EFFECTS OF GROWTH REGULATOR AND FERTILIZER MANAGEMENT PRACTICES ON THE GROWTH, FLOWERING AND YIELD OF BITTER GOURD (*Momordica charantia* L.)

A THESIS
BY
MIZANUR RAHMAN

Registration No. 26230/00521
Semester: July-December 2006
Session: 2005-2006

MASTER OF SCIENCE (MS)
IN
HORTICULTURE

DEPARTMENT OF HORTICULTURE AND POSTHARVEST TECHNOLOGY,
SHER-E-BANGLA AGRICULTURAL UNIVERSITY,
SHER-E-BANGLA NAGAR, DHAKA-1207.

DECEMBER 2006

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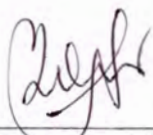
A Thesis

Submitted to the Department of Horticulture & Posthervest Technology
Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka
in partial fulfillment of the requirements for the degree of

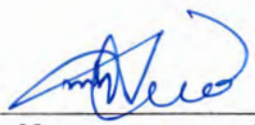
MASTER OF SCIENCE
IN
HORTICULTURE

SEMESTER: JULY – DECEMBER 2006

Approved by:



Dr. Md. Nazrul Islam
(Associate Professor)
Department of Horticulture
and Postharvest Technology
SAU. Dhaka.
(Supervisor)



Md. Hasanuzzaman Akand
(Assistant Professor)
Department of Horticulture
and Postharvest Technology
SAU. Dhaka.
(Co-supervisor)

Prof. Md. Ruhul Amin
Chairman
Department of Horticulture and Postharvest Technology
Sher-e-Bangla Agricultural University
Sher-e-Bangla Nagar, Dhaka-1207.

DECEMBER 2006

CERTIFICATE

This is to certify that thesis entitled, "**Effects of Growth Regulator and Fertilizer Management Practices on the Growth, Flowering and Yield of Bitter gourd**" submitted to the Department of Horticulture & Postharvest 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 **Mizanur Rahman** Registration No. **26230/00521** 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.

.....
Dr. Md. Nazrul Islam
Department of Horticulture
and Postharvest Technology
SAU, Dhaka.

ACKNOWLEDGEMENT

All praises are due to the Almighty "Allah" Who kindly enabled the author to complete the research work and the thesis leading to Master of Science.

The author feels proud to express his profound respect, deepest sense of gratitude, heartful appreciation to Dr. Md. Nazrul Islam, Associate Professor, Department of Horticulture and Postharvest Technology, Sher-e-Bangla Agricultural University, Dhaka for his constant inspiration, scholastic guidance and valuable suggestions during the conduct of the research and for his constructive criticism and whole hearted cooperation during preparation of this thesis.

The author express his heartfelt gratitude and indebtness to Assistant Professor Md. Hasanuzzaman Akand, Department of Horticulture and Postharvest Technology, Sher-e-Bangla Agricultural University, Dhaka for his assistance in planning and execution of the study and for his constructive instruction, critical reviews and heartiest cooperation during preparation of the manuscript.

The author also express his heartfelt thanks to all the teachers of the Dept. of Horticulture and Postharvest Technology, Sher-e-Bangla Agricultural University, Dhaka, for their help, valuable suggestions and encouragement during the period of study.

The author is grateful to all his friends, especially Ripon, Limon, Wazed, Mizan, Shahin, Habib, Rony, Mahi, Nurul, Mamun Bhai, Bakul Bhai, Shamim and Sanjoy for their help, encouragement and moral support towards the completion of the degree.

Cordial thanks are also to Mr. Hamim Reza, Senior Scientific Officer, Bangladesh Agricultural Research Institute, Rongpur for his special help during completion this thesis and Mr. Mokhlesur Rahman, Assistant Scientist, Horticultural Farm, Sher-e-Bangla Agricultural University for his kind help during the research work.

Lastly, the author would like to acknowledge his heartiest gratitude to his parents, sister and brothers whose blessings, inspiration and encouragement opened the gate and paved the way to his higher studies.

The author

EFFECTS OF GROWTH REGULATOR AND FERTILIZER MANAGEMENT PRACTICES ON GROWTH, FLOWERING AND YIELD OF BITTER GOURD (*Momordica charantia* L.)

ABSTRACT

An experiment was conducted to examine the effect of growth regulator (Ripen-15) and fertilizer management practices on the growth, flowering and yield of bitter gourd (Gaj Corolla) during April to July 2006 at the Horticulture farm of Sher-e-Bangla Agricultural University, Dhaka. Four different concentrations of growth regulator (Ripen-15) viz. H_1 (100 ppm), H_2 (200 ppm), H_3 (300 ppm) with control (No growth regulator) and four different fertilizers; F_1 (Cowdung), F_2 (Inorganic fertilizer), F_3 (Cowdung + Inorganic fertilizer) and F_0 (Control) were applied in the experiment. All the result of experiment had significant influences on all parameters studied i. e. time to first flower, number of male and female flower per plant, ratio of male/female flower, number of node with first flower, number of branches per plant, number of fruits per plant, length of fruit, diameter of fruit. Maximum number of female flower per plant was obtained from H_2 (24.4), F_3 (21.2) and F_3H_2 (26.4) cm). Maximum yield (t/ha) was obtained from H_2 (18.1 t), F_3 (19.7 t) and F_3H_2 (22.9 t) followed by F_3H_1 (20.6 t).

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ABBREVIATIONS AND ACRONYMS

cv	= Cultivar
et al.	= and others
RCBD	= Randomized Complete Block Design
SAU	= Sher-e-Bangla Agricultural University
TSP	= Triple Super Phosphate
MP	= Murate of Potash
Viz.	= Namely

CHAPTER I

INTRODUCTION

Bitter gourd (*Momordica charantia* L.) is a popular vegetable, belongs to the family Cucurbitaceae. In Bangladesh, bitter gourd is available in summer season and adored for its special taste, high nutrient and medicinal value. It ranks first among the cucurbits in respect of iron and vitamin C content. The fruit has wormicidal properties and extracts are used to cure rheumatism (Indira, 1981).

Vegetables are the main source of vitamins and minerals that are essential for maintaining good health. Though Bangladesh is an agricultural country it has a serious deficiency in vegetables and the scarcity is much more dominate during summer. Bitter gourd can play important role to elevate vegetable consumption in lien summer season. Nutrition council of Bangladesh recommended at least 235 g/day/person of vegetables for Bangladeshi adult but the availability is only 65.5 g/day/person. The annual production of vegetable is only 4.31 million tons including potato but we need around 11.15 million tons (Anon, 2002).

