EFFECT OF NITROBENZENE ON GROWTH AND YIELD OF BOTTLE GOURD (*Lagenaria siceraria* L.)

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DECEMBER, 2019

EFFECT OF NITROBENZENE ON GROWTH AND YIELD OF BOTTLE GOURD (*Lagenaria siceraria* L.)

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REG. NO. 13-05307

A Thesis
Submitted to The Department of Horticulture,
Faculty of Agriculture
Sher-e-Bangla Agricultural University, Dhaka
In partial fulfillment of the requirements
for the degree of

MASTERS OF SCIENCE (MS)
IN
HORTICULTURE

SEMESTER: JULY-DECEMBER 2019

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CERTIFICATE

This is to certify that the thesis entitled **"EFFECT OF NITROBENZENE ON GROWTH AND YIELD OF BOTTLE GOURD (*Lagenaria siceraria* L.)"** *submitted to the Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE in HORTICULTURE****, embodies the result of a piece of bona fide research work carried out by* **MD. ABDUS SAMAD,** *Registration No.* ***13-05307*** *under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

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

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DEDICATED TO-

My Beloved Parents and
Respected Research Supervisor

ACKNOWLEDGEMENTS

*All praises and compliments are due to the Supreme Regulator and Ruler of the Universe, "**Almighty Allah**" for the blessing upon the successful accomplishment of education, to complete the research work and thesis leading to Master of Science (MS) in Horticulture.*

*The author likes to express his heartfelt respect, deep sense of gratitude and profound indebtedness to his reverend Supervisor **Prof**. **Dr. Tahmina Mostarin,** Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka for her scholastic guidance, valuable advice, important suggestions, affection feelings, endless encouragement, and supervision throughout this research work and in preparing this thesis.*

*The author also extends his sincere appreciation, profound regards and cordial thanks to his Co-supervisor, **Prof. Dr. Khaleda Khatun,** Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka for her kind help, constructive advise, fruitful criticism, creative suggestion, necessary correction and encouragement during the compilation of this thesis.*

*The author feels to express his heartfelt thanks to the honorable chairman of Horticulture **Prof. Dr. Mohammad Humayun Kabir** and honorable teacher **Prof. Dr. A.F.M. Jamal Uddin** along with all other teachers and staff members of the department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka. The author also grateful to Minister of Science and Technology, The Peoples Republic of Bangladesh for providing him a National Science and Technology (NST) fellowship to conduct his research properly.*

The author wishes to express his wholehearted thanks to his well-wishers, classmates Mir Arman Hossain, Mousumi Akter, Osman Gani for their keen help as well as heartiest co-operation and encouragement.

December, 2019 ***The Author***

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ABSTRACT

The experiment was conducted in the Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. The experiment consisted of two factors. Factor A: Different concentrations of nitrobenzene as C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L and Factor B: N_1= One spray, N_2= Two spray, N_3= Three spray in the growing period. The experiment was laid out in a Randomized Complete Block Design with three replications. In case of different concentrations of nitrobenzene the maximum number of flower (male 51.06 and female 40.18), the highest number of fruit harvested per plant (10.95) and the highest yield (55.69 t/ha) were found from C_1 treatment, whereas the lowest from C_0 treatment. For number of spray the highest number of flower (male 49.02 and female 38.05), the maximum number of fruit per plant (10.32) and the highest yield (52.94 t/ha) were recorded from N_3 treatment, while the minimum were from N_1 treatment. Due to combined effect, the maximum number of flower (male 57.78 and female 47.12), the maximum number of fruit harvested per plant (12.55), the highest yield (63.38 t/ha) with net income (Tk. 587384.7) and BCR (2.23) were observed from C_1N_3 treatment combination, while the lowest were from C_0N_1 treatment combination. So, economic analysis revealed that the C_1N_3 treatment combination appeared to be the best for achieving the higher growth, yield and economic benefit of bottle gourd.

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LIST OF ABBREVIATIONS AND ACRONYMS

BARI	=	Bangladesh Agricultural Research Institute
AEZ	=	Agro-Ecological Zone
BCR	=	Benefit cost ratio
BBS	=	Bangladesh Bureau of Statistics
cm	=	Centimeter
m	=	Meter
DAT	=	Days after sowing
M. S.	=	Master of Science
et al	=	and others (*at elli*)
GA_3	=	Gibberellic acid
SAU	=	Sher-e-Bangla Agricultural University
$Kg/_{ha}$	=	Kilogram/hectare
g	=	Gram
ml/l	=	Milliliter per liter
LER	=	Land Equivalent Ratio
m^2	=	Meter squares
LSD	=	Least Significant Difference
CV%	=	Percent of coefficient of Variation
MoP	=	Muriate of Potash
PGR	=	Plant growth regulator
RCBD	=	Randomized Complete Block Design
TSP	=	Triple Super Phosphate
t/ha	=	ton/hectare
%	=	Per cent

CHAPTER I
INTRODUCTION

Bottle gourd (*Lagenaria siceraria* L.) is one of the most important vegetables grown worldwide. It belongs to family Cucurbitaceae originated from wild populations of southern Africa. The bottle gourd can be easily distinguished from other pumpkin varieties by its white flowers and characteristic fruit, seed and leaf shapes (Cutler and Whitaker, 1967). The cultivated species is commonly known as bottle gourd, birdhouse gourd, calabash gourd and white flowered gourd. In Bangladesh it is known as lau. It is cultivated in tropics and subtropics of the world. Bottle gourd is one of the most popular and important vegetable crop grown in Bangladesh both in rabi and kharif season. Bottle gourd is one of the most highly praised vegetables consumed widely and it is a major source of vitamins and minerals. It is one of the most popular vegetables in Bangladesh and is taken with great relish. Edible portion of bottle gourd is 86%. Young bottle gourd fruits are used as vegetables. Its leaves and tender stem are also used as delicious and nutritious vegetables. The tender fruits are used as vegetable and for preparation of sweets and pickles in the hills. It is reported as an easily digestible vegetable, which keeps the body cool and prevents constipation (Haque, 1985). Regular consumption of this vegetable provides relief to people suffering with digestive, diabetics problems, dehydration and convalescents. It is good for people suffering from indigestion and biliousness (Thamburaj and Singh, 2003). The fruit contains considerable amount of 96.1 g water, 0.5 g minerals , 0.6 g fiber , 2.5 g carbohydrates, 0.22 g protein, 0.1 g fat and 12 kcal energy per 100 g of edible portion and leaves contain 87.9 g water, 6.1 g carbohydrates , 2.3 g protein, 0.7 g fat, 1.7 g minerals, 1.3 g fiber and 39 kcal energy per 100 g of edible portion (Gopalan *et al.*, 1982). The total production of bottle gourd in Bangladesh was 232000 ton during the year 2017−2018 (BBS, Statistical Year Book Bangladesh 2018).

Bottle gourd is an annual, tendril bearing and cross-pollinated crop due to its monoecious nature. Cross pollination occurs from 60 to 80% (Chowdhury, 1979). Sex expression and sex ratio in cucurbits are important factors for governing the yield. All the cultivars of cucurbits differ in production of pistillate flowers. It is a tendency of all the cucurbits to produce more number of male flowers and less number of pistillate

and hermaphrodite flowers. Secondly, the early node bears male flower, while later ones hermaphrodite and pistillate flowers. Thus, these conditions yield poor and delay in harvesting. When bottle gourd is exposed to environmental stresses during the flowering and fruiting period, abscission of flowers and flower buds may occur (Rambabu *et al*., 2017). This loss of reproductive structures can result in serious yield decrease, and constitutes a major risk factor in bottle gourd production.

The exogenous application of plant growth regulators has proved to be quite useful in the regulation of flowering and fruiting. To enhance plant growth and improve yield by increasing fruit number, fruit set and size, plant growth regulators (PGRs) are extensively used in horticultural crops. Plant growth regulators play a key role in controlling internal mechanisms of plant growth by interacting with key metabolic processes such as, nucleic acid metabolism and protein synthesis. The application of plant growth regulators might be a great alternative to increase crop production. Now it is a global realization that PGRs play an important role in increasing crop yield. Different plant growth regulators are auxins, gibberellins, nitrobenzene, cytokinins, abscisic acid and ethylene etc. Among them nitrobenzene (20% w/w) play an important role for higher growth and yield of vegetables. 'Flora' is a commercially available plant growth substance containing 20% (w/w) nitrobenzene. Pathan (2014) reported that nitrobenzene (20% w/w) used to repair the hormonal function of a plant thus promotes the flowering activity and growth of roots. It acts as a plant energizer, flowering stimulant and yield booster. Nitrobenzene is a combination of nitrogen and plant growth regulators, extracted from sea weeds that act as plant energizer, flowering stimulant and yield booster (Aziz and Miah, 2009). It has the capacity to increase flowering in plant and also prevent flower shedding. It is specially recommended for vegetable crops and flowering plants. Nitrobenzene (20% w/w) is a new generation plant energizer and yield booster of low cost PGRs compared to others. Nitrobenzene is quickly absorbed into the plants. It influences the bio-chemical pathway of the plants to uptake more nutrients from the soil. It also increases the nutrient use efficiency thus improves the vegetative growth. Induces profuse flowering and helps in the retention of the flowers and fruits (Mithila *et al*., 2012). Kohombange *et al*. (2017) conducted an experiment on bell pepper, they stated that application of nitrobenzene produces the highest number of fruits and flowers per plant. Babu *et al*. (2009) stated that nitrobenzene spray resulted in high number of

inflorescences in Jatropha. Flora (nitrobenzene) improves the organoleptic factors and keeping quality of the produce, which increases the harvestable yield of any crops. Yield contributing characters like plant height increase by 8-10% and number of branches per plant increase by 15-20%. Beside concentration of nitrobenzene, no. of spray of nitrobenzene has effect on the production. Four sprays of nitrobenzene during 40, 55, 80 and 105 days after sowing (DAS) improve the yield up to 40% (Jeyakumar, 2005). The use of plant growth regulators at proper stage plays an important role in growth and yield of bottle gourd (Sircar, 1971). As a further improvement step for fruit set of bottle gourd, nitrobenzene can be adopted. Unfortunately, very limited researches have been carried out regarding the effect of various concentrations and number of spray of nitrobenzene on bottle gourd for higher growth and yield. Furthermore, it is expected to assess the most effective nitrobenzene concentration and number of spray to reduce cost of production in order to improve the profit.

In view of their wide spectrum effectiveness on every aspect of nitrobenzene, the present experiment aimed that nitrobenzene might have a useful potentiality for increasing the growth and yield with the following objectives:

OBJECTIVES

- To identify the suitable concentration of nitrobenzene for higher growth and yield of bottle gourd.
- To determine the optimum number of spray for higher growth and yield of bottle gourd.
- To find out the suitable combination between concentration of nitrobenzene and number of spray for maximum growth, yield and economic benefit of bottle gourd.

CHAPTER II

REVIEW OF LITERATURE

Bottle gourd (*Lagenaria siceraria* L.) is one of the most popular vegetables of many countries of the world as well as in Bangladesh. It is a relatively cool temperature-loving crop, hence, grown in temperate countries and in the dry winter months of tropical countries. Plant growth regulators refer to the chemical substances that regulate and modify growth, development and yield of different plants. For a long time scientists all over the world are involved in changing pattern of the growth, development and yield of different crops using different plant growth regulators. Nitrobenzene is a growth regulator which has such characteristics by which it can improve the growth, development and ultimately yield of different crops. Though different works have been carried out on the effect of plant growth regulators on bottle gourd in Bangladesh and many other countries, no work on the effect of nitrobenzene on bottle gourd. So, the effect of nitrobenzene on some crops and related research work regarding the effect of Nitrobenzene on different crops are reviewed here.

Kohombange *et al*. (2019) studied on Sweet Cucumber (*Cucumis sativus* L.) to know the effect of nitrobenzene on yield and yield quality under green house condition. The study was conducted at a farmer poly tunnel located in Athgala (WU1). The experiment was laid out in a Completely Randomize Design (CRD) with four treatments randomized in three replicates. The treatments were T_1 – Control (without Nitrobenzene), T_2 – Nitrobenzene 10%, T_3 – Nitrobenzene 15%, T_4 – Nitrobenzene 20%. Plants were established in drip-fertigated bags in the Poly tunnel and standard crop management practices were done throughout the study. Nitrobenzene was sprayed to the seedlings 20 and 35 days after sowing. Albert solution, 6: 30: 30 fertilizer mixture 20: 20 fertilizer mixture and $Ca(NO_3)_2$ were used as recommended fertilizers. Measurements were taken on growth, flowering, Fruit setting and postharvest stages. The highest values of plant growth parameters, reproductive parameters, yield parameters and postharvest parameters were observed in T_4, i.e. 20% Nitrobenzene applied treatments. On the other hand the lowest values were recorded from T_1 (control of the experiment). Specially, advanced flowering and fruit setting, number of flowers per plant and total yield per plant were recorded from T_4,

i.e. 20% Nitrobenzene applied treatments. So, 20% nitrobenzene applied plants showed superior results in contrast to other nitrobenzene levels with enhancing flowering, fruit setting, yield qualities as well as postharvest performances.

Begum *et al*. (2018) executed an experiment to study the influence of different agrochemicals on yield and yield components of rice variety GNV10-89 at Agricultural Research Station, Gangavati, UAS, Raichur, Karnataka. The experiment consisting of 10 treatment along with control *i.e.,* T_1: 25 % extra nitrogen (N) soil application, T_2: NPK (19:19:19) @ 1.0 %, T_3: triacontanol (2.0 ml l-1), T_4: GA3 (50 ppm), T5: nitrobenzene (20 ppm), T_6: salicylic acid (500 ppm), T_7: 6-BAP (20 ppm), T_8: borax (0.2 %), T_9: T_3 + T_8 foliar applications and T_{10}: control. The results revealed that the yield and yield attributes of rice was differed significantly by foliar as well as soil application of different agrochemicals at 65 (10 days before panicle initiation) and 85 days after transplanting (10 days after panicle initiation). Foliar spray of T_2 (NPK- 19:19:19 @ 1.0 %) recorded the significantly higher Phenology and physiological parameters, number of filled spikelets per panicle (232.9), percent increase of filled spikelet's over control (33.6), least number of unfilled spikelets per panicle (61.3), less per cent of chaffyness (20.9 %), 1000 grain weight (23.6 g), the highest grain yield (8709.8 kg ha-1) and percent increase of grain yield over T_{10} (control) (22.9 %) as compared to rest of the treatments. Soil application of T_1 (N- 25 % extra) was the third highest among 10 different treatments.

