant height significantly.

Increased K doses reduced the height and number of main branches. The seed yield increased with increasing doses by N and P but K beyond 40 kg/ha did not show any significant effect.

All gourds respond well to manures and fertilizer application. The doses of fertilizers depend upon the soil type, climate and system of cultivation. In cucurbits, excessive nitrogen and consequently enormous vine growth require to be avoided. In general, high N under high temperature conditions promote maleness in flowering and number of female/perfect flowers per vine gets reduced resulting in low fruit set and low yield (Seshadri, 1986).

Pelaez *et al.* (1984) studied the effect of NPK and organic matter on yield and marketable fruits of squash (*Cucurbita pepo* L.). According to their investigations plots receiving 10 t/ha poultry manure gave the highest followed by plots receiving 100 kg N, 300 kg P_2O_5 and 75 kg K_2O per hectare, which yielded 21.24 t/ha and 3.2 fruits/plant.

Ogunremi (1978) reported that the fruit size and numbers were the highest when applied with N at 48 kg/ha in melon.

Makal *et al.* (1977) studied the effect of NPK on yield of tinda. It was reported that N, P_2O_5 and K_2O at the rate of 75, 50 and 100 kg/ha enhanced the yield from 3207.7 kg/ha to 3697.7 kg/ha.

Catedral (1974) found that ampalaya (bitter gourd) is very responsive to nitrogen fertilization applied as high as 480 kg/ha. The most significant effect was on the significant increase in the number of pistillate flowers. In that study, the increase was as high as 6 times when the rate of the level of N was increased from 0 to 480 kg/ha. It was also shown that fruit number per plant increased with increasing levels of N, where as phosphorus had no effect.

Lingle and Wight (1964) obtained the yield increases of 20 to 30 percent after application of nitrogen in cantaloupes.

From the above review of literature it wasrevealed that different plant growth regulators and fertilizer management practices significantly affectes the growth and yield of cucurbits. The treatments of the present work justify the singale and combained effect of IAA and Ripen-15with fertilizer management to identify most suitabe treatment for bitter gourd production.

CHAPTER III
MATERIALS AND METHODS

The experiment was undertaken to examine the effect of growth regulators (IAA &Ripen-15) and fertilizer management practices on the flowering, fruit set and yield of bitter gourd (*Momordica charantia* L.)

3.1 Experimental Site

The research was conducted at the Horticultural farm of Sher-e-Bangla Agricultural University, Dhaka-1207, during the period from April to July 2007. The experimental field was located at 90^0 22' E longitudes and 23^0 41' N latitude at an altitude of 8.6 meters above the sea level. The land was in Agro-Ecological Zone of Madhupur tract (AEZ No-28). It was deep red brown terrace soil and belonged to “Nodda” cultivated series. The soil was sandy loam in texture having pH 5.47 to 5.63. The physical and chemical characteristics of the soil have been presented in appendix I.

3.2 Climate

The experimental area was under the sub-tropical monsoon climate, which is characterized by heavy rainfall during Kharif season (April to July) and scantly of rainfall during the rest of the year. The monthly total rainfalls, average sunshine hour, temperature during the study period (April to July 2007) are shown in appendix II.

3.3 Planting materials used for experiment

Seeds of Hybrid corolla- Penta green (Bitter gourd) were purchesed from the government enlisted seed diller Rajdani Seed Company, Siddik Bazar; Dhaka.Seed rate used 6 kg per hactare.

3.4 Experimental Treatment

Experiments consisted two factors:

Factor A:

There were four treatments of growth regulators (IAA & Ripen-15) in the experiment. The treatments were-

1. H_0: Control (No Hormone)
2. H_1: IAA (200 ppm)
3. H_2: Ripen-15 (200 ppm)
4. H_3: IAA +Ripen-15 (mixture of 200 ppm of each)

Factor B:

There were four fertilizer treatments in the experiment. The treatments were-

1. F_0: Control (No fertilizer)
2. F_1: Cow dung (25 t/ha)
3. F_2: Inorganic fertilizer (Urea, TSP, MP)

3.5 Application of growth regulator

The selected growth regulators was applied at three times, first at 7 days after transplanting (DAT) at the 8 leaves stage, second after 27 DAT and third at 47 DAT (just or before the flower initiation stage) with the help of hand sprayer.

Total 12 treatment combinations were as follows:

F_0H_0	F_1H_0	F_2H_0
F_0H_1	F_1H_1	F_2H_1
F_0H_2	F_1H_2	F_2H_2
F_0H_3	F_1H_3	F_2H_3

3.6 Experimental design and layout

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The experiment was divided into three blocks and consisted of 12 plots. Each unit plot in from of raised bed was 6.25 m^2 (2.5m × 2.5m) in size. Altogether there were 36 unit plots in experiment and required 349.125m^2 lands. Row to row and plot-to-plot distance were 50 cm and 25cm respectively. The treatments were randomly assigned to each of the block. Each unit plot had 2 rows and each with 3 plants. So there were 6 plants per unit plot.

3.7 Land preparation

The land, which was selected to conduct the experiment, was opened on 14 April by disc plough. After opening the land with a tractor it was ploughed and cross-ploughed six times with a power tiller and laddering to break up the soil clods to obtain level the land followed each ploughing.

3.8 Manures and fertilizer application

As per recommendation of Rashid (1995) following doses per hectare of manures and fertilizer were applied:

Fertilizer	**Dose (per ha)**
Cowdung	15 ton

Urea	150 kg
TSP	125 kg
MP	100 kg

Source: Rashid (1995)

Incase of F_1 treatment (Organic) recommended dose of cowdung plus recommended dose of urea was converted to Cowdung (according to supply of nutrient by urea and cowdung) and the total amount of cowdung was applied. In F_2 treatment (Inorganic) recommended dose of urea plus recommended dose of cowdung was converted to urea (according to supply of nutrient by urea and cowdung) and the total amount of urea was applied.

Levels of manure and fertilizer	**Dose per hectare**	**Dose per plot**
F_0 (Control)		
F_1 (Organic)		
Cowdung	15 + 10 = 25 t	15.63 kg
F_2 (Inorganic)		
Urea	150 + 230 = 380 kg	237 g
TSP	125 + 187 = 312 kg	195 g
MP	100 + 175 = 275 kg	171 g

1 Kg Cowdung =23gm Urea, 18.7gm TSP & 17.5 gm MP (Rashid, 2004)

As per three levels of fertilizer management practices, the dose of N for the F_1, F_2 and F_3 treatment should have been the same. But slighter deviation could not be avoided due to practical reasons.

3.9 Sowing of seeds and transplanting of seedling

Seeds were sown in polybags having compost mixed soil on 14 April 2006 for germination and seedling rising. Two seeds were sown in each polybag. The polybags were kept in shady place. They were watered regularly during the seedling-raising period. When the seedlings (11 days old) attained 4 leaves and hard enough, they were transplanted in the main field on 25 April 2006.

3.10 Intercultural operations

The crop was kept free from weeds by regular weeding and irrigated as when required.

3.10.1 Gap filling

Dead, injured and weak seedlings were replaced by new vigor seedling from the same stock of the experiment.

3.10.2 Weeding

Weeding was done whenever it was necessary to keep the plots free from weeds.

3.10.3 Irrigation

Irrigation was done whenever it was necessary.

3.10.4 Vine management

Stormy weather may cause the tendering vine of the plants fell down from the supports (Trellis). For proper growth and development of the plants the vines were managed upward with the help of iron rope by hand.

3.10.5 Pest control

There was a plan to protect the plant from the attack of insects-pests specially fruit flies and fruit borer by spraying of pesticides. Since there was no incidence of disease no fungicide was applied in the crop field during the experimental period.

3.10.6 Trellis

Six bamboo poles were set slantingly keeping 5 feet high from the ground level in every plot. The poles were connected to one another tightly by iron rope in such a way that they make opposite “V” shaped. A net from rope were placed on iron rope. Thus a trellis for each plot was made for creeping the vines of crop.

3.11 Harvesting

Total 6 times harvesting was done. Harvesting was done at seven days interval from every plant of every plot for collecting data.

3.12 Collection of experimental data

Data were recorded on the following parameters.

3.12.1 Time to first flower (days)

Number of days from sowing to time required to first flower was recorded for every plant and the average was calculated.

3.12.2 Number of male and female flowers

Total number of male and female flowers was counted from three randomly selected plants per plot. It was done at ten days interval after first flowering to ensure all flowers to be counted.

3.12.3 Ratio of Male/female flower

Ratio of male/female flower was counted by dividing of male flower by female flower.

3.12.4 Plant height

Plant height was recorded at first flower and at last harvest stages of crop growth for all treatments. The height of every plant were measured from the ground to the longest end of the stem and expressed in centimeter (cm).

3.12.5 Number of nodes per plant at first flower

Number of nodes per plant was counted at first flower stage and total number of nodes was counted by adding number of nodes of main shoot and nodes of branches.

3.12.6 Number of branches per plant at first flower

Number of branches per plant was counted at first flower stage and average was calculated.

3.12.7 Number of fruits per plant

The number of fruits in every plant of bitter gourd was counted at every harvest and thus the total number of fruits per plant was recorded and average number of fruits was recorded.

3.12.8 Length and diameter of fruit

Length of 10 randomly selected fruits per plot was measured after each harvest and then the average was taken. A total of 8 times measurement was taken during the total experiment period. Diameter of the same 10 randomly selected fruits as harvested was measured and the average was calculated in cm.

3.12.9 Weight per fruit (g)

After each harvest, the weight of randomly selected 10 fruits per plot was recorded and then the average weight per fruit was calculated.

3.12.10 Fruit yield

To estimate yield, all the six plants in every plot and all the fruits in every harvest were considered. Thus the average yield per plot was measured. The yield per hectare was calculated considering the area covered by the six plants.

3.12.11 Statistical analysis

The recorded data on different parameters were statistically analyzed using MSTAT software to find out the significance of variation resulting from the experimental treatments. The mean for the treatments was calculated and analysis of variance for each of the characters was performed by F (variance ratio) test. The differences between the treatment means were evaluated by LSD test at 5% probability.

