GROWTH AND YIELD OF CUCUMBER AS INFLUENCED BY STEM PRUNING AND FOLIAR APPLICATION OF GIBBERELLIC ACID AND CYTOKININ

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DHAKA 1207

DECEMBER, 2021

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A Thesis

Submitted to the Department of Horticulture

Sher-e-Bangla Agricultural University, Dhaka

in partial fulfillment of the requirements

for the degree of

MASTER OF SCIENCE (M.S.)

IN

HORTICULTURE

SEMESTER: JULY- DECEMBER, 2021

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CERTIFICATE

*This is to certify that the thesis entitled "**GROWTH AND YIELD OF CUCUMBER AS INFLUENCED BY STEM PRUNING AND FOLIAR APPLICATION OF GIBBERELLIC ACID AND CYTOKININ**" submitted to the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (M.S.)** in **HORTICULTURE**, embodies the results of a piece of bona fide research work carried out by **ISRAT JAHAN EVA**, Registration. No.**19-10177** under my supervision and guidance. No part of this thesis has been submitted for any other degree or diploma.*

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

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ACKNOWLEDGEMENT

All praises to the Almighty Allah, the great, the gracious, merciful and supreme ruler of the universe who enables me to complete this present piece of work for the degree of Master of Science (MS) in the Department of Horticulture.

The author would like to express his deepest sense of gratitude, respect to his research supervisor, ***Prof. Dr. Md. Nazrul Islam****, Department of Horticulture, Sher-e-Bangla Agricultural University, for his kind and scholastic guidance, untiring effort, valuable suggestions, inspiration, extending generous help and encouragement during the research work and guidance in preparation of manuscript of the thesis.*

The author sincerely expresses his deepest respect and boundless gratitude to his co-supervisor ***Dr. Shormin Choudhury****, Associate professor, Department of Horticulture, for her helpful suggestion and valuable advice during the preparation of this manuscript.*

It is highly appreciating words for ***Prof. Dr. Khaleda Khatun****, Chairman, Department of Horticulture, Sher-e-Bangla Agricultural University, for the facilities provided, in carrying out this work. The author also acknowledges with deep regards the help and cooperation received from his respected teachers and stuff of the Department of Horticulture, Sher-e-Bangla Agricultural University while carrying out this work.*

The author feels proud to express his sincere appreciation and gratitude to Ministry of Science and Technology, The People's Republic of Bangladesh for awarding his National Science and Technology (NST) fellowship.

At last, but not the least, the author feels indebtedness to his beloved parents and friends whose sacrifice, inspiration, encouragement and continuous blessing paved the way to his higher education and reach at this stage. May Allah bless us all.

The Author

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BY

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ABSTRACT

An experiment was conducted during the period of April to June 2021 at Horticulture farm of Sher-e-Bangla Agricultural University, Dhaka 1207, Bangladesh to evaluate the effect of stem pruning and foliar application of gibberellic acid (GA_3) and cytokinin on growth and yield of cucumber. The experiment was laid out in the Randomized Complete Block Design with four replications. Treatment as four levels of gibberellic acid (GA_3) and cytokinin application i.e., T_0=No spray, T_1= 50 ppm GA_3 spray, T_2= 2.5 ppm cytokinin spray, T_3= 50 ppm GA_3 and 2.5 ppm cytokinin spray; and three levels of stem pruning i.e., P_0= No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches which in combination made 12 treatment combination. Application of GA_3 and cytokinin resulted the highest vine length (27.13 cm at 25 DAS and 74.00 cm at 35 DAS), number of leaves (12.33 at 25 DAS and 34.50 at 45 DAS), number of fruits (15.08 plant^{-1}), individual fruit weight (242.99 g), fruit yield (23.05 t ha^{-1}) from T_3 treatment. In case of pruning, the highest vine length (73.34 cm at 35 DAS), number of leaves (39.31 plant^{-1} at 45 DAS), number of fruits (14.75 plant^{-1}), individual fruit weight (266.17 g), fruit yield (23.07 t ha^{-1}) from P_2 treatment. The combined effect of P_2T_3 gave the best result for all vegetative and reproductive growth and development i.e., vine length (100.75 cm), total number of fruits (17.88) and fruit yield (34.68 t ha^{-1}). So, the combination of P_2T_3 found the best to cultivate cucumber.

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LIST OF ABBREVIATIONS

AEZ	Agro-Ecological Zone
BARI	Bangladesh Agricultural Research Institute
BBS	Bangladesh Bureau of Statistics
ha^{-1}	Per hectare
RCBD	Randomized Complete Block Design
CV%	Percentage of coefficient of variance
LSD	Least Significant Difference
cv.	Cultivar
DAE	Department of Agricultural Extension
DAS	Days after sowing
et al.	And others
FAO	Food and Agriculture Organization
GA_3	Gibberellic acid
Kn	Kinetin
MoP	Muriate of Potash
TSP	Triple Super Phosphate
NS	Non-significant
SAU	Sher-e-Bangla Agricultural University
SRDI	Soil Resources and Development Institute
^{0}C	Degree Celsius
Wt.	Weight

CHAPTER I

INTRODUCTION

Cucumber (*Cucumis sativus* L.) is one of the most important and popular vegetable crops grown extensively throughout the tropical and subtropical region of the world. It belongs to the family cucurbitaceae and is native to Southern Asia (Adams *et al*., 1992). Cucumber is a truly versatile vegetable because of wide range of uses from salads to pickles and digestive aids to beauty products (More, 2015). It is a vine that bears cucumiform fruits that are used as vegetables. It has a diploid chromosome number of 14, 2n= 14 (Kadi *et al*., 2018). Although it is very watery, with little flavor and not very nutritious, it is a common ingredient of salads and pickles, being valued primarily for its crisp texture and juiciness. The seeds are extremely enriched with nutritive compounds; protein (33.8%), fat (45.2%), carbohydrates (10.3%), and crude fibers (2.0%) and the seed oil consist of four chief fatty acids; linoleic acid (61.6%), oleic acid (15.7%), stearic acid (11.1%), and palmitic acid (10.7%) (Mariod *et al*., 2017). The fruits are extremely nutritive and consist of 95% water, extremely small calories (about 15 calories per cup) (Mukherjee *et al.,* 2013). The fruit also consists of calcium (20mg/100g), iron (0.7mg/100g), thiamin (0.3mg/100g), niacin (0.01mg/100gm) and some natural antioxidants that reduce chronic diseases (Trichopoulou *et al*., 2000; Baset Mia *et al*., 2014). It is often applied in cosmetics, beauty, and sometimes in case of burns and skin complications since it contains high percentage of water and lactic acid (~7-8% w/w) which acts as detoxifying agent (Sotiroudis *et al*., 2010). It is very rich in antioxidants and vitamin K and C (Jyoti *et al*., 2016).

There are three main varieties of cucumber: slicing, pickling, and seedless. Within these varieties, several cultivars have been developed. Increasing cucumber production requires appropriate cultivation techniques. One possible action taken to increase the cucumber production is by improving the cultivation techniques through a proper pruning. According to (Usenik *et al*., 2008), pruning influenced vegetative growth and fruit quality. The significance of yield may be qualified by factors such as fruit quality, fruit size, or price development of the market determined by season. Fruit exceeding a certain size are of no value, and nowadays, consumers demand good fruit shape and quality (Than, 1996). The growth of plants and other factors can be modified by pruning to suit human needs and desires (Than, 1996).

Plant growth regulators (PGRs) are widely using in the agricultural sector for different purposes from seed germination to final yield. The major problem is maleness in cucumber which greatly decrease the fruit yield (Singh *et al*., 2015). Other problems include shape distortion, untimed maturity, fruit drop, late flowering, early senescence, and so on which can be solved by the recommended dose of plant growth regulators. PGRs improved the germination of vegetable seeds, increased total yield, protected the plant from pests and sometimes also used to avoid the loss of yield due to the unfavorable condition (Halter *et al*., 2005). In addition to these PGRs were extensively used for the quick plant growing purpose through seed soaking (Jankauskiene and Surviliene, 2009). PGRs have an excellent effect on the sex expression and flowering in different vegetables including cucurbits (Al-Masoum and Al-Masri, 1999; Kadi *et al*., 2018). Foliar application of PGRs changed the sex ratio along with the sequence during the two- or four-leaf stage (Hossain *et al*., 2006).

Different studies suggested that the number of female flowers in cucumber can be increased through the application of plant growth regulators in the different levels of plant growth. Exogenous application of growth regulators has been shown to shift the sex expression towards femaleness by increasing the production of the female flowers by suppressing the male flower in cucumber (Arora *et al*., 1994). PGRs also showed to have an effect on the initiation of early flowering, increased the number of fruits, fruit weight, and the yield (Gedam *et al*., 1998; Gopalkrishman and Choudhury, 1978). Early female flowering and fruit maturation were reported after the application of PGRs in a high yielding variety of cucumber and bitter gourd (Hossain, 2004).

Plant growth regulators are also used to control the vegetative growth of cucumber plants, thereby increasing the plant population per unit area with regard to yield (Latimer, 1991). In this study, we have applied GA_3 and Cytokinin in cucumber plants and stem pruning to identify the standard PGRs and pruning for the good production of Alavi Green Hybrid cucumber variety.

OBJECTIVES

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

1. To evaluate the effect of foliar spraying of GA_3 and Cytokinin on the growth, yield, fruit quality of cucumber fruit.
2. To evaluate the effect of stem pruning on flowering, fruiting and quality fruit production of cucumber.
3. To study the interactions between different plant growth regulators (GA_3 and Cytokinin) and pruning on flowering, fruiting and yield of cucumber.

CHAPTER II

REVIEW OF LITERATURE

3.1 Effect of plant growth regulators (GA_3 and Cytokinin)

Plant Growth Regulators (PGRs) are natural and Synthetic compounds applied to plants or plant organs to regulate growth and development. Exogenous application of the PGRs may in addition to a response by a plant tissue, be accompanied by a change in hormonal concentration, frequency and availability of a receptor protein, which amplify the hormonal signal. This could bring about changes in plant developmental processes.

Plant growth regulators play an important role in high value horticultural crops to increase yield, enhance crop quality and management (Davies, 1995; Latimer, 1992). Exogenous application of gibberellins to Arabidopsis induced early flowering and affected flower morphology (Richards *et al.,* 2001). In similar studies GA_{4+7} increased flowering in a genotype of Aquilegia species (Gianfagna and Merrit, 1998) and increased fruit set and fresh weight in cucumber (Yang *et al*., 1992).

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.

(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.

(Dalai *et al*., 2016) an experiment was conducted to assess the effect of various doses of GA_3 and NAA on growth, flowering, yield and yield contributing parameters in cucumber. Total eight treatments of the growth regulators viz, GA_3 10, GA_3 20, GA_3 30 ppm, NAA 50, NAA 100, NAA 150 ppm, GA_3 20 + NAA 100 and control were tried in Randomized Block Design and replicated thrice. Out of these, an application of combined dose @ GA_3 20 ppm + NAA100 ppm was found significantly superior in terms of growth, flowering and yield and yield attributing parameters i.e.

vine length plant^{-1} (cm), number of primary branches plant^{-1}, number of leaves plant^{-1}, length and width of longest leaf (cm), days to first flower formation, number of male and female flower plant^{-1}, sex ratio, number of fruits plant^{-1}, length and width of fruit (cm) at alternate days, length and width of fruit (cm) at five days, weight of fruit^{-1}, fruit yield plant^{-1}, fruit yield plot^{-1} and yield (qha^{-1}) as compared to control and other applied treatment. Overall, the impact of above observation, the highest yield (173.60 qha^{-1}) of tender green was recorded with a combined dose of GA_3 20 ppm + NAA100 ppm and minimum yield (150.53 qha^{-1}) of tender green under control.

(Sapkota, B., *et al*., 2020) an experiment was done at Rambagh, Chitwan during March to May 2018 with the objective to evaluate the effect of plant growth regulators on growth, flowering and yield of cucumber (*Cucumi ssativus*.) cv. Malini. The experiment consisted of nine treatments viz., control (no spray), silver nitrate 250 ppm spray, ethephon 250 ppm spray, gibberellic acid (GA_3) 300 ppm spray, napthalene acetic acid (NAA) 50 ppm spray, silver nitrate 500 ppm spray, ethephon 250 ppm spray, gibberellic acid (GA_3) 500 ppm spry, and napthalene acetic acid (NAA) 100 ppm spray; each treatment was replicated thrice. Findings revealed that use of plant growth regulators significantly affected growth, flowering and fruit yield of cucumber. The highest plant height was measured for GA_3 300 ppm spray whereas lowest plant height was measured for NAA 100 ppm spray. Likewise, GA_3 300 ppm spray had produced highest number of lateral branches. On the other hand, highest number of male flowers was recorded in control, but highest number of female flowers was recorded for ethephon 250 ppm spray whereas it was lowest for control (14.00). The highest and lowest fruit length was recorded in GA_3 500 ppm and ethephon 250 ppm were sprayed, respectively. Likewise, the highest fruit numbers per plant was recorded in GA_3 300 ppm application whereas the control had the lowest number of fruits produced. The highest fruit yield was produced from the application of GA_3 300 ppm (109.7 t/ha) while the lowest fruit yield was recorded in control (40.53 t/ha). The B: C ratio was high in GA_3 300 ppm (4.37) application as well. These results indicate the benefit of spraying GA_3 300 ppm to have a better performance and fruit yield of cucumber compared to the other treatments with varied concentrations of NAA and GA_3.

(Rahman, M. A., *et al*., 2020) an experiment was conducted to assess growth, flowering and fruiting attributes of four cucumber varieties as influenced by GA_3 was studied during March to May, 2018 at research field of Crop Physiology and Ecology Department, Hajee Mohammad

Danesh Science and Technology University, Dinajpur-5200, Bangladesh. The experiment consisted of two factors, two growing conditions (control and foliar application of GA_3); and four cucumber varieties (Shohag, Sarothi, Sufala-1 and Shila). Total eight treatment combinations were implemented in a randomized complete block design and replicated thrice. Foliar application of GA_3 was found significantly superior over control in terms of different growth, flowering and fruiting behaviors of cucumber. Under foliar application of GA_3, the maximum fruit yield (24.58 t ha^{-1}) was recorded in Sufala-1, whereas minimum fruit yield (19.73 t ha^{-1}) was recorded in Sarothi. Moderate fruit yield was recorded from rest of the two varieties (23.95 and 20.50 t ha^{-1} in Shila and Shohag, respectively).