Chowdhury *et al.* (2018) conducted an experiment at the research field of Patuakhali Science and Technology University (PSTU), Patuakhali during the period from December 2013 to March 2014 to evaluate the effect of nitrobenzene as plant growth regulators on growth and yield parameters of Boro Rice. It also observed the comparative growth and yield performance of foliar application nitrobenzene (0, 1.0, 3.0 and 5.0 ml L^{-1}). Data were collected on plant height; number of leaves plant–1; number of total, effective and non–effective tillers $hill^{-1}$; leaf area (LA); leaf area index (LAI); total dry matter (TDM); Crop and relative growth rate (CGR and RGR); and Yield and yield contributing characters such as length of root; length of panicle; number of total, sterile and non–sterile spikelets $panicle^{-1}$; 1000–grain weight; grain, straw and biological yield and harvest index (HI). The experiment was laid out in a

complete randomized block design with three replications. The collected data were analyzed statistically and means were adjudged by DMRT at 5% level of probability. The treatments nitrobenzene @ 3.0 ml L^{-1} as foliar application gave the highest performance in respect of plant height (90.39 cm), LAI (3.514), TDM (19.17 g $plant^{-1}$), effective tiller (20.33 $hill^{-1}$), total tillers (22.73 $hill^{-1}$), panicle length (26.01 cm),non sterile spikelets (134.70 $panicle^{-1}$), total spikelets (155.80 $panicle^{-1}$), 1000–grain weight (28.21 g), grain yield (5.86 t ha^{-1}), straw yield (8.44 tha^{-1}), biological yield (14.29 t ha^{-1}) and HI (41.00%) of boro rice.

Pramoda and Sajjan (2018) conducted Field experiments were in the Department of Seed Science and Technology, University of Agricultural Sciences, Dharwad, Karnataka during 2016-17. The field experiment consisted of 18 treatment combinations involving two seasons viz., kharif 2016 and rabi 2016-17 and plant growth regulators viz., G_1: Control, G_2 : GA_3 @ 50 ppm, G_3 : NAA @ 40 ppm, G_4 : Cycocel @ 100 ppm, G_5 : Mepiquat chloride @ 50 ppm, G_6 : Nitrobenzene @ 200 ppm, G_7: TIBA @ 50 ppm, G_8 Brassinosteroids @ 200 ppm, G_9 : GA_3 @ 5 ppm + IAA @ 5 ppm and experiment was laid out in Factorial RBD with three replications. The more number of pods per plant (117.19), number of seeds per pod (4.25), dry pod yield per plant (118.53 g), dry pod yield per plot (2.07 kg), seed yield per plant (114.48 g), pod length (5.66 cm), seed yield per plot (2.32 kg), seed yield per hectare (1,281 kg) was recorded in rabi season than kharif. Among the plant growth regulators more number of pods per plant (120.44), number of seeds per pod (4.44), dry pod yield per plant (120.17 g), dry pod yield per plot (2.21 kg), seed yield per plant (117.60 g), seed yield per plot (2.55 kg), seed yield per hectare (1,360 kg) and pod length (6.04 cm) was recorded in NAA @ 40 ppm, followed by nitrobenzene @ 200 ppm, (119.78, 4.35, 119.54, 2.11, 116.76, 2.42, 1,299 kg and 5.93 cm, respectively). The interaction effect was found to be non-significant for majority of the characters studied. However, foliar spray of NAA @ 40 ppm during rabi season recorded higher crop growth, seed yield and quality parameters as compared to control.

Ahmad *et al*. (2017) conducted an experiment in the Horticulture Farm of Department of Horticulture, Sher-e-Bangla Agricultural University to evaluate the influence of

different plant growth promoters on growth and yield of JP-27 summer cherry tomato line. Four different growth promoters including control viz. F_0= Control (Water), F_1= Flora (Nitrobenzene 20% w/w) @ 2.5ml/L, F_2= 4-CPA @ 2.5 ml/L and F_3= GA3 @ 200ppm was used in this experiment arranged in a Randomized Complete Block Design (RCBD) with three replications. Maximum plant height, no. of leaves, no. of branches, days to first flower, no. of flowers, no. of fruits, fruit length, single fruit weight, yield/plant and yield/ha (194.5 cm, 28.7, 12.7, 18.0, 48.3, 34.7, 19.9 mm, 20.4 gm, 458.7 gm and 19.0 ton respectively) were found in F_3 treatment and maximum fruit diameter (40.7 mm) were found in F_2 whereas the minimum (179.7 cm, 13.1, 5.7, 27.3, 36.3, 22.3, 13.5 mm, 33.0 mm, 10.6 gm, 287.9 gm and 13.2 ton respectively) were observed in F_0. Thus application of plant growth promoters for improving overall performance of cherry tomato produced in summer can be recommended.

An experiment was accomplished by Kohombange *et al*. (2017) at a farmer poly tunnel located in Pilimathalawa (WU1), Sri Lanka. Bell pepper (*Capsicum annuum* L.) is grown extensively throughout the world especially in temperate countries. Poor fruit-set as well as loss of reproductive structures due to moisture stress is one of the major barriers to tropical adaptation of bell pepper. Hence the objective of the present study was to examine the effect of various concentration of nitrobenzene (flowering stimulant and yield booster) on bell pepper yield. The treatments were T_1 – Control (without Nitrobenzene), T_2 – Nitrobenzene 15%, T_3 – Nitrobenzene 20%, T_4 – Nitrobenzene 25%. Plants were established in drip-fertigated bags in the Poly tunnel and standard crop management practices were applied throughout the study. Nitrobenzene was sprayed to the seedlings 40, 55, 80 and 105 days after planting. Albert solution, 6: 30: 30 fertilizer mixture 20: 20 fertilizer mixture and $Ca(NO_3)_2$ were used as recommended fertilizers. Measurements were taken on flowering, fruit setting, yield as well as the quality of the fruits. The highest number of fruits and flowers/plant was observed in T_3 and T_4, i.e. 20% and 25% Nitrobenzene applied treatments. On the other hand the lowest number of flowers as well as fruits were recorded from T_2 (15% nitrobenzene) and T_1 (control of the experiment). Among different treatments tested, 25% nitrobenzene applied plants showed superior results in contrast to other nitrobenzene levels with enhancing flowering, fruit setting, yield quality as well as postharvest performances under greenhouse condition

An experiment was performed by Nuruzzaman *et al.* (2015) at Horticultural Farm, Sher-E-Bangla Agricultural University, Dhaka-1207 to study the influence of different growth chemicals on growth, fruit yield and quality attributes of strawberry. Different growth regulators such as, Gibberelic acid (GA_3) (F_1), 4-Chloro phenoxy acetic acid (4-CPA) (F_2) and Flora (Nitrobenzene 20% w/w) (F_3) were used as foliar feeding. To find out the effect of these growth chemicals only fresh water was used as control (F_0). Among the growth regulators, GA_3 significantly influenced the flower bud, number of flower and berry. Individual fruit weight (9.1 g) was highest in Flora but the highest total fruit weight (343.9 g) and degree of brix (6.8%) were with 4-CPA. Though Foliar feeding of GA_3 increases the various growth, flowering and fruiting attributes but 4-Chloro phenoxy acetic acid ultimately increases the total yield also degree of brix. So 4-CPA could be used for strawberry production to get higher yield.

Saraswathi and Praneetha (2013) performed an experiment to study comparative efficacy of growth regulators and *panchakavya* on growth, yield and biochemical constitution of tomato. It is well known that *panchakavya* plays a vital role in organic cultivation. Hence, the present experiment was laid out to determine the effect of this biostimulant on yield and quality in tomato. Recommended dose of fertilizers recorded highest yield. Next best results were obtained by combined spray of *panchakavya* (3%) + salicylic acid (100ppm) + nitrobenzene (150ppm); *panchakavya* (3%) alone and *panchakavya* (3%) + salicylic acid (100ppm). Results also revealed comparable performance of *panchakavya* over salicylic acid and nitrobenzene indicating, that, *panchakavya* can be utilized as an organic component to increase yield in tomato.

Mithila *et al.* (2012) executed an experiment to study the effect of nitrobenzene (a plant growth regulator) on the growth, nutrient contents and accumulation of arsenic (As) in tomato plants (*Solanum lycopersicum*). Seven different treatments viz., control (C), nitrobenzene only (N), full recommended dose of fertilizer (FRD), 1/2 recommended dose of fertilizer (1/2 RD), 1/2 recommended dose of fertilizer plus nitrobenzene ($^1/_2$ RD+N), ^{3}/4 recommended dose of fertilizer (^{3}A RD), ^{3}/4 recommended dose of fertilizer plus nitrobenzene ($^3/_4$ RD+N) were applied under both arsenic free and arsenic treated conditions. The growth

increased due to nitrobenzene application. The highest growth was found with $^{3}/_{4}$ recommended fertilizer dose with nitrobenzene. The height and fresh matter production of tomato plants were improved in the presence of nitrobenzene in all cases. $^{3}/_{4}$ RD+N showed the highest accumulation of nitrogen (N) and potassium (K) in shoot and root in both As free and As treated soils. The highest accumulation of phosphorus (P) in shoot and root of As free soils was found in ^{3}A RD+N. In As non-treated plant samples, the accumulation of sulfur (S) in shoot was found to be at the highest in $^{1}/_{2}$ RD+N, whereas the highest accumulation in root was found in FRD. The highest accumulation of As in shoot and root was found in FRD for As treated soils.

Agrawal and Guhey (2009) conducted an experiment with a sunflower variety and the plant were treated with different concentrations of nitrobenzene in 5ml l^{-1}, 10ml l^{-1} and 15ml l^{-1} was given as foliar spray at different phonological crop growth stages viz. vegetative, head formation, flowering and maturity stages. Observations on plant height, number of leaves, head diameter, fresh and dry weight of head, RGR, LAR, leaf area, SLW, total chlorophyll, oil content and yield components were estimated. The result inferred that nitrobenzene increased crop growth and yield of sunflower at all concentrations studied over control.

Aziz and Miah (2009) carried out an investigation. One experiment was conducted at Bangladesh Rice Research Institute farm and another experiment was conducted at farmer's field, Samantopur, Gazipur during the T. aman season, 2006 in order to determine the performance of flora on the growth and yield of wetland rice. The following four treatment combinations were tested in both site: T_1= Control (No-fertilizer), T_2= Flora @ 3ml/lit. of water, T_3= Soil Test Based (STB) dose and T_4= T_3 + Flora @ 3ml/lit. of water. BRRIdhan-31 was used as test crop. The blanket doses of fertilizers were applied on soil test based (STB). The experiments were laid out in Randomized Complete Block Design with 3 replications of each treatment. The sources of N, P, K and S were Urea, TSP, MP and gypsum. Urea was applied into three equal splits, 1/3rd basal, 1/3rd maximum tillering stage and the remaining 1/3rd at panicle initiation stage. The treatment T_4 where chemical fertilizer was applied on STB in combination with flora produced the maximum yield but in terms of economic point of view the treatment T_3 (STB) was found superior to other treatments.

A field experiment was conducted by Babu *et al*. (2009) to evaluate the Role of growth regulators on flowering and fruit set in two Jatropha genotypes their treatments were T_1-Control, T_2 - Naphthalene acetic Acid, T_3 – Gibberellic acid, T_4 – Ethrel, T_5 – Brassinolide, T_6 – Nitrobenzene , T_7 - Mepiquat chloride . Mepiquat chloride and ethrel sprays hastened flowering earlier than others. But, the important flowering characters, namely, number of inflorescences, number of female flowers, number of male flowers to one female and fertility coefficient were effectively enhanced by gibberellic acid and brassinolide treatments. Among the growth regulators, nitrobenzene spray resulted in high number of inflorescences per plant followed by brassinolide and gibberellic acid.

CHAPTER III

MATERIALS AND METHODS

The experiment was conducted during the period from October 2018 to March 2019 to investigate on the application of nitrobenzene with different concentration and number of spray for higher growth and yield of bottle gourd (*Lagenaria siceraria* L.). This chapter includes a brief description of the experimental period, location, soil and climate condition of the experimental area and materials that were used for conducting the experiment i.e. treatment and design of the experiment, growing of crops, intercultural operations, data collection procedure and procedure of data analysis that were used for conducting the experiment.

3.1 Experimental Site

The research was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh. The experiment was carried out during rabi season. The location of the experimental site is situated at 90° 22 ' E longitude and 23° 41' N latitude. The altitude of 8.6 meters above the sea level . The experimental site is presented in Appendix I.

3.2 Characteristics of soil

The soil of the experimental area belongs to the Modhupur Tract (UNDP, 1988) under AEZ No. 28. The selected plot was medium high land and the soil series was Tejgaon (FAO, 1988). The characteristics of the soil under the experimental plot were analyzed in the Soil Testing Laboratory, Soil Research Development Institute Farmgate, Dhaka and the results showed that the soil composed of 27% sand, 43% silt and 30% clay. The soil was having a texture of sandy loam with pH and organic matter 5.47 – 5.63 and 0.83%, respectively. The details soil characteristics are presented in Appendix II.

3.3 Climatic condition of the experimental site

The experimental area was under the subtropical climate, characterized by three distinct seasons, winter season from November to February and the pre-monsoon or hot season from March to April and the monsoon period from May to October (Edris

et al., 1979). During the experimental period the maximum temperature (32.24 ^{0}C), highest relative humidity (78.82%) and highest rainfall (68.5 mm), highest rainfall (68.5 mm) was recorded in the month of September 2018, whereas the minimum temperature (13.6 ^{0}C), minimum relative humidity (62.04%) and no rainfall was recorded for the month of January, 2019.The climatic conditions during the period of experiment was collected from the Bangladesh Meteorological Department, Agargaon, Dhaka and the data are presented in Appendix III.

3.4. Agro-ecological region

The experimental field belongs to the agro-ecological region of the Madhupur Tract (AEZ-28). The landscape comprises level upland, closely or broadly dissected terraces associated with either shallow or broad, deep valleys.

3.5. Experimental details

3.5.1 Planting materials and nitrobenzene (20% w/w)

The seeds of variety BARI Lau-3 were collected from the Horticulture Research Centre (HRC), Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur.

Flora was used as the source of nitrobenzene (20% w/w). Flora is a product of ACI Formulations Ltd. which contain nitrobenzene (Nitrobenzene 20% w/w). It was collected from ACI Formulations Ltd.

3.5.2 Experimental treatments: The experiment consists of two factors:

Factor A: Concentration of nitrobenzene

C_0 =Control (Water)

C_1 = Nitrobenzene @ 2 ml/L

C_2= Nitrobenzene @ 3 ml/L

Factor B: Number of spray

N_1 = One spray (At 20 days after transplanting)

N_2 = Two spray (At 20 and 40 days after transplanting)

N_3 = Three spray (At 20 ,40 and 60 days after transplanting)

There are 9 treatment combinations such as C_0N_1, CoN_2, C_0N_3, C_1N_1, C_1N_2, C_1N_3, C_2N_1, C_2N_2, C_2N_3.