Compared with the world agriculture, the average production of vegetables in Bangladesh is far lower than the average world production, though in cereals we are in better place especially in rice. Till recently, in Bangladesh agriculture research concerned with enhanced crop yields, landed primarily on the use of fertilizers, pesticides, better water management, development and exploitation of genetic resources. Plant growth regulators are now widely used as a magic substance in modern farming. Recently in our farmers or the commercial producer are being used different kinds of growth hormones to increase their production.

Recently, Ripen-15 (Ethephon 42.50%) is used by the farmers to increase the yield of bitter gourd as per recommendation of National Agricare (a reputed Non Government Organization). Ripen-15 is an organo phosphate compound and a growth regulating agent and the function of it is to increase female flowers and reduce time (days) to first flower (National Agricare).

The role of growth regulators in various physiological and biochemical process in plant is well known from its identification. Growth regulators are known to 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 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. Recently organic farming is appreciated by vegetable consumers as it enhances quality of the produce bitter gourd.

However, very limited research was conducted to improve the fruit set and yield of bitter gourd by hormone application and fertilizer management practices.

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

1. To find out effect of Growth regulator (Ripen-15) on the growth, flowering and yield of bitter gourd.
2. To determine the appropriate concentration of Ripen-15 to increase the yield of bitter gourd.
3. To find out the effect of different fertilizer on the growth, flowering and yield of bitter gourd.
4. To asses the interaction effect of growth regulator and fertilizer management practices on the growth, flowering 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

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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 water melon.

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.

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.

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.

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.

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.

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.

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 snake gourd. Nodes per female flower as well as days to flower were minimum at 1000 ppm in snake 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 snake gourd but at 1500 ppm in bottle gourd.

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.

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.

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)

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 snake 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

2.2 Effect of Fertilizers

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_2O_5/rai) and 2 rates of potassium (0 and 10 kg K_2O/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_2O_5 and K_2O/rai, respectively.

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.

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.

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.

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.

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.

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.

With other cucurbits, nitrogen fertilization has been reported to increase the number of pistillate and perfect flowers in muskmelons (Brantley and Warren, 1960).

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

In cucumber, Matzusaki and Hayase (1963) reported that when all the nitrogen was applied before planting, early vegetative growth was retarded by higher levels. They said that the number of flowers was not affected by different levels but the higher N level increased fruit set and length of ovary at flowering time.

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%).

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).

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

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).

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.

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.

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.

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.

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.

CHAPTER III

MATERIALS AND METHODS

The experiment was undertaken to examine the effect of growth regulator (Ripen-15) and fertilizer management practices on the growth, flowering 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 2006. 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 September) 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 2006) are shown in appendix II.

3.3 Planting materials used for experiment

Seeds of Gaj corolla (Bitter gourd) were obtained from the Bangladesh Agricultural Development Corporation (BADC), Sher-e-Bangla Nagar, Dhaka.used in the experiment.

3.4 Experimental Treatment

Experiments consisted two factors

Factor A:

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

1. F_0: Control (No fertilizer)
2. F_1: Cowdung (24.8 t/ha)
3. F_2: Inorganic fertilizer (Urea 378 kg/ha, TSP 312.5 kg/ha, MP 275 kg/ha)
4. F_3: Cowdung + Inorganic fertilizer (Cowdung 15 t/ha, Urea 150 kg/ha, TSP 125 kg/ha, MP 100 kg/ha)

Factor B:

There were four concentrations of growth regulator (Ripen-15) treatments in the experiment. The treatments were-

1. H_0: Control (No Ripen-15)
2. H_1: 100 ppm.
3. H_2: 200 ppm
4. H_3: 300 ppm

3.5 Application of growth regulator

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

Total 16 treatment combinations were as follows:

F_0H_0	F_1H_0	F_2H_0	F_3H_0
F_0H_1	F_1H_1	F_2H_1	F_3H_1
F_0H_2	F_1H_2	F_2H_2	F_3H_2
F_0H_3	F_1H_3	F_2H_3	F_3H_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 16 plots. Each unit plot in from of raised bed was 6 m^2 (2m × 3m) in size. Altogether there were 48 unit plots in experiment and required 498 m^2 land. Row to row and plot to plot distance were 1 m and 50 cm 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. A layout of the experiment has been shown in Figure 1.

3.7 Land preparation

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

3.8 Manures and fertilizer application

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

Cowdung 15 ton

Urea 150 kg

TSP 125 kg

MP 100 kg

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. In F_3 treatment (Organic + Inorganic fertilizer) fertilizer were applied according to recommended dose.

Levels of manure and fertilizer	Dose per hectare	Dose per plot
F_0 (Control)		
F_1 (Organic)		
Cowdung	15 + 9.8 = 24.8 t	14.8 kg
F_2 (Inorganic)		
Urea	150 + 228 = 378 kg	226 g
TSP	125 + 187.5 = 312.5 kg	187 g
MP	100 + 175 = 275 kg	165 g
F_3 (Organic + Inorganic)		
Cowdung	15 t	9 kg
Urea	150 kg	90 g
TSP	125 kg	75 g
MP	100 kg	60 g

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.