CHAPTER IV

RESULTS AND DISCUSSION

The present experiment was conducted to determine the effect of plant growth regulators and fertilizer management practices on flowering, growth and yield of bitter gourd. The analyses of variance (ANOVA) of the data on different components are given in Appendix III to V. The results have been presented,

discussed, and possible interpretations have been given under the following headings:

4.1 Time to first flower

Different plant growth regulators showed a statistically significant variation on time of first flowering. Time of first flowering showed a gradual increasing trend for different plant growth regulators comparing the control. The minimum (42.65 days) time of first flower was recorded for the application of IAA (Table 1) that was closely followed by Ripen-15 (42.93days) and the maximum (45.05 days) time of first flower was recorded in combined condition (H_3). The results indicated that minimum time of first flower was produced by the application of plant growth regulators comparing with the control.

Different fertilizer management practices showed a statistically significant variation on time of first flowering. The minimum (42.65 days) time of first flower was recorded in application of inorganic fertilizer (F_2) that was closely followed by (44.02 days) with organic fertilizer (Table 1) and the maximum (44.31 days) time of first flower was recorded in control condition where no fertilizer was applied. The results indicated that minimum time of first flower was recorded by the application of organic or inorganic fertilizer than the control with ensuring the better growth and development of bitter gourd. Olivira *et al*. (2005) reported the similar results from their earlier experiments in cucurbits.

Table 1. Effect of plant growth regulators and fertilizer management practices on time to first flower, number of male and female flower and ratio and fruits per plant of bitter gourd

Treatment	Time to first flower (days)	No. of male flower	No. of female flower	Ratio of male and female flower	No. of Fruits per plant
Plant growth regulators					

Control	44.01_{B}	67.39_{B}	17.64_{B}	3.91_{A}	11.55_{D}
IAA	42.65_{C}	72.40_{A}	20.89_{A}	3.52_{B}	14.33_{C}
Ripen-15	42.93_{C}	71.25_{AB}	21.29_{A}	3.46_{B}	18.26_{A}
IAA +Ripen-15	45.05_{A}	72.88_{A}	22.75_{A}	3.08_{C}	15.27_{B}
S(x)	0.31	1.35	0.72	0.10	0.24
$LSD_{(0.05)}$	0.90	3.95	2.10	0.29	0.78
Significant level	**	**	**	**	**
Fertilizer management practices					
Control	44.31_{A}	68.18_{B}	17.96_{C}	3.87_{A}	12.57_{C}
Organic	44.02_{A}	70.48_{B}	20.23_{B}	3.55_{B}	15.65_{B}
Inorganic	42.65_{B}	74.29_{B}	23.72_{A}	3.06_{C}	16.35_{A}
S(x)	0.27	1.17	0.62	0.09	0.20
$LSD_{(0.05)}$	0.78	3.42	1.82	0.25	0.90
Significant level	**	**	**	**	**

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.

** : Significant at 0.05 level of significance.

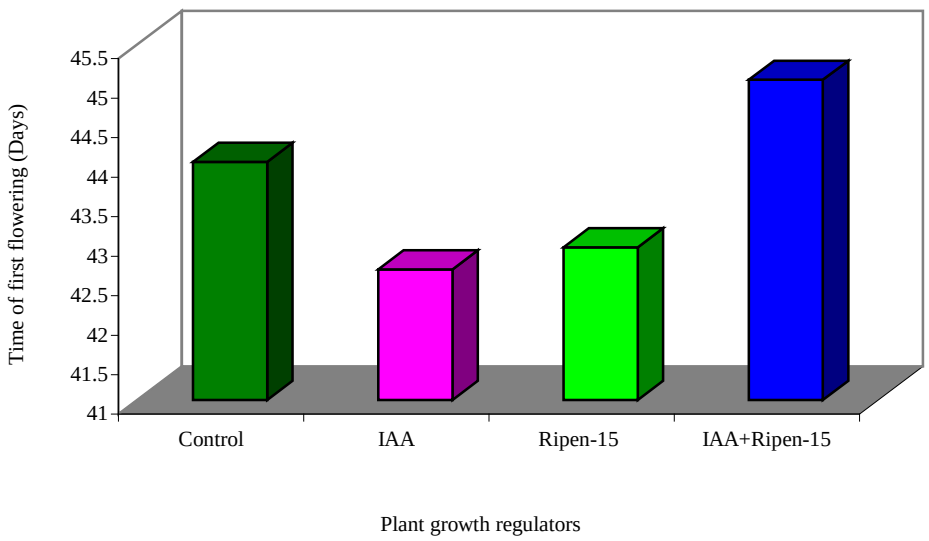

Figure 1. Effect of plant growth regulators on time of first flowering of bitter gourd

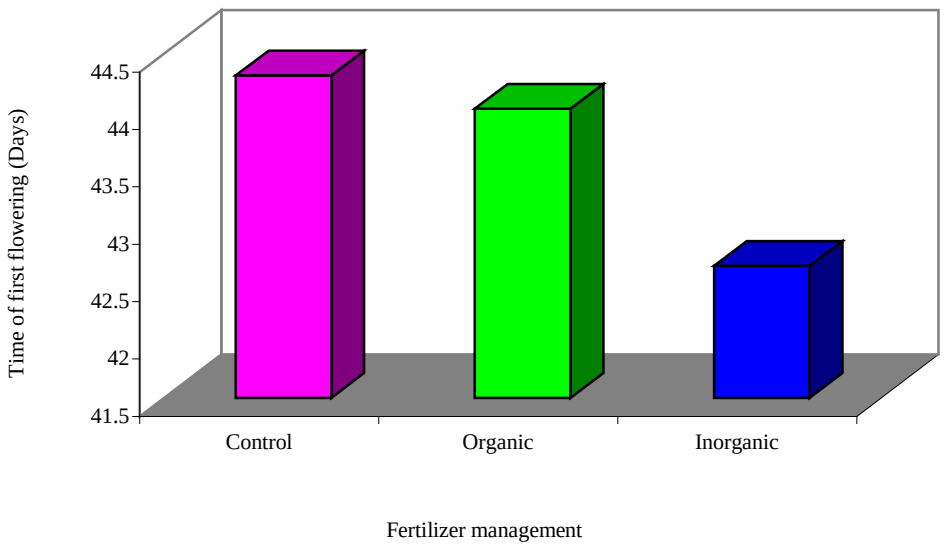

Figure 2. Effect of fertilizer management practices on time of first flowering of bitter gourd

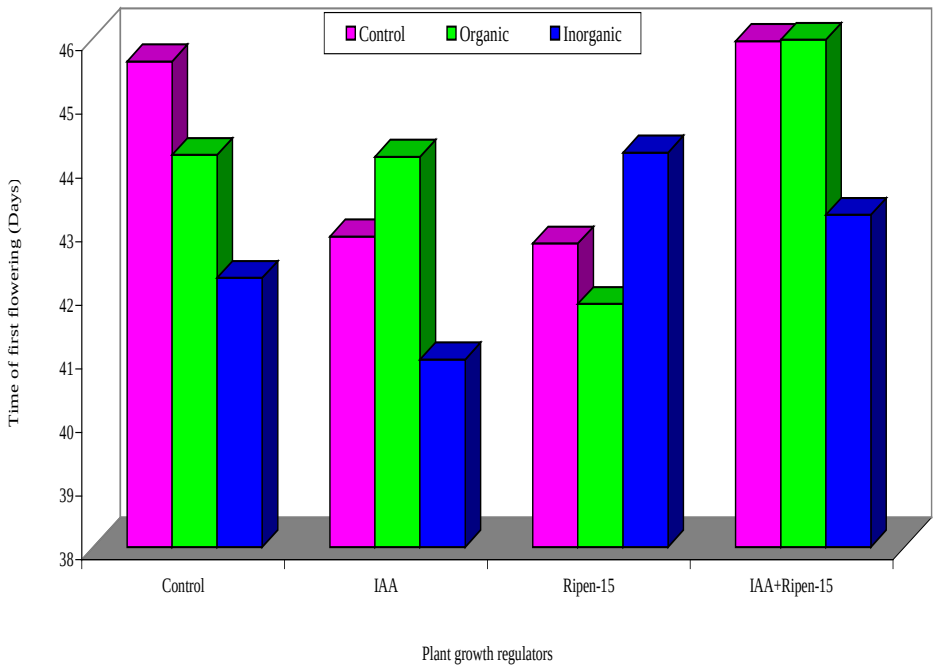

Figure 3. Interaction between plant growth regulators and fertilizer management practices on time of first flowering of bitter gourd

Interaction effect between plant growth regulators and fertilizer management practices showed a statistically significant variation in consideration of time of first flowering. The minimum (40.95 days) time to first flower was recorded in the treatment of IAA and inorganic fertilizer management practices (H_1F_2) and the maximum (45.97days) time to first flower was recorded in the treatment combination of IAA+Ripen-15 and organic fertilizer management H_3F_1 (Table 2). The results indicated that plant growth regulators and fertilizer ensures the optimum condition for the growth and development of bitter gourd and the ultimate result is the minimum time to first flower.

4.2 No. of male flower

Different plant growth regulators showed a statistically significant variation on number of male flower. The minimum (67.39) male flower in number was recorded for control condition (Table 1) which was closely followed (71.25) by Ripen-15 (H_2) and the maximum (72.88) male flower in number was recorded in IAA+Ripen-15 (H_3). The results indicated that minimum male flower was produced in control comparing with plant growth regulators.

In terms of male flower in number for different fertilizer management practices a statistically significant variation was recorded under the trial. The minimum (68.18) male flower in number was recorded in application of no fertilizer (F_0) which was closely followed by (70.48) with organic fertilizer (Table 1) and the maximum (74.29) male flower in number was recorded for inorganic fertilizer(F_2) . The results indicated that minimum male flower in number were produced in control condition.

Interaction effect between plant growth regulators and fertilizer management practices did not showed a statistically significant variation in consideration of male flower in number. The minimum (64.94) male flower in number was recorded in control treatment combination (H_0F_0) and the maximum (79.11) was recorded in the treatment combination of IAA+Ripen-15 and inorganic fertilizer (H_3F_2) which is given in Table 2. The results indicated that combination of plant growth regulators and fertilizer ensures the optimum condition for flowering.