3.5.3 Design and layout of the experiment

The two factors experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications where the experimental area was divided into three equal blocks representing the replications to minimize the soil heterogeneous effects .The length of the experimental area 24 m and width 15 m and the total area of the experimental plot was 360m^2. The total area is divided into three equal blocks. Each block was divided into 9 plots where 9 treatments combination were allotted at random. There were total 27 unit plots in the experiment. The size of the each plot was 4 m × 2 m. The distance maintained between two blocks and two plots were 1 m and 0.5 m, respectively. Both the row to row and plant to plant distances were 2 m and 2 m, respectively. The layout of experimental field is presented in Fig. 1.

3.6. Seed treatment

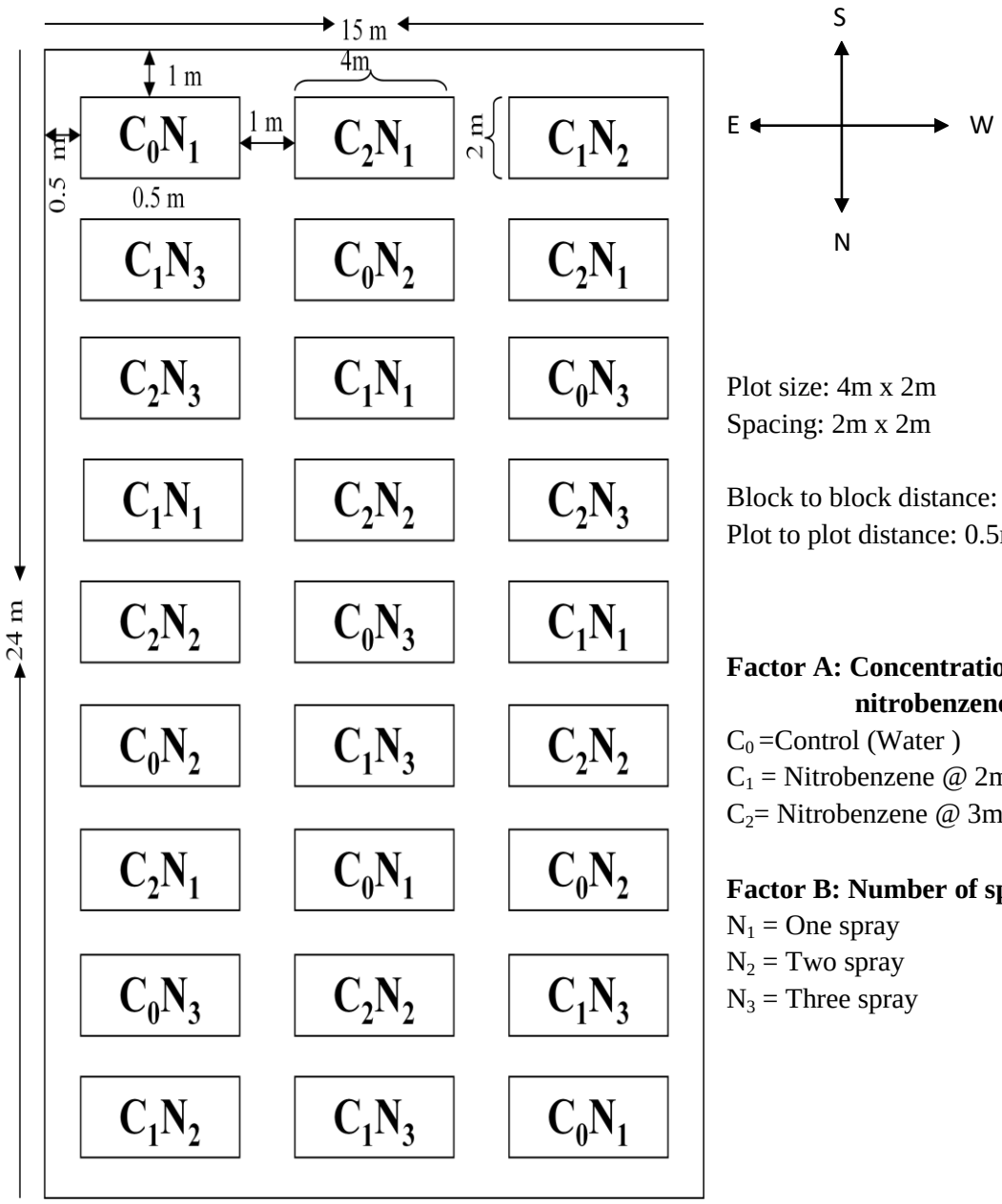
For rapid and uniform germination the seeds of BARI Lau 3 were soaked for 12 hours in water before sowing in the plastic glass. Seeds were treated with Vitavex @ 2 gkg^{-1} seeds before sowing to avoid seed borne diseases and get vigorous seedlings.

3.7 Plastic glass preparation

Plastic glass was prepared for sowing the seeds and for raising the seedlings. Soil and compost was mixed to produce seedling. No chemical fertilizers were applied for raising of seedlings. Sevin 50WP @ 5 kg/ha was applied to soil for protecting the young plants from the attack of ants and cutworms.

3.8 Seed sowing

Seeds were sown in the plastic glass on 24 October, 2018. Two seeds were sown in every plastic glass (Plate 1). Seeds were sown at a depth of 2 cm and they were kept in shady place. The plastic glasses were watered everyday. Seedlings were not attacked by any kind of insect or disease.



Plot size: 4m x 2m
Spacing: 2m x 2m

Block to block distance: 1m
Plot to plot distance: 0.5m

Factor A: Concentration of nitrobenzene

C_0 =Control (Water)
C_1 = Nitrobenzene @ 2ml/L
C_2= Nitrobenzene @ 3ml/L

Factor B: Number of spray

N_1 = One spray
N_2 = Two spray
N_3 = Three spray

Fig. 1. Field layout of the experimental plot on bottle gourd in the Randomized Complete Block Design.

3.9 Land and pits preparation

At the 3rd week of October the main plot selected for conducting the experiment was opened with a power tiller, and left exposed to the sun for a week. Then the land was harrowed, ploughed and cross-ploughed several times followed by laddering to obtain good puddle condition. The weeds and different kind of stubbles were removed to make it clean. In accordance to the experimental design the experimental area was partitioned into different unit plots. Different organic and inorganic fertilizers were mixed with soil. Pits of 50 × 50 × 45 cm^3 sized were prepared.

3.10 Fertilizers and manure application

The fertilizer and manures for bottle gourd were applied at the recommended doses (Plate 1). The recommended dose for bottle gourd production comprising cowdung, urea, TSP, MoP, zypsum, zinc oxide @ 10 t/ha, 150 kg/ha, 175 kg/ha, 100 kg/ha, 10 kg/ha, 12 kg/ha, respectively (Krishi Projukti Hatboi, BARI, 2011). Half of the quantity of cowdung was applied during final land preparation. The remaining half of cowdung, the entire amount of TSP, gypsum, zinc oxide and one third of urea and MoP were applied during pit preparation. Urea and MoP were applied in two equal installments at before flowering and fruit setting.

3.11 Transplanting

After 15 days of seed sowing two healthy and uniform seedlings were transplanted on 8 november 2018 (Plate 1). During transplanting the plastic glasses were cut and removed carefully so that the root remain intact. The seedlings were transplanted in the afternoon and light watering was given.

3.12 Preparation and application of nitrobenzene

The nitrobenzene was applied at different doses and at different stages of bottle gourd (Plate 2). Before the application of nitrobenzene, the 2 ml/L and 3 ml/L solution was prepared. To prepare the solutions, 2 ml and 3 ml flora was mixed with 1 L of water in separate container. No nitrobenzene was applied on C_0N_1, C_0N_2, C_0N_3 plots. Nitrobenzene at 2 ml/L concentration was applied on C_1N_1 plot at 20 days after transplanting (DAT) with the help of sprayer.

(a)

(b)

(c)

(d)

Plate 1. Pictorial presentation of land preparation during field experiment. **a.** sowing of seed in plastic glass ; **b**. seedling under polythene shed; **c.** transplanting of seedling ; **d.** application of fertilizers.

Nitrobenzene at 2 ml/L concentration was applied on C_1N_2 plot at 20 DAT and 40 DAT with the help of sprayer. Nitrobenzene at 2 ml/L concentration was applied on C_1N_3 plot at 20 DAT, 40 DAT and 60 DAT with the help of sprayer. Nitrobenzene at 3 ml/L concentration was applied on C_2N_1 plot at 20 DAT with the help of sprayer. Nitrobenzene at 3 ml/L concentration was applied on C_2N_2 plot at 20 DAT and 40 DAT with the help of sprayer. Nitrobenzene at 3 ml/L concentration was applied on C_2N_3 plot at 20 DAT, 40 DAT and 60 DAT with the help of sprayer.

3.13 Intercultural operations

Various intercultural operations, such as gap filling, weeding, mulching with water hyacinth, earthing up, irrigation, pest and disease control etc. were accomplished for better growth and development of the bottle gourd seedlings. The crop was kept free from weeds by regular weeding and irrigated as and when required.

3.13.1 Gap filling

The experimental plot was taken under careful observation. Very few seedlings were damaged after transplanting. The damaged seedlings were replaced by new healthy seedlings. The seedlings were taken from the same stock. The seedlings were transplanted with big mass of soil to avoid any damages. The newly transplanted seedlings were under special care for their proper establishment.

3.13.2 Weeding

Weeding was done at 15, 30, 45 and 60 days after transplanting to ensure the plot free from weeds.

3.13.3 Mulching

For the retention of water the water hyacinth was given at the base of plants. It helps to conserve the water.

3.13.4 Irrigation and drainage

Earlier on the seedling establishment stages light watering was given by a watering cane in every afternoon (Plate 2). After well establishment of the seedlings watering was given with irrigation channels. At the reproductive stage no water stress was

encountered. Proper drainage facilities were made surrounding the experimental plots for drainage of excess water.

3.13.5 Vine management

For proper growth and development of the plants the vines were managed by hand to spread them over the net of trellis.

3.13.6 Trellis

Four bamboo poles were set keeping 5 feet high from the ground level in every plot. These poles were connected to one another by bamboo. Bamboo, plastic rope and jute rope was used to make the trellis. A bamboo stick was placed near the seedling. Thus a trellis for each plot was made for creeping the vines of crop.

3.13.7 Pest control

During the period of establishment of seedling in the field insect infestation was a serious problem. Cut worm attacked at the seedling stages, it was controlled both mechanically and spraying Darsban 29 EC @ 3%. Some plants were infested with Aphid, to control them Tafgar @ 2.5 ml/l was applied. Along with these some plants were infected with powdery mildew to control it S-dust (sulcox) was sprayed @ 5 gm/l. At the reproductive stage fruit fly was seen to harm the fruit, to control them pheromone trap was set up 1 trap/10m. At different times diseased leaves were removed from the field.

3.14 Harvesting

Harvesting was done by hand picking. Fruits were harvested at tender stage and before full maturity. They were harvested when the fruits contain hair on their skin. The branches were harvested using scissor (Plate 2). Harvesting of fruits was started at 72 DAT and continued upto final harvest based on the marketable size of fruits.

(a) **(b)**

(c) **(d)**

Plate 2. Pictorial presentation of different operations during field experiment. **a**. preparation of nitrobenzene solution ; **b**. Irrigating the field ; **c.** spraying of nitrobenzene ; **d**. harvesting of branch.

3.15 Data collection

The data were recorded on following parameters from the plants during the experiment.

3.15.1. Vine length (m)

The vine length was recorded at 20, 40, 60 and 140 DAT (Plate 3). Data were recorded as average of all plants (two) of each plot in meter (m). The height of every plant was measured from the ground to the tip of the stem.

3.15.2 Number of leaves per plant

The total number of leaves per plant were recorded at 20, 40, 60 and 140 DAT. Then the average data were calculated.

3.15.3 Leaf length (cm)

The length of 5 leaves was recorded from each plant and average was calculated.

3.15.4 Leaf breadth (cm)

For the measurement of leaf breadth 5 leaves per plant was selected at randomly. The leaf breadth was measured in cm (centimeter) and average value was calculated for each plant.

3.15.5. Number of primary branches per plant at harvest

The total number of branches per plant was recorded from each plant of bottle gourd. The data were recorded at final harvest (140 DAT) and average was calculated.

3.15.6 Days required to 1st male flowering

The number of days required between the date of transplanting to the date of 1st male flower emergence of a plant was recorded and average was calculated.

3.15.7 Days required to 1st female flowering

The number of days required between the date of transplanting to the date of 1st female flower emergence of a plant was recorded and average was calculated

3.15.8 Number of male flowers per plant

The total number of male flowers per plant was counted from each plot after flowering and mean value was calculated.

3.15.9 Number of female flowers per plant

From each plot total number of female flowers was calculated after flowering and mean value was found out.

3.15.10 Days to 1st fruit harvest

This data was recorded during the first harvest of fruit from every plant and plot. It was measured as the days taken from transplanting to first harvesting.

3.15.11 Fruit length (cm)

Length of each fruit was recorded during the harvesting from individual plant and average fruit length was calculated (Plate 3). Fruit length was calculated in centimeter (cm).

3.15.12 Fruit diameter (cm)

During harvesting diameter of each fruit was recorded from individual plant and average fruit diameter was calculated (Plate 3). Fruit diameter was calculated in centimeter (cm).

3.15.13 Number of fruits per plant

The total number of fruits per plant was counted after setting of fruits and average was calculated.

3.15.14 Individual fruit weight (kg)

The weight of individual fruit was recorded after each harvest (Plate 3) and expressed in kilogram (kg) and mean value was calculated.

3.15.15 Fruit yield/plant (kg)

The fruit weight of all the fruits harvested from a plant was recorded and the sum of all fruit of a plant was calculated. The fruit weight was expressed in kilogram (kg).

3.15.16 Fruit yield/plot (kg)

The fruit weight of all the fruits harvested from a plot (2 plants) were recorded and the sum of the weight of all fruits of a plot were calculated. The fruit yield was expressed in kilogram (kg).

3.15.17 Fruit yield/hectare (t)

Yield per hectare of bottle gourd was calculated by converting the per plot yield into hectare and was expressed in ton.

3.16 Statistical analysis

The recorded data on different parameters were statistically analyzed using Statistic 10 software. The significance of the difference among the treatments means was estimated by least significant difference test (LSD) at 5% level of probability.

3.17 Economic analysis

The cost of production was calculated to find out the most economic combination of concentration of nitrobenzene and number of spray. All input cost like the cost for land lease and interests on running capital were computing in the calculation. The interests were calculated @ 13% in simple rate. The market price of bottle gourd was considered for estimating the return. Analyses were done according to the procedure of Alam *et al.* (1989).

3.17.1 Analysis for total cost of production of bottle gourd

All the material and non-material input cost, interest on fixed capital of land and miscellaneous cost were considered for calculating the total cost of production. Total cost of production (input cost, overhead cost), gross return, net return and BCR (Benefit cost ratio) are presented in Appendix XII.