Natural cytokinins in fruit play an important role in determining the eventual cell number of the fruit (Williams and Letham, 1969). Exogenous application of gibberellins has been reported to promote cell enlargement by increasing plant cell wall extensibility (Brock and Cleland, 1990; Keyes *et al*., 1990). Plant organ, such as fruits, with increased sink strength may have increased growth due to plant hormones in fruit seed. Cytokinins have the ability to promote carbohydrate metabolism and create new source- sink relationship (Monthens and Engelbrecht, 1961; Dyer *et al*., 1990) thus leading to increased sink strength (fruit), fruit size and fruit dry matter at harvest (Emongor and Murr, 2001; Dyer *et al*., 1990).

Delayed senescence, increased vegetative growth, well developed chloroplast could enhance photosynthetic efficiency and CO_2 assimilation at leaf and plant level, resulting in improved yields. Plant growth regulators can be used to modify plant growth and development in such a manner to increase crop yield (El-Otmani *et al*., 2000; Emongor, 1997).

(Papadopoulos, A. P., *et al*., 2006) at the Greenhouse and Processing Crops Research Centre of Agriculture and Agri-Food Canada, Harrow, Ont. Two replicated experiments were conducted to study the effect of kinetin spray on growth and production of all three crops: the first in spring—summer 2004 and the second in fall—winter 2004. Foliar sprays of kinetin at 2.5, 5, and 10 ppm concentrations were tested against a water spray (control) on each crop. A 2.5-ppm kinetin spray had beneficial effects on the growth of cucumber transplants (taller plants and greater leaf area and fresh weight of leaves and stems). Furthermore, this treatment resulted in higher marketable yield in the spring—summer crop and in larger fruit size in the fall—winter crop. Regression analysis showed that cucumber marketable yield had an overall quadratic response to kinetin spray

concentration in spring—summer season maximizing at 5.1 ppm kinetin. Kinetin spray also had beneficial effects on the growth of tomato seedlings, but not on yield. On the other hand, significant beneficial effects were observed on the growth of pepper seedlings and on marketable yield and fruit quality. Regression analysis showed that the response of pepper marketable yield to kinetin spray concentration was positive and linear. It must be noted that, given the rather short-term nature of our experiments, the observed beneficial effects of the kinetin sprays on yield can only be interpreted as beneficial effects on early yield rather than on the total yield. We concluded that under our growing conditions, cucumber production would benefit from a dilute (2.5 ppm) kinetin spray, and pepper production from a high concentration spray (10 ppm); tomato transplant growth will also benefit from a kinetin spray at 2.5 ppm.

(Abu-Romman., *et al*., 2015) an experiment was done in vitro shoot multiplication of cucumber (*Cucumis sativus*) was examined from the nodal explants of 10-day-old aseptic plantlets using Murashige and Skoog (MS) media supplemented with different concentration (0, 0.5, 1, 2, 3 mg L^{-1}) of cytokinins (6-Benzylaminopurine-BAP, Kinetin-Kn, Thidiazuron-TDZ, and Zeatin). Nodal explants of cucumber showed shoot induction and multiplication in response to all cytokinins tried. MS medium containing Kn was the most effective for inducing shoots from nodal explants of cucumber. The maximum rate of regeneration (83%), the highest number of obtained shoots (7.93 shoots/explant) and the longest shoots (3.61 cm) were obtained on MS medium fortified with 1 mg L^{-1} Kn. The lowest culture responses were recorded for media supplemented with either BAP or Zeatin. In conclusion, using Kn is strongly recommended than using Zeatin, TDZ and BAP to obtain the highest percentage of regeneration, the highest number of shoot/explants, and the highest shoot length for nodal explants of cucumber.

An experiment conducted by (Terzi and Kocaçalişkan, *et al*., 2010) and reported that, Juglone (5-hydroxy-1, 4-naphthoquinone) is an allelochemical responsible for walnut allelopathy. The effects of gibberellic acid (GA_3) and kinetin (KIN) on overcoming the effects of juglone stress on seed germination and seedling growth were investigated in barley, wheat, cucumber, alfalfa, and tomato. Seeds pre-treated with plant growth regulators were used to test their effects on the alleviation of juglone stress. It was observed that seed germination in tomato and wheat was inhibited by juglone and that the plant growth regulators alleviated it significantly. Elongation and dry weight of the seedlings of all the species used in the study were reduced significantly by

juglone, and the plant growth regulators alleviated them. The most effective treatment was the GA_3 +KIN combination, which was best on seedling growth in tomato and wheat.

3.2 Effect of pruning

An experiment conducted by (Mardhiana *et al*., 2017) and reported that, in recent years, cucumber production in Tarakan, North Kalimantan only reaches 20 tons ha^{-1}. In fact, cucumber production potential could reach 49 tons ha^{-1}. Several factors that limit the low productivity of cucumbers in Tarakan are acid soil and cultivation techniques which are still limited. This study aimed to determine the effect of pruning on the growth and yield of cucumbers in acid soil in Tarakan. The study was conducted using Randomized Complete Block Design with the treatment of without pruning (P_0), shoot of pruning on the main stem (P_1), pruning of whole lateral branches above the third section (P_2), and pruning of 2 lateral branches that emerged first above the third section (P_4). The results showed that plant height was 16.17% (P_1) and 2.26% (P_2) lower also 0.13% higher (P_3) than the control (P_0). The highest number of leaves was found in treatment P_1 (16.19%) compared to P_0. The best fruit diameter was also found in P_1 treatment with 4.93% difference compared to P_0. Furthermore, a highly significant and the best result on weight per fruit were also obtained by P1treatment. The results showed that the fruit weight of P_1 treatment (11.39%) was higher than P_0. This study provided new information that the pruning treatment of shoots on the main stem of cucumber variety Mercy in acid soil could increase the diameter and weight of cucumber.

Pruning and planting density plays an important role in the growth and yield of greenhouse cucumber. In order to the effect of pruning and plant density on yield of cucumber factorial experiment in a randomized complete block design with three replications was conducted. Factors planting density that densities of 30,000, 35,000 and 40,000 plants per hectare. Pruning in three methods of Pruning No. 1 (after 40-30 cm height, a fruit and a leaf on each branch was kept and then the terminal bud branches were cut). Pruning No. 2 (after the 40-35 cm height, 25 cm at the top of leaves on each branch was kept a cucumber and a terminal bud branch were cut and then second at 25 cm on each branch 2 cucumbers and 2 leaves and 25 cm 3 cucumbers and three leaves on each branch holds the third and delete the residues, and so up until four fruits and the plant will be pulled down. This procedure is repeated pruning and pruning (3) (all branches on the main stem at an angle of each leaf is removed and allowed only one fruit grow from the main stem), Karim

on the company Gavrish the major crops and export region, were studied. Data recorded includes total yield per unit area, yield per plant, average fruit weight, fruit number, length and fruit diameter measurements were analyzed. Data analysis with SAS statistical software and means were compared using Duncan test. The results showed significant differences among the three methods of pruning and density was relation to the total yield, yield per plant, number of fruits per plant, average fruit weight per plant. In this study it was found that the highest performance and most desirable in pruning fruit quality was No. 3 with a density of 35,000 plants per hectare. Vine pruning increased total yield, yield per plant, number of fruits per plant, average fruit weight per plant in cucumber crop (Khoshkam, 2016).

(Maboko *et al*., 2011) reported that a study was conducted in 2009 to 2010 and 2010 to 2011 to investigate the effect of plant population, fruit and stem pruning of hydroponically grown tomatoes in a 40% (black and white) shade-net structure at the ARC-Roodeplaat VOPI. An open bag hydroponic system containing sawdust as a growing medium was used in this experiment. Tomato plants were subjected to three plant populations (2, 2.5 or 3 plants/m2), two stem pruning treatments (one stem and two stems) and three fruit pruning treatments (four fruits, six fruits per truss, and no fruit pruning). Experimental layout was a complete randomized block design with three replicates. Data on fruit number, fruit mass, unmarketable yield, marketable yield and total yield was collected from 10 plants for all treatments. Plants pruned to two stems with zero fruit pruning or pruned to six fruits produced significantly higher marketable and total yield, as compared to the other treatments. Plant population of 3 plants/m^2, resulted in significantly higher marketable yield of tomatoes, compared to 2.5 and 2 plants/m^2. Results showed that tomato yield and quality can be effectively manipulated by plant population and stem pruning, while fruit pruning had only a limited effect.

(McFadyen *et al*., 2011) conducted an experiment to find out the post-pruning shoot growth increases fruit abscission and reduces stem carbohydrates and yield in macadamia. They stated that, there was good evidence for deciduous trees that competition for carbohydrates from shoot growth accentuates early fruit abscission and reduces yield but the effect for evergreen trees is not well defined. Here, whole-tree tip-pruning at anthesis was used to examine the effect of post pruning shoot development on fruit abscission in the evergreen subtropical tree macadamia (*Macadamia integrifolia, M. integrifolia* × *tetraphylla*). Partial-tree tip-pruning was also used to

test the localization of the effect. In the first experiment (2005/2006), all branches on trees were tip-pruned at anthesis, some trees were allowed to re-shoot (R treatment) and shoots were removed from others (NR treatment). Fruit set and stem total non-structural carbohydrates (TNSC) over time, and yield were measured. In the second experiment (2006/2007), upper branches of trees were tip-pruned at anthesis, some trees were allowed to re-shoot (R) and shoots were removed from others (NR). Fruit set and yield were measured separately for upper (pruned) and lower (unpruned) branches. In the first experiment, R trees set far fewer fruit and had lower yield than NR trees. TNSC fell and rose in all treatments but the decline in R trees occurred earlier than in NR trees and coincided with early shoot growth and the increase in fruit abscission relative to the other treatments. In the second experiment, fruit abscission on upper branches of R trees increased relative to the other treatments but there was little difference in fruit abscission between treatments on lower branches. This study was the first to demonstrate an increase in fruit abscission in an evergreen tree in response to pruning. The effect appeared to be related to competition for carbohydrates between post-pruning shoot growth and fruit development and was local, with shoot growth on pruned branches having no effect on fruit abscission on unpruned branches.

A field trial was conducted to evaluate the effect of pruning and staking on the vegetative growth and yield of cucumber (*Cucumis sativus* L.). The experiment was a 3 x 2 factorial laid out in Randomized Complete Block Design (RCBD) with five replications. The results showed that vine length, number of flowers, total number of fruits and the number of non-marketable fruits were higher on the nonstaked treatment while staking resulted in a higher number of marketable fruits, weight, length and diameter of fruits. The unpruned plants produced the highest total number of fruits, marketable and non-marketable fruits while the weight, length and diameter of fruits were highest on one stem pruning. Staking, pruning and their interaction had no significant effect on the number of days to 50% anthesis. In Abakaliki agro-ecological zone, non-staking and non-pruning treatments produced optimum marketable yield of cucumber (Ekwu and Utobo, 2010).

(Utobo *et al*., 2010) reported that the effect of pruning on the growth and yield of four cucumber varieties was evaluated using a4 x 2 factorials laid out in a Randomized Complete Block Design (RCBD). Market more 76, Marketer and Point-sett varieties produced significantly ($p<0.05$) higher total and marketable yield than Market more 70. Similar trend was observed for total and marketable fruit weight, and marketable fruit number per plant. Significant differences in some

vegetative growth parameters were found between the cucumber varieties. Market more 76 and Marketer varieties had similar but significantly ($p<0.01$) shorter days to 50% anthesis than Market more 70 followed by Point-sett. Marketer had significantly ($p<0.05$) longer stem length than the other cucumber varieties. Market more 76 and Marketer varieties produced similar, but significantly ($p<0.05$) higher number of branches per plant than Market more 70 and Point Sett. Significant differences ($p<0.05$) in terms of yield and yield components were found between the two pruning treatments. The no pruning treatment produced the highest total yield and total fruit number per plant. The pruning treatment produced the highest marketable fruit yield, total and marketable fruit weight, and marketable fruit number per plant. Pruning significantly ($p<0.05$) affected the days to 50% anthesis and stem length. Unpruned cucumber varieties took shorter days of 26 for the 50% of the plants to flower while pruned cucumber varieties produced longer stem lengths of 18.46 than the non-pruned treatment.

(Suthar *et al*., 2006) found that, pruning and Ethrel [ethephon] treatments, viz. pruning of side shoots up to 5^{th} node, and 10 and 25 ppm, respectively, were assessed for maximum cucumber (cultivars Pusa, Sanyog, Stimora and Rani) production under polyhouse environment. Maximum height was recorded in Rani with pruning, while foliar spray of Ethrel decreased the plant height. Pruning produced maximum number of fruits per vine (16.9 and 15.7) in Stimora. Foliar application of Ethrel 25 ppm exhibited maximum number of fruits (13.9 and 12.5). Rani recorded maximum individual fruit weight (136.9 and 147.3). Pruning in all cucumber genotypes induced maximum fruit weight, while Ethrel 25 ppm slightly improved this character. Pruning produced maximum fruit yield (2.2 kg/vine) in Rani. Fruit yield was also maximum (2.2 kg/vine) with Ethrel 25 ppm in Rani. Ethrel 25 ppm in combination with pruning produced maximum fruit yield.