4.3 No. of female flower

Different plant growth regulators showed a statistically significant variation in number of female flower. The maximum (22.75) female flower in number was recorded for the application of IAA +Ripen-15 (Table 1)

Table 2. Interaction effect of plant growth regulators and fertilizer management practices on time to first flower, number of male and female flower and ratio and fruits per plant of bitter gourd

Treatment		Time to first flower (days)	No. of male flower	No. of female flower	Ratio of male and female flower	No. of Fruits per plant
Control	Control	45.63_{AB}	64.94	15.94	4.27_{A}	10.05_{F}
	Organic	44.16_{BC}	65.03	17.63	3.70_{ABC}	11.54_{E}
	Inorganic	42.23_{DE}	72.20	19.33	3.77_{AB}	13.05_{D}
IAA	Control	42.88_{CD}	68.92	18.50	3.73_{ABC}	$11.12e_{F}$
	Organic	44.13_{BC}	73.50	20.44	3.66_{BC}	16.21_{C}
	Inorganic	40.95_{E}	74.78	23.72	3.18_{CD}	15.67_{C}
Ripen-15	Control	42.77_{CD}	68.17	18.11	3.81_{AB}	16.82_{BC}
	Organic	41.82_{DE}	74.54	19.31	3.86_{AB}	17.92_{B}
	Inorganic	44.20_{BC}	71.05	26.44	2.70_{DE}	20.05_{A}
IAA+ Ripen-15	Control	45.95_{A}	70.70	19.30	3.69_{ABC}	12.28_{DE}
	Organic	45.97_{A}	68.83	23.55	2.97_{DE}	16.92_{BC}
	Inorganic	43.22_{CD}	79.11	25.39	2.58_{E}	16.61_{C}
S(x)		0.54	2.34	1.24	0.18	0.41
$LSD_{(0.05)}$		1.57	--	--	0.51	1.19
Significant level		**	NS	NS	**	**
CV (%)		2.13	5.70	10.45	8.78	4.75

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.

** : Significant at 0.05 level of significance.

which is closely followed by Ripen-15 (21.29) and the minimum (17.64) female flower in number was recorded in control condition (H_0). The results indicated that maximum female flower in number were produced by the application of plant growth regulators compared with the control. Al Masoum and Al Masri (1999) reported similar trends from their experiments. Chudhury *et al*. (1967) reported that NAA 100 ppm, IAA 100 ppm and 200 ppm and MH 50 ppm and 200 ppm were equally effective in suppressing the male flowers and increasing the number of female flowers in cucumber.

A statistically significant variation was recorded in number of female flower for different fertilizer management practices. The maximum (23.72) female flower in number was recorded in application of inorganic fertilizer (Table 1) and the minimum (17.96) female flower in number was recorded in control condition (F_0). The results indicated that maximum number of female flower was produced by the application of inorganic or organic fertilizer than the control with ensuring the better yield of bitter gourd. Olivira *et al*. (2005) reported the similar results from their earlier experiments.

But Interaction effect between plant growth regulators and fertilizer management practices showed no statistically significant variation in consideration of female flower in number. The maximum (26.44) female flower in number was recorded in the treatment combination of Ripen-15 and inorganic fertilizer management practices and the minimum (15.94) were recorded in the treatment combination control condition (H_0F_0) which is given in Table 2. The results indicated that combination of plant growth regulators and fertilizer ensures the optimum condition for increasing femaleness and fruitset of bitter gourd and the ultimate result is the maximum yield. Pandey and Singh (1973) reported the similar results of fertilizer and maleic hydrazide hormone application.

4.4 Ratio of male and female flower

Ratio of male and female flower for different plant growth regulators showed a statistically significant variation. The minimum (3.08) ratio of male and female flower was recorded for the application of IAA +Ripen-15 (Table 1)which was closely followed by Ripen-15 and IAA (3.46 and 3.52 respectively) and the maximum (3.91) ratio of male and female flower was recorded in control condition. The results indicated that minimum ratio of male and female flower were produced by the application of plant growth regulators comparing with the control.

Different fertilizer management practices showed a statistically significant variation for ratio of male and female flower. The minimum (3.06) ratio of male and female flower was recorded in application of inorganic fertilizer (Table 1) that was statistically identical with organic fertilizer (3.55) and the maximum (3.87) ratio of male and female flower was recorded in control condition (F_0). The results indicate that minimum ratio of male and female flower were produced by the application of organic or inorganic fertilizer than the control with ensuring the better growth and development of bitter gourd.

Interaction effect between plant growth regulators and fertilizer management practices showed a statistically significant variation in consideration of ratio of male and female flower. The minimum (2.58) ratio of male and female flower was recorded in the treatment combination of IAA +Ripen-15 and inorganic fertilizer management practices (H_3F_2) and the maximum (4.27) was recorded in the treatment combination control condition i.e. no plant growth regulators and no fertilizer application (Table 2). The results indicated that combination of plant growth regulators and fertilizer ensures the optimum condition for the growth and development of bitter gourd and the ultimate result is the minimum ratio of male and female flower.

A view of experimental site at first flowering stage

A view of experimental site at second harvest stage

4.5 No. of fruits per plant

Different plant growth regulators showed a statistically significant variation on number of fruits per plant. Fruits per plant showed a gradual increasing trend for different plant growth regulators comparing the control. The maximum (18.26) fruits per plant in number were recorded for the application of Ripen-15 (Table 1) that was closely followed by IAA+Ripen-15 (15.27) and the minimum (11.55) fruits per plant were recorded in control condition. The results indicated that application of plant growth regulators (Ripen-15) maximizes the number of fruits per plant.

Different fertilizer management practices showed a statistically significant variation on number of fruits per plant. The maximum (16.35) number of fruits per plant was recorded in application of inorganic fertilizer (F_2) which was closely followed (15.65) by organic fertilizer (Table 1) and the minimum (12.57) fruits per plant in number were recorded in control condition (F_0). The results indicated that

maximum fruits per plant were produced by the application of organic or inorganic fertilizer than the control with ensuring the better yield of bitter gourd. Olivira *et al*. (2005) reported the similar results from their earlier experiments.

Interaction effect between plant growth regulators and fertilizer management practices showed a statistically significant variation in consideration of fruits per plant in number. The maximum (20.05) number of fruits per plant was recorded in the treatment combination of Ripen-15 and inorganic fertilizer management practices (H_2F_2) and the minimum (10.05) was recorded in the treatment combination control condition i.e. no plant growth regulator and no fertilizer application (Table 2). The results indicated that combination of plant growth regulators and fertilizer ensures the optimum condition for the growth and development of bitter gourd and the ultimate result is the maximum fruits per plant.

4.6 Plant height (cm)

A statistically significant variation was recorded in terms of plant height at 1st flowering and last harvest for different plant growth regulators. The tallest (163.90 cm) plant at 1st flowering time was recorded for the application of IAA+ Ripen-15 (H_3) (Table 3) which was statistically identical with Ripen-15 and IAA (155.91 cm and 148.30 cm respectively) and the shortest (142.31 cm) plant was recorded in control condition where no plant growth regulator was applied.

At last harvest tallest (504.84 cm) plant was recorded for the application of IAA+ Ripen-15 (H_3) that was closely followed by IAA (490.34 cm) and the shortest (459.21 cm) plant at harvest was recorded in control condition (H_0) which was statistically identical (487.21 cm) with the application of Ripen-15 (H_2). The

results indicated that tallest plant at 1st flowering and last harvest was produced by the application of plant growth regulators compared to control.

In terms of plant height at 1st flowering and last harvest in relation with different fertilizer management practices results were varied significantly under the trial. The tallest (160.72 cm) plant at 1st flowering was recorded by the application of inorganic fertilizer (Table 3) and the shortest (143.18 cm) plant at 1st flowering was recorded in control condition where no organic or inorganic fertilizer was applied. At last harvest the tallest (506.61cm) plant was recorded by the application of inorganic fertilizer (F_2) that was closely followed by (486.51 cm) the application of organic fertilizer (F_1) and the shortest (463.08cm) plant was recorded in control condition (F_0) where no fertilizer was applied. The results indicated that tallest plant was produced at 1st flowering and last harvest by the application of inorganic fertilizer than the control condition with ensuring the better growth and development. Ali *et al*. (1995) recorded the highest plant height for inorganic fertilizer. Similar results were also found by Arora and Satish (1989) and Islam (1995).

Table 3. Effect of plant growth regulators and fertilizer management practices on plant height, no. of nodes and branches per plant of bitter gourd

Treatment	Plant height (cm) at		No. of nodes per plant at		No. of branch per plant
	1st flowering	last harvest	1st flowering	last harvest	
Plant growth regulators					
Control	142.31_D	459.21_B	25.05	118.52	10.97
IAA	148.30_C	490.34_B	25.63	120.71	11.69
Ripen-15	155.91_B	487.21_A	24.72	125.86	10.93

IAA+ Ripen-15	163.90_{A}	504.84_{A}	24.79	123.70	10.77
S(x)	0.47	6.84	0.77	0.69	0.42
$LSD_{(0.05)}$	1.38	20.06	--	--	--
Significant level	**	**	NS	NS	NS
Fertilizer management practices					
Control	143.18_{C}	463.08_{C}	23.71_{B}	112.69_{B}	10.06_{B}
Organic	153.92_{B}	486.51_{B}	25.11_{AB}	124.72_{A}	11.35_{A}
Inorganic	160.72_{A}	506.61_{A}	26.33_{A}	129.18_{A}	11.86_{A}
S(x)	0.41	5.92	0.67	0.78	0.36
$LSD_{(0.05)}$	1.19	17.38	1.95	7.57	1.06
Significant level	**	**	**	**	**