3.17.2 Gross income

Gross income was calculated on the basis of sale of branch and fruit. The price of branch and fruit was assumed to be Tk. 10/four branches and Tk. 18/kg on the basis of current market value of Kawran Bazar, Dhaka at the time of harvesting.

3.17.3 Net return

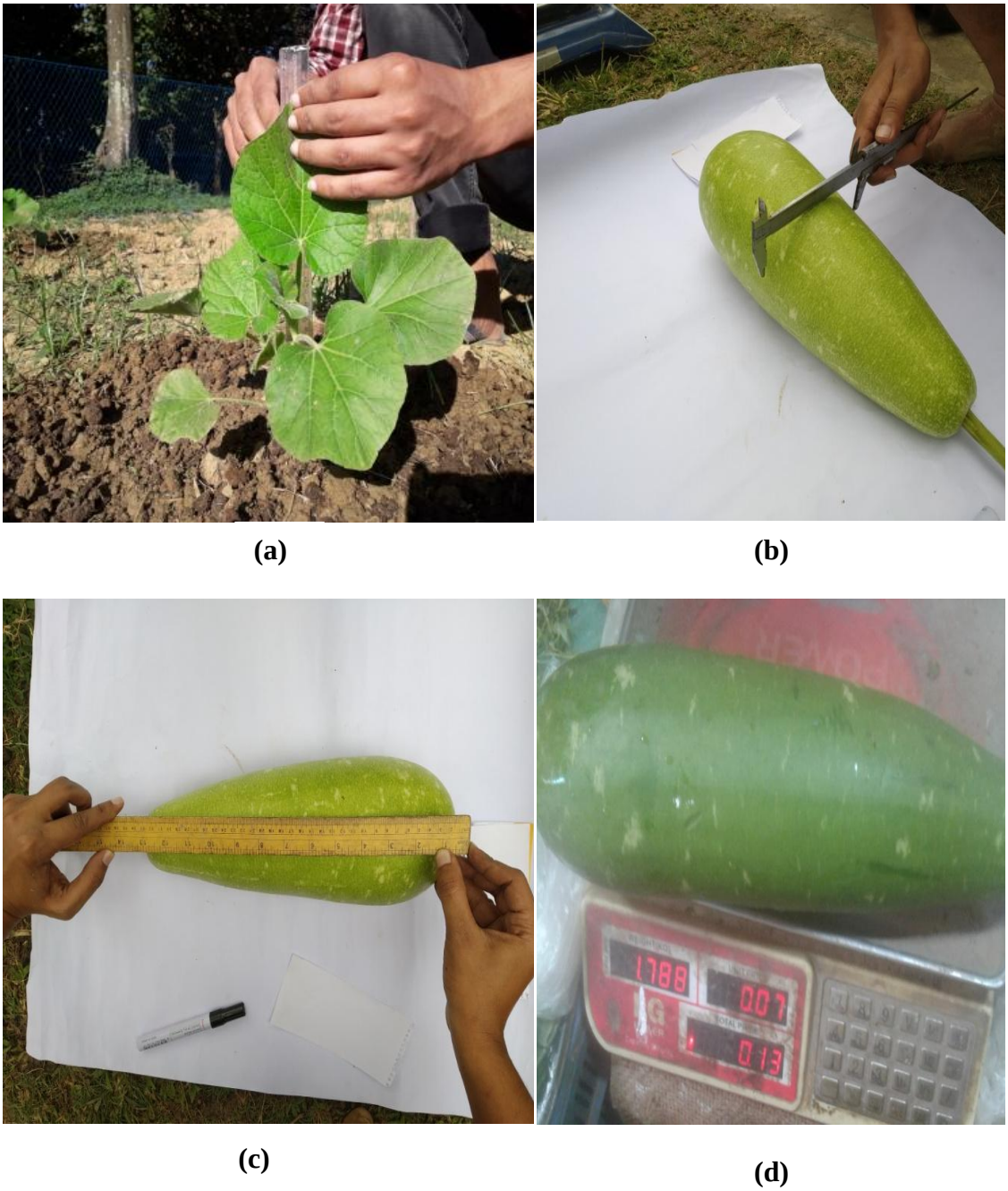
Net return was calculated by deducting the total production cost from gross income for each treatment combination.

Net return = Gross return per hectare (Tk.) - Total cost of production per hectare (Tk.)

3.17.4 Benefit cost ratio (BCR)

The benefit cost ratio (BCR) was calculated as follows:

Benefit cost ratio (BCR) = Gross return per hectare (Tk.) /Total cost of production per hectare (Tk.)



(a) **(b)**

(c) **(d)**

Plate 3. Pictorial presentation of data collection. **a**. Measurement of vine length at 20 days after transplanting (DAT) using meter scale in cm(centimeter); **b.** Measurement of fruit diameter using slide calipers in cm (centimeter); **c.** Measurement of fruit length using meter scale in cm (centimeter); **d.** Measurement of individual fruit weight using digital weight machine in Kg (Kilogram).

CHAPTER IV
RESULTS AND DISCUSSION

The experiment was conducted to study the growth and yield of bottle gourd (*Lagenaria siceraria* L.) as influenced by different concentrations and number of sprays of nitrobenzene. Data on different growth and other parameter, yield attributes and yield were recorded. The analyses of variance (ANOVA) of the data on different parameters are presented in Appendix section (IV-XII). The results have been presented with the help of graphs and tables and possible interpretations have been given under the following headings.

4.1 Vine length (m)

Significant influence was not found in terms vine length of bottle gourd at 20 days after transplanting (DAT) affected by different concentrations but later at 40, 60 and 140 DAT there was significant differences in vine length (Table 1 and Appendix IV). However, at 40 DAT the highest vine length (1.30 m) was recorded from C_2 (nitrobenzene @ 3 ml/L) treatment and the lowest vine length (0.93 m) was found from C_0 (control) treatment. AT 60 DAT, the highest vine length (3.41 m) was recorded from C_2 (nitrobenzene @ 3 ml/L) treatment and the lowest vine length (2.14 m) was found from C_0 (control) treatment. Finally, at harvest (140 DAT), the highest vine length (12.23 m) was observed in C_2 (nitrobenzene @ 3 ml/L) treatment while the lowest vine length (8.45 m) was found in C_0 (control) treatment. At 20 DAT there were no significant differences because first dose of nitrobenzene was applied at 20 DAT. It revealed that nitrobenzene increased plant height, which might be due to regulating effect of exogenous application of nitrobenzene. Aziz and Miah (2009), Agarwal and Guhey (2009), Mithila *et al.* (2012), Nuruzzaman *et al.* (2015), Chowdhury *et al*. (2018), Kohombange *et al*. (2019) observed similar trend of results. They opined that application of nitrobenzene increases the plant height.

Vine length of bottle gourd was not varied significantly for different number of spray at 20 and 40 DAT but vine length varied significantly at 60 and 140 DAT (Table 2 and Appendix IV). At 60 DAT, the highest vine length (3.04 m) was recorded from N_2 (two spray) treatment, which was statistically identical to N_3 (three spray) and the lowest vine length (2.57 m) was found from N_1 (one spray) treatment. At harvest, the

highest vine length (11.30) was performed by N_3 (three spray) treatment while N_1 (one spray) treatment gave the lowest vine length (9.51 m). There were no significant differences at 20 and 40DAT because first dose of nitrobenzene was applied at 20 DAT and at 40 DAT all treatment plots get only one spray.

Table 1. Effect of different concentrations of nitrobenzene on vine length at different days after transplanting of bottle gourd

Treatment	Vine Length (m)			
	20 DAT	**40 DAT**	**60 DAT**	**140 DAT**
C_0	0.28	0.93 c	2.14 c	8.45 c
C_1	0.27	1.18 b	3.03 b	11.10 b
C_2	0.28	1.30 a	3.41 a	12.23 a
LSD(0.05)	0.0390^{NS}	0.0594	0.1123	0.3247
CV%	13.84	5.24	3.95	3.09

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L

Table 2. Effect of different number sprays of nitrobenzene on vine length at different days after transplanting of bottle gourd

Treatment	Vine Length (m)			
	20 DAT	**40 DAT**	**60 DAT**	**140 DAT**
N_1	0.28	1.14	2.57 b	9.52 c
N_2	0.29	1.15	3.04 a	10.96 b
N_3	0.27	1.12	2.97 a	11.30 a
LSD(0.05)	0.0390^{NS}	0.0594^{NS}	0.1123	0.3247
CV%	13.84	5.24	3.95	3.09

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, N_1= One spray, N_2= Two spray, N_3= Three spray

Significant variation was not observed due to the combined effect of plant on different concentrations and number of spray in terms of vine length of bottle gourd at 20 DAT but vine length varied significantly at 40, 60 and 140 DAT (Table 3 and Appendix IV). At 40 DAT, the treatment combination C_2N_1 gave the highest vine length (1.35 m) which is statistically similar to C_2N_2 and C_2N_3 treatment combinations and the lowest vine length (0.91 m) was observed in C_0N_3 treatment combination which is statistically identical to C_0N_1 and C_0N_2 treatment combinations. At 60 DAT, the highest vine length (3.77 m) was observed from C_2N_2 treatment combination and the lowest vine length (2.06 m) was observed from C_0N_1 treatment combination which is

statistically identical to C_0N_2 and C_0N_3 treatment combination. Finally at harvest (140 DAT), the highest vine length (13.28 m) was observed in treatment combination C_2N_3 and the lowest vine length (8.1 m) was observed in C_0N_1 treatment combination which is statistically similar to C_0N_3 treatment combination.

Table 3. Combined effect of different concentrations and number of sprays of nitrobenzene on vine length at different days after transplanting of bottle gourd

Treatment Combination	Vine Length (m)			
	20 DAT	40 DAT	60 DAT	140 DAT
C_0N_1	0.30	0.93 d	2.06 e	8.10 h
C_0N_2	0.27	0.97 d	2.15 e	8.72 g
C_0N_3	0.26	0.91 d	2.23 e	8.54 gh
C_1N_1	0.23	1.15 c	2.75 d	9.71 f
C_1N_2	0.31	1.21 bc	3.22 c	11.51 d
C_1N_3	0.28	1.19 bc	3.13 c	12.09 c
C_2N_1	0.30	1.35 a	2.91 d	10.74 e
C_2N_2	0.29	1.28 ab	3.77 a	12.65 b
C_2N_3	0.25	1.27 ab	3.54 b	13.28 a
LSD(0.05)	0.0768^{NS}	0.1028	0.1944	0.562
CV%	13.84	5.24	3.95	3.09

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L. Where, N_1= One spray, N_2= Two spray, N_3= Three spray

4.2 Number of leaves per plant

Number of leaves per plant is an important parameter of crop plant because of its physiological role in photosynthetic activities. Significant influence was not found in terms number of leaves per plant of bottle gourd at 20 days after transplanting (DAT) affected by different concentrations but later at 40, 60 and 140 DAT there was significant differences in number of leaves per plant (Table 4 and Appendix V). At 40 DAT, the highest number of leaves per plant (19.61) was recorded from C_2 (nitrobenzene @ 3 ml/L) treatment which is statistically identical to C_1 (nitrobenzene @ 2 ml/L) and lowest number of leaves per plant (14.83) was found from C_0 (control) treatment. At 60 DAT, the highest number of leaves per plant (54.88) was recorded from C_2 (nitrobenzene @ 3 ml/L) treatment and the lowest (40.61) was found from C_0 (Control) treatment. Finally, at harvest (140 DAT), the highest number of leaves per plant (333.56) was observed in C_2 (nitrobenzene @ 3 ml/L) treatment while the lowest number of leaves per plant (269.44) was found in C_0 (control) treatment. At 20 DAT

there were no significant differences because first dose of nitrobenzene was applied at 20 DAT. Kohombange *et al.* (2017) also found similar kind of result when they were investigating on effect of various concentrations of nitrobenzene on bell pepper. Similar observations were recorded by Nuruzzaman *et al*. (2015), Agarwal and Guhey (2009) and Begum *et al*. (2018).

Table 4. Effect of different concentrations of nitrobenzene on number of leaves per plant at different days after transplanting of bottle gourd

Treatment	Number of leaves per plant			
	20 DAT	40 DAT	60 DAT	140 DAT
C_0	9.50	14.83 b	40.61 c	269.44 c
C_1	9.44	18.22 a	49.68 b	310.00 b
C_2	9.11	19.61 a	54.88 a	333.56 a
LSD(0.05)	1.5426^{NS}	2.0328	0.9746	8.6419
CV%	16.65	11.69	2.03	2.86

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L

Table 5. Effect of different number of sprays of nitrobenzene on number of leaves per plant at different days after transplanting of bottle gourd

Treatment	Number of leaves per plant			
	20 DAT	40 DAT	60 DAT	140 DAT
N_1	9.38	17.33	43.29 b	283.22 c
N_2	9.05	18.50	51.27 a	309.28 b
N_3	9.61	16.83	50.61 a	322.50 a
LSD(0.05)	1.5426^{NS}	2.0328^{NS}	0.9746	8.6419
CV%	16.65	11.69	2.03	2.86

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, N_1= One spray, N_2= Two spray, N_3= Three spray.

Number of leaves per plant of bottle gourd was not varied significantly for different number of spray at 20 and 40 DAT but number of leaves per plant varied significantly at 60 and 140 DAT (Table 5 and Appendix V). At 60 DAT, the highest number of leaves per plant (51.27) was recorded from N_2 (two spray) treatment which is statistically identical to N_3 (three spray) treatment and the lowest number of leaves per plant (43.29) was found from N_1 (one spray) treatment. At harvest the highest number of leaves per plant (322.50) was performed by N_3 (three spray) treatment while N_1 (one spray) treatment gave the lowest number of leaves per plant (283.22). There

were no significant differences at 20 and 40 DAT because first dose of nitrobenzene was applied at 20 DAT and at 40 DAT all treatment plots got only one spray.