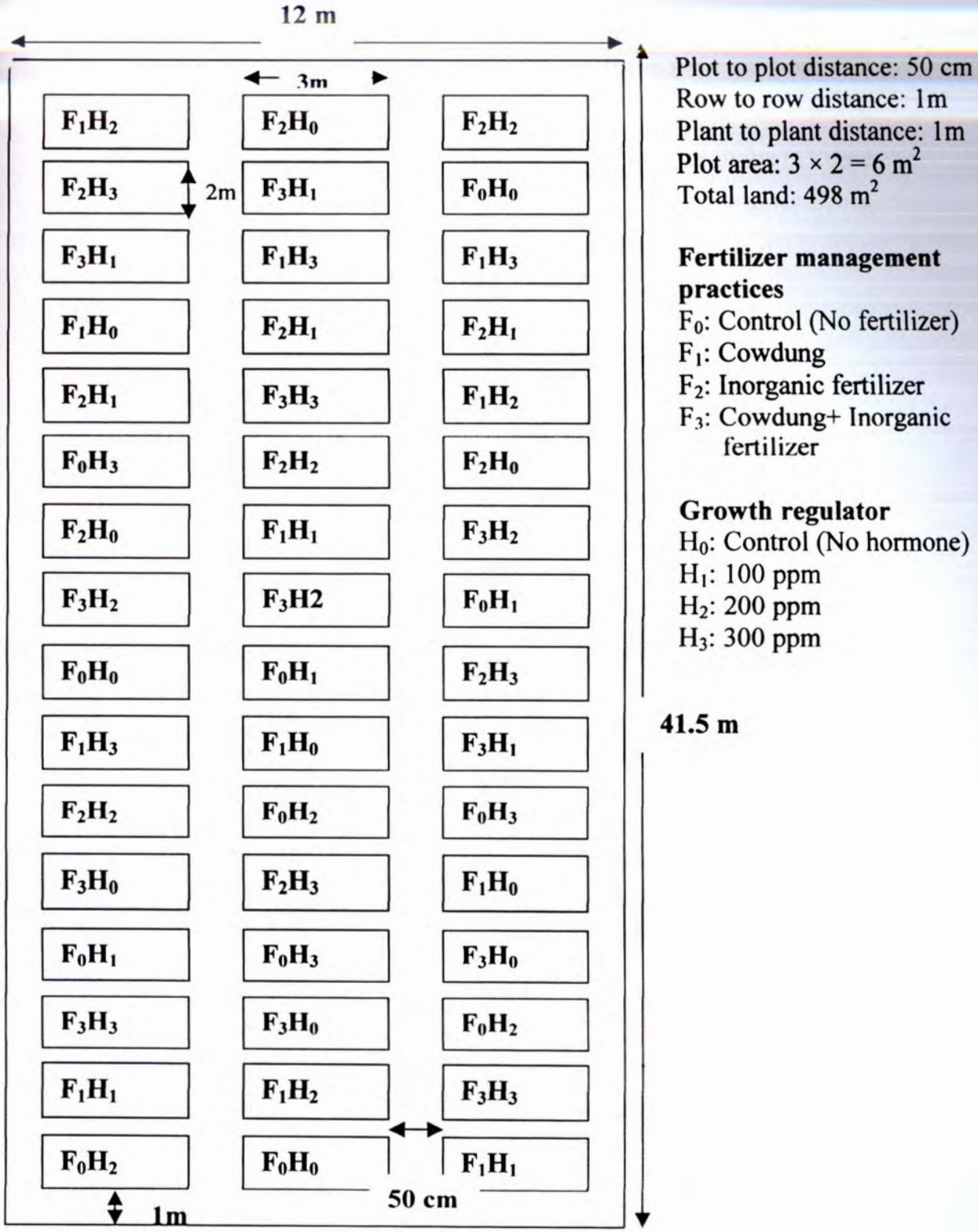

Fig. 1 Layout and design of the experimental plot

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 raising. 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 8 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 (cm)

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 (cm)

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.

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 1% or 5% probability.

CHAPTER IV

RESULTS AND DISCUSSION

The present study was undertaken to investigate the effect of growth regulator (Ripen-15) and fertilizer management practices on the growth, flowering and yield of bitter gourd. This chapter comprises the presentation and discussion of the results obtained due to the application of three different concentrations of Ripen-15 and three different management of fertilizer on bitter gourd. The analyses of variances (ANOVA) for different characters have been presented in Appendix III. The results of the study have been presented and discussed in this chapter under the following headings.

4.1 Time to first flower (days)

Different levels of plant growth regulator exhibited a significant influence on the time (days) to first flower (Table 1). The first flower was observed in H_2 treatment (46.1 days) followed by H_1 (47.9 days), H_3 (50.1 days) and that of control was (53.4 days). There was little difference (Appendix IV) on the time required to first male and female flower but the difference was not significant. From this result it is evident that growth regulator has significant influence on the time to first flower (days) of bitter gourd. Similar result also found by Mangal *et al.* (1981).

Time to first flower (days) was not significantly influenced by fertilizer management practices (Table 1). It was almost same for all treatments and it was around 49 days. Boonmanop (1997) stated that fertilizers had no significant effect on the first bloom of male and female flower (earliness).

Table 1. Effect of growth regulator (Ripen-15) and fertilizer management practices on the time required to flower initiation (days) of bitter gourd

Fertilizer treatment	Hormone concentration				
	H_0 (Control)	H_1 (100 ppm)	H_2 (200 ppm)	H_3 (300 ppm)	Mean
F_0 (Control)	53.9	48.1	46.1	50.0	49.5
F_1 (Cowdung)	53.9	48.0	46.0	50.0	49.4
F_2 (Inorganic fertilizer)	53.8	47.9	46.0	50.0	49.4
F_3 (Cowdung+Inorganic fertilizer)	52.3	47.9	46.3	50.0	49.1
Mean	53.4	47.9	46.1	50.1	

The combined effect of growth regulator and fertilizer management practices was also significant (Table. 1). The first flower was found in F_2H_2 and F_1H_2 treatment (46 days) followed by F_2H_1 (47.9 days) and longest time was taken by the treatment combination of H_0F_0 (53.9 days).

4.2 Number of male and female flowers

Application of plant growth regulator significantly influenced the number of male flower. The lowest number (67) of male flowers was found in H_2 treatment (Table 2). The maximum number of female flower was observed in H_2 treatment (24.4) followed by H_1 (20.1) and H_3 (19).The lowest number of female flower was observed in control (17.4). It was observed that growth regulator markedly reduces the number of male flower but increase the female flower to a certain level (Table 2). It might be due to absorbed of growth regulator through the stem and leaf of the plant. Then transported to other tissues, cells and readily hydrolyzed and increased female flowers of bitter gourd plants. These findings were similar to that of Ravindran (1971) in bitter gourd.

The fertilizer management practices had significant effect on the number of flowers per plant. The maximum number of male flowers (74.5) was obtained from the F_3 (Table 2). All the treatments showed better performance over control (68.9). These findings were similar to that of Ali *et al.* (1995) in bitter gourd and Brantley and Warren (1960) in muskmelon.

The combined effect between fertilizer management practices and growth regulators in respect of number of flowers per plant was found to be significant. The combined effect revealed that plants, which treated with F_3H_0, had the maximum number of male flowers per plant (79.9) and treatment combination of F_3H_2 produced the highest number of female flowers (26.4) per plant (Table 2). Similar result also found by Pandey and Singh (1973).

4.3 Ratio of male/female flower

It was revealed from the experiment that all the concentration of growth regulator increased femaleness and reduced maleness in bitter gourd. Among four treatments the lowest male/female flower ratio was observed in H_2 treatment (2.7) followed by H_1 (3.4), H_3 (3.7) and that of control was 4.3 (Table 2). With the increasing of concentration of growth regulator, the ratio of male/female flowers were decreased up to a certain limit and then increased. The effect of growth regulator in the present investigation was in conformity with the result of Prasad and Tyagi (1963). Similar result also found by McMurray and Miller (1969), Irving *et al.* (1968), Bisaria (1974).