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

**: Significant at 0.05 level of significance

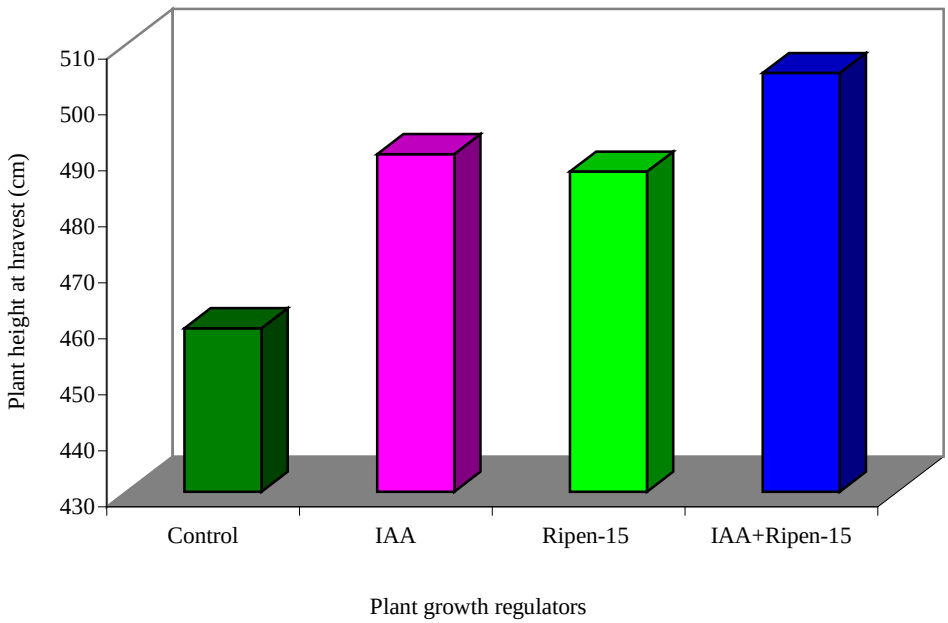

Figure 4. Effect of plant growth regulators on plant height at harvest of bitter gourd

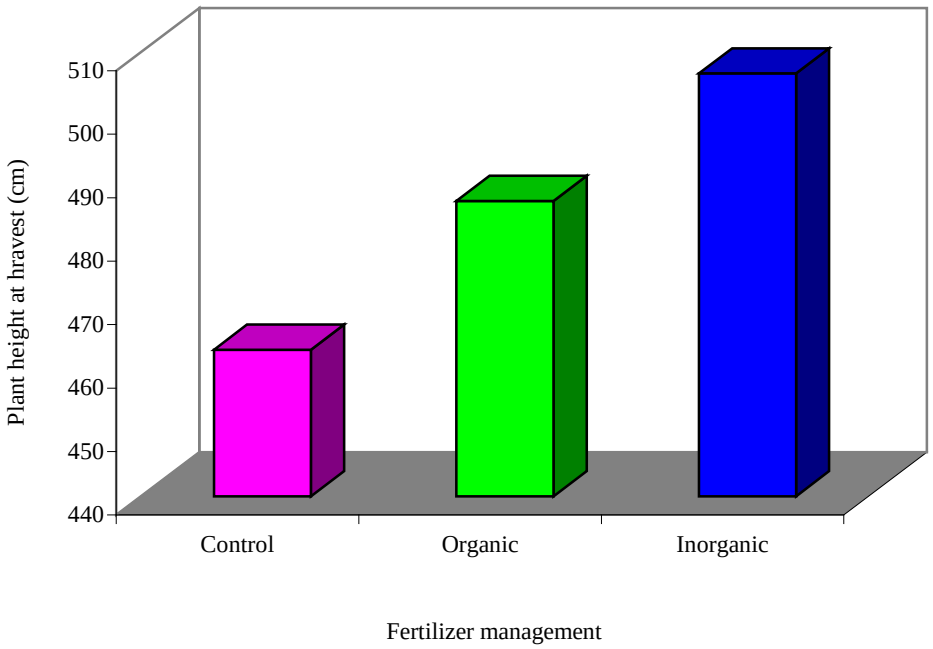

Figure 5. Effect of fertilizer management practices on plant height at harvest of bitter gourd

Interaction effect between plant growth regulators and fertilizer management practices showed a statistically significant variation in consideration of plant height at 1st flowering. The tallest (171.17 cm) plant at 1st flowering was recorded in the treatment combination of IAA+ Ripen-15 and inorganic fertilizer (H_3F_2) management practices and the shortest (135.21 cm) was recorded in the treatment combination of control condition (Table 4). At last harvest, the tallest (525.38 cm) plant was recorded in the treatment combination of IAA and inorganic fertilizer management practices (H_1F_2) and the shortest (421.93 cm) was recorded in the treatment combination of control condition i.e. no plant growth regulator and no

fertilizer application. The results indicated that combination of plant growth regulators and fertilizer ensures the optimum condition for the growth and development of bitter gourd and the ultimate result is the longest plant at both the time of 1st flowering and at last harvest.

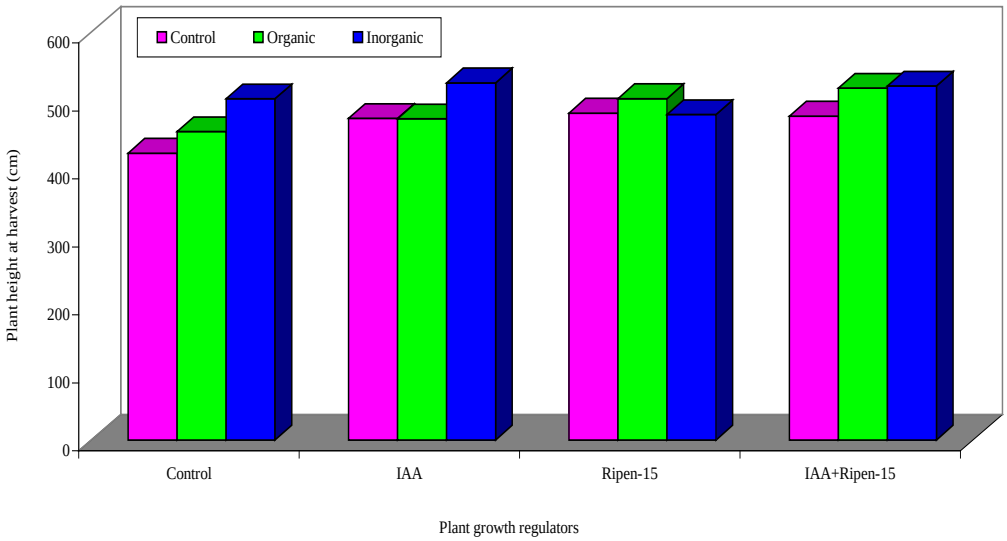

Figure 6. Interaction between plant growth regulators and fertilizer management practices on plant height at harvest of bitter gourd

4.7 No. of nodes per plant

Plant growth regulators showed a no statistically significant difference for number of nodes per plant at 1st flowering and last harvest. Nodes per plant showed a gradual increasing trend for different plant growth regulators comparing the control. The maximum (25.63) nodes per plant at 1st flowering were recorded for the application of IAA (Table 3), which was statistically identical, by control and IAA +Ripen-15 (25.05 and 24.79 respectively) and the minimum (24.72) nodes per plant at that period was recorded for Ripen-15. At last harvest the maximum

(125.86) nodes per plant was recorded for the application of IAA (H_2) and the minimum (118.52) number of nodes at last harvest was recorded in control condition. The results indicated that maximum nodes per plant at 1st flowering and last harvest were produced by the application of plant growth regulators compared to the control.

Statistically significant difference was recorded for number of nodes per plant at 1st flowering and last harvest for different fertilizer management practices under the trial. At 1st flowering, the maximum (26.33) nodes per plant was recorded by the application of inorganic fertilizer (F_2) which was closely followed by (25.11) with organic fertilizer (F_1) and the minimum (23.71) nodes per plant was recorded in control condition where no fertilizer was applied (Table 3). At last harvest maximum (129.18) number of nodes was recorded in application of inorganic fertilizer that was statistically identical (124.72) with organic fertilizer and the minimum (112.69) number of nodes at last harvest was recorded in control condition (Table 3). The results indicated that maximum nodes per plant at 1st flowering and last harvest were produced by the application of inorganic fertilizer than the control condition with ensuring the better growth and development of bitter gourd. Pelaez *et al*. (1984) reported the similar results.

Table 4. Interaction effect of plant growth regulators and fertilizer management practices on plant height, no. of nodes and branches per plant of bitter gourd

Treatment		Plant height (cm) at		No. of nodes per plant at		No. of branch per plant
		1st flowering	last harvest	1st flowering	last harvest	
Control	Control	135.21_{J}	421.93_{E}	22.23	99.27_{D}	9.48
	Organic	141.33_{H}	453.78_{DE}	25.97	127.1_{AB}	11.99

	Inorganic	150.39_{EF}	501.93_{ABC}	26.94	129.2_{AB}	11.45
IAA	Control	138.42_{I}	473.05_{CD}	25.27	116.5_{BC}	10.78
	Organic	150.13_{F}	472.60_{CD}	25.33	121.1_{BC}	11.83
	Inorganic	156.33_{D}	525.38_{A}	26.30	124.5_{AB}	12.45
Ripen-15	Control	146.33_{G}	480.87_{BCD}	23.83	129.6_{AB}	10.20
	Organic	156.40_{D}	502.17_{ABC}	24.63	126.4_{AB}	10.82
	Inorganic	164.99_{C}	478.61_{CD}	25.70	121.6_{BC}	11.77
IAA + Ripen-15	Control	152.75_{E}	476.47_{CD}	23.50	105.4_{CD}	9.77
	Organic	167.79_{B}	517.50_{AB}	24.50	124.3_{AB}	10.77
	Inorganic	171.17_{A}	520.53_{A}	26.37	141.3_{A}	11.77
S(x)		0.82	11.85	1.34	1.44	0.73
$LSD_{(0.05)}$		2.39	34.75	--	15.15	--
Significant level		**	**	NS	**	NS
CV (%)		1.93	4.23	9.23	7.32	11.33

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

** : Significant at 0.05 level of significance

Interaction effect between plant growth regulators and fertilizer management practices showed no statistically significant variation in consideration of nodes per plant at 1st flowering and last harvest. The maximum (26.94) node per plant was recorded in the treatment combination of control and inorganic fertilizer management practices (H_0F_2) and the minimum (22.23) was recorded in the treatment combination of control condition (Table 4). At last harvest, the maximum (141.3) number of nodes was recorded in the treatment combination of

IAA +Ripen-15 and inorganic fertilizer management practices (H_3F_2) and the minimum (99.27) was recorded in the treatment combination of control condition i.e. no plant growth regulators and no fertilizer (Table 4). The results indicated that combination of plant growth regulators and fertilizer ensure the optimum condition for the growth and development of bitter gourd and the ultimate result is the maximum nodes per plant.

4.8 No. of branches per plant

Number of branches per plant for different plant growth regulators showed no statistically significant variation. The maximum (11.69) number of branches per plant was recorded for the application of IAA (Table 3) that was closely followed (10.97) by control (H_0) and the minimum (10.77) branches per plant were recorded for IAA +Ripen-15 (H_3). The results indicated that maximum branches per plant were produced by the application of IAA comparing with others.