Table 6. Combined effect of different concentrations and number of sprays of nitrobenzene on number of leaves per plant at different days after transplanting of bottle gourd

Treatment combination	Number of leaves per plant			
	20 DAT	40 DAT	60 DAT	140 DAT
C_0N_1	10.83	15.50 cd	38.33 h	264.17 f
C_0N_2	9.16	15.16 cd	42.33 g	270.83 f
C_0N_3	8.5	13.83 d	41.16 g	273.33 f
C_1N_1	8.17	17.16 bcd	44.37 f	288.83 e
C_1N_2	9.16	19.16 ab	51.33 d	312.33 d
C_1N_3	11.00	18.33 abc	53.33 c	328.83 c
C_2N_1	9.16	19.33 ab	47.16 e	296.67 e
C_2N_2	8.83	21.16 a	60.16 a	344.67 b
C_2N_3	9.33	18.33 abc	57.33 b	365.33 a
LSD(0.05)	2.8518^{NS}	3.5209	1.688	14.968
CV%	16.65	11.69	2.03	2.86

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L, Where, N_1= One spray, N_2= Two spray, N_3= Three spray

Significant variation was not observed due to the combined effect of different concentrations and number of spray on number of leaves per plant of bottle gourd at 20 DAT but number of leaves per plant varied significantly at 40, 60 and 140 DAT (Table 6 and Appendix V). At 40 DAT, the highest number of leaves per plant (21.16) was recorded from C_2N_2 treatment combination which is statistically similar result to C_1N_2, C_1N_3, C_2N_1 and C_2N_3 treatment combination; lowest number of leaves per plant was observed in C_0N_3 (13.83) treatment combination which is statistically similar to C_0N_1, C_0N_2 and C_1N_1 treatment combinations. At 60 DAT the highest number of leaves per plant (60.16) was observed from treatment combination C_2N_2 and lowest number of leaves per plant (38.33) was observed from C_0N_1 treatment combination. Finally at harvest (140 DAT), the highest number of leaves per plant (365.33) was observed in treatment combination C_2N_3 treatment combination and lowest number of leaves per plant (264.17) was observed in C_0N_1 treatment combination which is statistically identical to C_0N_2 and C_0N_3 treatment combinations. From the results of the present study it indicated that combined effect of different concentrations and

number of spray combination might have induced better growing condition which ultimately led to the production of more leaves per plant. Nitrobenzene enhanced the number of leaves which ultimately increased the leaf number of bottle gourd. Similar result was observed by Ahmad *et al.* (2017).

4.3 Leaf length (cm)

Variation on leaf length at harvest differed significantly due to different concentrations of nitrobenzene (Fig.2. and Appendix VI, X). Results revealed that maximum leaf length (37.11 cm) was observed from C_2 (nitrobenzene @ 3 ml/L) treatment and minimum leaf length (30.48 cm) was found from C_0 (control) treatment. The present finding is agreed with the statement of Agarwal and Guhey (2009) and Chowdhury *et al*. (2018).

Significant influence was observed in terms of leaf length of bottle gourd influenced by different number of spray (Fig. 3. and Appendix VI, XI). Result signified that maximum leaf length (35.89 cm) was observed from N_3 (three spray) and minimum leaf length (31.65 cm) was found from N_1 (one spray) treatment.

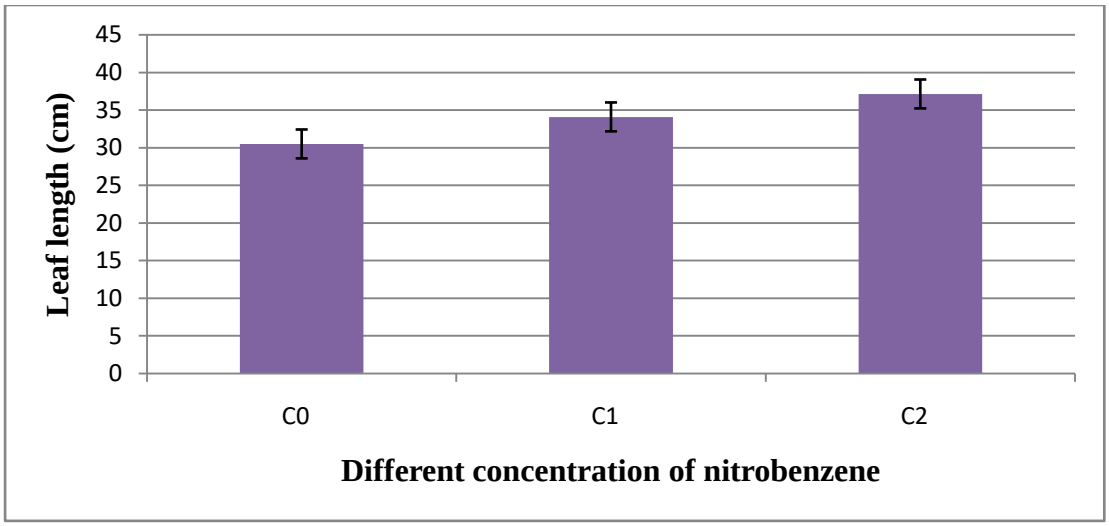


Fig. 2. Effect of different concentrations of nitrobenzene on leaf length of bottle gourd at harvest. Where, C_0= Control (Water only), C1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L

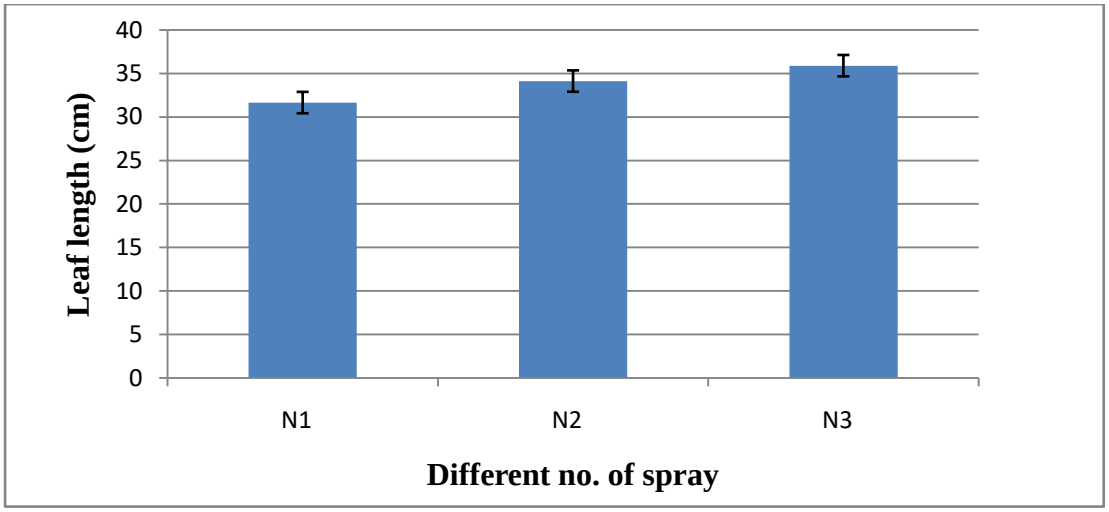


Fig. 3. Effect of different number of sprays of nitrobenzene on leaf length of bottle gourd at harvest. Where, N_1= One spray, N_2= Two spray, N_3= Three spray

Combined effect of different concentrations and number of spray showed statistically significant variation on leaf length of bottle gourd at harvest (Table 7. and Appendix VI). The result showed that maximum leaf length (40.72 cm) was recorded from treatment combination of C_2N_3 which is significantly different from other treatment combinations whereas the minimum leaf length (30.05 cm) was found from the treatment combination of C_0N_1 which is statistically identical with C_0N_2 and C_0N_3 treatment combinations. From the above result it revealed that application of nitrobenzene increases the leaf length.

Table 7. Combined effect of different concentrations and number of sprays of nitrobenzene on leaf length of bottle gourd at harvest

Treatment combination	Leaf length (cm) at harvest
C_0N_1	30.05 f
C_0N_2	30.33 f
C_0N_3	31.06 f
C_1N_1	32.27 e
C_1N_2	34.03 d
C_1N_3	35.90 c
C_2N_1	32.62 e
C_2N_2	38.00 b
C_2N_3	40.72 a
LSD(0.05)	1.2065
CV%	2.08

Where, C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L, where, N_1= One spray, N_2= Two spray, N_3= Three spray

4.4 Leaf breadth (cm)

Significant influence was noted on leaf breadth at harvest of bottle gourd affected by different concentrations of nitrobenzene (Table 8 and Appendix VI). At harvest, it was eminent that the highest leaf breadth (36.45 cm) was recorded from C_2 (nitrobenzene @ 3 ml/L) treatment which was significantly different from others whereas the lowest leaf breadth (26.71 cm) was recorded from C_0 (control) treatment. It showed that leaf breadth of bottle gourd increased with the increase of concentration of nitrobenzene. The present finding is agreed with the statement of Agarwal and Guhey (2009) and Chowdhury *et al*. (2018).

Table 8. Effect of different concentrations of nitrobenzene on leaf breadth of bottle gourd at harvest

Treatment	Leaf breadth (cm) at harvest
C_0	26.71 c
C_1	30.59 b
C_2	36.45 a
LSD(0.05)	1.1546
CV%	3.73

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L

At harvest leaf breadth of bottle gourd was varied significantly due to different number of spray (Table 9 and Appendix VI). The result revealed that the highest leaf breadth (32.71 cm) was recorded from N_3 (three spray) treatment which was significantly different from others whereas the lowest leaf breadth (29.73 cm) was recorded from N_1 (one spray) treatment.

Table 9. Effect of different number of sprays of nitrobenzene on leaf breadth of bottle gourd at harvest

Treatment	Leaf breadth (cm) at harvest
N_1	29.73 c
N_2	31.31 b
N_3	32.71 a
LSD(0.05)	1.1546
CV%	3.73

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, N_1= One spray, N_2= Two spray, N_3= Three spray

Significant variation was remarked on leaf breadth at harvest influenced by combined effect of different concentrations and number of spray (Table 10 and Appendix VI). Results exposed that the highest leaf breadth (38.67 cm) was obtained from the treatment combination of C_2N_3. The lowest leaf breadth (26.04 cm) was obtained from treatment combination of C_0N_1 which was statistically identical to the treatment combination of C_0N_2 and statistically similar to the treatment combination of C_0N_3. From the above result it revealed that application of nitrobenzene increases the leaf breadth.

4.5 Number of primary branches per plant at harvest

The number of primary branches per plant showed significant difference due to application of different concentrations of nitrobenzene (Fig. 3. and Appendix VI, X). At harvest (140 DAT) the maximum number of primary branches (19.99) was found from C_2 (nitrobenzene @ 3 ml/L) treatment while minimum number of branches (14.82) was counted from C_0 (control) treatment. Sarawathi and Praneetha (2013) found similar result.

Application of different number of spray of nitrobenzene showed significant variations on number of primary branches per plant (Fig. 4. and Appendix VI, XI). At harvest (140 DAT) the maximum number of branches (19.03) was found in N_3 (three spray) treatment while the minimum number of branches (15.44) was recorded in N_1 (one pray) treatment. The result also indicated that the increasing rate of number of spray significantly increased the number of branches. This result is in agreement with the findings of Pandita *et al.* (1989).

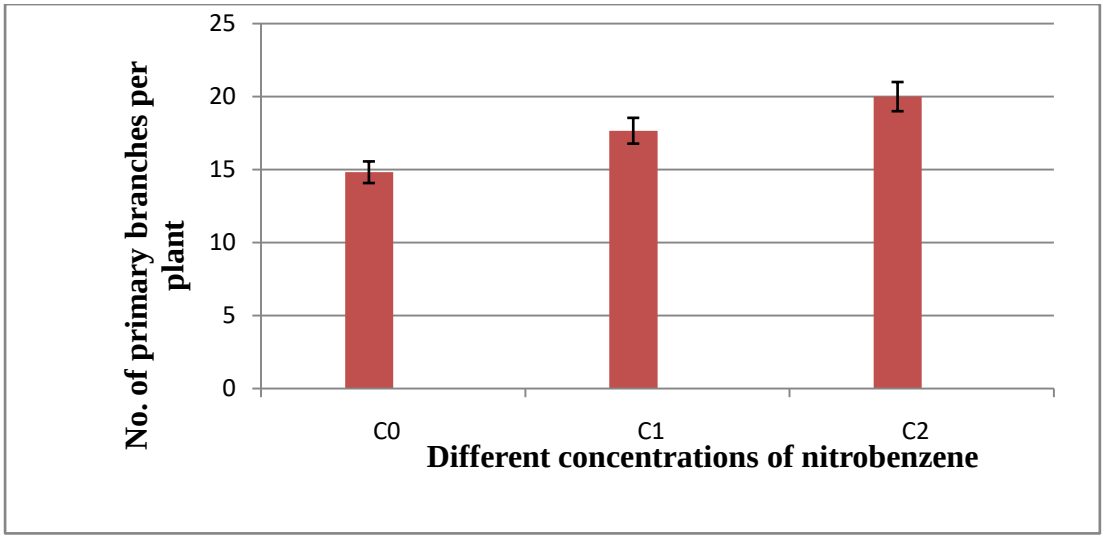


Fig. 4. Effect of different concentrations of nitrobenzene on number of primary branches per plant at harvest of bottle gourd. Where, C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L

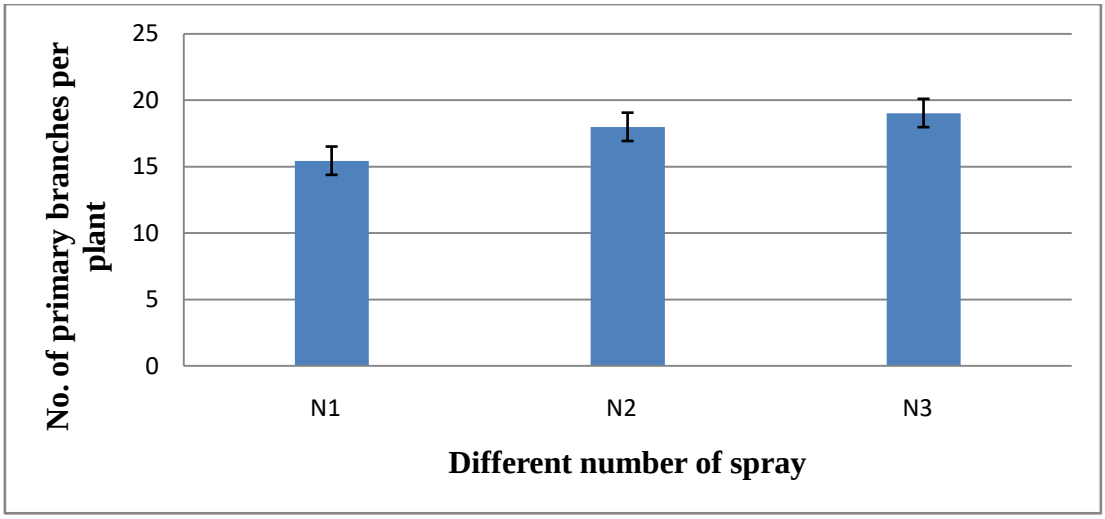


Fig. 5. Effect of different number of sprays of nitrobenzene on number of primary branches per plant at harvest of bottle gourd. Where, N_1= One spray, N_2= Two spray, N_3= Three spray

The combined effect of different concentrations and number of spray performed wide range of variations on number of primary branches per plant at harvest (Table 10 and Appendix VI). At harvest (140 DAT) the highest number of branch (22.64) was counted from C_2N_3 treatment combination while the minimum number of branches per plant (14.02) was found from C_0N_1 treatment combination. It was observed in present study that plant growth regulators increase number of branches per plant of sweet pepper. It can be said that plant growth regulators play a vital role in several

physiological processes, *viz*, photosynthesis, respiration, energy store, transfer, cell division which will significantly enhance the auxiliary stalk or branching of plants.