(Nu, 1996) stated that the effect of pruning (pinching out the branches on main stem at node 4 up to the bottom and prune when lateral shoots on main stem set fruit on first on second node of lateral shoot) on yield and fruit quality of four cucumber varieties, namely; Lanna-5 (Fi), Nopakao (Fj), Lan-Laem (op) and Poung (op) was evaluated using a 4×2 factorial experimental design with no pruning treatment. The experiment was carried out at the ARC-AVRDC experimental field, located at Kasetsart University, Nakhon Pathom, Thailand form November 1996 to February 1997. The no pruning treatment produced the highest total yield 22.18 ton/ha as well as highest non-marketable yield 7.70 t/ha while the pruning treatment produce low non-marketable yield 5.16 t/ha

and total yield 17.11. But, the number of branches, nodes and stem length was higher in the pruning treatment.

(Thang, 1995) reported that an experiment was carried out on the effect of six different pruning methods on the yield of cucumber variety Poung and evaluated from December 1995 to February 1996 at AVRDC-ARC experimental field, Kamphaengsaen, Nakhon Pathom, Thailand. The local cucumber variety Poung was chosen for the field experiment. The treatments of the experiment were no pinching (M_0), Pinching branches on main stem at node 10 up to down (M_1), Pinching branches on main stem at node 15 up to down (M_2), No pruning (P_0) and pruning branches at node 4. The highest yield (total yield = 19.72 t/ha) was obtained by the treatment M_0P_1, with no pinching of branches on main stem but pruning branches at node 4. The method of pruning branches had no significant effect on horticultural character such as fruit size and plant height. The pinching treatments had low yield. This was resulted because of the absence of sufficient branches.

(Gobeil and Gosselin, 1989) conducted an experiment on the influence of pruning season of cucumber. They reported that summer pruning gave a high production of fruits.

(Arora and Malik, 1989) reported that pruning of ridge gourd plants to six primary branches with a medium spacing level (45 cm) produced the longest plants, gave maximum number of secondary branches, resulted in early appearance of pistillate flowers, lowered sex ratio and gave higher number and weight of fruits from early and total yield. The result of reduced sex ratio for pruning was due to more production of secondary branches on which pistillate flowers appeared in large number.

An experiment was conducted by (Gobeil and Gosselin, 1990) and reported that the cucumber plants (*Cucumis sativus* L. cultivar 'Corona') were cultivated in a sequence cropping system from 24 April 1987 to 31 January 1988. They were supported on V-shaped structures and received 120 μ mol $m^{-2}s^{-1}$ of supplemental lighting from high-pressure sodium (HPS) lamps. Four pruning methods were compared, each at four levels of photosynthetic photon flux density (PPFD). The first method allowed the production of 12–14 fruits on the main stem. The second method prolonged production on short secondary suckers for a total of 18–20 fruits. Anticipated yield for the third method was 18–20 fruits on the main stem and on a long secondary sucker left near the top of the plant. The last method prolonged production on the main stem, which grew back down the support structure. The number of fruits produced per plant was not influenced by the level of

PPFD. Pruning Method 1 yielded an average of 12.0 fruits per plant, whereas Methods 2, 3 and 4 produced an average of 16.5 fruits. Average fruit weight and daily yields of plants decreased with a reduction in daily PPFD. Methods 3 and 4 allowed yields of 225 fruits m^{-2} $year^{-1}$and required only 10 successive crops. Method 2, which relies on the growth of secondary suckers, required 12 successive crops and was the most productive with an annual yield of 280 fruits m^{-2}.

CHAPTER III

MATERIALS AND METHOD

This chapter deals with the major information's that were considered to conduct the experiment.

3.1 Experimental site

The experiment was conducted at the Horticulture farm of Sher-e-Bangla Agricultural University, Dhaka. The experiment was carried out during the period from April to June 2021. The location of the site in 23°74" N latitude and 90°35" E longitude with an elevation of 8.2 meter from sea level (Anon, 1989).

3.2 Climate

The experimental site is located in subtropical region where climate is characterized by heavy rainfall during the months from April to September (Kharif season) and scanty rainfall during rest of the month (Rabi season).

The maximum and minimum temperature, humidity rainfall and soil temperature during the study period are collected from the Sher-e-Bangla Mini weather station (Appendix-1).

3.3 Soil

The soil of the experimental area belongs to the Modhupur Tract. Soil analysis report of the experimental area was collected from Khamarbari, Dhaka which was determined by Soil testing Laboratory (SRDI). The analytical data have been presented in appendix-II. The experimental site was a medium high land and pH of the soil was 5.4 to 5.6. AEZ No. 28 Soil series- Tejgaon General soil, non-calcareous dark gray. The soil test report was shown in Appendix II.

3.4 Plant Materials

The cucumber cultivar i.e., Alavi Green Hybrid Seed was used as a test crop.

3.5 Treatments of the Experiment

The experiment was designed to study the effects of varying GA_3 and Cytokinin doses and shoot pruning practices on growth, flowering, fruiting and yield of cucumber.

The experiment consisted of two factors as follows:

Factor A: GA_3 and Cytokinin doses

a. T_0=No GA_3 and Cytokinin spray/ control

b. T_1= GA_3 Spray (50 ppm)

c. T_2= Cytokinin spray (2.5 ppm)

d. T_3= GA_3 and Cytokinin spray (T_1+T_2)

Factor B: Pruning

a. P_0=No pruning/ control

b. P_1= Pruning of two primary branches

c. P2= Pruning of three primary branches

Treatments combinations P_0T_0, P_0T_1, P_0T_2, P_0T_3, P_1T_0, P_1T_1, P_1T_2, P_1T_3, P_2T_0, P_2T_1, P_2T_2 and P_2T_3.

3.6 Experimental design and layout

It was a factorial experiment. The experiment was laid out in a Randomized Complete Block Design (RCBD) with four replications. The experimental area was divided into four equal blocks. Each block was divided into 12 plots. First blocks were treated as first replication (R_1) and 2nd block was as second replication (R_2) and 3rd block was as 3rd replication (R_3) and last blocks was used as fourth replication (R_4). Every replication had twelve plots where 12 treatments were allotted at random. The size of each plot was 1.2 m × 1.2 m. The distance between two blocks and two of plots both were 50 cm.

3.7 Land preparation

The selected land for the experiment was opened 11 April, 2021 with the help of a power tiller and then it was kept open to sun for 4 days prior to further ploughing. Then the land was prepared well

by ploughing and cross ploughing followed by well by laddering at 15 April, 2021. Weeds and stubble were removed and the basal doses of fertilizers were applied and mixed thoroughly with the soil before final land preparation. The unit plots were prepared by keeping 50 cm spacing in between two plots and 50 cm drain was dug around the land. The space between two blocks and two plots were made as drain having a depth of about 30 cm.

3.8 Pit preparation in the plots

There were 4 pits in every plot. The pit size was 30 cm and 30 cm respectively. There was 20 cm depth in pits and 35 cm distance from the border of the plots. The pits were prepared with necessary manures and fertilizers in 16 April, 2021.

3.9 Application of manures and fertilizers

Following doses of manures and fertilizers were used for cucumber production (Fertilizer recommendation guide, 2012).

Fertilizers	**Doses pit^{-1}**
Cow dung	6 kg
Urea	30 g
TSP	20 g
MoP	8 g
Furadan 5G	6 g
Boron	3 g

A common dose of cow dung @ 6 kg per pit, urea @ 10 g per pit, TSP @ 20 g per pit and MoP @ 8 g per pit and Boron @ 3 g was applied during pit preparation in the respective plots a week before seed sowing. The Furadan 5G at 6 g in each pit was also applied during pit preparation to avoid the pest attack. Rest 20 g Urea was applied as a top dressing at two installments before flowering.

3.10 Sowing of seeds and selection of seedlings

The seeds were sown directly in the pit on 23 April 2021. 2 to 3 seeds were sown in each pit at 2 to 3 cm depth when the seedlings attained 10-15 cm height and hard enough then one healthy

seedling was selected to remain in each pit and others were thinned out. During seed sowing 60 cm × 60 cm spacing was maintained.

3.11 Application of pruning treatment

Primary branches on main stem were pruned according to treatments. When the branches were appeared from the main stem and became 2-3 cm long then that was pruned. Pruning was done from the basal nodes of the plants according to treatments. Pruning was done on 13th may, 2021.

3.12 Foliar application of GA_3 and Cytokinin

50 ppm GA_3 and 2.5 ppm Cytokinin are applied as a foliar application on 19 May 2021, at 25 DAS.

a. **50 ppm (GA_3):** To make GA_3 50 ppm solution, 50 mg. of GA_3 powder was mixed with 2 pellets of NaOH in 4 ml distilled water solution. Then 4 ml surfactant was added with the solution for increasing the additive value. Then the solution was made up to 1000 ml by adding distilled water and shacked well.
b. **2.5 ppm Cytokinin:** To make Cytokinin 2.5 ppm solution, 2.5 mg of Cytokinin powder (kinetin) was mixed with 2 pellets of NaOH in 4 ml distilled water solution. Then 4 ml surfactant was added with the solution for increasing the additive value. Then the solution was made up to 1000 ml by adding distilled water and shacked well.

3.13 Intercultural Operations

3.13.1 Weeding

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

3.13.2 Staking

When the seedlings were established, staking was given to each plant. Stick of bamboo was given to support the growing twig.

3.13.3 Vine management

For proper growth and development of the plants the vines were managed upward by hand and with the help of bamboo and plastic rope. So, the rainy and stormy weather could not damage the growing vines and fruits of the plants.

3.13.4 Irrigation

The experiment was done in summer season. So, irrigation was given when it was necessary. Sometimes rain was supplied sufficient water then irrigation was not needed. When irrigation was supplied then it was given through drains of the plots.

3.13.5 Plant protection

Cucumber is a very sensitive plant to various insect pests and diseases. So, various protection measures were taken. Melathion 57 EC and Ripcord 10 EC was applied @ 2 ml/l against the insect pests like beetle, fruit fly, fruit borer and other. The insecticide application was made fortnightly from 10 days after seed sowing to a week before first harvesting. During cloudy and hot weather precautionary measures against viral disease like mosaic of cucumber was taken by spraying. Furadan 5 G was also applied @ 2.6 g/pit during pit preparation as soil insecticide.

3.14 Harvesting

When the green fruits were in marketable condition then they were harvested.

3.15 Data collection

Data was collected for the following parameters

i. Vine length (cm)
ii. Number of branches plant^{-1}
iii. Number of leaves plant^{-1}
iv. Number of male flowers plant^{-1}
v. Number of female flowers plant^{-1}
vi. Total number of fruits plant^{-1}
vii. Fruits length (cm)
viii. Fruits girth (cm)

ix. Individual fruit weight (g)

x. Fruit weight plant^{-1} (kg)

xi. Fruit yield ha^{-1} (ton)

3.16 Data collection procedure

3.16.1 Vine length

Vine length was taken at two times and measured in centimeter from ground level to tip of the main stem from each plant of each treatment and mean value was calculated.

3.16.2 Number of branches per plant

Total number of branches was counted at two times at 25 and 35 DAS from each plant of the treatment and mean value was calculated. The pruned branches number was also included in counting.

3.16.3 Number of leaves plant^{-1}

The total number of leaves was counted from each plant. Data was calculated at three times at 25 DAS, 35 DAS and 45 DAS from each plant of the treatment and mean value was calculated.

3.16.4 Number of male and female flowers per plant

Number of female flowers per plant was counted from first female flower appearance. Number of female flowers was recorded for each treatment. Number of male flowers was also counted from first flowering. Number of male flowers was recorded from each treatment as like female flowers.

3.16.5 Number of fruits per plant

Number of fruits was counted from first harvest to last harvest. The total number of fruits per plant was counted and average number of fruits was recorded.

3.16.6 Fruit length and girth

Fruit length and girth was taken by measuring tape in centimeter. Girth i.e., breath of fruit was measured at the middle portion of fruits from each plot and their average was taken. Average length of same fruits was also taken.

3.16.7 Individual fruit weight

Among the total number of fruits during the period of first to final harvest the fruits, except the first and final harvest, was considered for determining the individual fruit weight.

3.16.8 Weight of fruits per plant

To estimate weight of fruits per plant, all the plants in every plot and all the fruits in every harvest were considered. Thus, the average yield per plot was measured.

3.16.9 Fruit yield ha^{-1}

After collection of per plot yield, it was converted to ton per hectare by the following formula:

$$\text{Fruit yield } ha^{-1} \text{ (ton)} = \frac{\text{Fruit yield per plot (kg)} \times 10000\ m^2}{\text{Plot size } (m^2) \times 1000kg}$$

3.17 Statistical analysis

The recorded data on different parameters were statistically analyzed using Statistix 10 software and mean separation was done by LSD test at 5% level of probability.

CHAPTER IV

RESULTS AND DISSCUSIONS

Cucumber is an important vegetable fruit in Bangladesh. GA_3, cytokinin and pruning are important factor to increase cucumber yield. With the respect the experiment was conducted to find out the growth and yield of cucumber as influenced by GA_3 cytokinin and pruning materials. The analysis of variance (ANOVA) of the data on different growth and yield parameters are presented in Appendices. The results have been presented and discussed with the help of table and graphs and possible interpretations are given under the following sub-headings:

4.1 Growth parameters

4.1.1 Vine length (cm)

4.1.1.1 Influence of pruning

Pruning activities significantly influence on vine length and showed that P_2 produced highest vine length where control produced lowest vine length (Table 1, Appendix III). Results indicate that P_2 produced 30.94 cm, and 73.34 cm vine length at 25 and 35 DAS respectively. The control treatment (P_0) produced 18.48 cm and 37.72 cm, respectively. This might be due to that, pruning helped for proper vegetative growth of cucumber plant. Mardhiana *et al*. (2017), Khoshkam (2016), Maboko *et al*. (2011), McFadyen *et al*. (2011), Ekwu and Utobo (2010), Utobo *et al*. (2010) and Suthar *et al*. (2006) also reported the similar result.