Statistically significant variation was found for number of branches per plant for different fertilizer management practices. The highest (11.86) number of branches per plant was recorded in application of inorganic fertilizer (F_2) that was closely followed by (11.35) with organic fertilizer (Table 3) and the minimum (10.06) number of branches per plant was recorded in control condition (F_0). The results indicated that maximum branches per plant were produced by the application of o inorganic fertilizer than the control, which ensure the maximum number of fruit h and yield of bitter gourd.

Interaction effect between plant growth regulators and fertilizer management practices did not showed statistically significant variation in consideration of number of branches per plant. The maximum (12.45) number of branches per plant was recorded in the treatment combination of IAA and inorganic fertilizer management practices (H_1F_2) and the minimum (9.48) were recorded in the treatment combination of control condition (Table 4). The results indicated that combination of plant growth regulators and fertilizer ensure the optimum

condition for the branches growth and development of bitter gourd, as a result number of fruit also increase.

4.9 Fruit length

Plant growth regulators showed a statistically significant variation on fruit length. Fruit length showed a gradual increasing trend for different plant growth regulators comparing the control. The maximum (21.55 cm) fruit length was recorded for the application of Ripen-15 (Table 5) and the minimum (13.29 cm) fruit length was recorded in control (H_0).

Different fertilizer management practices showed statistically significant variation on fruit length. The maximum (19.98 cm) fruit length was recorded in application of inorganic fertilizer (Table 5) and the minimum (14.96 cm) fruit length was recorded in case of control condition (F_0).

Interaction effect between plant growth regulators and fertilizer management practices showed a statistically significant variation for fruit length. The maximum (23.46 cm) fruit length was recorded in the treatment combination of Ripen-15 and inorganic fertilizer management practices (H_2F_2) and the minimum (11.40 cm) were recorded in the treatment combination of control (H_0F_0), which is shown in Table 6. Susmita, D.*et.all* (1998) found similar results from their earlier experiment.

A fruit of maximum fruit diameter (4.47cm) found in treatment combination of H_3F_2

A fruit of maximum fruit length (23.46) found in replication of H_2F_2

4.10 Fruit diameter

Plant growth regulators showed no statistically significant variation on fruit diameter. Fruit diameter showed a gradual increasing trend for different plant growth regulators comparing the control. The maximum (4.47 cm) fruit diameter was recorded from the application of IAA+Ripen-15 (Table 5) and the minimum (3.61 cm) fruit diameter was recorded in control condition.

Statistically significant variation was recorded under the trial for fruit diameter for different fertilizer management practices. The maximum (4.32 cm) fruit diameter was recorded for organic fertilizer application (Table 5) and the minimum (3.92 cm) fruit diameter was recorded in control condition. Olivira *et al*. (2005) reported the similar results from their earlier experiments.

Interaction effect between plant growth regulators and fertilizer management practices showed statistically significant variation in consideration of fruit diameter. The maximum (4.51 cm) fruit diameter was recorded in treatment combination of IAA+Ripen-15 and organic fertilizer (H_3F_1) and the minimum (3.02 cm) was recorded in the treatment combination no plant growth regulator and no fertilizer (H_0F_0) which is given in Table 6.

4.11 Fruit weight

Fruit weight for different plant growth regulators showed a statistically significant variation. The maximum (129.10 g) fruit weight was recorded for the application of IAA + Ripen- 15 (Table 5) which was closely followed by Ripen-15 and IAA (120.9 g and 115.40 g respectively) and the minimum (105.5 g) fruit weight were recorded in control condition. The results indicated that the maximum fruit weight was produced by the application of plant growth regulators compared with the control.

Table 5. Effect of plant growth regulators and fertilizer management practices on fruit- length, diameter, weight and yield per plot and hectare of bitter gourd

Treatment	Average Fruit length (cm)	Average Fruit diameter (cm)	Average Fruit weight (g/fruit)	Yield (kg/plot)	Yield (t/ha)
Plant growth regulators					
Control	13.29_{D}	3.61_{C}	105.51_{D}	6.47_{D}	12.34_{D}
IAA	17.82_{C}	4.18_{B}	115.40_{C}	9.12_{C}	16.10_{C}
Ripen-15	21.55_{A}	4.28_{B}	120.91_{B}	13.01_{A}	21.89_{A}
IAA+Ripen-15	18.98_{B}	4.47_{A}	129.10_{A}	10.99_{B}	18.65_{B}
S(x)	0.30	0.06	0.65	0.34	0.26
$LSD_{(0.05)}$	0.89	0.18	1.91	0.98	0.76
Significant level	**	**	**	**	**
Fertilizer management practices					
Control	14.96_{C}	3.92_{B}	113.64_{A}	7.65_{C}	14.81_{C}
Organic	18.80_{B}	4.16_{A}	119.64_{A}	10.2_{B}	17.81_{B}
Inorganic	19.98_{A}	4.32_{A}	119.92_{A}	11.84_{A}	19.11_{A}
S(x)	0.26	0.05	0.56	0.29	0.23
$LSD_{(0.05)}$	0.77	0.15	1.65	0.85	0.952
Significant level	**	**	**	**	**

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

** : Significant at 0.05 level of significance.

Baruah and Das (1997) ovserved that plants sprayed with NAA at 25 ppm and MH at 50-ppm proced the best yields (231 and 242g respectively).

Different fertilizer management practices showed statistically significant variation on fruit weight. The maximum (119.92 g) fruit weight was recorded in application of inorganic fertilizer (Table 5) and the minimum (113.64 g) fruit weight was recorded in control condition where no fertilizer was applied. The results indicated that maximum fruit weight was produced by the application of organic or inorganic fertilizer than the control with ensuring the better growth and development of bitter gourd.

Interaction effect between plant growth regulators and fertilizer management practices showed a statistically significant variation in consideration of fruit weight. The maximum (136.85 g) fruit weight was recorded in the treatment combination of IAA + Ripen-15 and inorganic fertilizer management practices (H_3F_2) and the minimum (102.80) was recorded in the treatment combination of control condition i.e. no plant growth regulator and inorganic fertilizer (Table 6). The results indicated that combination of plant growth regulators and fertilizer ensures the optimum condition for the growth and development of bitter gourd and the ultimate result is the maximum fruit weight.

4.12 Yield (kg/plot)

Yield per plot for different plant growth regulators showed a statistically significant variation. Yield per plot showed a gradual increasing trend for different plant growth regulators comparing with the control. The maximum (13.01 kg) yield per plot was recorded for the application of Ripen-15 (Table 5) which was closely followed by IAA + Ripen-15 (10.99 kg) and the minimum (6.47 kg) yield per plot was recorded in control condition. The results indicated that maximum

yield per plot was produced by the application of plant growth regulators compared with the control.

Table 6. Interaction effect of plant growth regulators and fertilizer management practices on fruit- length, diameter, weight and yield per plot and hectare of bitter gourd

Treatment		Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g/fruit)	Yield (kg/plot)	Yield (t/ha)
Control	Control	11.40_{D}	3.02_{F}	102.80_{H}	5.06_{F}	10.40_{H}
	Organic	13.85_{C}	3.72_{F}	105.17_{H}	5.82_{F}	12.45_{G}
	Inorganic	14.64_{C}	4.10_{CD}	108.57_{G}	8.54_{E}	14.16_{F}
IAA	Control	14.94_{C}	4.06_{D}	114.42_{EF}	6.12_{F}	13.64_{FG}
	Organic	18.80_{B}	4.14_{BCD}	120.27_{D}	10.45_{D}	18.20_{D}
	Inorganic	19.71_{B}	4.33_{A-D}	111.52_{GH}	10.78_{CD}	16.46_{E}
Ripen-15	Control	18.49_{B}	4.15_{BCD}	115.89_{E}	10.04_{DE}	18.46_{D}
	Organic	22.70_{A}	4.29_{A-D}	124.11_{C}	13.26_{B}	21.72_{B}
	Inorganic	23.46_{A}	4.39_{A-D}	122.73_{CD}	15.73_{A}	25.50_{A}
IAA+ Ripen-15	Control	15.00_{C}	4.44_{ABC}	121.45_{CD}	9.39_{DE}	16.75_{E}
	Organic	19.84_{B}	4.51_{A}	129.00_{B}	11.27_{CD}	18.86_{D}
	Inorganic	21.10_{A}	4.47_{AB}	136.85_{A}	12.33_{BC}	20.33_{C}
S(x)		0.53	0.11	1.13	0.58	0.45
$LSD_{(0.05)}$		1.54	0.31	3.31	1.70	1.32
Significant level		**	**	**	**	**
CV (%)		5.09	4.50	2.66	10.16	4.53

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

* : Significant at 0.05 level of significance.

Different fertilizer management practices showed statistically significant variation on yield per plot. The maximum (11.84 kg) yield per plot was recorded in application of inorganic fertilizer (Table 5) which was closely followed by (10.20 kg) by organic fertilizer application and the minimum (7.65 kg) yield per plot was recorded in control condition where no fertilizer was applied. The results indicated that maximum yield per plot was produced by the application of organic or inorganic fertilizer than the control with ensuring the better growth and development of bitter gourd.

Interaction effect between plant growth regulators and fertilizer management practices showed statistically significant variation in consideration of yield per plot. The maximum (15.73 kg) yield per plot was recorded in the treatment combination of Ripen-15 and inorganic fertilizer management practices (H_2F_2) and the minimum (5.06 kg) was recorded in the treatment combination of control condition i.e. no plant growth regulator and fertilizer application (H_0F_0) which is given in Table 6. The results indicated that combination of plant growth regulators and fertilizer ensures the optimum condition for the growth and development of bitter gourd and the ultimate result is the maximum yield per plot.

4.13 Yield (t/ha)

A statistically significant variation was recorded in terms of yield per hectare for different plant growth regulators. Yield per hectare showed a gradual increasing trend for different plant growth regulators comparing with the control. The maximum (21.89 ton) yield per hectare was recorded for the application of Ripen-15 (Table 5) which was closely followed by IAA + Ripen-15 and IAA only (18.65 and 16.10 ton respectively) and the minimum (12.34 ton) yield per hectare was recorded in control condition. The results indicated that maximum yield per hectare was produced by the application of plant growth regulators compared with

the control. Chudhury *et al*. (1967) reported that NAA 100 ppm; IAA 100 ppm and 200 ppm and MH 50 ppm and 200 ppm were equally effective in suppressing the male flowers and increasing the number of female flowers in cucumber.The effects subsequently increased the percentage of fruit set and ultimately the yield per hectare increased.