Ratio of male/female flower was not significant by fertilizer management practices (Table 2). Ratio of male-female flower was almost same for all treatment and it was around 3.5.

Table 2. Effect of growth regulator (Ripen-15) and fertilizer management practices on the number of flower (male and female) and ratio of male/female flower of bitter gourd

ertilizer reatment	Hormone concentration														
	H_0 (control)			H_1 (100 ppm)			H_2 (200 ppm)			H_3 (300 ppm)			Mean		
	Male	Female	Male/ female ratio	Male	Female	Male/ female ratio	Male	Female	Male/ female ratio	Male	Female	Male/ female ratio	Male	Female	Male/ female ratio
F_0	72.5	15.4	4.7	68.3	19.3	3.5	64.5	22.8	2.8	70.5	18.1	3.8	68.9	18.9	3.7
F_1	74.2	17.6	4.2	69.9	20.4	3.4	66.7	23.8	2.8	70.8	19.3	3.6	70.4	20.2	3.5
F_2	74.6	17.8	4.1	70.7	20.6	3.4	68.1	24.7	2.7	72.1	19.2	3.7	71.3	20.5	3.4
F_3	79.9	18.8	4.2	72	20.3	3.5	68.9	26.4	2.6	77.3	19.6	3.9	74.5	21.2	3.5
Mean	75.3	17.4	4.3	70.2	20.1	3.4	67	24.4	2.7	72.6	19	3.7			

F_0= Control (no fertilizer)

F_1= Cowdung

F_2= Inorganic fertilizer

F_3= Cowdung + Inorganic fertilizer

The combined effect of growth regulator and fertilizer management practices was also significant. The lowest ratio of male/female flower was obtained from the treatment combination of F_3H_2 (2.6) followed by F_2H_2 (2.7), F_1H_2 (2.8), F_2H_1 (3.4) and F_3H_1 (3.5). The highest ratio of male/female flower (4.7) was recorded from F_0H_0 (Table 2).

4.4 Plant height (cm)

Plant height was not statistically significant by growth regulator (Table 3).

Fertilizer management practices exhibited a significant influence on the plant height of bitter gourd at different growth stage i.e. at first flowering and last harvest. During first flowering highest plant height was found from F_3 treatment (170.6 cm) whereas, the lowest plant height was obtained from control (142.2 cm). The plant height increased with increasing time. At last harvest, the highest plant height was obtained from the F_3 treatment (559.9 cm) followed by F_2 (473.1 cm) and F_1 (472.3 cm). The shortest plant (403.5 cm) was given by the control (Figure 2).

The combined effect of growth regulator and fertilizer management practices was also significant (Table 3) on plant height at last harvest. At last harvest, the maximum plant height was obtained from the treatment combination of F_3H_0 (575.3 cm) followed by F_3H_1 (568.7 cm) and F_3H_3 (555.5 cm). Minimum plant height was recorded from F_0H_0 (381.2 cm).

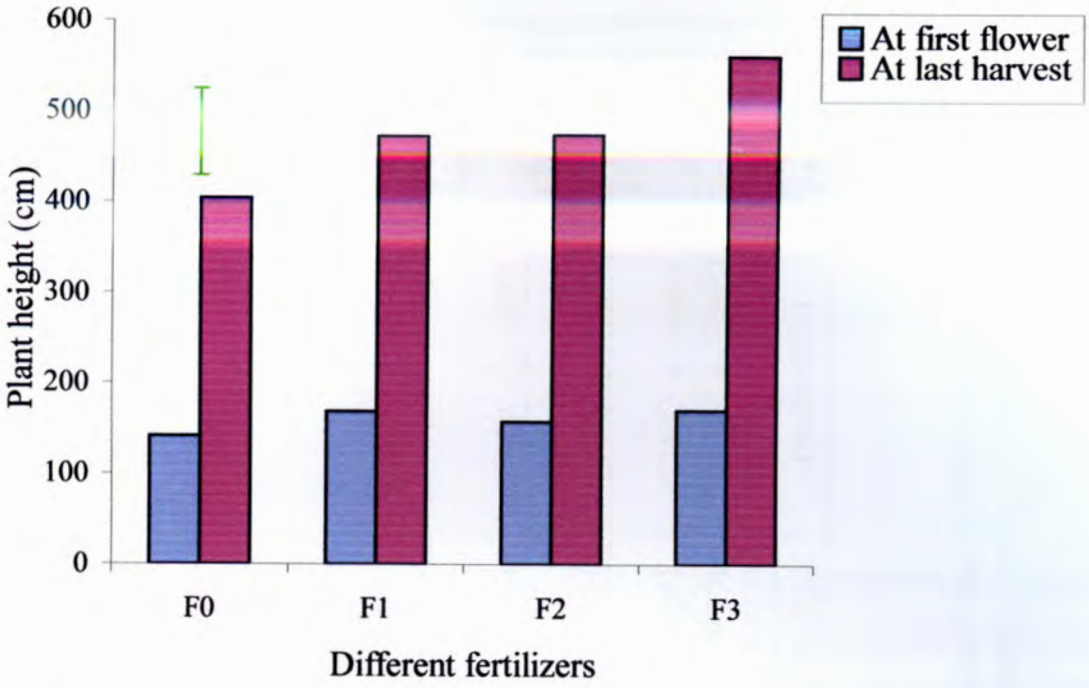

Fig. 2. Effect of fertilizer management practices on plant height of bitter gourd (Vertical bar represents LSD Value at 5% level of significance)

F_0= Control (no fertilizer)

F_1= Cowdung

F_2= Inorganic fertilizer

F_3= Cowdung + Inorganic fertilizer

4.5 Number of Nodes per plant

The total numbers of nodes per plant of bitter gourd were almost same for different doses of growth regulator but number of nodes with first flower was significant (Table 4).

Effect of fertilizer management practices on the total number of nodes per plant at first flowering was found statistically significant (Table 4). However, at first flowering, the maximum number of nodes per plant was recorded from F_3 (146.9) followed by F_2 (144.9), F_1 (117.2) and minimum nodes per plant were obtained from control (99.4).

able 3. Effect of growth regulator (Ripen-15) and fertilizer management practices on the plant height (cm) at first flower and at last harvest of bitter gourd

Fertilizer treatment	Growth regulator concentration									
	H_0 (control)		H_1 (100 ppm)		H_2 (200 ppm)		H_3 (300 ppm)		Mean	
	At first flower	At last harvest	At first flower	At last harvest	At first flower	At last harvest	At first flower	At last harvest	At first flower	At last harvest
F_0 (Control)	138.9	381.2	142.6	414.1	141.4	408.7	146.2	410.3	142.2	403.5
F_1 (Cowdung)	169.1	475.5	168.9	471.3	167.5	471.4	171.5	471.2	169.2	472.3
F_2 (Inorganic fertilizer)	168.1	476.9	157.3	473.5	151.7	470.8	155.3	471.5	158.1	473.1
F_3 (Cowdung + Inorganic fertilizer)	171.7	575.3	169.9	568.7	171.1	540.1	169.8	555.5	170.6	559.9
Mean	161.8	477.2	159.6	481.9	157.9	472.7	160.7	477.1		

The effect of increased number of nodes per plant was possibly due to readily available plant nutrients from F_3 that might have encouraged more vegetative growth and development. Number of nodes with first flower was not statistically significant for fertilizer management practices treatment.