4.1.1.2 Influence of GA_3 and cytokinin

Application of GA_3 and cytokinin showed significantly positive influence on vine length of cumber at different days after sowing (DAS). Vine length ranged from 24.73- 27.13 cm and 41.00-74.00 cm at 25 and 35 DAS, respectively (Table 1, Appendix III). The highest value of vine length (27.13 cm and 74.00 cm at 25 and 35 DAS, respectively) was recorded for T_3 and the lowest (24.73 cm and 41.00 cm at 25 and 35 DAS, respectively) for T_0. The fact that, application of GA_3 and cytokinin help to get higher vegetative growth in cucumber plant. The present finding is agreed with the finding of Kaushik *et al*. (1974), Saleh and Abdul (1980), Davies (1995), Latimer (1992), Dalai *et al*. (2016), Sapkota, B., *et al*. (2020), Rahman, M. A., *et al*. (2020), Papadopoulos, A. P., *et al*. (2006), Abu-Romman., *et al*. (2015).

Table 1: Effect of pruning, GA_3 and cytokinin on vine length of cucumber at different days after sowing (DAS)

Pruning	**Vine length (cm)**	
	25 DAS	**35 DAS**
P_0	18.48 c	37.72 c
P_1	27.67 b	60.50 b
P_2	30.94 a	73.34 a
CV%	9.27	6.72
$LSD_{0.05}$	1.714	2.766
Treatment		
	25 DAS	**35 DAS**
T_0	24.73 b	41.00 d
T_1	25.19 ab	49.88 c
T_2	25.75 ab	63.88 b
T_3	27.13 a	74.00 a
CV%	9.27	6.72
$LSD_{0.05}$	1.979	3.193

Means followed by same letter(s) in a column do not differ significantly at 5 % level of LSD.

P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches.

T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3= 50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.1.1.3 Combined effect of pruning, GA_3 and cytokinin on vine length of cucumber

The non-significant variation of vine length was observed due to combine effect of stem pruning, GA_3 and cytokinin of cucumber (Figure 1 and Appendix III, IX). In spite of having non-significant effect, the highest vine length 100.75 cm at 35 DAS was found in P_2T_3 treatment combination compared to other treatments at 25 DAS and 35 DAS.

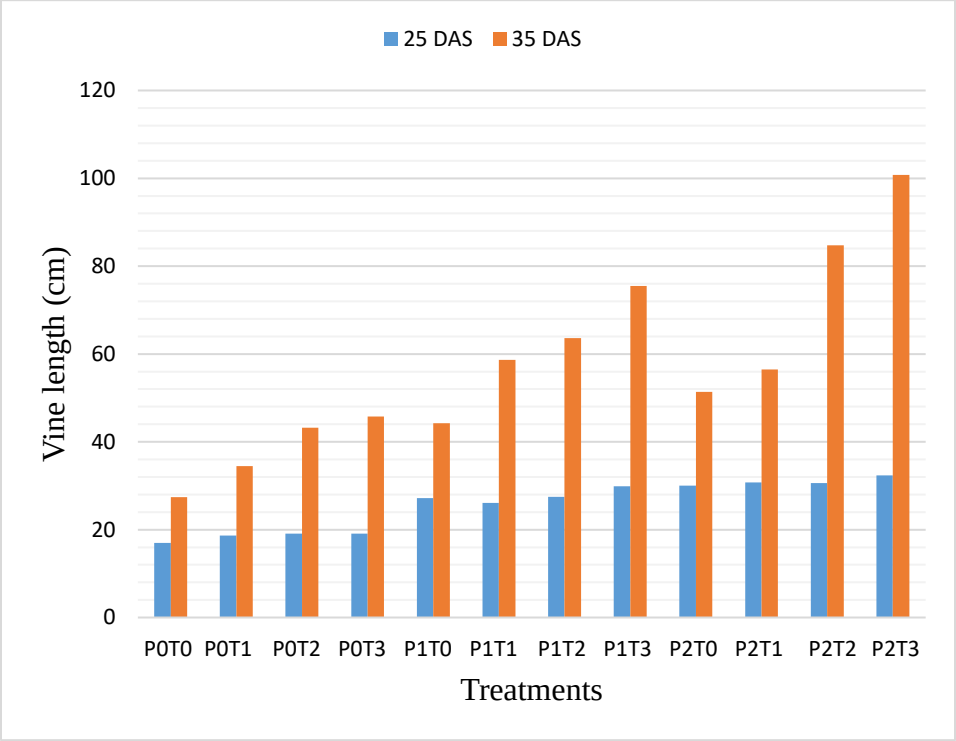

Figure 1. Combined effect of pruning, GA_3 and cytokinin on vine length of cucumber.

DAS= Days after sowing; P_0= No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches; T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3= 50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.1.2 Number of branches plant^{-1}

4.1.2.1 Influence of pruning

The non- significant effect of pruning was recorded in number of branches plant^{-1} (Table 2, Appendix IV). The ranged of branches were 1.75 to 3.13 at 25 DAS and 2.69 to 3.94 at 35 DAS. The maximum number of primary branches plant^{-1} was found in P_2 treatment (3.13 and 3.94 at 25 DAS and 35 DAS, respectively) compared to other treatments. This might be due to that, pruning helped for proper vegetative growth of cucumber plant. Khoshkam (2016), Maboko *et al*. (2011), Suthar *et al*. (2006), Nu (1996), Thang (1995), Gobeil and Gosselin (1989), Arora and Malik (1989), Gobeil and Gosselin (1990) were also reported the similar trend of results.

4.1.2.2 Influence of GA_3 and cytokinin

Number of branches plant^{-1} showed non-significant variation due to GA_3 and cytokinin application in cucumber at all sampling dates (Table 2, Appendix IV). The highest number of branches was recorded in T_3 (2.83 and 3.75 at 25 DAS and 35 DAS, respectively). The lowest values of this trait were found in T_0 (2.00 and 2.50 at 25 DAS and 35 DAS, respectively). The fact that, application of GA_3 and cytokinin helped to get higher vegetative growth in cucumber plant. The present finding is agreed with the finding of Kaushik *et al*. (1974), Saleh and Abdul (1980), Davies (1995), Latimer (1992), Dalai *et al*. (2016), Sapkota, B., *et al*. (2020), Rahman, M. A., *et al*. (2020), Papadopoulos, A. P., *et al*. (2006), Abu-Romman., *et al*. (2015).

Table 2: Effect of pruning, GA_3 and cytokinin on number of branches plant^{-1} of cucumber at different days after sowing (DAS)

Pruning	**Number of branches plant^{-1}**	
	25 DAS	**35 DAS**
P_0	1.75 b	2.69 b
P_1	2.69 a	3.13 b
P_2	3.13 a	3.94 a
CV%	31.15	24.55
$LSD_{0.05}$	0.565	0.574
Treatment		
	25 DAS	**35 DAS**
T_0	2.00 b	2.50 c
T_1	2.50 ab	3.08 bc
T_2	2.75 a	3.67 ab
T_3	2.83 a	3.75 a
CV%	31.15	24.55
$LSD_{0.05}$	0.652	0.663

Means followed by same letter(s) in a column do not differ significantly at 5 % level of LSD.

P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches. T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3= 50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.1.2.3 Combined effect of pruning, GA_3 and cytokinin

Combine effect of pruning**,** GA_3 and cytokinin showed non-significant variation for number of branches plant^{-1} at all sampling dates (Figure 2 and Appendix IV, X). But the highest number of branches plant^{-1} was found in P_2T_3 treatment combination (3.75 and 5.00 at 25 DAS and 35 DAS, respectively) compared to other combinations. McFadyen *et al*. (2011), Ekwu and Utobo (2010), Utobo *et al*. (2010), Suthar *et al*. (2006), Nu (1996), Gobeil and Gosselin (1990) were also reported the similar trend of results.

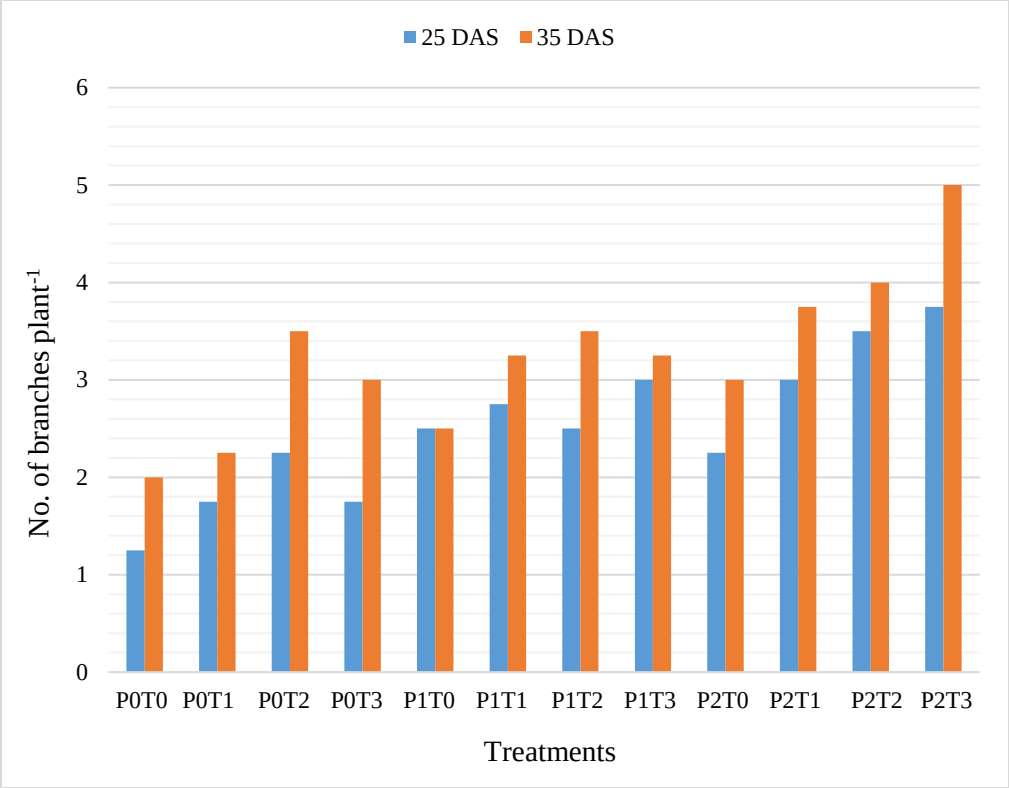

Figure 2: Combined effect of pruning, GA_3 and cytokinin on number of branches plant^{-1} of cucumber

DAS=Days after sowing; P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches; T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3= 50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.1.3 Number of leave plant^{-1}

4.1.3.1 Influence of pruning

The positively significant effect of pruning was observed in terms of number of leaves plant^{-1} (Table 3, Appendix V). The ranged of number leaves plant^{-1} were 5.56 to 17.31 at 25 DAS, 12.13 to 44.69 at 35 DAS and 16.94 to 39.31 at 45 DAS. The maximum number of leaves plant^{-1} was found in P_2 treatment (17.31, 44.69 and 39.31 at 25 DAS, 35 DAS and 45 DAS, respectively) compared to other treatments. This might be due to that, pruning helped for proper vegetative growth of cucumber plant. Mardhiana *et al*. (2017), Khoshkam (2016), Maboko *et al*. (2011), McFadyen *et al*. (2011), Ekwu and Utobo (2010) and Utobo *et al*. (2010), Suthar *et al*. (2006) were also reported the similar result.

4.1.3.2 Influence of GA_3 and cytokinin

Number of leaves plant^{-1} was significantly influenced by GA_3 and cytokinin application in cucumber at all sampling dates (Table 3, Appendix V). The highest number of leaves was recorded in T_3 (12.33, 33.25 and 34.50 at 25 DAS, 35 DAS and 45 DAS, respectively). The lowest values of this trait were found in T_0 (9.83, 22.33 and 22.08 at 25 DAS, 35 DAS and 45 DAS, respectively). The fact that, application of GA_3 and cytokinin helped to get higher vegetative growth in cucumber plant. The present finding is agreed with the finding of Kaushik *et al*. (1974), Saleh and Abdul (1980), Davies (1995), Latimer (1992), Dalai *et al*. (2016), Sapkota, B., *et al*. (2020), Rahman, M. A., *et al*. (2020), Papadopoulos, A. P., *et al*. (2006), Abu-Romman., *et al*. (2015).

Table 3: Effect of pruning, GA_3 and cytokinin on number of leave plant^{-1} of cucumber at different days after sowing (DAS)

Pruning	**No. of leave plant^{-1}**		
	25 DAS	**35 DAS**	**45 DAS**
P_0	5.56 c	12.13 c	16.94 c
P_1	10.06 b	26.50 b	26.69 b
P_2	17.31 a	44.69 a	39.31 a
CV%	17.74	11.02	14.21
$LSD_{0.05}$	1.401	2.202	2.826
Treatment			
	25 DAS	**35 DAS**	**45 DAS**
T_0	9.83 b	22.33 d	22.08 c
T_1	10.83 ab	26.08 c	23.92 c
T_2	10.92 ab	29.42 b	30.08 b
T_3	12.33 a	33.25 a	34.50 a
CV%	17.74	11.02	14.21
$LSD_{0.05}$	1.618	2.542	3.264

Means followed by same letter(s) in a column do not differ significantly at 5 % level of LSD.

P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches. T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3= 50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.1.3.3 Combined effect of pruning, GA_3 and cytokinin

Combined effect of pruning, GA_3 and cytokinin showed a wide range of variation for number of leaves plant^{-1} at all sampling dates (Figure 3 and Appendix V, XI). The highest number of leaves per plant was found in P_2T_3 treatments (20.50, 50.25 and 48.75 at 25 DAS, 35 DAS and 45 DAS, respectively) compared to other combinations.