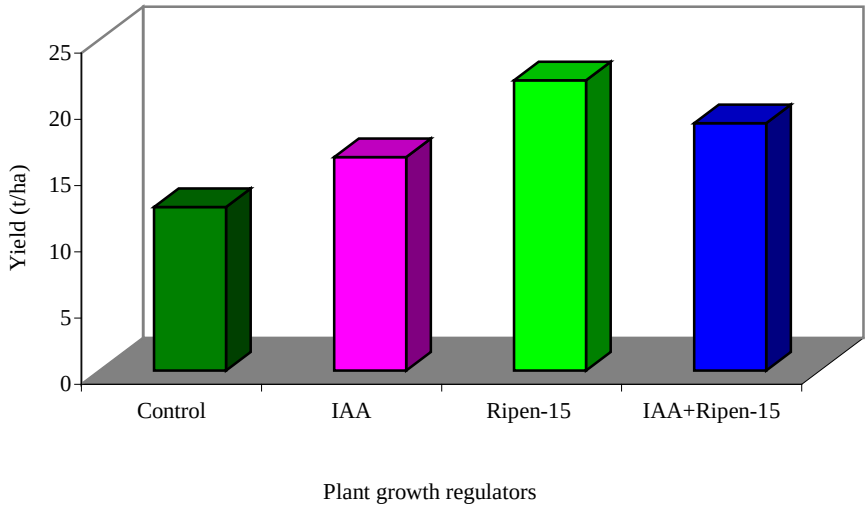

Figure 7. Effect of plant growth regulators on yield per hectare of bitter gourd

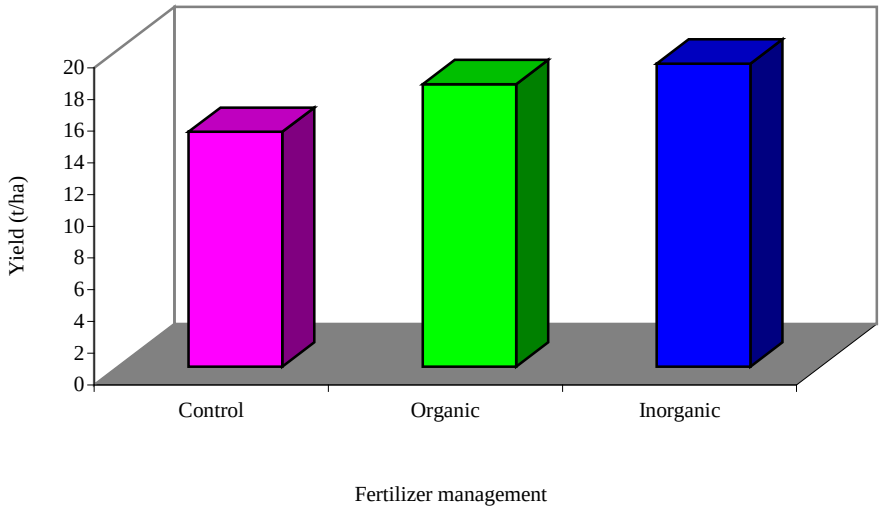

Figure 8. Effect of fertilizer management practices on yield per hectare of bitter gourd

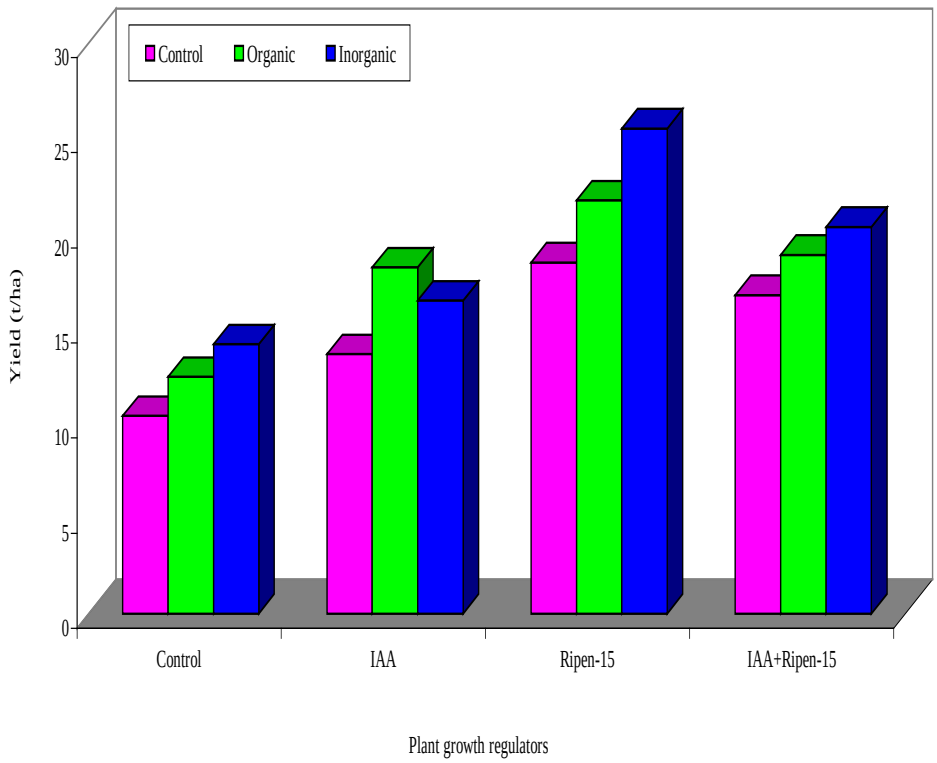

Figure 9. Interaction between plant growth regulators and fertilizer management practices on yield per hectare of bitter gourd

Different fertilizer management practices showed statistically significant variation on yield per hectare. The maximum (19.11 ton) yield per hectare was recorded in application of inorganic fertilizer (Table 5) that was closely followed by (17.81 ton) by organic fertilizer application (F_1) and the minimum (14.81 ton) yield per hectare was recorded in control condition where no fertilizer was used. The results indicated that maximum yield per hectare was produced by the application of

organic or inorganic fertilizer than the control with ensuring the better growth and development of bitter gourd. Olivira *et al*. (2005) reported the similar results from their earlier experiments.

Interaction effect between plant growth regulators and fertilizer management practices showed statistically significant variation in consideration of yield per hectare. The maximum (25.50 ton) yield per hectare was recorded in the treatment combination of Ripen-15 and inorganic fertilizer management practices (H_2F_2) and the minimum (10.40 ton) was recorded in the treatment combination of control condition i.e. no plant growth regulator and inorganic fertilizer (Table 6). The results indicated that combination of plant growth regulators and fertilizer ensures the optimum condition for the growth and development of bitter gourd and the ultimate results is the minimum yield per hectare.

4.14 Cost benefit analysis

4.14.1 Gross return

In the combination of plant growth regulators and fertilizer management practices maximum gross return (Tk.510, 000) was obtained from the treatment combination of Ripen-15 and inorganic fertilizer application (H_2F_2) and the second highest gross return (Tk.434, 400) was obtained in IAA and organic fertilizer (H_2F_1). The lowest gross return (Tk.208, 000) was obtained in the combination of control conditions i.e. no plant growth regulator and no fertilizer application (Table 7).

4.14.2 Net return

Different treatment combination gives different types of net return. In combination of plant growth regulators and fertilizer management practices highest net return (Tk.3, 63,044) was obtained from the treatment combination of Ripen-15 and inorganic fertilizer application (H_2F_2) and the second highest net return (Tk. 2,97,822) was obtained in Ripen-15 and organic fertilizer application (H_2F_1). The

lowest net return (Tk. 78,858) was obtained in the combination of control conditions (H_0F_0) in this trial.

Table 7. Cost and return of bitter gourd as influenced by plant growth **regulators and fertilizer management practices**

Treatment		Cost of production (Tk./ha)	Yield of bitter gourd (t/ha)	Price of bitter gourd (Tk.)	Gross return (Tk./ha)	Net return (Tk./ha)	Benefit cost ratio
Control	Control	129142	10.40	208000	208000	78858	0.61
	Organic	136131	12.45	249000	249000	112869	0.83
	Inorganic	146509	14.16	283200	283200	136691	0.93
IAA	Control	129813	13.64	272800	272800	142987	1.10
	Organic	136802	18.20	364000	364000	227198	1.66
	Inorganic	147180	16.46	329200	329200	182020	1.24
Ripen-15	Control	129589	18.46	369200	369200	239611	1.85
	Organic	136578	21.72	434400	434400	297822	2.18
	Inorganic	146956	25.50	510000	510000	363044	2.47
IAA+ Ripen-15	Control	130260	16.75	335000	335000	204740	1.57
	Organic	137250	18.86	377200	377200	239950	1.75
	Inorganic	147627	20.33	406600	406600	258973	1.75

Market price of bitter gourd @ Tk. 20000/t

4.14. 3 Benefit cost ratio

In combination of plant growth regulators and fertilizer management practices the highest benefit cost ratio (2.47) was attained from the treatment combination of Ripen-15 and inorganic fertilizer application and the closest benefit cost ratio (2.18) was acquired in Ripen-15 and organic fertilizer application. The lowest benefit cost ratio (0.61) was obtained from combination of controlled conditions i.e. no plant growth regulator and no fertilizer application (Table 7).

CHAPTER V

SUMMARY

A field experiment was conducted in the Horticulture Farm of Sher-e Bangla Agricultural University, Dhaka, Bangladesh during the period from April to July 2007 to study the effect of different plant growth regulators and fertilizer management practices on flowering, fruitset and yield of bitter gourd. The experiment considered of two factors, Factor A: different plant growth regulators (4 levels): No hormone (control), IAA (H1), Ripen-15 (H2) and IAA+ Ripen-15 (H3); and Factor B: Fertilizer management practices: any fertilizer (F_0), organic fertilizer (F_1) and inorganic fertilizer (F_2). There were on the whole 12 (4 × 3) treatment combinations. The experiment was laid out in the two factors Randomized Complete Block Design (RCBD) with three replications. After emergence of seedlings, various intercultural operations were accomplished for better growth and development of the plant. Data were collected in respect of the bitter gourd growth characters and yield and yield contributing characters. The data obtained for different characters were statistically analyzed to find out the significance of the difference plant growth regulators and fertilizer management practices.