The combined effect of growth regulator (Ripen-15) and fertilizer management practice significantly influenced the number of nodes with first flower (Table 4). But total number of nodes at first flowering was almost same for all treatment.

4.6 Number of branches per plant at first flowering

Number of branches per plant was significantly influenced by the application of growth regulator (Table 4). The maximum number of branches per plant was obtained from H_3 treatment (9.2). Similar result also found by Tomar Ramgiry (1997).

Highly significant variation was found in respect of total number of branches per plant at first flowering due to different fertilizer management practice (Table 4). The maximum number of branch was observed from F_1 (10.8) followed by F_3 (9.6), F_2 (9.2) and the minimum number of branches was observed in control (6.2). The effect of fertilizer management practices in the present investigation was in conformity with the result of Mishra (1987).

Table 4. Effect of growth regulator (Ripen-15) and fertilizer management practices on the number of node at first flower, total node (main shoot and branches) and number of branches at first flower of bitter gourd

tment	Growth regulator concentration														
	H_0 (control)			H_1 (100 ppm)			H_2 (200 ppm)			H_3 (300 ppm)			Mean		
	No.of node at first flower	Total Node (main Shoot & branches	Total branch	No.of node at first flower	Total Node (main Shoot & branches	Total branch	No.of node at first flower	Total Node (main Shoot & branches	Total branch	No.of node at first flower	Total Node (main Shoot & branches	Total branch	No.of node at first flower	Total Node (main Shoot & branches	Total branch
F_0	15.5	99.1	6.1	14.4	99.1	6.4	14.2	99.1	6.4	17.3	100.5	6.3	15.3	99.4	6.3
F_1	15.8	119.5	10.1	15.1	116.8	10.8	15	114.6	11.1	16.5	118.1	11.4	15.6	117.2	10.8
F_2	15.8	147.1	9.1	14	144.3	9.2	13.2	143.3	9.3	13.8	145	9.2	14.2	144.9	9.2
F_3	17.3	150	9.7	14.6	146	9.4	13.2	146.1	9.7	15.8	145.6	9.9	15.2	146.9	9.6
lean	16.1	128.9	8.7	14.5	126.5	8.9	13.9	125.7	9.1	15.8	127.3	9.2			

Control (no fertilizer)

Cowdung

norganic fertilizer

Cowdung + Inorganic fertilizer

The combined effect of fertilizer management practices and growth regulators in respect of number of branches per plant at first flowering was found to be significant. The combined effect revealed that the maximum number of branches per plant at first flowering was found in F_1H_2 (11.1) and the lowest number (6.1) of branches per plant at first flowering was produced by F_0H_0 (Table 4).

4.7 Number of fruits per plant

There was significant variation among the different levels of growth regulator treatments in respect of number of fruits per plant. The maximum number of fruits per plant was obtained from H_2 (16.3) and the minimum number (13.7) of fruits per plant was found in the control (Table 5). Similar result was also reported by Gopalkrishnan and Choudhury (1978) in water melon, Tomar and Ramgiry (1997) in water melon.

Analysis of variance showed that the effect of fertilizer management practice on number fruits per plant was highly significant (Table 5). The maximum number of fruits per plant was obtained from F_3 (18) followed by F_2 (16.9) and the minimum number of fruits per plant was obtained from control (10.6). Similar result also found by Boonmanop (1997), Islam (1995) Satish *et al.* (1988), Naik and Srinivas (1992).

There was significant combined effect of fertilizer management practices and growth regulator in respect of number of fruits per plant. The maximum number of fruit per plant was obtained from F_3H_2 (19.4) followed by F_3H_3 (18.6), F_2H_2 (17.6). The minimum number (8.7) of fruits per plant was found from F_0H_0 (Table 5).

t of growth regulator (Ripen-15) and fertilizer management practices on the number of fruits per plant ruit weight (g) of bitter gourd

lizer ment	Growth regulator concentration									
	H_0 (Control)		H_1 (100 ppm)		H_2 (200 ppm)		H_3 (300 ppm)		Mean	
	Number of fruits per plant	Fruit weight (g)	Number of fruits per plant	Fruit weight (g)	Number of fruits per plant	Fruit weight (g)	Number of fruits per plant	Fruit weight (g)	Number of fruits per plant	Fruit weight (g)
0 trol)	8.7	56.3	11	99.4	11.8	100.8	11.1	91.3	10.6	86.9
1 ung)	14	102.8	16.1	107.2	16.5	108.4	16.2	107	15.7	106.3
2 ganic lizer)	15.8	107.2	16.9	109.9	17.6	113	17.3	108.8	16.9	109.7
3 dung + ganic izer)	16.4	111.2	17.9	114.7	19.4	117.8	18.6	113.8	18	114.3
ean	13.7	94.3	15.4	107.8	16.3	110	15.8	105.2		

4.8 Fruit length (cm)

Growth regulator had the strong positive effect on the fruit length of bitter gourd. The fruit length was also increased with increases of concentration of growth regulator up to a certain limits and then decreased. Among the four levels of growth regulator maximum fruit length was recorded from H_2 (17.9 cm) followed by H_3 (17 cm) and H_1 (16.6 cm). The minimum fruit length (15.9 cm) was found in control (Table 6). Same result also found by Singh and Upadhayaya (1967) in tomato.

There was a highly significant effect on fruit length due to the different fertilizer management practices (Table 6). The maximum fruit length was produced in F_3 (18 cm) followed by F_2 (17.3 cm) and F_1 (16.6 cm) whereas, the lowest fruit length was obtained from control (15.5 cm). The effect of fertilizer management practices in the present investigation was in conformity with the result of Naik and Srinivash (1992).

The analysis of variance revealed that, fruit length varied significantly due to combined of growth regulator and fertilizer management practice (Table 6). The maximum fruit length was obtained from F_3H_2 (19.7cm) and the lowest fruit length was recorded from F_0H_0 (14.9 cm).