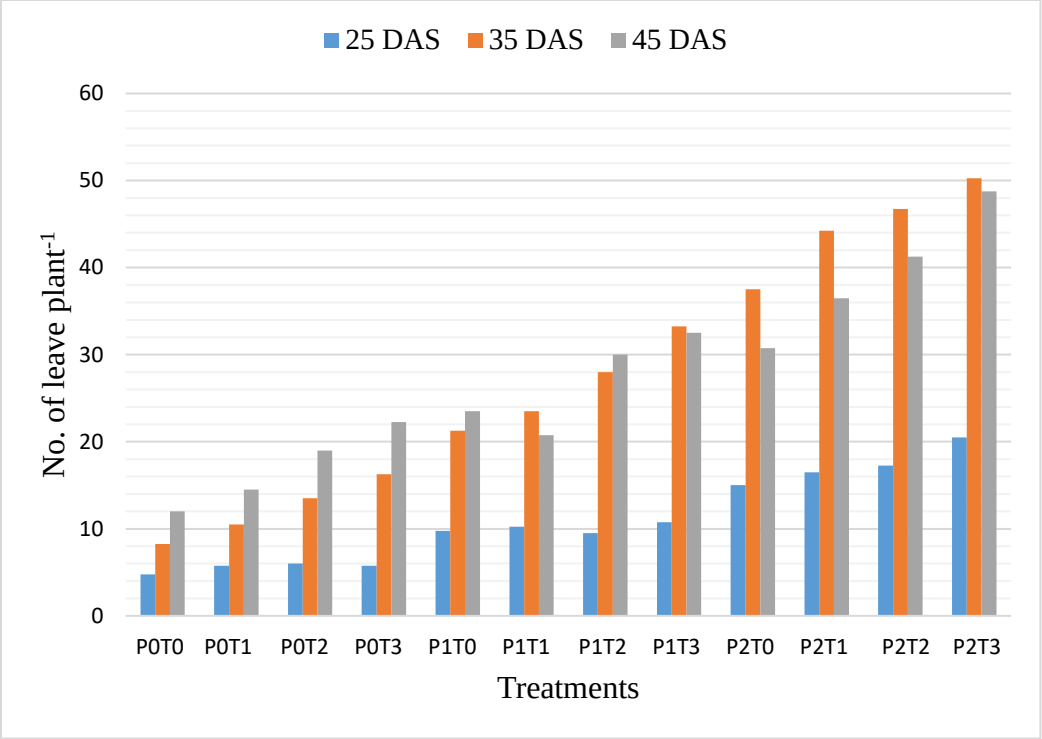

Figure 3: Combined effect of pruning, GA_3 and cytokinin on number of leave plant^{-1} of cucumber.

DAS=Days after sowing; P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches; T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3= 50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.2 Yield contributing parameters

4.2.1 Number of female and male flowers plant^{-1}

4.2.1.1 Influence of pruning

The positively significant effect of pruning was observed in Number of female and male flowers plant^{-1} (Table 4, Appendix VI). The maximum number of female flowers plant^{-1} was found in P_2 treatment (35.50) compared to others treatments. And the maximum number of male flowers 36.38 plant^{-1} was found in P_2 treatment where control treatment produced lowest number of male flowers plant^{-1} (Table 4, Appendix VI). Result indicated that P_2 produced highest number of male flowers plant^{-1} (36.38). The control treatment (P_0) produced 18.25 number of male flowers plant^{-1}. This might be due to that, pruning helped for proper reproductive development of cucumber plant. Mardhiana *et al*. (2017), Khoshkam (2016), Maboko *et al*. (2011), McFadyen *et al*. (2011), Ekwu and Utobo (2010), Utobo *et al*. (2010), Suthar *et al*. (2006), Nu (1996), Thang (1995), Gobeil and Gosselin (1990) were also reported the similar result.

4.2.1.2 Influence of GA_3 and cytokinin

Application of GA_3 and cytokinin showed significant influence on number of female and male flowers per plant of cumber. Number of female flowers plant^{-1} ranged from 16.50 to 29.92 (Table 4, Appendix VI). The highest value of number of female flowers plant^{-1} was recorded in T_3 (29.92) and the lowest in T_0 (16.50). The number of male flowers plant^{-1} ranged from 23.33 to 32.92 (Table 4, Appendix VI). The highest value of number of male flowers plant^{-1} was recorded in T_3 (32.92) and the lowest in T_0 (23.33). The fact that, adequate supply of GA_3 and cytokinin helped to get reproductive development of cucumber plant. The present finding is agreed with the finding of Kaushik *et al*. (1974), Saleh and Abdul (1980), Davies (1995), Latimer (1992), Dalai *et al*. (2016), Sapkota, B., *et al*. (2020), Rahman, M. A., *et al*. (2020), Papadopoulos, A. P., *et al*. (2006), Abu-Romman., *et al*. (2015).

Table 4: Effect of pruning, GA_3 and cytokinin on no. of female and male flowers plant^{-1} of cucumber

Pruning	**No. of female flowers plant^{-1}**	**No. of male flowers plant^{-1}**
P_0	13.25 c	18.25 c
P_1	24.13 b	31.13 b
P_2	33.50 a	36.38 a
CV%	9.08	7.23
$LSD_{0.05}$	1.543	1.487
Treatment		
T_0	16.50 d	23.33 d
T_1	21.83 c	27.58 c
T_2	26.25 b	30.50 b
T_3	29.92 a	32.92 a
CV%	9.08	7.23
$LSD_{0.05}$	1.781	1.717

Means followed by same letter(s) in a column do not differ significantly at 5 % level of LSD.

P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches. T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3= 50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.2.1.3 Combined effect of pruning, GA_3 and cytokinin

Positively significant variation of number of female flowers plant^{-1} was observed due to combine effect of pruning, GA_3 and cytokinin application of cucumber (Figure 4 and Appendix VI, XII). The highest number of female flowers plant^{-1} was found in P_2T_3 treatment combination (39.50) compared to other treatments. The lowest values of number of female flowers plant^{-1} were recorded in P_0T_0 (7.50).

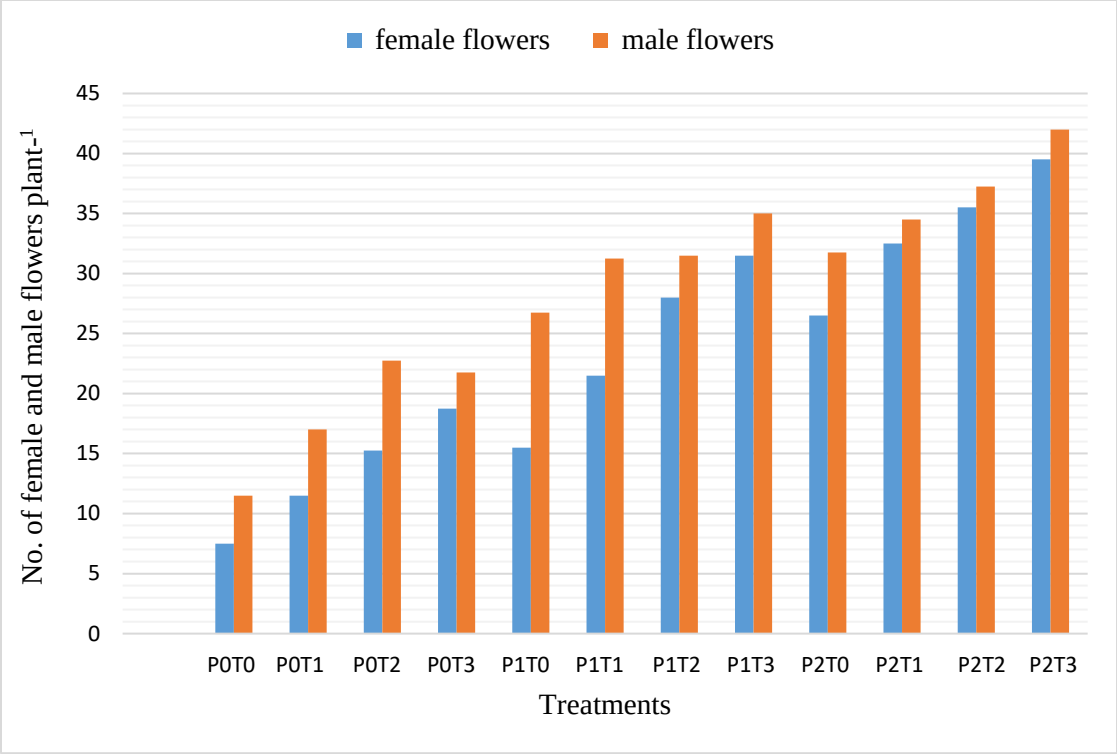

Figure 4: Combined effect of pruning, GA_3 and cytokinin on number of female and male flowers per plant of cucumber.

P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches; T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3= 50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.2.2 Total no. of fruits plant^{-1}

4.2.2.1 Influence of pruning

Pruning activities significantly influenced on total number of fruits plant^{-1} and showed that P_2 produced highest total number of fruits plant^{-1} (14.75) where P_0 produced lowest total number of fruits plant^{-1} (9.81) (Table 5, Appendix VII). This might be due to that, pruning help for proper reproductive development of cucumber plant. Mardhiana *et al*. (2017), Khoshkam (2016), Maboko *et al*. (2011), McFadyen *et al*. (2011), Ekwu and Utobo (2010), Utobo *et al*. (2010), Suthar *et al*. (2006), Nu (1996), Thang (1995), Gobeil and Gosselin (1989), Arora and Malik (1989), Gobeil and Gosselin (1990) were also reported the similar result.

4.2.2.2 Influence of GA_3 and cytokinin

Application of GA_3 and cytokinin showed significantly positive influence on total number of fruits plant^{-1} of cucumber (Table 5, Appendix VII). The highest value of total number of fruits plant^{-1} was recorded for T_3 (15.08) and lowest for T_0 (10.08). The present finding is agreed with the finding of Kaushik *et al*. (1974), Saleh and Abdul (1980), Davies (1995), Latimer (1992), Dalai *et al*. (2016), Sapkota, B., *et al*. (2020), Rahman, M. A., *et al*. (2020), Papadopoulos, A. P., *et al*. (2006), Abu-Romman., *et al*. (2015).

Table 5: Effect of pruning GA_3 and cytokinin on total no. of fruits plant^{-1} of cucumber

Pruning	**Total no. of fruits plant^{-1}**
P_0	9.81 c
P_1	12.06 b
P_2	14.75 a
CV%	7.32
$LSD_{0.05}$	0.643
Treatment	
T_0	10.08 d
T_1	11.04 c
T_2	12.63 b
T_3	15.08 a
CV%	7.32
$LSD_{0.05}$	0.743

Means followed by same letter(s) in a column do not differ significantly at 5 % level of LSD.

P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches. T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3= 50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.2.2.3 Combined effect of pruning, GA_3 and cytokinin

Non-significant variation of total number of fruits plant^{-1} was observed due to combine effect of pruning, GA_3 and cytokinin of cucumber (Figure 5 and Appendix VII, XIII). The highest total number of fruits plant^{-1} was found in P_2T_3 (17.88) compared to others combinations.

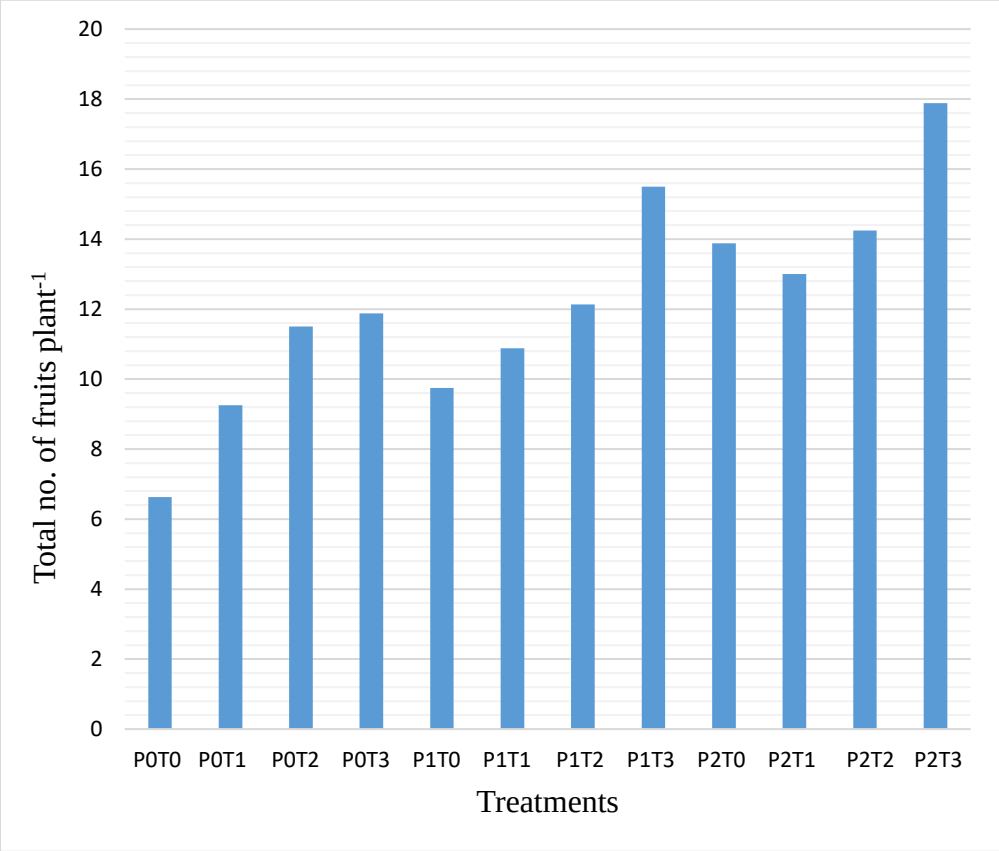

Figure 5: Combined effect of pruning, GA_3 and cytokinin on total number of fruits per plant of cucumber.

P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches; T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3=50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.2.3 Individual fruit length (cm)

4.2.3.1 Influence of pruning

The non-significant effect of pruning was observed in individual fruit length of cucumber (Table 6, Appendix VII). The highest individual fruit length was found in P_2 treatment (15.29 cm) whereas the minimum 13.64 cm was found from P_0. This might be due to that, pruning helped for proper reproductive development of cucumber plant. Mardhiana *et al*. (2017), Khoshkam (2016), Maboko *et al*. (2011), McFadyen *et al*. (2011), Ekwu and Utobo (2010), Utobo *et al*. (2010), Suthar *et al*. (2006), Nu (1996), Thang (1995), Gobeil and Gosselin (1989), Arora and Malik (1989), Gobeil and Gosselin (1990) were also reported the similar result.