The tallest (163.90 cm) plant at 1st flowering was recorded for the IAA+ Ripen-15 (H_3) application and at last harvest, the tallest (504.84cm) was recorded for the application of IAA+ Ripen-15 and the shortest plant at both stages (142.31cm

and 459.21 cm respectively) was recorded in control condition. The maximum branches (11.69) per plant were recorded for the application of IAA and the minimum (10.77) branch per plant was recorded in control condition. The minimum (42.65 days) time of first flower was recorded for the application of IAA and the maximum (45.05 days) time of first flower was recorded in combined condition. The minimum (3.08) ratio of male and female flower was recorded for the application of IAA+ Ripen-15 (H_3) and the maximum (3.91) ratio of male and female flower were recorded in control. The maximum (18.26) fruits per plant in number were recorded for the application of Ripen-15 (H_2) and the minimum (11.55) fruits per plant were recorded in control condition. The maximum (21.55 cm) fruit length was recorded for the application of Ripen-15 (H_2) and the minimum (13.29 cm) fruit length was recorded in control condition. The maximum (4.47 cm) fruit diameter was recorded for IAA+ Ripen-15 and the minimum (3.61cm) fruit diameter was recorded in control condition. The maximum (129.9 g) fruit weight was recorded for the application of IAA+ Ripen-15 (H_3) and the minimum (105.51g) were recorded in control condition. The maximum (21.89 ton) yield per hectare was recorded for the application of Ripen-15 and the minimum (12.34 ton) yield per hectare was recorded in control condition.

The tallest (160.72 cm and 506.61 cm) plant at 1^{st} flowering and last harvest was recorded in application of inorganic fertilizer and the shortest (143.18 cm and 463.08cm) plant at both stages were recorded in control condition. The maximum (11.86) branch per plant was recorded in application of inorganic fertilizer and the minimum (10.06) branch per plant was recorded in control condition. The minimum (42.65 days) time of first flower was recorded in application of inorganic fertilizer and the maximum (44.31 days) time of first flower was recorded in control condition. The minimum (3.06) ratio of male and female flower was recorded in application of inorganic and the maximum (3.87) ratio of

male and female flower was recorded in control condition. The maximum (16.35) number of fruits per plant was recorded in application of inorganic fertilizer and the minimum (12.57) fruits per plant in number were recorded in control condition. The maximum (19.98 cm) fruit length was recorded in application of inorganic fertilizer and the minimum (14.96 cm) fruit length was recorded in inorganic fertilizer were applied. The maximum (4.32cm) fruit diameter was recorded in application of inorganic fertilizer and the minimum (3.92cm) fruit diameter was recorded in control. The maximum (119.92 g) fruit weight was recorded in application of inorganic fertilizer and the minimum (113.64 g) fruit weight was recorded in control condition where neither organic nor inorganic fertilizer was application. The maximum (19.11ton) yield per hectare was recorded in application of inorganic fertilizer and the minimum (14.81 ton) yield per hectare was recorded in control condition.

In combination of Ripen-15 and inorganic fertilizer (H_2F_2) gave the highest gross return (Tk. 510,000) and the lowest gross return (Tk. 208,000) was obtained in the combination of control conditions (H_0F_0). In combination of Ripen-15 and inorganic fertilizer (H_2F_2) gave highest benefit cost ratio (2.47). The lowest benefit cost ratio (0.61) was obtained in the combination of control condition (H_0F_0).

CHAPTER VI
CONCLUSION AND RECOMMENDATION

From the study, it might be concluded that both fertilizer management practices and plant growth regulators (Ripen-15 and IAA) had the positive effect up to a certain limit on the sex modification, fruit set and yield of bitter gourd. Among the three treatments of fertilizer management practices significantly the highest positive effect was recorded on flowering, fruit set and yield of bitter gourd from the plant treated with inorganic fertilizer F_2. Again, among the three treatments of plant growth regulators, Ripen-15 significantly the highest positive result was obtained on the sex modification, fruit set, fruit length and yield of bitter gourd from H_2 except in number of nodes and number of branches at first flowering.

Thus from result obtained the following recommendations may be forwarded

- The concentration 200-ppm “Ripen-15” may be used to get desirable flower initiation, fruit set and yield of bitter gourd.
- The inorganic fertilizer may be used to get more fruits per plant and total yield of bitter gourd.

As plants treated with fertilizer management practices and plant growth regulator (Ripen-15) produced higher yield compared to untreated control plants, it may provide substantial benefit to the farmers. So it may be recommended to the farmer for application, who is not familiar with it.

REFERENCES

Abascal K, Yarnell E (2005) "Using bitter gourd to treat diabetes" Altern Complemen Ther 11(4):179-184

Ali, N.; M. Rehman and S. A. Hussain. 1995. Response of *Momordica charantia* L. (Bitter gourd) cultivars to nitrogen levels. Sarhad J. Agric., 11(5): 585-589.

Al-Masoum, A. A. and H. Al-Masri. 1999. Effect of ethephon on flowering and yield of monoecious cucumber. Egyptian Journal of Horticulture, 26: 229-236.

Ameena,M and S.George.2002.Allelopathic influence of purple nutsedge (Cyperus rotundus L.) on germination and growth of vegetables.College of Agriculture,, Trivandrum, Kerala, India. Allelopathy Journal. 10: 2, 147-152; 5.

Anonymous. 2002. Statistical Pocket Book of Bangladesh 2002. Bangladesh Bureau of Statistics. Government of the Peoples' Republic of Bangladesh, Dhaka, Bangladesh, pp. 184.

Arora, S. K. and Satish Siyag. 1989. Effect of N and P on growth, flowering and sex expression of sponge gourd. Horyana Journal of Horticultural Sciences, 18 (1-2): 106-112

Arora, S.K.; M.L. Paudita and P. S. Partap. 1988. Effect of plant growth regulators on vegetative growth, flowering and yield of sponge gourd (*Lagenaria cylindrical* L.). Res. Dev. Reporter, 5(1-2): 95-98

Bacha,M.R.; S.A.Hussain.; A.Rab and D.Wadan.2005.Effect of phosphorus levels and sowing dates on the growth and production of bitter gourd. Department of Horticulture, NWFP Agricultural University, Peshawar, Pakistan. Sarhad J.Agric. 21(4): 591-594

Baldwa VS, Bhandari CM, Pangaria A, Goyal RK (1977) "Clinical trial in patients with diabetes mellitus of an insulin-like compound obtained from plant source" Upsala J Med Sci 82:39-41.

Banerjee, M. K. and J. L. Mangal. 1986. Chemicals in prolonging keeping quality of vegetables- A Review. Haryana J. Hort. Sci. 15(3-4):249-254.

Baruah, G. K. S. and R. K. Das. 1997. Effect of plant growth regulators on growth, flowering and yield of bottle gourd at different sowing dates. Annals Agril. Res., 18(3): 371-374.

BBS. 2005. Year Book of Agricultural Statistics of Bangladesh, 1997. Bangladesh Bureau of Statistics. Ministry of Planning. Govt. of the People's Republic of Bangladesh. Dhaka..

Bisaria, A. K. 1974. Sex expression and fruit development in cucumber as effect by Gibberellins. Indian J. Hort., 16: 233-235.

Boonmanop, S. 1997. Influences of nitrogen, phosphorus and potassium fertilizers on seed yield, yield and seed quality of bitter gourd. Bull, Kasetsart Univ. Bangkok, Thailand. Pp. 711-729.

Brantley, B. B. and C. F. Warren. 1960. Effect of nitrogen nutrition of flowering, fruiting and quality in muskmelon. Proc. Amer Soc. Hort. Sci., 77: 424

Catedral, I. G. 1974. Seed production studies in Ampalaya. MS Thesis, UPLB College, Laguna, The Philippines.

Chakrabarti, A.K. 1982. Fasicles of Flora of India II. Cucurbitaceae. Botanical Survey of Hawra. W.B. p.136.

Choudhury, B. and S. C. Pahatak. 1959. Sex expression and sex ratio in cucumber (*Cucumis sativus* L.) as affected by plant regulator sprays. Indian J. Hort., 17: 145-153.

Choudhury, B.; S. C. Pahatak and A. V. Patil. 1967. Effect of plant regulator sprays on sex, fruits set and fruit development in cucumber (*Cucumis sativus* L.). Proceedings Bihar academy of Agric. Sciences, 11: 251-257.

Gedam, V. M.; R. B. Patil; Y. B. Suryawanswhi and S. N. Mate. 1998. Effect of plant growth regulators and boron of flowering, fruiting and seed yield in bitter gourd. Seed Res., 26(1): 97-100.

Gopalkrishnan, P. K. and B. Choudhury. 1978. Effect of plant regulator sprays on modification of sex, fruit set and development in watermelon (*Citrullus lanatus*). Indian J. Hort., 35: 235-241.

Gopalan, C., B. V.Rama Sastri and S.C.Balasubramanian. 1982. Nutritive value of Indian food. Indian Council of Medical Research, National Institute of Nutrition, Hyderabad.

Irshad Ahmad and P. K. Gupta. 1981. Effect of cycocel on sex expression in three members of cucurbitaceae. Indian. J. Hort., 38: 100-102.

Irving, R. M.; B. Rogers and F. O. Lanphear. 1968. Studies in growth promoting substances of cucumber. American J. Hort. Sci. 94: 419-422.

Issac, S.R. and R. Pusphakumari. 1997. Effect of green fruit picking and nutrient sources on the seed production of okra (*Abelmoschus esculentus* (L.) Monech.). Seed Research, 25(1): 83-85.

Islam, M. S. 1995. Seed production studies on bitter gourd (*Momordica charantia* L.) Ph. D Thesis, CLSU, Munoz, Nueva Ecija, the Philippines.

Kalia, H. R. and H. S. Dhillon. 1964. Alternation in genetic pattern of sex ratios in *Lagenaria siceraria* stand1 by asafetida a new sex regulant. Punjab agric. Univ. J. Res., 1: 30-40.