4.9 Diameter of fruit (cm)

Variation was found in case of diameter of fruit of bitter gourd. The diameter of fruit was higher up to specific concentrations of growth regulator and then decreased (Table 6). Growth regulator at higher concentrations reduced diameter of fruit compared to lower concentrations, which might be due to its inhibitory effect on cell division and enlargement.

Table 6. Effect of growth regulator (Ripen-15) and fertilizer management practices on the fruit length (cm) and diameter of fruit (cm) of bitter gourd

Fertilizer treatment	Growth regulator concentration								Mean	
	H_0 (Control)		H_1 (100 ppm)		H_2 (200 ppm)		H_3 (300 ppm)			
	Fruit length (cm)	Diameter of fruit (cm)	Fruit length (cm)	Diameter of fruit (cm)	Fruit length (cm)	Diameter of fruit (cm)	Fruit length (cm)	Diameter of fruit (cm)	Fruit length (cm)	Diameter of fruit (cm)
F_0 (Control)	14.9	3.4	15.4	3.7	16.3	3.8	15.4	3.8	15.5	3.6
F_1 (Cowdung)	15.9	4	16.8	4.1	17.3	4.2	16.5	4.1	16.6	4.1
F_2 (Inorganic fertilizer)	16.4	4	17	4.2	18.3	4.3	17.7	4.2	17.3	4.1
F_3 (Cowdung + Inorganic fertilizer)	16.6	4.2	17.4	4.4	19.7	4.5	18.6	4.4	18	4.3
Mean	15.9	3.9	16.6	4.1	17.9	4.2	17	4.1		

The diameter of fruit was significantly influenced by the fertilizer management practices (Table 6). The maximum diameter of fruit was obtained from F_2 (4.2 cm) and minimum from F_0 (3.6 cm). This result was agreed with Ogunremi (1978).

The combined effect of fertilizer management practices and plant growth regulators was found to be significant (Table 6). The highest diameter of fruit was obtained from F_3H_2 (4.5 cm), while the minimum from control F_0H_0 (3.4 cm).

4.10 Weight of fruit (g)

In better gourd the maximum weighted fruit was obtained from H_2 (110 g) of growth regulator. It was higher from the result of other treatments viz. H_1 (107.8 g) and H_3 (105.2 g) and that of control (94.3 g). From the finding it was observed that with the increases of concentrations of the growth regulator the fruits weight was increased up to certain limit and then decreased (Table 5). Significant higher fruit weight from growth regulator treated plant than that of control might be due to accumulation of more metabolites in fruit. This result was agreed with the result of Gopalkrishno and Choudhury (1978) and Kaushik *et al.* (1974).

Weight of fruit (g) varied significantly among different sources of fertilizer (Table 5). The maximum weight of fruit was obtained from F_3 (114.3 g). This was followed by F_2 treatment (109.7 g), while the control treatment gave the lowest weight of fruit (86.9 g). Similar result also found by Boonmanop (1997).

The combined effect of growth regulator and fertilizer management practices on the weight of fruit was significant (Table 5). The highest

weight of fruit was obtained from F_3H_2 (117.8 g) treatment combination followed by F_3H_1 (114.7 g) treatment combination. The lowest weight of fruit was observed in F_0H_0 (56.3 g) treatment combination.

4.11 Yield (kg/ plot)

The yield/plot (kg) was found to be significantly influenced by the different levels of growth regulator. The highest yield/plot was recorded in H_2 (11.2 kg). These was followed H_3 (10.5 kg) and H_1 (10.1 kg) and the lowest yield (8.5 kg) was found in H_0 (Table 7). It might be due to increased fruit girth, fruit length and fruit number recorded from the plant treated with growth regulator. Same result also found by Saleh and Abdul (1980).

Table 7. Effect of growth regulator (Ripen-15) and fertilizer management practices on the yield/plot (kg) and yield/ha (t) of bitter gourd

Fertilizer treatment	Growth regulator concentration									
	H_0 (control)		H_1 (100 ppm)		H_2 (200 ppm)		H_3 (300 ppm)		Mean	
	Yield (kg/ plot)	Yield (t/ha)	Yield (kg/ plot)	Yield (t/ha)	Yield (kg/ plot)	Yield (t/ha)	Yield (kg/ plot)	Yield (t/ha)	Yield (kg/ plot)	Yield (t/ha)
F_0 (Control)	4.4	7.3	6.5	10.9	7.1	11.9	6.3	10.1	6	10
F_1 (Cowdung)	8.6	14.4	10.4	17.3	10.7	17.9	10.2	16.9	9.9	16.6
F_2 (Inorganic fertilizer)	10.2	17	11.2	18.6	11.9	19.9	11.6	18.7	11.2	18.5
F_3 (Cowdung + Inorganic fertilizer)	10.9	18.3	12.3	20.6	15.4	22.9	14.1	17.1	13.1	19.7
Mean	8.5	14.2	10.1	16.8	11.2	18.1	10.5	15.7		

There was a highly significant effect on the yield/plot due to fertilizer management practices (Appendix III). The highest yield (kg/plot) was obtained from F_3 treatment (13.1 kg) followed by F_2 (11.2 kg) and F_1 (9.9 kg) (Table 7). The lowest yield/plot was obtained from control (6 kg). These findings were similar to that of Pelaez *et al.* (1984) in squash.

The combined effect of growth regulator and fertilizer management practices significantly influenced on the yield/plot (Table 7). The highest yield/ plot obtained from treatment combination of F_3H_2 (15.4 kg). This was followed by F_3H_3 (14.1 kg) and F_3H_1 (12.3 kg). The lowest yield/plot were obtained from control (4.4 kg). This result was agreed with the result of Pandey Singh (1973).

4.12 Yield (t/ha)

The yield (t/ha) was found to be significantly influenced by the different level of growth regulator (Appendix III). About four ton higher yield/ha was recorded from treated area than that of control. Among the four treatments, the highest yield/ha was recorded in H_2 (18.1 t) followed by H_1 (16.8 t), H_3 (15.7 t) and the lowest yield (14.2 t) was recorded from control (Table 7 and Figure 3). This result indicate that there was a strong positive effect of growth regulator on yield, which agreed with the findings of Saleh and Abdul (1980), Singh and Upadhayaya (1967).

Different fertilizer management practices showed a highly significant variation on the yield/ha. The highest yield (19.7 t) of bitter gourd per hectare was found in F_3 (Table 7 and Figure 4). The lowest yield/ha was recorded in control (10 t). These findings were similar to that of Isaac and Pushpakumari (1997).