4.2.3.2 Influence of GA_3 and cytokinin

Individual fruit length was non-significantly influenced by GA_3 and cytokinin application in cucumber (Table 6, Appendix VII). With the application of GA_3 and cytokinin, the highest value of fruit length was recorded in T_3 (15.96 cm). The lowest value of the individual fruit length was found in T_0 (13.41 cm). The fact that, adequate supply of GA_3 and cytokinin help to get reproductive development of cucumber plant. The present finding is agreed with the finding of Kaushik *et al*. (1974), Saleh and Abdul (1980), Davies (1995), Latimer (1992), Dalai *et al*. (2016), Sapkota, B., *et al*. (2020), Rahman, M. A., *et al*. (2020), Papadopoulos, A. P., *et al*. (2006), Abu-Romman., *et al*. (2015).

Table 6: Effect of pruning, GA_3 and cytokinin on individual fruit length of cucumber

pruning	Individual fruit length (cm)
P_0	13.64 b
P_1	15.04 a
P_2	15.29 a
CV%	7.17
$LSD_{0.05}$	0.757
treatment	
T_0	13.41 b
T_1	14.16 b
T_2	15.12 a
T_3	15.96 a
CV%	7.17
$LSD_{0.05}$	0.873

Means followed by same letter(s) in a column do not differ significantly at 5 % level of LSD.

P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches. T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3= 50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.2.3.3 Combined effect of pruning, GA_3 and cytokinin

Combined effect of pruning, GA_3 and cytokinin showed non-significant variation for individual fruit length (Figure 6 and Appendix VII, XIII). But the highest Individual fruit length was found in P_2T_3 treatments (18.25 cm) compared to other combinations where the lowest individual fruit length was recorded in P_0T_0 (11.13 cm).

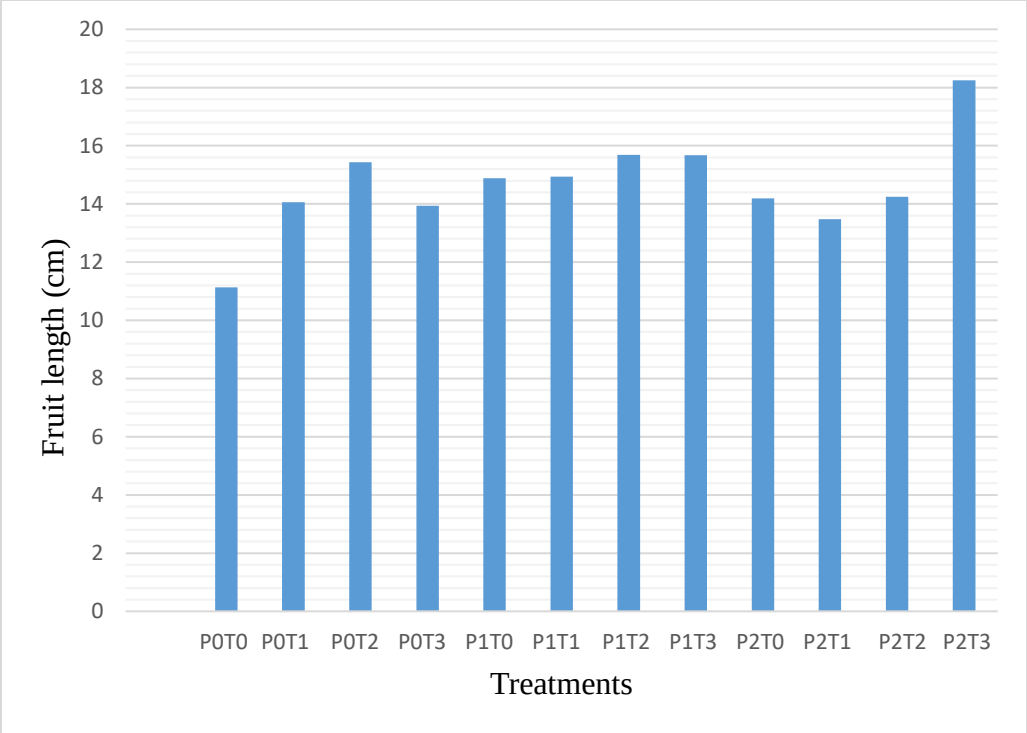

Figure 6: Combined effect of pruning, GA_3 and cytokinin on individual fruit length per plant of cucumber.

DAS=Days after sowing; P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches; T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3= 50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.2.4 Fruit girth (cm)

4.2.4.1 Influence of pruning

The pruning activities of cucumber showed significant effect on fruit girth (Table 7, Appendix VII). Result indicated that P_2 produced the maximum (4.70 cm). The control treatment P_0 produced the minimum (3.21 cm). This might be due to that, pruning help for proper reproductive development of cucumber plant. Mardhiana *et al*. (2017), Khoshkam (2016), Maboko *et al*. (2011), McFadyen *et al*. (2011), Ekwu and Utobo (2010), Utobo *et al*. (2010), Suthar *et al*. (2006), Nu (1996), Thang (1995), Gobeil and Gosselin (1989), Arora and Malik (1989), Gobeil and Gosselin (1990) were also reported the similar result.

4.2.4.2 Influence of GA_3 and cytokinin

GA_3 and cytokinin application in cucumber showed significant effect on fruit girth (Table 7, Appendix VII). The treatment T_3 produced highest fruit girth (4.52 cm) and lowest was recorded for T_0 (3.43 cm). The fact that, adequate supply of GA_3 and cytokinin help to get reproductive development of cucumber plant. The present finding is agreed with the finding of Kaushik *et al*. (1974), Saleh and Abdul (1980), Davies (1995), Latimer (1992), Dalai *et al*. (2016), Sapkota, B., *et al*. (2020), Rahman, M. A., *et al*. (2020), Papadopoulos, A. P., *et al*. (2006), Abu-Romman., *et al*. (2015).

Table 7: Effect of pruning, GA_3 and cytokinin on fruit girth of cucumber

pruning	**Fruit girth (cm)**
P_0	3.21 c
P_1	4.19 b
P_2	4.70 a
CV%	9.63
$LSD_{0.05}$	0.279
Treatment	
T_0	3.43 c
T_1	3.88 b
T_2	4.29 a
T_3	4.52 a
CV%	9.63
$LSD_{0.05}$	0.322

Means followed by same letter(s) in a column do not differ significantly at 5 % level of LSD.

P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches. T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3=50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.2.4.3 Combined effect of pruning, GA_3 and cytokinin

Significant variation of fruit girth was observed due to combined effect of pruning, GA_3 and cytokinin of cucumber (Figure 7 and Appendix VII, XIII). The highest fruit girth was found in P_2T_3 treatment (5.81 cm) and lowest was found in P_0T_0 (2.66 cm) compared to others combinations.

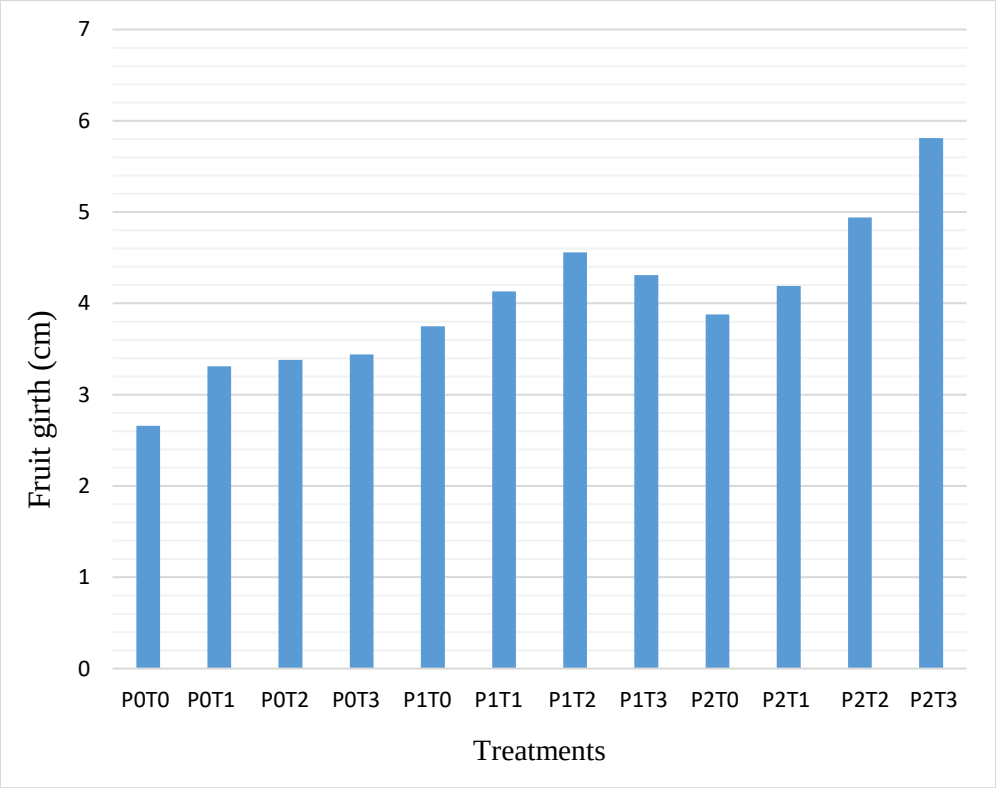

Figure 7: Combined effect of pruning, GA_3 and cytokinin on fruit girth plant^{-1} of cucumber.

P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches; T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3=50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.2.5 Individual fruit weight (g)

4.2.5.1 Influence of pruning

The pruning showed a significant effect on individual fruit weight of cucumber (Table 8, Appendix VIII). The highest individual fruit weight was found in P_2 treatment (266.17 g) compared to others treatments and lowest was found in P_0 (142.10 g). This might be due to that, pruning help for proper reproductive development of cucumber plant. Mardhiana *et al*. (2017), Khoshkam (2016), Maboko *et al*. (2011), McFadyen *et al*. (2011), Ekwu and Utobo (2010), Utobo *et al*. (2010), Suthar *et al*. (2006), Nu (1996), Thang (1995), Gobeil and Gosselin (1989), Arora and Malik (1989), Gobeil and Gosselin (1990) were also reported the similar result.

4.2.5.2 Influence of GA_3 and cytokinin

Individual fruit weight showed significant variations for GA_3 and cytokinin application in cucumber (Table 8, Appendix VIII). The highest individual fruit weight was recorded in T_3 (242.99 g). The lowest individual fruit weight was recorded in T_0 (156.44 g). The fact that, adequate supply of GA_3 and cytokinin helped to get reproductive development of cucumber plant. The present finding is agreed with the finding of Kaushik *et al*. (1974), Saleh and Abdul (1980), Davies (1995), Latimer (1992), Dalai *et al*. (2016), Sapkota, B., *et al*. (2020), Rahman, M. A., *et al*. (2020), Papadopoulos, A. P., *et al*. (2006), Abu-Romman., *et al*. (2015).

Table 8: Effect of pruning, GA_3 and cytokinin on individual fruit weight of cucumber

pruning	**Individual fruit weight (g)**
P_0	142.10 c
P_1	193.08 b
P_2	266.17 a
CV%	9.35
$LSD_{0.05}$	13.477
Treatment	
T_0	156.44 d
T_1	191.73 c
T_2	210.65 b
T_3	242.99 a
CV%	9.35
$LSD_{0.05}$	15.562

Means followed by same letter(s) in a column do not differ significantly at 5 % level of LSD.

P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches. T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3=50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.2.5.3 Combined effect of pruning, GA_3 and cytokinin

The combined effect of pruning, GA_3 and cytokinin showed a significant variation on individual fruit weight of cucumber (Figure 8 and Appendix VIII, XIV). The highest individual fruit weight was found in P_2T_3 treatments (372.44 g) and lowest was found in P_0T_0 (111.50 g) compared to others combinations.

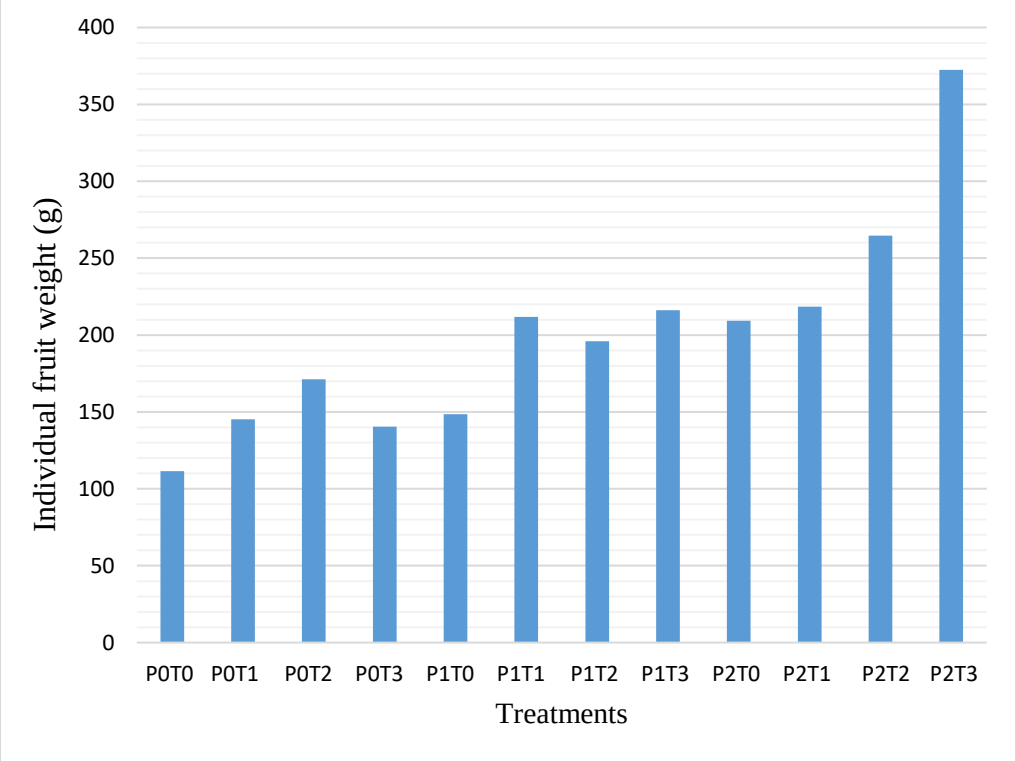

Figure 8: Combined effect of pruning, GA_3 and cytokinin on individual fruit weight of cucumber.