Kaushik, K. P.; J. K. Sharma and I. Singh. 1974. Effect of alpha naphthalene acetic acid, gibberellic acid, kinetin and norphactin on yield of tomato. PI. Sci., 6: 51-53.

Lingaiah, H. B.; B. C. Uthaiah; P. S. Herle and K. B. Rao. 1988. Influence of nitrogen and phosphorus on the yield of bitter gourd in the coastal region of Karnataka. Current Res. Univ. Agri. Sci. Bagalore, India, 17(9): 116

Lingle, J. C. and J. R. Wight. 1964. Fertilizer experiment with cantaloupe. Bull. Calif. Agric. Expt. Sta., 807: 22.

Makal, K. G.; A. T. Joshi; P. O. Deshmukh and P. R. Pawar. 1977. Effect of N, P and K on tinda (*Citrullus vulgaris* var. *fistulosus*). Orissa J. Hort., 5(1/2): 62-63. [Cited from hort. Abst. 50(7): 5167, 1980]

Mangal, J. L.; M. L, Pandita and G. R. Singh. 1981. Effect of various chemicals on growth, flowering and yield of bitter gourd. Indian J. Agric. Res., 15(3): 185-188.

McMurray, A. L. and C. H. Miller. 1969. The effect of 2-chloro ethane phosphonic acid (ethrel) on the sex expression and yields of *Cucumis sativus*. American J. Hort. Sci., 94: 400-402.

Mishra, H. P. 1987. Effect of NPK on growth seed yield and quality of radish cv. Puna radish grow in the calcareous oils of North Bihar. Indian J. Hort., 44(1/2): 69-73.

Naik, L. B. and K. Srinivas. 1992. Influence of nitrogen and phosphorus fertilization on seed crop of okra (*Hibiscus esculentus*). Indian J. Agron., 37(4):769-771.

Ogunremi, E. A. 1978. Effect of nitrogen on melon (*Citrullus lanatus*) at lbadan, Nigeri. Hort., 32(1): 11-14.

Olivira, P. P., C. Ranjit, and P. Satya. 2005. Sex expression and phenotypic performance of local pumpkin cultivars as influenced by ethrep application. *Revista de Ciencias Agrarias*. 2005; (43): 77-81.

Pandey, R. P. and K. Singh. 1973. Note on the effect of nitrogen and maleic hydrazide on sex expression, sex ratio and yield of bottle gourd. Indian. J. Agril. Sc., 43(9): 882-883.

Pandey, R. P.; K. Singh and J. P. Tiwari. 1976. Effect of growth regulators on sex expression, fruit set and yield of sponge gourd (*Lagenaria cylindrical* Poem). Res. J., 10(1): 1-4 [Cited from Hort Abst. 49911: 733, 1979].

Patnaik, A.; R. S. Mishra; G.C. Nayak and T. Maharana. 1974. Effect of Cococel and Ethrel on sex expression and yield of Ridge gourd. Bangladesh Horticulture, 2: 19-22.

Pelaez, R. J.; C. Calero De La Pava and V. Jaramillo. 1984. Response of squash (*Cucurbita pepo* L.) and organic matter. Acta Agronomica, 34(3): 86-95.

Prakash, G. F. 1974. Effect of photoperiod, alpha-NAA and MH on sex expression and ratio in bitter gourd (*Momordica charantia* L.). Plant Sci., 6: 553.

Prasad, A. and J. D. Tyagi. 1963. Effect of maleic hydrazide on the sex expression and sex ratio in bitter gourd. Sci. and cult, 29(12): 605-6.

Rashid, M. 2004. Sabji Biggan. University press, Dhaka.

Ravindran, D. N. 1971. Effect of photoperiod and growth substances on sex expression in bitter gourd (*Trichosanthes anguina* L.) South Indian Hort., 15:1-21.

Rekha, C. R. and T. R. Gopalakrishnan. 2001. Effect of levels and frequencies of organic manures and inorganic fertilizers on growth and productivity of bitter gourd (*Momordica charantia* L.). South Indian Hort., 49(Special): 137-139.

Reddy, P.K and P.V.Rao.2004. Growth and yield of bitter gourd (Momordica charantia L.) as influenced by vermicompost and nitrogen management practices. Indian J. Res. 32(3): 15-20

Saleh, M.; M. S. and K. S. Abdul. 1980. Effects of gibberellic acid and cycocel on growth, flowering and fruiting of tomato (*Lycopersicon esculentum* Mill) plants. Mesopolmiaji of Agric., 15(1): 137-166.

Satish, S. S.; K. Arora and S. Siyag. 1988. Effect of nitrogen and phosphorus on fruit yield and quality of sponge gourd (*Lagenaria aegytiaca*). Indian J. Agril. Sci., 58(11): 860-861. [Cited from Hort. Abst. 60(3): 202, 1990]

Seshardi, V. S. 1986. Cucurbits. In: Vegetable Crops in India, edited by T. K. Bose and M. G. Som. 1986. Naya Prokash, Calcutta, India, Pp. 91-166.

Singh, K. and S. K. Upadhaya. 1967. A comparative study of soil and foliar of indole acetic acid (IAA) and naphthalene acetic acid (NAA) on several responses of tomato (*Lycopersicon esculentum* Mill.). Horticulturist, 2: 3.

Sreeamulu, N. 1987. Effect of ethrel on sex expression and endogenous auxin content in sponge gourd (*Luffa cylindrica*). Indian J. Hort., 44: 85-87.

Suresh, J. and C. M. Pappiah. 1991. Growth and yield of bitter gourd as influenced by nitrogen, phosphorus and maleic hydrazide. South Indian Hort., 38(3).

Susmita, D.;P.S Basu; and S.Das.1998. Effect of silver nitrate on flowering, fruit setting and development of Momordica charantia L. Department of Botany, Burdwan University, Gopalbag, Burdwan, India. 25: 2, 140-143.

Tomar, I. S. and S. R. Ramgiry. 1997. Effect of growth regulators on yield and yield attributes in tomato (*Lycopersicon esculentum* Mill.). Advance in plant Sciences, 10(2): 29-31.

Tsuchiya, T. and P.K.Gupta. 1991. Chromosome Engineering in Plants: Genetics Breeding Evolution. Elsevier. Amsterdam.

Verma, V. K.; P. S. Sirohi and B. Choudhury. 1948. Note on the response of chemicals to treatment on sex expression and fruiting in bitter gourd. Indian J. Hort., 41: 113-115.

Vishnu, S. H.; B. S. Prabhakar and V. Sukla. 1987. Effect of plant spacing and fertilizer on yield of bottle gourd. South Indian hort., 35(6): 453-454.

Wang,Q.M. and Q.M. Wang.2001. Effect of CPPU on growth and endogenous phytohormone contents of balsmpear (Momordica charantia L.) fruit. China Journal of Zhejiang Univ. Agriculture and Life Sciences. 27: 5, 513-517.

Zhang .1992. Research on Bitter Gourd and other vegetables as treatment for HIV -Aids

APPENDICES

Appendix I: Soil characteristics of horticulture farm is analyzed by Soil Resources Development Institute (SRDI), Farmgate, Dhaka.

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Horticulture garden, SAU, Dhaka
AEZ	Modhupur 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
Cropping pattern	N/A

Source: SRDI

B. Physical and chemical properties of the initial soil

Characteristics	**Value**
Partical size analysis	
% 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/100g soil)	0.10
Available S (ppm)	45

Source: SRDI

Appendix II: Monthly record of air temperature, rainfall, relative humidity and sunshine hours during the period from April 2007 to July 2007

Year	Month	Average air temperature (^{o}C)	Total	Average	Total

		Maximum	Minimum	Mean	rainfall (mm)	humidity (%)	sunshine hours
2007	April	33.74	23.87	28.81	185	69.41	234.6
	May	33.2	24.2	28.7	291	73	241.8
	June	33.4	26.8	30.1	259	79	96.0
	July	31.4	25.8	28.6	542	81	127.1
	July	32.0	26.6	29.3	361	82	108.5

Source: Dhaka meteorology center

Appendix III. Analysis of variance of the data on plant height, no. of nodes and branches per plant of bitter gourd as influenced by growth regulators and fertilizer management practices

Source of variation	Degrees of freedom	Mean square				
		Plant height (cm) at		No. of nodes per plant		No. of branch per plant
		1st flowering	last harvest	1st flowering	last harvest	
Replication	2	10.319	169.221	0.276	40.650	2.462
Plant growth	3	789.494	3273.63	1.552	94.108	1.506

regulator (A)		**	**	NS	NS	NS
Fertilizer management (B)	2	938.426**	5696.308**	20.599**	872.887**	10.393**
Interaction (A × B)	6	11.542*	1418.64*	2.639NS	343.138**	0.626NS
Error	22	1.995	421.166	5.350	80.040	1.578

** : Significant at 0.05 level of significance.

Appendix IV. Analysis of variance of the data on time to first flower, male and female flower and ratio and fruits per plant of bitter gourd as influenced by growth regulators and fertilizer management practices

Source of variation	Degrees of freedom	Mean square				
		Time to first flower (days)	No. of male flower	No. of female flower	Ratio of male and female flower	No. of Fruits per plant

Replication	2	0.021	16.516	15.708	0.588	0.685
Plant growth regulator (A)	3	10.783 **	55.736 **	41.827 **	1.045 **	68.946 **
Fertilizer management (B)	2	9.404 **	114.042 **	100.890 **	2.028 **	48.560 **
Interaction (A × B)	6	6.276 *	28.966 **	6.237 *	0.255 **	3.331 **
Error	22	0.866	16.396	4.649	0.094	0.498

** : Significant at 0.05 level of significance.

Appendix V. Analysis of variance of the data on fruit length, diameter, fruit weight and yield kg per plot and hectare of bitter gourd as influenced by growth regulators and fertilizer management practices

Source of variation	Degrees of freedom	Mean square				
		Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g/fruit)	Yield (kg/plot)	Yield (t/ha)
Replication	2	0.787	0.095	28.307	4.035	4.519
Plant growth regulator (A)	3	107.136 **	1.224 **	882.089 **	69.667 **	146.96 **
Fertilizer management (B)	2	82.588 **	0.494 **	150.990 **	53.473 **	58.363 **
Interaction (A × B)	6	2.037 *	0.168 **	56.647 **	2.612 **	5.066 **
Error	22	0.830	0.035	3.827	1.011	0.609

** : Significant at 0.05 level of significance