Table 10. Combined effect of different concentrations and number of sprays of nitrobenzene on leaf breadth, number of primary branches per plant of bottle gourd

Treatment combination	Leaf breadth (cm) at harvest	Number of primary branches per plant at harvest
C_0N_1	26.04 g	14.02 g
C_0N_2	26.64 g	15.24 f
C_0N_3	27.46 fg	15.20 f
C_1N_1	29.06 ef	16.05 ef
C_1N_2	30.69 de	17.67 d
C_1N_3	32.01 d	19.27 c
C_2N_1	34.09 c	16.27 e
C_2N_2	36.58 b	21.08 b
C_2N_3	38.67 a	22.64 a
LSD(0.05)	1.9999	0.9977
CV%	3.73	3.32

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L Where, N_1= One spray, N_2= Two spray, N_3= Three spray.

4.6 Days required to first male flowering

Different concentrations of nitrobenzene had significant influence on days required to first male flowering of bottle gourd (Table 11 and Appendix VII). It was observed that maximum days (69.95) to first male flowering was required in C_2 (nitrobenzene @ 3 ml/L)) treatment whereas minimum days to first male flowering (58.03) was required in C_1 (nitrobenzene @ 2 ml/L) treatment. This is might be due to regulating effect of exogenous application of nitrobenzene that influences early floral initiation. Dogra *et al*. (2012), Sudhakar and Kumar (2012) and Sarkar *et al*. (2014) where they stated that, PGRs promotes vegetative growth, increases the photosynthetic and metabolic activities causing more transport and utilization of photosynthetic products resulting early flowering in different plants. Ahmad *et al*. (2017) also found that those JP-27 cherry tomato plants required less time to flowering which are treated with nitrobenzene over control. Kohombange *et al*. (2019), Saraswathi and Praneetha (2013) found similar result.

The data on days required to first male flowering was found to be significant in terms of different number of spray of nitrobenzene on bottle gourd (Table 12 and Appendix VII). Results exposed that maximum days (65.75) to first male flowering was required in N_1 (one spray) treatment whereas minimum days (61.14) to first male flowering was required in N_3 (three spray) treatment which is statistically identical to N_2 (two spray) treatment.

Significant variation was remarked on days to first male flowering influenced by combination of different concentrations and number of spray of nitrobenzene on bottle gourd (Table 13 and Appendix VII). It was observed that maximum days (71.88) to first male flowering was required in C_2N_3 treatment combination whereas minimum days (53.16) to first male flowering was required from C_1N_3 treatment combination.

4.7 Days required to first female flowering

The days required to first female flowering showed significant difference for different concentrations of nitrobenzene application (Table 11 and Appendix VII). Due to application of different concentrations of nitrobenzene, the maximum days required to first female flowering (70.83) was recorded in C_2 (nitrobenzene @ 3 ml/L) treatment while the minimum day to first female flowering (61.88) was recorded in C_1 (nitrobenzene @ 2 ml/L) treatment. This might be due to that nitrobenzene treatment facilitated better reproductive development of plant. Ahmed *et al*. (2017) also found that those JP-27 cherry tomato plants required less time to flowering which are treated with nitrobenzene over control. Kohombange *et al*. (2019), Saraswathi and Praneetha (2013) found similar result.

Application of different number of spray on bottle gourd showed significant effect on days to first female flowering (Table 12 and Appendix VII). The maximum days required to first female flowering (67.73) was found in N_1 (one spray) treatment while the minimum days to first female flowering (65.05) was recorded in N_3 (three spray) treatment which is statistically identical to N_2 (two spray) treatment. This might be due to application of nitrobenzene helped to early flowering in bottle gourd plants.

Days to first female flowering was significantly influenced by the combination of different concentrations and number of spray of nitrobenzene (Table 13 and Appendix VII). It was verified that the maximum days required to first female (73.83) flowering was found from C_2N_3 treatment combination whereas minimum days to first female (58.16) was obtained from treatment combination of C_1N_3.

4.8 Number of male flowers per plant

The data on number of male flower per plant was found to be significant in terms of for different concentrations of nitrobenzene application on bottle gourd (Table 11 and Appendix VII). The maximum (51.06) number of male flower per plant was recorded from C_1 (nitrobenzene @ 2 ml/L) treatment which is statistically significant from other treatments while the minimum number of male flower per plant (38.73) was recorded from C_0 (control) treatment. This might be due to that nitrobenzene helped in proper reproductive development in bottle gourd.

Application of different number of spray on bottle gourd showed significant effect on number of male flower per plant (Table 12 and Appendix VII). The maximum number of male flower (49.01) was recorded from N_3 (three spray) treatment which is statistically significant from other treatments while the minimum (41.78) number of male flower per plant was recorded from N_1 (one spray) treatment.

Combined effect between plant different concentrations and number of spray of nitrobenzene showed a statistically significant variation in consideration to number of male flower per plant. The maximum number of male flower per plant (57.78) was recorded from the treatment combination of C_1N_3 while the minimum number of male flower per plant (37.36) was recorded from combination treatment of C_0N_2 which is statistically similar to C_0N_1 treatment combination (Table 13 and Appendix VII). Babu *et al.* (2009) observed nitrobenzene spray resulted in high number of inflorescences per plant followed by brassinolide and gibberellic acid. Kohombange *et al.* (2017) also observed that application of nitrobenzene increases the number of flowers in bell pepper.

4.9 Number of female flower per plant

The recorded data on number of female flower per plant was significant with different concentrations of nitrobenzene (Fig. 6. and Appendix VII, X). The result showed that the maximum number of female flower (40.18) was found from treatment C_1 (nitrobenzene @ 2 ml/L). On the other hand minimum number of female flower (27.15) was found from C_0 (control) treatment.

The number of female flower per plant showed statistically significant impact due to different number of spray of nitrobenzene application in bottle gourd cultivation (Fig. 7. and Appendix VII, XI). Due to influence of different number of spray of nitrobenzene the maximum number of female flower per plant (38.05) was recorded in N_3 (three spray) treatment while the minimum number of female flower per plant (29.50) was observed in N_1 (one spray) treatment. This might be due to that nitrobenzene helped in proper reproductive development in bottle gourd.

Remarkable variation was found on number of female flower per plant influenced by combination of different concentrations and number of spray of nitrobenzene (Table 13 and Appendix VII). It was verified that maximum number of female flower per plant (47.12) was recorded from the treatment combination of C_1N_3. On the other hand, the minimum (25.16) number of female flower per plant was recorded from combined treatment of C_0N_1, which is statistically similar to C_0N_2 treatment combination. Nuruzzaman *et al*. (2015) also found similar result. They found that application of nitrobenzene produce more number flowers in strawberry over control.

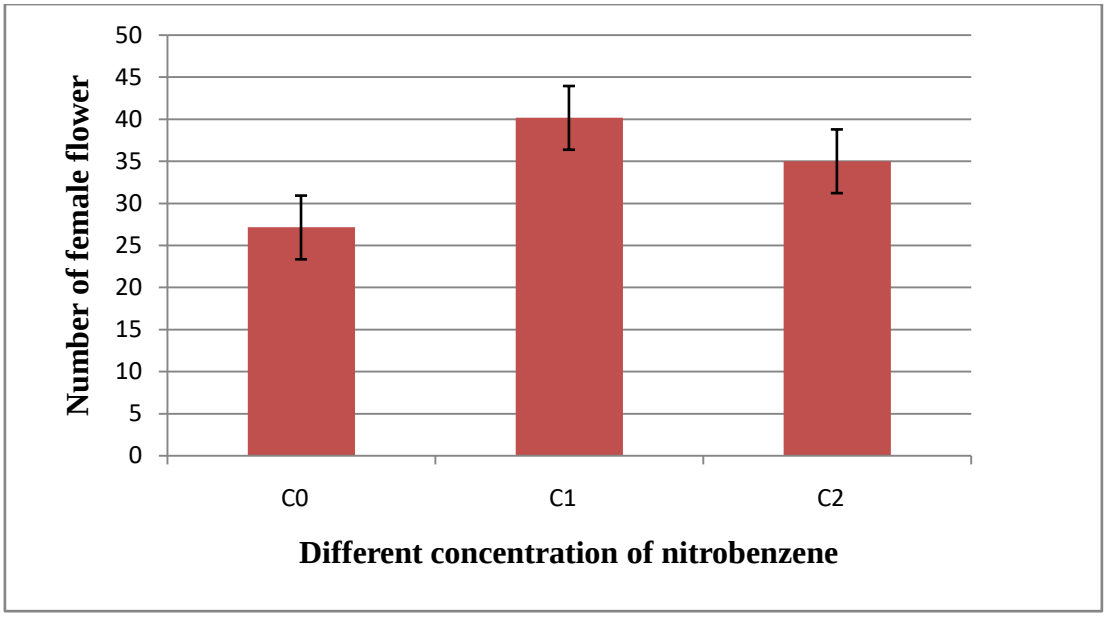


Fig. 6. Effect of different concentrations of nitrobenzene on number female flowers per plant of bottle gourd. Where, C_0= Control (Water only),C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L

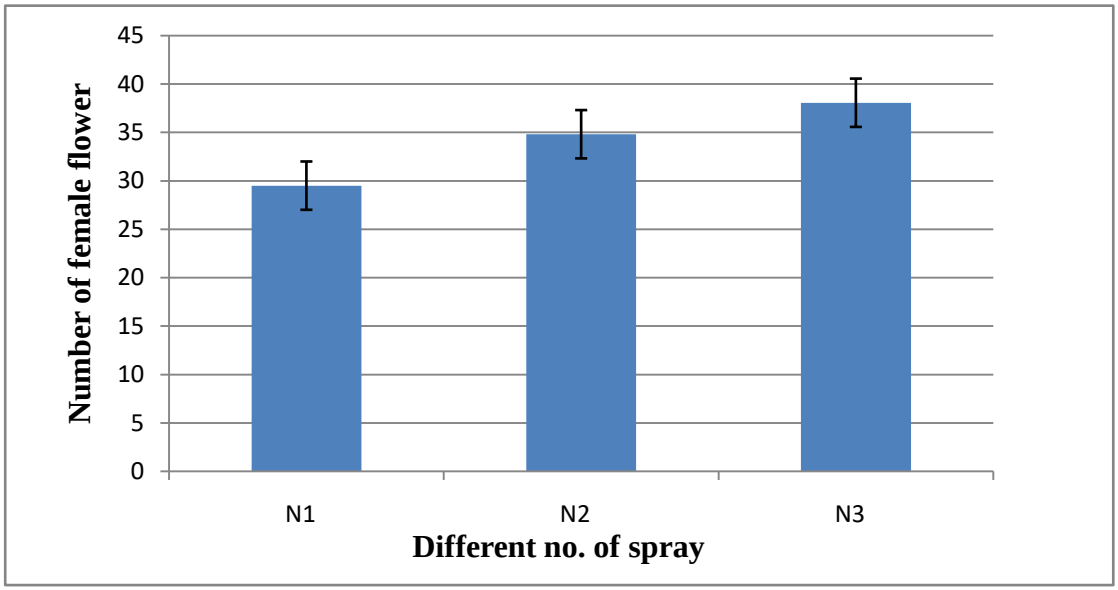


Fig.7. Effect of different number of sprays of nitrobenzene on number of female flower per plant of bottle gourd. Where, N_1= One spray, N_2= Two spray, N_3= Three spray

Table 11. Effect of different concentrations of nitrobenzene on number of days required to first male flower of, days required to first female flower, number of male flower bottle gourd

Treatment	Days required to first male flower	Days required to first female flower	Number of male flower
C_0	61.11 b	65.50 b	38.73 c
C_1	58.03 c	61.88 c	51.06 a
C_2	69.95 a	70.83 a	46.29 b
LSD(0.05)	1.1138	1.4378	1.0283
CV%	1.78	2.2	2.29

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L

Table 12. Effect of different number of sprays of nitrobenzene on number of days to first male flower of, days to first female flower, number of male flower bottle gourd

Treatment	Days required to first male flower	Days required to first female flower	Number of male flower
N_1	65.75 a	67.73 a	41.78 c
N_2	62.14 b	65.44 b	45.28 b
N_3	61.14 b	65.05 b	49.01 a
LSD(0.05)	1.1138	1.4378	1.0283
CV%	1.78	2.2	2.29

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, N_1= One spray, N_2= Two spray, N_3= Three spray

4.10 Days required to first fruit harvest

Significant variation was observed on days required to first fruit harvest of bottle gourd influenced by different concentrations of nitrobenzene (Table 14 and Appendix VIII). Results indicated that maximum days required to first fruit harvest (85.96) was recorded from C_2 (nitrobenzene @ 3 ml/L) treatment, while minimum days to first fruit harvest was (77.42) recorded from C_1 (nitrobenzene @ 2 ml/L) treatment.

Table 13. Combined effect of different concentrations and number of sprays of nitrobenzene on number of days required to first male flower of, days required to first female flower, number of male flower, number of female flower bottle gourd

Treatment combination	Days required to first male flower	Days required to first female flower	Number of male flower	Number of female flower
C_0N_1	64.01 d	69.02 bc	38.82 fg	25.16 h
C_0N_2	60.94 e	64.33 d	37.36 g	27.39 gh
C_0N_3	58.39 f	63.16 d	40.02 f	28.90 fg
C_1N_1	65.24 d	66.83 c	42.90 e	31.24 ef
C_1N_2	55.69 g	60.66 e	52.50 b	42.19 b
C_1N_3	53.16 h	58.16 f	57.78 a	47.12 a
C_2N_1	68.01 c	67.33 c	43.64 e	32.10 e
C_2N_2	69.95 b	71.33 b	45.98 d	34.83 d
C_2N_3	71.88 a	73.83 a	49.26 c	38.14 c
LSD(0.05)	1.9291	2.4904	1.7811	2.5257
CV%	1.78	2.2	2.29	4.32

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L, Where, N_1= One spray, N_2= Two spray, N_3= Three spray

Days to first fruit harvest of bottle gourd was significantly varied due to different number of spray of nitrobenzene (Table 15 and Appendix VIII). It was examined that maximum days required to first fruit harvest (83.23) was recorded from N_1 (one spray) treatment while minimum days required to first fruit harvest (79.65) was recorded from N_3 (three spray) treatment.

Combined effect between different concentrations and number of spray of nitrobenzene was found to be significant on days required to first fruit harvest. Among the combined treatments, the days required to first fruit harvest was maximum (89.06) in the treatment combination of C_2N_3, while the days required to first fruit harvest was minimum (73.01) in the treatment combination of C_1N_3.