P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches; T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3=50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.2.6 Fruits weight plant^{-1}(kg)

4.2.6.1 Influence of pruning

The significant effect of pruning on fruit weight plant^{-1} was found and data showed that P_2 produced highest fruit weight plant^{-1} where control produced lowest fruit weight plant^{-1} (Table 9, Appendix VIII). Result indicated that P_2 produced 3.32 kg. This might be due to that, pruning help for proper reproductive development of cucumber plant. The control treatment (P_0) produced 1.33 kg. Mardhiana *et al*. (2017), Khoshkam (2016), Maboko *et al*. (2011), McFadyen *et al*. (2011), Ekwu and Utobo (2010), Utobo *et al*. (2010), Suthar *et al*. (2006), Nu (1996), Thang (1995), Gobeil and Gosselin (1989), Arora and Malik (1989), Gobeil and Gosselin (1990) also reported the similar result.

4.2.6.2 Influence of GA_3 and cytokinin

A significant influence was found due to application of GA_3 and cytokinin on fruit weight plant^{-1} (Table 9, Appendix VIII). The highest fruit weight plant^{-1} (3.32 kg) were recorded in T_3 and the lowest fruit weight (1.55 kg) were in T_0. The fact that, adequate supply of GA_3 and cytokinin helped to get reproductive development of cucumber plant. The present finding is agreed with the finding of Kaushik *et al*. (1974), Saleh and Abdul (1980), Davies (1995), Latimer (1992), Dalai *et al*. (2016), Sapkota, B., *et al*. (2020), Rahman, M. A., *et al*. (2020), Papadopoulos, A. P., *et al*. (2006), Abu-Romman., *et al*. (2015).

Table 9: Effect of pruning, GA_3 and cytokinin on fruits weight plant^{-1} of cucumber

Pruning	**Fruits weight plant^{-1} (kg)**
P_0	1.33 c
P_1	2.27 b
P_2	3.32 a
CV%	11.27
$LSD_{0.05}$	0.187
Treatment	
T_0	1.55 c
T_1	2.11 b
T_2	2.26 b
T_3	3.32 a
CV%	11.27
$LSD_{0.05}$	0.216

Means followed by same letter(s) in a column do not differ significantly at 5 % level of LSD.

P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches.

T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3=50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.2.6.3 Combined effect of pruning, GA_3 and cytokinin

Positively significant variation of fruit weight plant^{-1} was observed due to combine effect of pruning, GA_3 and cytokinin of cucumber (Figure 9 and Appendix VIII, XIV). The highest fruit weight per plant (4.99 kg) was found in P_2T_3 treatment combination compared to others treatments. The treatment combination P_0T_0 produced the lowest fruit weight plant^{-1} (0.86 kg).

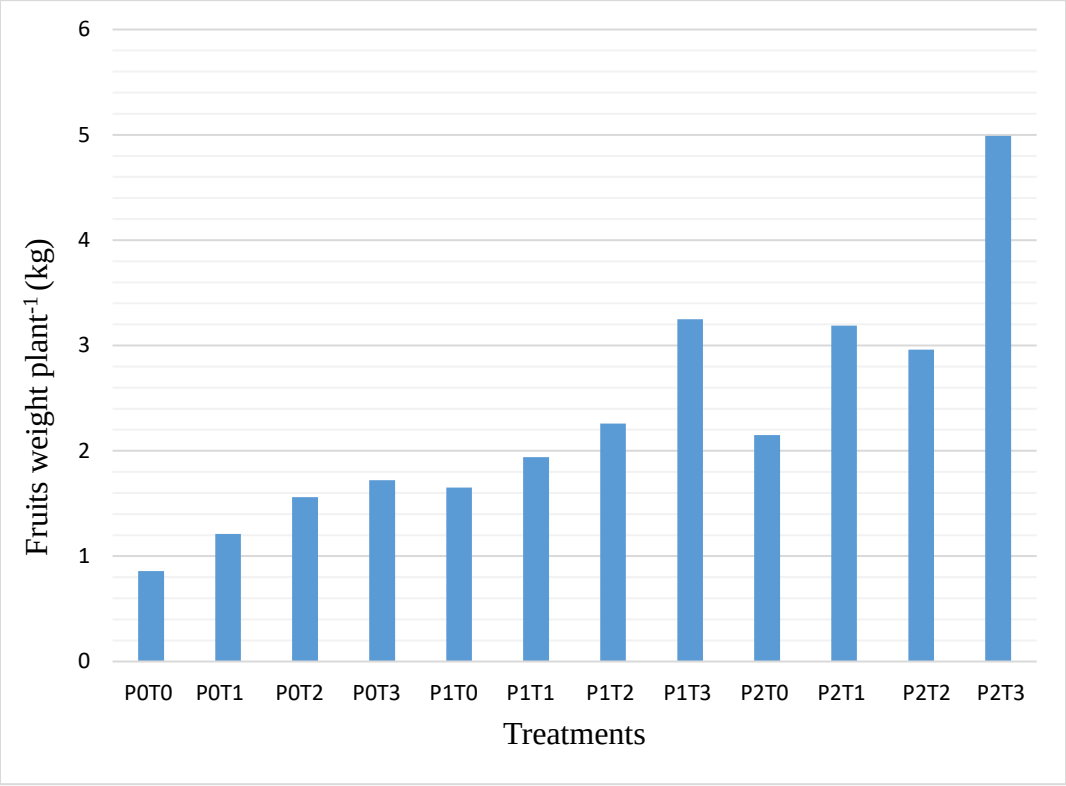

Figure 9: Combined effect of pruning, GA_3 and cytokinin on fruits weight plant^{-1} of cucumber.

P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches; T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3=50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.2.7 Fruit yield ha^{-1}

4.2.7.1 Influence of pruning

The positively significant effect of pruning was observed in fruit yield ha^{-1} (Table 10, Appendix VIII). The maximum value of fruit yield ha^{-1} was found in P_2 treatment (23.07 t ha^{-1}) and lowest was found in P_0 (9.26 t ha^{-1}) compared to others treatments. This might be due to that, pruning help for proper reproductive development of cucumber plant. Mardhiana et al. (2017), Khoshkam (2016), Maboko et al. (2011), McFadyen et al. (2011), Ekwu and Utobo (2010), Utobo et al. (2010), Suthar et al. (2006), Nu (1996), Thang (1995), Gobeil and Gosselin (1989), Arora and Malik (1989), Gobeil and Gosselin (1990) were also reported the similar result.

4.2.7.2 Influence of GA_3 and cytokinin

The fruit yield ha^{-1} was significantly influenced by GA_3 and cytokinin application in cucumber (Table 10, Appendix VIII). The highest fruit yield ha^{-1} was recorded in T_3 (23.05 t ha^{-1}). The lowest value of fruit yield ha^{-1} was found in T_0 (10.79 t ha^{-1}) compared to other treatments. The fact that, adequate supply of GA_3 and cytokinin helped to get reproductive development of cucumber plant. The present finding is agreed with the finding of Kaushik *et al*. (1974), Saleh and Abdul (1980), Davies (1995), Latimer (1992), Dalai *et al*. (2016), Sapkota, B., *et al*. (2020), Rahman, M. A., *et al*. (2020), Papadopoulos, A. P., *et al*. (2006), Abu-Romman., *et al*. (2015).

Table 10: Effect of pruning, GA_3 and cytokinin on fruit yield ha^{-1} (ton) of cucumber

Pruning	**Fruit yield ha^{-1} (ton)**
P_0	9.26 c
P_1	15.79 b
P_2	23.07 a
CV%	11.27
$LSD_{0.05}$	1.300
Treatment	
T_0	10.79 c
T_1	14.64 b
T_2	15.67 b
T_3	23.05 a
CV%	11.27
$LSD_{0.05}$	1.501

Means followed by same letter(s) in a column do not differ significantly at 5 % level of LSD.

P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches. T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3=50 ppm GA_3 and 2.5 ppm Cytokinin spray.

4.2.7.3 Combined effect of pruning, GA_3 and cytokinin

Combined effect of pruning, GA_3 and cytokinin showed a wide range of variation in terms of fruit yield ha^{-1} (Figure 10 and Appendix VIII, XIV). The highest fruit yield ha^{-1} was found in P_2T_3 treatments (34.68 t ha^{-1}) while P_0T_0 produced lowest value of fruit yield (5.98 t ha^{-1}) compared to others combinations.

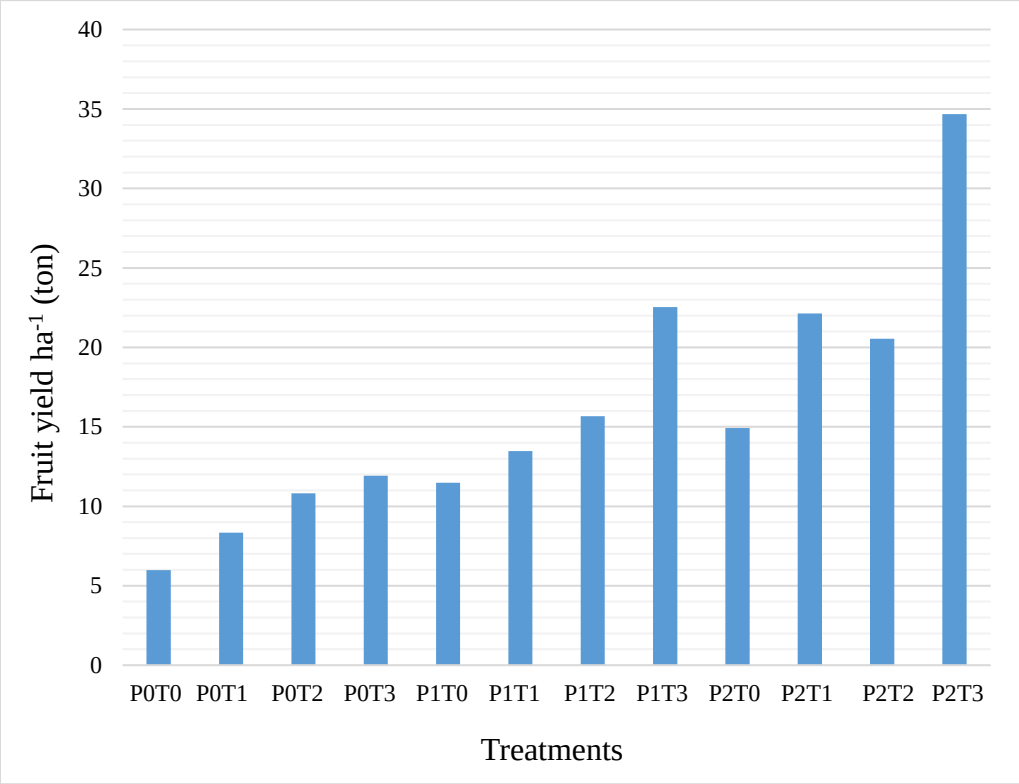

Figure 10: Combined effect of pruning, GA_3 and cytokinin on fruit yield ha^{-1} (ton) of cucumber.

P_0=No pruning, P_1= Pruning to two primary branches, P_2= Pruning to three primary branches; T_0=No GA_3 and Cytokinin spray/ control, T_1= GA_3 Spray, T_2= Cytokinin spray, T_3= 50 ppm GA_3 and 2.5 ppm Cytokinin spray.

CHAPTER V

SUMMARY AND CONCLUSION

The experiment was conducted at the Horticulture Farm, Sher-e-Bangla Agricultural University to find out Growth, flowering, fruiting and yield of cucumber (*Cucumis sativus*) influenced by stem pruning and foliar application of GA_3 and cytokinin during the period from April to June 2021. The cucumber cultivar i.e., Alavi Green Hybrid Seed was used as a test crop.

Result revealed that vegetative growth and reproductive studied parameter were highest for stem pruning, GA_3 and cytokinin application.

For stem pruning P_2 produced 30.94 cm and 73.34 cm vine length at 25 DAS and 35 DAS, respectively. The control treatment (P_0) produced 18.484 cm and 37.72 cm, respectively. For GA_3 and cytokinin, vine length ranged from 24.73- 27.13 cm at 25 DAS and 41.00- 74.00 cm at 35 DAS. The highest value of vine length was recorded for T_3 and lowest for T_0. And for combine effect, the highest vine length was found in P_2T_3 treatment combination compared to other treatments at 25 DAS and 35 DAS.

In case of stem pruning, the range of branches were 1.75 to 3.13 at 25 DAS and 2.69 to 3.94 at 35 DAS. The maximum number of branches plant^{-1} was found in P_2 treatment (3.13 and 3.94 at 25 DAS and 35 DAS, respectively) compared to others treatments. For GA_3 and cytokinin, the highest number of branches was recorded in T_3 (2.83 and 3.75 at 25 DAS and 35 DAS, respectively). The lowest values of this trait were found in T_0 (2.00 and 2.50 at 25 DAS and 35 DAS, respectively). Even for combine effect, the highest number of branches plant^{-1} was found in P_2T_3 treatments (3.75 and 5.00 at 25 DAS and 35 DAS, respectively).