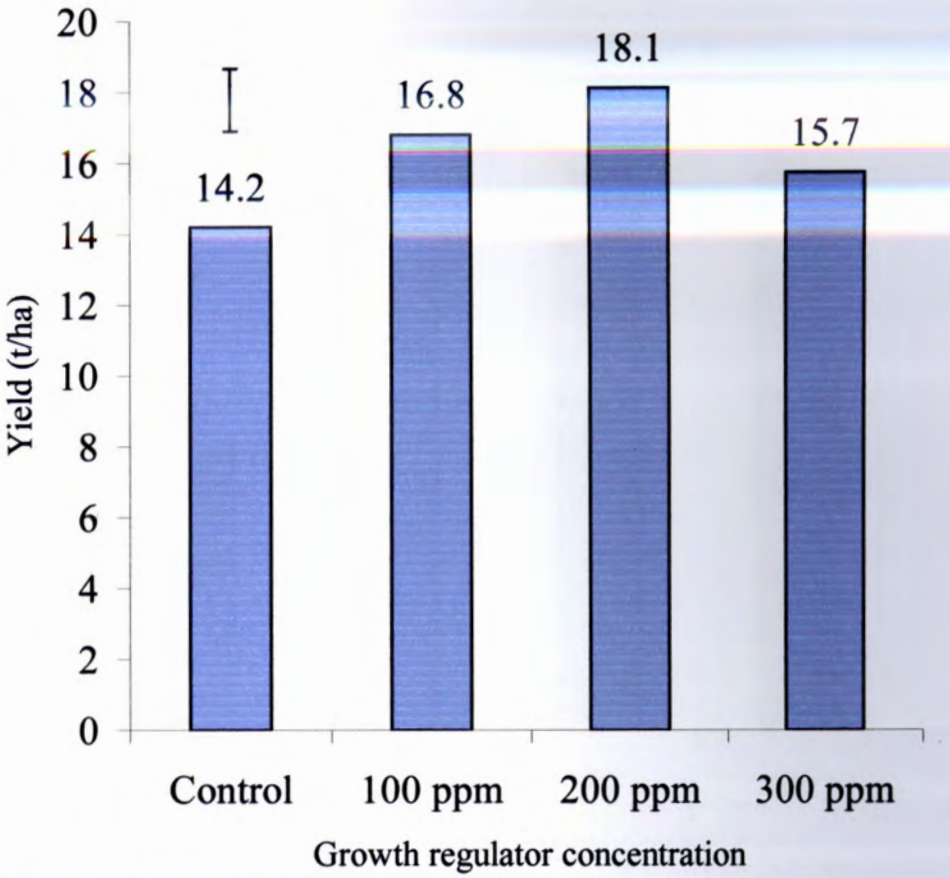

Fig. 3. Effect of growth regulator on the yield (t/ha) of bitter gourd (Vertical bar represents LSD value at 5% level of significance)

There was a significant combined effect of different levels of growth regulator and different fertilizer management practices on the yield of bitter gourd (t/ha). The highest yield/ha was produced by the treatment combination of F_3H_2 (22.9 t) followed by treatment combination of F_3H_1 (20.6 t), F_2H_2 (19.9 t), F_2H_3 (18.7 t) and F_2H_1 (18.6 t). The lowest yield (7.3 t) were obtained from the treatment combination of F_0H_0 (Table 7).

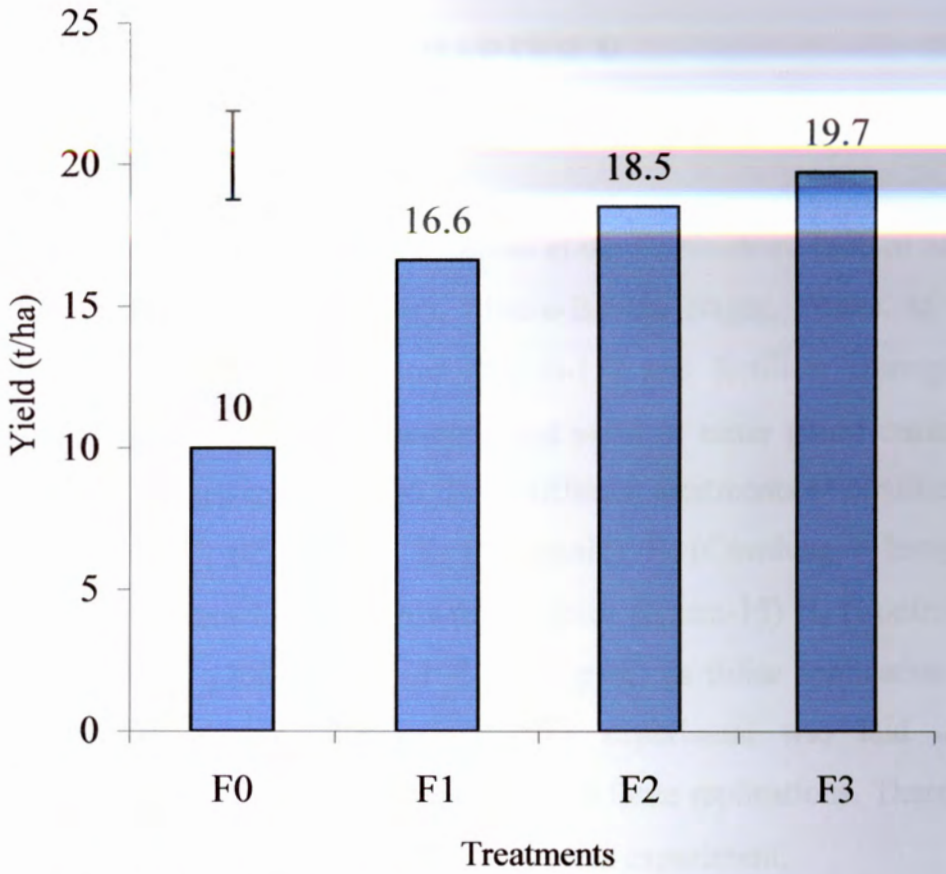

Fig. 4. Effect of fertilizer management practices on the yield (t/ha) of bitter gourd (Vertical bar represents LSD value at 5% level of significance)

F0= Control (no fertilizer)

F1= Cowdung

F2= Inorganic fertilizer

F3= Cowdung + Inorganic fertilizer

CHAPTER V

SUMMARY AND CONCLUSION

The present experiment was conducted at the Horticulture farm of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, to study the effect of growth regulator (Ripen-15) and fertilizer management practices on the growth, flowering and yield of bitter gourd during the period from April to July 2006. Four different treatments of fertilizer viz. F_0 (Control), F_1 (Cowdung), F_2 (Inorganic), F_3 (Cowdung + Inorganic) and four different level of growth regulator (Ripen-15) H_0 (Control), H_1 (100 ppm), H_2 (200 ppm) and H_3 (300 ppm) as foliar application were used in experiment. The two factors experiment was laid out in Randomized Complete Block Design with three replications. There were altogether 16 treatment combinations in this experiment.