4.11 Fruit length (cm)

Variation on fruit length differed significantly due to different concentrations of nitrobenzene at growth stage (Table 14, Plate 4 and Appendix VIII). Results revealed that maximum fruit length (36.29 cm) was observed from C_2 (nitrobenzene @ 3 ml/L)

treatment and minimum fruit length (31.88 cm) was found from C_0 (control) treatment. This result is similar with Nuruzzaman *et al.* (2015) and Kohombange *et al.* (2017).

Significant influence was observed in terms of fruit length of bottle gourd influenced by different number of spray (Table 15 and Appendix VIII). Result signified that maximum fruit length (35.42 cm) was observed from N_3 (three spray) treatment which is statistically identical to N_2 (two spray) treatment and minimum fruit length (32.80 cm) was found from N_1 (one spray) treatment.

Combined effect of different concentrations and number of spray showed statistically significant variation on fruit length of bottle gourd (Table 16 and Appendix VIII). The result showed that maximum fruit length (38.08 cm) was recorded from treatment combination C_2N_3 which is statistically similar to C_2N_2 treatment combination and the minimum fruit length (31.04 cm) was found from the treatment combination of C_0N_1 which is statistically similar to C_0N_3 treatment combination. From the above result it revealed that application of nitrobenzene increases the fruit length. Pramoda *et al.* (2018) also found similar result.

4.12 Fruit diameter (cm)

Significant influence was noted on fruit diameter of bottle gourd affected by different concentrations of nitrobenzene (Table 14, Plate 4 and Appendix VIII). It was eminent that the highest fruit diameter (13.26 cm) was recorded from C_2 (nitrobenzene @ 3 ml/L) treatment which was significantly different from others whereas the lowest fruit diameter (11.21 cm) was recorded from C_0 (control) treatment. It showed that fruit diameter of bottle gourd increased with the increase of concentration of nitrobenzene. This result is similar with the findings of Nuruzzaman *et al.* (2015).

Fruit diameter of bottle gourd was varied significantly due to different number of spray (Table 15 and Appendix VIII). The result revealed that highest fruit diameter (12.82 cm) was recorded from N_3 (three spray) treatment which was significantly identical to N_2 (two spray) treatment whereas the lowest fruit diameter (11.77 cm) was recorded from N_1 (one spray) treatment.

Significant variation was remarked on fruit diameter influenced by combined effect of different concentrations and number of spray (Table 16 and Appendix VIII). Results exposed that the highest fruit diameter (14.27 cm) was obtained from the treatment combination of C_2N_3 which is statistically similar to the treatment combination of C_2N_2. The lowest fruit diameter (11.02 cm) was obtained from treatment combination of C_0N_1 which is statistically similar with the treatment combination of C_0N_2 and C_0N_3. From the above result it revealed that application of nitrobenzene increases the fruit diameter.

Table 14. Effect of different concentrations of nitrobenzene on days to first fruit harvest, fruit length, fruit diameter of bottle gourd

Treatment	Days to first fruit harvest	Fruit length (cm)	Fruit diameter (cm)
C_0	80.57 b	31.88 c	11.21 c
C_1	77.42 c	34.89 b	12.67 b
C_2	85.96 a	36.29 a	13.26 a
LSD(0.05)	0.9325	0.6889	0.4753
CV%	1.16	2.01	3.84

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L

Table 15. Effect of different number of sprays of nitrobenzene on days required to first fruit harvest, fruit length, fruit diameter of bottle gourd

Treatment	Days required to first fruit harvest.	Fruit length (cm)	Fruit diameter (cm)
N_1	83.24 a	32.80 b	11.77 b
N_2	80.66 b	34.83 a	12.55 a
N_3	79.65 c	35.42 a	12.82 a
LSD(0.05)	0.9325	0.6889	0.4753
CV%	1.16	2.01	3.84

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, N_1= One spray, N_2= Two spray, N_3= Three spray

4.13 Number of fruit harvested per plant

Significant variation was observed on number of fruit harvested per plant of bottle gourd influenced by different concentrations of nitrobenzene (Table 17 and Appendix IX). Results indicated that the maximum number of fruit harvested per plant (10.95) was recorded from C_2 (nitrobenzene @ 3 ml/L) treatment while the minimum number of fruit harvested per plant was (8.01) recorded from C_0 (control) treatment.

Table 16. Combined effect of different concentrations and number of sprays of nitrobenzene on days required to first fruit harvest, fruit diameter, fruit length of bottle gourd

Treatment combination	Day required to first fruit harvest	Fruit length (cm)	Fruit diameter (cm)
C_0N_1	84.40 c	31.04 g	11.02 f
C_0N_2	79.25 e	32.42 ef	11.44 ef
C_0N_3	78.06 e	32.18 fg	11.17 ef
C_1N_1	83.23 cd	33.48 de	12.42 cd
C_1N_2	76.01 f	35.17 c	12.57 cd
C_1N_3	73.01 g	36.02 bc	13.01 bc
C_2N_1	82.08 d	33.88 d	11.87 de
C_2N_2	86.74 b	36.91 ab	13.63 ab
C_2N_3	89.06 a	38.08 a	14.27 a
LSD(0.05)	1.6151	1.1933	0.8232
CV%	1.16	2.01	3.84

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L. Where, N_1= One spray, N_2= Two spray, N_3= Three spray

The number of fruit harvested per plant of bottle gourd showed statistically significant impact due to different number of spray of nitrobenzene application (Table 18 and Appendix IX). Due to influence of different number of spray of nitrobenzene the maximum number of fruit harvested per plant (10.32) was recorded from N_3 (three spray) treatment while the minimum number of fruit harvested per plant (8.61) was from N_1 (one spray) treatment. This might be due to that nitrobenzene helped in proper reproductive development in bottle gourd.

Combined effect of different concentrations and number of spray showed statistically significant variation on number of fruit harvested per plant of bottle gourd (Table 19 and Appendix IX). The result showed that maximum number of fruit harvested per plant (12.55) was recorded from treatment combination of C_1N_3 which is significantly different from other treatment combinations. The minimum number of fruit harvested per plant (7.88) was found from the treatment combination C_0N_1 which is statistically identical to C_0N_2 and statistically similar to C_0N_3 treatment combinations. From the above result it revealed that application of nitrobenzene increases number of fruit harvested per plant. This might be due to that nitrobenzene helped in proper reproductive development in bottle gourd. This result is also in agreement with the

findings of Saraswathi and Praneetha (2013), Nuruzzaman *et al.* (2015), Kohombange *et al.* (2017) and Kohombange *et al.* (2019).

4.14 Individual fruit weight (kg)

There was significant variation on individual fruit weight of bottle gourd influenced by different concentrations of nitrobenzene. It was observed that the highest individual fruit weight (2.11 kg) was achieved from C_2 (Nitrobenzene @ 3ml/L) treatment whereas the lowest individual fruit weight (1.96 kg) was achieved from C_0 (Control) treatment (Table 17 and Appendix IX).

Individual fruit weight of bottle gourd was significantly influenced by different number of spray of nitrobenzene. It was found that the highest individual fruit weight (2.08 kg) was achieved from N_3 (two spray) treatment which is statistically identical with N_2 (two spray) treatment whereas the lowest individual fruit weight (1.98 kg) was achieved from N_1 (one spray) treatment (Table 18 and Appendix IX).

Combined effect between different concentrations and number of spray of nitrobenzene was found to be significant of individual fruit weight (Table 19 and Appendix IX). Among the combined treatments, the individual fruit weight was maximum (2.17 kg) in the treatment combination of C_2N_2 which is statistically similar to C_2N_3 and the individual fruit weight was minimum (1.89 kg) in the treatment combination of C_0N_1 which is statistically similar to C_0N_2 treatment combination (Table 19 and Appendix IX). This result similar with the previous findings Aziz *et al.*(2009), Kohombange *et al*. (2017) and Pramoda *et al.* (2018).

4.15 Yield per plant (kg)

Significant variation was noted on yield per plant of bottle gourd influenced by different concentrations of nitrobenzene (Table 17 and Appendix IX). The result revealed that highest yield per plant (22.28 kg) was observed from C_1 (nitrobenzene @ 2 ml/L) treatment while lowest yield per plant (15.68 kg) was found from C_0 (control) treatment.

Yield per plant of bottle gourd was significantly varied due to different number of spray of nitrobenzene (Table 18 and Appendix IX). It was examined that the highest yield per plant (21.18 kg) was observed from N_3 (three spray) treatment while the lowest yield per plant (17.08 kg) was found from N_1 (one spray) treatment. It indicated that with the increase of number of spray of nitrobenzene yield per plant increased.

Combined effect between different concentrations and number of spray showed a statistically significant variation for yield per plant (Table 19 and Appendix IX). The result indicated that the highest yield per plant (25.35 kg) was observed from C_1N_3 treatment combination while the lowest yield per plant (14.90 kg) was found from C_0N_1 (One spray) treatment combination which is significantly similar with treatment combination of C_0N_2. It indicated that with the increase of number of spray of nitrobenzene yield per plant increased. This might be due to that nitrobenzene helped in proper reproductive development in bottle gourd. This result was also an agreement with Ahmed *et al.* (2017), Kohombange *et al.* (2017), Pramoda *et al.* (2018), and Kohombange *et al.* (2019).

4.16 Yield per plot (kg)

Significant variation was noted on yield per plot of bottle gourd influenced by different concentrations of nitrobenzene (Table 17 and Appendix IX). The result revealed that the highest yield per plot (44.55 kg) was noted from C_1 (nitrobenzene @ 2 ml/L) treatment while the lowest yield per plot (31.37 kg) was found from C_0 (control) treatment.

Yield per plot of bottle gourd was significantly varied due to different number of spray of nitrobenzene (Table 18 and Appendix IX). It was examined that the highest yield per plot (42.35 kg) was observed from N_3 (three spray) treatment while the lowest yield per plot (34.17 kg) was found from N_1 (one spray) treatment. It indicated that with the increase of number of spray of nitrobenzene yield per plot is also increased.

Plate 4. A photograph showing the harvested bottle gourd from different treatment combinations which are different in length and diameter.

Combined effect between different concentrations and number of spray showed a statistically significant variation for yield per plot (Table 19 and Appendix IX). The result indicated that the highest yield per plot (50.70 kg) was observed from C_1N_3 treatment combination while the lowest yield per plot (29.81 kg) was found from C_0N_1 treatment combination which is significantly similar with treatment combination of C_0N_2. It indicated that with the increase of number of spray of nitrobenzene yield per plot increased. This might be due to that nitrobenzene helped in proper reproductive development in bottle gourd.

4.17 Fruit yield per hectare (t)

Significant variation was noted on fruit yield per plot of bottle gourd affected by different concentrations of nitrobenzene (Figure 8, Table 17 and Appendix IX). The result revealed that the highest fruit yield per hectare (55.70 t) was observed from C_1 (nitrobenzene @ 2 ml/L) treatment while the lowest fruit yield per hectare (39.21 t) was found from C_0 (control) treatment.

Fruit yield per hectare of bottle gourd was significantly varied due to different number of spray of nitrobenzene (Figure 9, Table 18 and Appendix IX). It was examined that the highest fruit yield per hectare (52.94 t) was observed from N_3 (three spray) treatment while the lowest fruit yield per hectare (42.71 t) was found from N_1 (one spray) treatment. It indicated that with the increase of number of spray of nitrobenzene fruit yield per hectare increased.

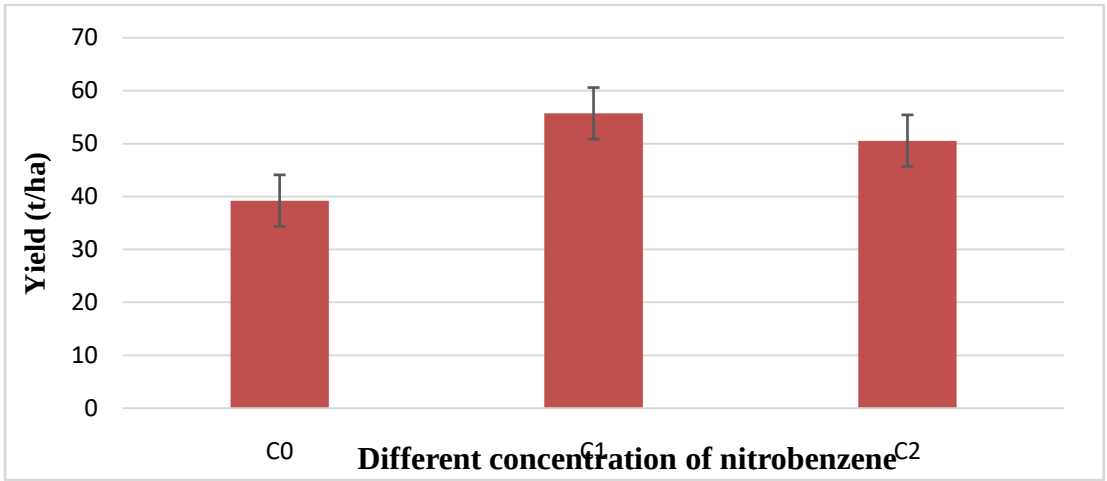


Fig.8. Effect of different concentrations of nitrobenzene on yield per hectare of bottle gourd. Where, C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2=Nitrobenzene @ 3 ml/L

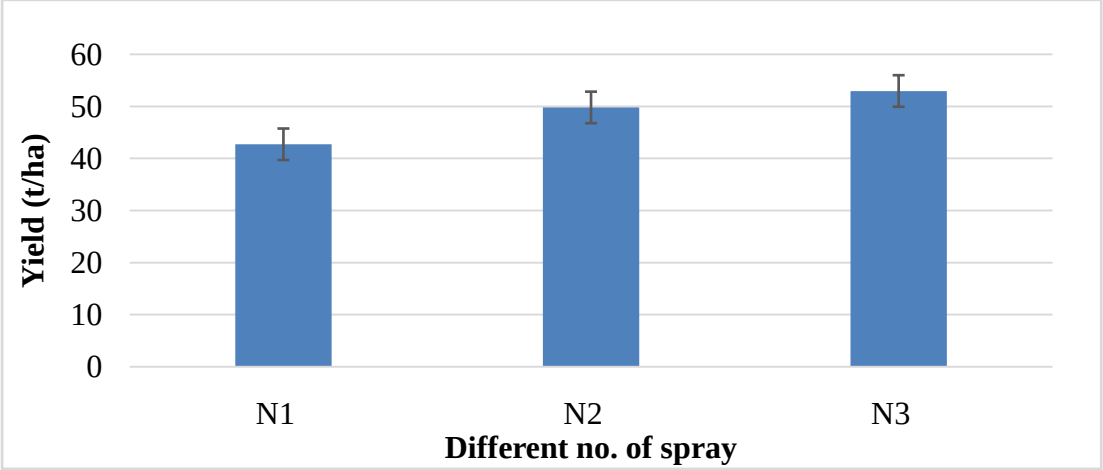


Fig.9. Effect of different number of sprays of nitrobenzene on yield per hectare of bottle gourd. Where, N_1= One spray, N_2= Two spray, N_3= Three spray

Combined effect between different concentrations and number of spray showed a statistically significant variation for fruit yield per hectare (Table 19 and Appendix IX). The result indicated that the highest fruit yield per hectare (63.38 t) was observed from C_1N_3 treatment combination while the lowest fruit yield per hectare (37.26 t) was found from C_0N_1 (one spray) treatment which is significantly similar with treatment combination of C_0N_2. It indicated that with the increase of number of spray of nitrobenzene fruit yield per hectare increased. This might be due to that nitrobenzene helped in proper reproductive development in bottle gourd. This result was also an agreement with Aziz and Miah (2009), Ahmed *et al.* (2017), Kohombange *et al.* (2017), Pramoda *et al.* (2018), Chowdhury *et al.* (2018) and Kohombange *et al.* (2019).