The maximum number of leaves plant^{-1} in case of stem pruning was found in P_2 treatment (17.31, 44.69 and 39.31 at 25 DAS, 35 DAS and 45 DAS, respectively) compared to others treatments. In case of GA_3 and cytokinin, the highest number of leaves was recorded in T_3 (12.33, 33.25 and 34.50 at 25 DAS, 35 DAS and 45 DAS, respectively). The lowest values of this trait were found in T_0 (9.83, 22.33 and 22.08 at 25 DAS, 35 DAS and 45 DAS, respectively). Even for combine effect, the highest number of leaves plant^{-1} was found in P_2T_3 treatment (20.50, 50.25 and 48.75 at 25 DAS, 35 DAS and 45 DAS, respectively) compared to others combinations.

The highest values of number of female flowers plant^{-1} pruning were found in P_2T_3 treatment combination (39.50) compared to others treatments. The lowest values of number of female flowers plant^{-1} were recorded in P_0T_0 (7.50).

In case of pruning result indicated that P_2 produced highest number of male flowers plant^{-1} (36.38). The control treatment (P_0) produced 18.25 number of male flowers plant^{-1}. In case of GA_3 and cytokinin, number of male flowers plant^{-1} ranges from 23.33 to 32.92. The highest value of number of male flowers plant^{-1} was recorded for T_3 (32.92) and lowest for T_0 (23.33). Even for combine effect, the highest number of male flowers plant^{-1} was found in P_2T_3 (42.00) treatment combination compared to others treatments.

In case of pruning result indicated that P_2 produced highest total number of fruits plant^{-1}. The control treatment (P_0) produced lowest values of total number of fruits plant^{-1}. The highest value of total number of fruits plant^{-1} for GA_3 and cytokinin was recorded for T_3 (15.08) and lowest for T_0 (10.08). Even for combine effect, the highest total number of fruits plant^{-1} was found in P_2T_3 (17.88) treatment combination compared to others combinations.

The highest Individual fruit length was found in P_2T_3 treatment (18.25 cm) compared to others combinations where the lowest individual fruit length was recorded in P_0T_0 (11.13 cm).

The highest fruit girth was found in P_2T_3 treatment combination (5.81 cm) compared to others treatments. The treatment combination P_0T_0 produced lowest fruit girth of cucumber (2.66 cm).

The individual fruit weight range for pruning were 142.10 g to 266.17 g. The highest individual fruit weight was found in P_2 treatment (266.17 g) compared to others treatments and lowest was found in P_0 (142.10 g). For GA_3 and cytokinin, the highest individual fruit weight was recorded in T_3 (242.99 g). The lowest individual fruit weight was recorded in T_0 (156.44 g). Even for combine effect, the highest individual fruit weight was found in P_2T_3 treatment (372.44 g) and lowest was found in P_0T_0 (111.50 g) compared to others combinations.

The fruit weight plant^{-1} for pruning suggested that P_2 produced (3.32 kg). The control treatment P_0 produced (1.33 kg). For GA_3 and cytokinin the highest fruit weight plant^{-1} was recorded in T_3 and lowest in T_0. Even for combine effect, the highest fruit weight per plant was found in P_2T_3 treatment combination (4.99 kg) compared to others treatments. The treatment combination P_0T_0 produced the lowest fruit weight plant^{-1} (0.86 kg).

The maximum value of fruit yield ha^{-1} was found in P_2 treatment (11.27 t ha^{-1}) and lowest was found in P_0 (9.26 t ha^{-1}) compared to others treatments. The highest fruit yield ha^{-1} was recorded in T_3 (23.05 t ha^{-1}). The lowest value of fruit yield ha^{-1} was found in T_0 (10.79 t ha^{-1}) compared to other treatments. The highest fruit yield ha^{-1} was found in P_2T_3 treatments (34.68 t ha^{-1}) while P_0T_0 produced lowest value of fruit yield (5.98 t ha^{-1}) compared to others combinations.

Conclusion

It can be concluded that the crop treated with P_2 (pruning of three primary branches) gave the best results in vegetative growth and reproduction. T_3 (Foliar application of GA_3 @50 ppm and cytokinin @ 2.5 ppm) performed the best in case of vegetative growth and reproductive development. Better vegetative growth, reproduction and yield was found in cucumber treated with P_2T_3.

Recommendation

This study was carried out only for one location even for one season. So, it is not possible to recommend this finding for farmer's level. Thus, it can be concluded that, this experiment should have carried out in different locations of Bangladesh in different seasons.

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APPENDICES

Appendix I. Monthly recorded the average air temperature, rainfall, relative humidity and sunshine of the experimental site during the period from April to May 2021.

Month	Air temperature (^{0}C)		Relative Humidity (%)	Total rainfall (mm)	Sunshine (hr.)
	Maximum	Minimum			
April, 2021	32.5	20.4	64	65.8	5.9
May, 2021	35.7	26.6	75	180.3	6.2

Source: Sher-e-Bangla Agricultural University Weather Station.

Appendix II. Physical characteristics & chemical composition of soil of the experimental plot.

Soil characteristics	Analytical results
Agrological Zone	Madhupur Tract
pH	6.00-6.63
Organic mater	0.84
Total N (%)	0.46
Available phosphorous	21 ppm
Exchangeable K	0.41meq / 100 g soil

Source: Soil resource and development institute (SRDI), Dhaka

Appendix III. Anova of influence of pruning, GA_3 and cytokinin on vine length of cucumber.

Sources of variation	Degrees of freedom	Mean square	
		Vine length (cm) at	
		25 DAS	35 DAS
Replication	3	16.196	13.56
Pruning	2	667.079	5208.23
Treatment	3	12.953	2571.56
Pruning*Treatment	6	2.626	289.11
Error	33	5.678	14.78

Appendix IV. Anova of influence of pruning, GA_3 and cytokinin on no. of branches of cucumber.

Sources of variation	Degrees of freedom	Mean square	
		No. of branches at	
		25 DAS	35 DAS
Replication	3	0.63194	1.00000
Pruning	2	7.89583	6.43750
Treatment	3	1.68750	4.05556
Pruning*Treatment	6	0.47917	0.65972
Error	33	0.61679	0.63636

Appendix V. Anova of influence of pruning, GA_3 and cytokinin on no. of leave of cucumber.

Sources of variation	Degrees of freedom	Mean square		
		No. of leave at		
		25 DAS	35 DAS	45 DAS
Replication	3	1.687	14.69	30.08
Pruning	2	562.333	4260.65	2013.58
Treatment	3	12.687	260.58	391.08
Pruning*Treatment	6	5.667	8.37	22.47
Error	33	3.794	9.37	15.44

Appendix VI. Anova of influence of pruning, GA_3 and cytokinin on no. of female and male flowers of cucumber.

Sources of variation	Degrees of freedom	Mean square	
		No. of female flowers	No. of male flowers
Replication	3	0.25	2.17
Pruning	2	1643.25	1391.58
Treatment	3	401.81	204.06
Pruning*Treatment	6	6.47	12.14
Error	33	4.60	4.27

Appendix VII. Anova of influence of pruning, GA_3 and cytokinin on no. of fruits plant^{-1}, fruit length and fruit girth of cucumber.

Sources of variation	Degrees of freedom	Mean square		
		No. of fruits plant^{-1}	Fruit length (cm)	Fruit girth (cm)
Replication	3	3.3333	0.8079	0.50403
Pruning	2	97.7708	12.7583	9.37599
Treatment	3	57.2639	14.9996	2.77764
Pruning*Treatment	6	4.7014	8.8432	0.59613
Error	33	0.7992	1.1060	0.15062

Appendix VIII. Anova of influence of pruning, GA_3 and cytokinin on individual fruit weight, fruits weight plant^{-1}, fruit yield ha^{-1} (ton) of cucumber.

Sources of variation	Degrees of freedom	Mean square		
		Fruit weight (g)	fruits weight plant^{-1} (kg)	Fruit yield ha^{-1} (ton)
Replication	3	767.9	0.0681	3.283
Pruning	2	62228.3	15.8323	763.621
Treatment	3	15705.8	6.5264	314.780
Pruning*Treatment	6	6470.3	0.8702	41.958
Error	33	351.1	0.0677	3.267

Appendix IX. Combined effect of pruning, GA_3 and cytokinin on vine length of cucumber

Treatment	Vine length (cm)	
	25 DAS	35 DAS
P_0T_0	17.000 e	27.38 i
P_0T_1	18.69 e	34.50 h
P_0T_2	19.13 e	43.25 g
P_0T_3	19.13 e	45.75 g
P_1T_0	27.19 cd	44.25 g
P_1T_1	26.13 d	58.63 de
P_1T_2	27.50 bcd	63.63 d
P_1T_3	29.88 abc	75.50 c
P_2T_0	30.00 abc	51.37 f
P_2T_1	30.75 ab	56.50 ef
P_2T_2	30.63 ab	84.75 b
P_2T_3	32.38 a	100.75 a
CV%	9.27	6.72
$LSD_{0.05}$	3.4281	5.5312

Appendix X. Combined effect of pruning, GA_3 and cytokinin on number of branches plant^{-1} of cucumber

Treatment	Number of branches plant^{-1}	
	25 DAS	35 DAS
P_0T_0	1.25 e	2.00 e
P_0T_1	1.75 de	2.25 de
P_0T_2	2.25 cde	3.50 bc
P_0T_3	1.75 de	3.00 bcde
P_1T_0	2.50 bcd	2.50 cde
P_1T_1	2.75 abcd	3.25 bcd
P_1T_2	2.50 bcd	3.50 bc
P_1T_3	3.00 abc	3.25 bcd
P_2T_0	2.25 cde	3.00 bcde
P_2T_1	3.00 abc	3.75 b
P_2T_2	3.50 ab	4.00 ab
P_2T_3	3.75 a	5.00 a
CV%	31.15	24.55
$LSD_{0.05}$	1.130	1.148

Appendix XI. Combined effect of pruning, GA_3 and cytokinin on number of leave plant^{-1} of cucumber

Treatment	No. of leave plant^{-1}		
	25 DAS	35 DAS	45 DAS
P_0T_0	4.75 d	8.25 h	12.00 g
P_0T_1	5.75 d	10.50 gh	14.50 fg
P_0T_2	6.00 d	13.50 fg	19.00 ef
P_0T_3	5.75 d	16.25 f	22.25 e
P_1T_0	9.75 c	21.25 e	23.50 e
P_1T_1	10.25 c	23.50 e	20.75 e
P_1T_2	9.50 c	28.00 d	30.00 d
P_1T_3	10.75 c	33.25 c	32.50 cd
P_2T_0	15.00 b	37.50 c	30.75 d
P_2T_1	16.50 b	44.25 b	36.50 bc
P_2T_2	17.25 b	46.75 ab	41.25 b
P_2T_3	20.50 a	50.25 a	48.75 a
CV%	17.74	11.02	14.21
$LSD_{0.05}$	2.802	4.404	5.653

Appendix XII. Combined effect of pruning, GA_3 and cytokinin on number of female and male flowers plant^{-1} of cucumber

Treatment	No. of female flowers plant^{-1}	No. of male flowers plant^{-1}
P_0T_0	7.50 h	11.50 h
P_0T_1	11.50 g	17.00 g
P_0T_2	15.25 f	22.75 f
P_0T_3	18.75 e	21.75 f
P_1T_0	15.50 f	26.75 e
P_1T_1	21.50 e	31.25 d
P_1T_2	28.00 d	31.50 d
P_1T_3	31.50 c	35.00 b
P_2T_0	26.50 d	31.75 cd
P_2T_1	32.50 bc	34.50 bc
P_2T_2	35.50 b	37.25 b
P_2T_3	39.50 a	42.00 a
CV%	9.08	7.23
$LSD_{0.05}$	3.085	2.974

Appendix XIII. Combined effect of pruning, GA_3 and cytokinin on total no. of fruits plant^{-1}, fruit length and fruit girth of cucumber

Treatment	Total no. of fruits plant^{-1}	Individual fruit length (cm)	Fruit girth (cm)
P_0T_0	6.63 h	11.13 e	2.66 h
P_0T_1	9.25 g	14.06 cd	3.31 g
P_0T_2	11.50 e	15.43 bc	3.38 fg
P_0T_3	11.88 de	13.94 cd	3.44 fg
P_1T_0	9.75 fg	14.88 bcd	3.75 efg
P_1T_1	10.88 ef	14.94 bcd	4.13 cde
P_1T_2	12.13 de	15.69 b	4.56 bc
P_1T_3	15.50 b	15.69 b	4.31 cd
P_2T_0	13.88 c	14.19 bcd	3.88 def
P_2T_1	13.00 cd	13.47 d	4.19 cde
P_2T_2	14.25 bc	14.25 bcd	4.94 b
P_2T_3	17.88 a	18.25 a	5.81 a
CV%	7.32	7.17	9.63
$LSD_{0.05}$	1.286	1.513	0.558

Appendix XIV. Combined effect of pruning, GA_3 and cytokinin on single fruit weight, fruits weight plant^{-1}, Fruit yield ha^{-1} of cucumber

Treatment	Individual fruit weight (g)	Fruits weight plant^{-1} (kg)	Fruit yield ha^{-1} (ton)
P_0T_0	111.50 g	0.86 g	5.98 g
P_0T_1	145.13 ef	1.21 fg	8.33 fg
P_0T_2	171.31 de	1.56 ef	10.81 ef
P_0T_3	140.46 f	1.72 de	11.92 de
P_1T_0	148.50 ef	1.65 de	11.48 de
P_1T_1	211.69 c	1.94 cd	13.47 cd
P_1T_2	196.06 cd	2.26 c	15.66 c
P_1T_3	216.06 c	3.25 b	22.54 b
P_2T_0	209.31 c	2.15 c	14.93 c
P_2T_1	218.38 c	3.19 b	22.13 b
P_2T_2	264.56 b	2.96 b	20.54 b
P_2T_3	372.44 a	4.99 a	34.68 a
CV%	9.35	11.27	11.27
$LSD_{0.05}$	26.955	0.374	2.600

PLATES

Plate 1: Application of manure and fertilizer

Plate 2: Flowering of cucumber plant

Plate 3: Staking of cucumber plant with bamboo stick.

Plate 4: Harvesting of the cucumber

Plate 5: Measuring single weight of cucumber

Plate 6: Measuring fruit weight plant^{-1}