Seedlings of bitter gourd were planted at the spacing of 1 m X 1 m. Data were collected on time to first flower (days), number of male and female flower per plant, ratio of male/female flower, plant height at first flowering and at last harvest, number of nodes with first flower, total number of nodes with first flower, number of branches at first flowering, number of fruits per plant, fruit length, diameter of fruit (cm), weight of fruit (g), yield (kg/plot) and yield (t/ha). All collected data of the present study were analyzed statistically and the mean differences were adjudged by Least Significance Difference (LSD) test.

The result of the experiment revealed growth regulator (Ripen-15) had significant influence on all parameters studied except plant height and total number of nodes. More or less all the characters attained highest

values when 200 ppm of growth regulator (H_2 treatment) was applied. Maximum number of female flower (24.4), the lowest ratio of male/female flower per plant (2.7), the highest number of fruits per plant (16.3), weight of fruit (110 g), maximum yield (11.2 kg/plot or 18.1 t/ha) were obtained by H_2. The control gave the lowest value in all the character studied.

Different fertilizer management practices had also significant effect on the parameters studied except time to first flower (days), ratio of male/female flower and number of nodes with first flower. The maximum yield (13.1 kg/plot or 19.7 t/ha) was obtained from F_3 (Cowdung + Inorganic).

The combined effect of different levels of growth regulator and fertilizer management practices was exhibited significant variation for all the parameters except total number of nodes at first flowering. The maximum yield (15.4 kg/plot or 22.9 t/ha) was recorded from the treatment combination of F_3H_2. While minimum yield (4.4 kg/plot or 7.3 t/ha) was found from F_0H_0 (Control).

From the study, it might be concluded that Ripen 15 performed early flower, more female flower, more fruit set and maximum yield, concentration of 200 ppm showed best result. Different fertilizer showed the various effects on the growth viz. plant height, number of branches of which F_3 exhibited best result and plants treated with fertilizer management practices and growth regulator (Ripen-15) produced higher yield compared to control plants and among those F_3H_2 showed best result. Further such type of research work may be conducted for more confirmation.

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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 2006 to August 2006

Year	Month	Average air temperature (°C)			Total rainfall (mm)	Average humidity (%)	Total sunshine hours
		Maximum	Minimum	Mean			
2006	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
	August	32.0	26.6	29.3	361	82	108.5

Source: Dhaka meteorology center

Appendix III: Analysis of variance of the data of experiment on the effect of growth regulator and fertilizer management practices on the growth, flowering and yield of bitter gourd

Source of variation (sv)	Degrees of freedom (df)	Mean of sum square					
		Days required to first flower initiation		Number of flowers		Ratio of male-female flower	Number of branches at first flowering
		Male	Female	Male	Female		
Replication	2	54.396*	39.063*	20.313^{NS}	6.771^{NS}	0.049	1.396**
Treatment	15	26.819	23.423	45.430	25.361	1.113	9.365
Growth regulator (H)	3	0.065*	1.882*	66.753*	16.188*	0.129*	45.566^{NS}
Fertilizer management practices (F)	3	133.786^{NS}	107.176^{NS}	148.105^{NS}	102.025*	5.284^{NS}	0.499*
H × F	9	0.082	2.686	4.095	2.864	0.052	0.255
Error	30	6.063	5.729	30.313	3.438	0.067	0.326

** Significance at 5% level of probability

* Means at 1% level of significance

^{NS} Not significant

Appendix III. Contd. Analysis of variance of the data of experiment on the effect of growth regulator and fertilizer management practices on the growth, flowering and yield of bitter gourd

Source of variation (sv)	Degrees of freedom (df)	Mean of sum square					
		Plant height (cm) at		Number of node		Number of fruits per plant	Fruit length (cm)
		First flowering	Last harvest	With first flower	At first flowering (total)		
Replication	2	236.831^{NS}	2522.661^{NS}	109.156*	8.312^{NS}	5.713**	3.013**
Treatment	15	449.612	10126.307	4.968	1264.367	29.055	4.824
Growth regulator (H)	3	2060.768^{NS}	49192.876^{NS}	6286.393*	4.311^{NS}	129.129*	14.468*
Fertilizer management practices (F)	3	34.781*	166.032*	22.287**	13.405*	15.241*	7.996*
H × F	9	50.838	424.209	4.387^{NS}	2.375	0.303	0.553
Error	30	73.7	1542.317	52.029	1.312	1.217	0.750

* *Significance at 5% level of probability
* Means at 1% level of significance
^{NS} Not significant

Appendix III. Contd. Analysis of variance of the data of experiment on the effect of growth regulator and fertilizer management practices on the growth, flowering and yield of bitter gourd

Sources of variation (sv)	Degrees of freedom (df)	Mean squares			
		Diameter of fruit (cm)	Fruit weight (gm)	Yield/ plot (kg)	Yield/ ha (ton)
Replication	2	0.123^{NS}	305.054^{NS}	14.794**	0.237^{NS}
Treatment	15	0.250	620.674	25.547	53.269
Growth regulator (H)	3	0.976**	1737.860**	107.472**	223.440*
Fertilizer management practices (F)	3	0.246*	580.016*	16.515*	33.215*
F×H	9	0.010	261.832^{NS}	1.251	3.231**
Error	30	0.075	171.686	3.812	1.456

** Significance at 5% level of probability
* Means at 1% level of significance
^{NS} Not significant

Appendix IV. Effect of growth regulator (Ripen-15) and fertilizer management practices on the time required to flower initiation (days) of bitter gourd

Treatment	H_0 (Control)		H_1 (100 ppm)		H_2 (200 ppm)		H_3 (300 ppm)		Mean	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
F_0 (Control)	53.6	54.3	47.6	48.7	45.7	46.6	49.3	50.7	49	50
F_1 (Cowdung)	53.5	54.4	47.7	48.3	45.6	46.4	49.4	50.6	49	49.4
F_2 (Inorganic fertilizer)	53.3	54.3	47.6	48.2	45.8	46.3	49.3	50.8	49	49.9
F_3 (Cowdung + Inorganic fertilizer)	53.9	50.7	47.7	48.2	45.9	46.8	49.2	50.8	49.1	49.1
Mean	53.5	53.4	47.6	48.3	45.7	46.5	49.3	50.7		