Table 17. Effect of different concentrations of nitrobenzene on number of fruits harvested, individual fruit weight, yield per plant, yield per plot, yield per hectare of bottle gourd

Treatment	Number of fruits harvested	Individual fruit weight(kg)	Yield per plant(kg)	Yield per plot(kg)	Yield per hectare (t)
C_0	8.01 c	1.96 c	15.68 c	31.37 c	39.21 c
C_1	10.95 a	2.04 b	22.28 a	44.55 a	55.70 a
C_2	9.55 b	2.11a	20.21 b	40.43 b	50.54 b
LSD(0.05)	0.5012	0.0555	0.7415	1.483	1.8538
CV%	5.32	2.73	3.86	3.86	3.86

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L

Table18. Effect of different number of sprays of nitrobenzene on number of fruits harvested, individual fruit weight, yield per plant, yield per plot, yield per hectare of bottle gourd

Treatment	Number of fruits harvested	Individual fruit weight(kg)	Yield per plant(kg)	Yield per plot(kg)	Yield per hectare (t)
N_1	8.61 c	1.98 b	17.08 c	34.17 c	42.71 c
N_2	9.59 b	2.06 a	19.91 b	39.83 b	49.78 b
N_3	10.32 a	2.08 a	21.18 a	42.35 a	52.94 a
LSD(0.05)	0.5012	0.0555	0.7415	1.483	1.8538
CV%	5.32	2.73	3.86	3.86	3.86

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, N_1= One spray, N_2= Two spray, N_3= Three spray

Table 19. Combined effect of different concentrations and number of sprays of nitrobenzene on number of fruits harvested, individual fruit weight, yield per plant, yield per plot, and yield per hectare of bottle gourd

Treatment combination	Number of fruits harvested	Individual fruit weight(kg)	Yield per plant(kg)	Yield per plot(kg)	Yield per hectare (t)
C_0N_1	7.88 f	1.89 d	14.90 g	29.81 g	37.26 g
C_0N_2	8.02 f	1.98 cd	15.88 fg	31.76 fg	39.70 fg
C_0N_3	8.12 ef	2.00 c	16.26 f	32.53 f	40.66 f
C_1N_1	8.93 de	2.01 c	17.94 e	35.89 e	44.86 e
C_1N_2	11.37 b	2.07 bc	23.54 b	47.07 b	58.84 b
C_1N_3	12.55 a	2.02c	25.35 a	50.70 a	63.38 a
C_2N_1	9.02 d	2.04 c	18.40 e	36.81 e	46.01 e
C_2N_2	9.37 d	2.17 a	20.33 d	40.65 d	50.81 d
C_2N_3	10.27 c	2.14 ab	21.92 c	43.83 c	54.79 c
LSD(0.05)	0.868	0.0961	1.2843	2.5687	3.21
CV%	5.32	2.73	3.86	3.86	3.86

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L, N_1= One spray, N_2= Two spray, N_3= Three spray

4.18 Economic analysis

Input costs for land preparation, fertilizer, irrigation, equipment for making trellis and manpower required for all the operations from seed sowing to harvesting, interest on fixed capital of land (Leased land by loan basis) and miscellaneous cost were calculated for unit plot and converted into cost per hectare (Table 20 and Appendix

XII). Price of bottle gourd branch and fruit were considered as per market rate. The economic analysis presented under the following headings-

4.18.1 Gross return

The combination of different concentrations and number of spray of nitrobenzene showed different values in terms of gross return under the trial (Table 20). The highest gross return (Tk. 1,06,3200) was found from the treatment combination of C_1N_3 and the second highest gross return (Tk. 9,82,650) was obtained in C_1N_2 treatment combination. The lowest gross return (Tk. 6,60,450) was obtained from C_0N_2 treatment combination.

4.18.2 Net return

In case of net return, different treatment combination showed different levels of net return under the present trial (Table 20). The highest net return (Tk. 5,87,384.7) was obtained from the treatment combination of C_1N_3 and the second highest net return (Tk. 5,07,733.8) was found from the treatment combination of C_1N_2. The lowest (Tk. 1,48,332) net return was found from C_0N_1 treatment combination.

4.18.3 Benefit Cost Ratio

The combination of different plant growth regulators and number of spray of nitrobenzene for benefit cost ratio was different in all treatment combination (Table 20). The highest benefit cost ratio (2.23) was found from the treatment combination of C_1N_3 and the second highest benefit cost ratio (2.07) was found from C_1N_2 treatment combination. The lowest benefit cost ratio (1.31) was found from the C_0N_1 treatment combination. From the economic point of view, it was apparent from the above results that the treatment combination of C_1N_3 was more profitable than rest of treatment combinations.

Table 20. Cost and return of bottle gourd cultivation as influenced by different concentrations and number of spray of nitrobenzene

Treatment	Cost of production (Tk / ha)	Yield (branch number)	Return (branch) (Tk)	Yield (t/ha)	Return(Fruit) (Tk)	Gross Return (Tk/ha)	Net return (Tk /ha)	BCR
C_0N_1	473118.0	6255	62550	37.26	670680	733230	148332.0	1.31
C_0N_2	473118.0	6495	64950	39.70	595500	660450	187332.0	1.40
C_0N_3	473118.0	7755	77550	40.66	609900	687450	214332.0	1.45
C_1N_1	474017.1	9255	92550	44.86	672900	765450	291432.9	1.61
C_1N_2	474916.2	10005	100050	58.84	882600	982650	507733.8	2.07
C_1N_3	475815.3	11250	112500	63.38	950700	1063200	587384.7	2.23
C_2N_1	474466.7	9750	97500	46.01	690150	787650	313183.3	1.66
C_2N_2	475815.3	12255	122550	50.81	762150	884700	408884.7	1.86
C_2N_3	477164	15255	152550	54.79	821850	974400	497236	2.04

Note: C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L and N_1= One spray, N_2= Two spray, N_3= Three spray

Price of branch = 10 Tk./four branch, Price of bottle gourd = 18 Tk./Kg

CHAPTER V
SUMMARY AND CONCLUSION

The research was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka, Bangladesh, the period from October 2018 to March 2019 to study the effect on growth and yield of bottle gourd (*Lagenaria siceraria* L.) as influenced by different concentration and number of spray of nitrobenzene. The experiment consists of two factors; (i) different concentration of nitrobenzene viz. C_0=Control (Water), C_1=Nitrobenzene @ 2 ml/L, C_2=Nitrobenzene @ 3 ml/L and different number of spray viz. N_1 = One spray, N_2 = Two spray, N_3 = Three spray. Levels of these two factors made 9 treatment combinations and the numbers of plots were twenty seven.

The two factors experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Data were collected on the following parameters-vine length, number of leaves per plant, leaf length, leaf breadth, number of primary branches per plant, number of branches harvested per plant, number of days to first male flower of, days to first female flower, number of male flower, number of female flower, days to first fruit harvest, fruit length, fruit diameter, number of fruits harvested, individual fruit weight, yield per plant, yield per plot, yield per hectare. The recorded data on different parameters were statistically analyzed using Statistic 10 software.

In case of different concentrations of nitrobenzene, no significant difference was found on vine length at 20 DAT (days after transplanting) of bottle gourd. But at 40, 60 and 140 DAT significant variation was found in case of vine length the highest vine length (1.30 m, 3.41 m, 12.23 m) was observed from C_2 (nitrobenzene @ 3 ml/L) treatment at 40, 60 and 140 DAT, respectively. While the lowest vine (0.93 m, 2.14 m, 8.45 m) was recorded from C_0 (control) treatment at 40, 60 and 140 DAT respectively. Similarly, at 20 DAT no significant variation was found on number of leaves per plant. But at 40, 60 and 140 DAT significant variation was found in case of number of leaves per plant the maximum number of leaves per plant (19.61, 54.88, 333.56) was observed from C_2 treatment at 40, 60 and 140 DAT, respectively.

Whereas minimum number of leaves per plant (14.83, 40.61, 269.44) was observed from C_0 (control) treatment at 40, 60 and 140 DAT respectively. The maximum leaf length (37.11 cm) was observed from C_2 treatment and minimum leaf length (30.48 cm) was found from C_0 treatment. At harvest, it was eminent that the highest leaf breadth (36.45 cm) was recorded from C_2 treatment which was significantly different from others whereas the lowest leaf breadth (26.71 cm) was recorded from C_0 treatment. At harvest (140 DAT) the maximum number of branches (19.99) was found from C_2 treatment while minimum number of branches (14.82) was counted from C_0 treatment. It was observed that maximum days (69.95 days) to first male flowering was required in C_2 treatment whereas minimum days to first male flowering (58.03 days) was required in C_1 (Nitrobenzene @ 2 ml/L) treatment. The maximum days required to first female flowering (70.83 days) was recorded in =treatment while the minimum day to first female flowering (61.88 days) was recorded in C_1 = treatment. The maximum (51.06) number of male flower per plant was recorded from C_1 treatment which is statistically significant from other treatments while the minimum number of male flower per plant (38.73) was recorded from C_0 treatment. The result showed that the maximum number of female flower (40.18) was found from C_1 treatment. On the other hand minimum number of female flower (27.15) was found from C_0 btreatment. The maximum days required to first fruit harvest (85.96 days) was recorded from C_2 treatment, while minimum days to first fruit harvest was (77.42) recorded from C_1 treatment. Results revealed that maximum fruit length (36.29 cm) was observed from C_2 treatment and minimum fruit length (31.88 cm) was found from C_0 treatment. It was eminent that the highest fruit diameter (13.26 cm) was recorded from C_2 which was significantly different from others whereas the lowest fruit diameter (11.21 cm) was recorded from C_0treatment. The highest individual fruit weight (2.11 kg) was achieved from C_2 treatment whereas the lowest individual fruit weight (1.96 kg) was achieved from C_0 treatment. The maximum number of fruit harvested per plant (10.95) was recorded from C_2 treatment while the minimum number of fruit harvested per plant was (8.01) recorded from C_0 treatment. The highest yield per plant (22.28 kg) was observed from C_1 treatment while lowest yield per plant (15.68 kg) was found from C_0 treatment. The highest yield per plot (44.55 kg) was observed from C_1 treatment while the lowest yield per plot (31.37 kg) was found from C_0 treatment.

For different number of spray, no significant difference was found on vine length at 20 and 40 DAT of bottle gourd. But at 60 and 140 DAT significant variation was found. In case of vine length.The longest vine length (3.04 m, 11.30 m) was observed from N_2 (two spray) and N_3 (three spray) treatment at 60 and 140 DAT, respectively. While at 60 and 140 DAT the shortest vine (2.57 and 9.52 m) was recorded from N_1 (one spray) treatment respectively. Similarly, at 20 DAT and 40 DAT no significant variation was found on number of leaves per plant. But at 60 and 140 DAT significant variation was found in case of number of leaves per plant, the maximum number of leaves per plant (51.27 and 322.5) was observed from N_3 treatment at 60 and 140 DAT, respectively. Whereas minimum number of leaves per plant (43.29 and 283.22) was observed from N_1 treatment at 60 and 140 DAT, respectively. The maximum leaf length (35.89 cm) was observed from N_3 and minimum leaf length (31.65 cm) was found from N_1. The highest leaf breadth (32.71 cm) was recorded from N_3 treatment which was significantly different from others whereas the lowest leaf breadth (29.73 cm) was recorded from N_1 treatment. At harvest (140 DAT) the maximum number of branches (19.03) was found in N_3 treatment while minimum number of branches (15.44) was recorded in N_1 treatment. The maximum days (65.75) to first male flowering was required in N_1 treatment whereas minimum days (61.14) to first male flowering was required in N_3 treatment which is statistically identical to N_2 (two spray) treatment. The maximum days (67.73) required to first female flowering was found in N_1 treatment while the minimum days(65.05) to first female flowering was recorded in N_3 treatment which is statistically identical to N_2 treatment. The maximum number of male flower (49.01) was recorded from N_3 treatment which is statistically significant from other treatments while the minimum (41.78) number of male flower per plant was recorded from N_1 treatment. The maximum number of female flower per plant (38.05) was recorded in N_3 treatment while the minimum number of female flower per plant (29.50) was observed in N_1 treatment. The maximum days (83.23) required to first fruit harvest was recorded from N_1 treatment while minimum days (79.65) required to first fruit harvest was recorded from treatment N_3. The maximum fruit length (35.42 cm) was observed from N_3 treatment which is statistically identical to N_2 treatment and minimum fruit length (32.80 cm) was found from N_1 treatment. The highest fruit diameter (12.82 cm) was recorded from N_3 treatment which was significantly identical to N_2 treatment whereas the lowest fruit diameter (11.77 cm) was recorded from N_1 treatment. The highest individual fruit weight (2.08 kg) was

achieved from N_3 treatment which is statistically identical with N_2 treatment whereas the lowest individual fruit weight (1.98 kg) was achieved from N_1 treatment. The maximum number of fruit harvested per plant (10.32) was recorded from N_3 treatment while the minimum number of fruit harvested per plant (8.61) was from N_1 treatment. The highest yield per plant (21.18 kg) was observed from N_3 treatment while the lowest yield per plant (17.08 kg) was found from N_1 treatment. The highest yield per plot (42.35 kg) was observed from N_3 treatment while the lowest yield per plot (34.17 kg) was found from N_1 treatment. The highest fruit yield per hectare (52.94 t) was observed from N_3 treatment while the lowest fruit yield per hectare (42.71 t) was found from N_1 treatment.

Due to the combined effect of different concentrations and number of spray, no significant difference was found on vine length at 20 DAT of bottle gourd. But at 40, 60 and 140 DAT significant variation was found. In case of vine length, the longest vine length (1.35 m, 3.77 m, 1328 m) was observed from C_2N_1, C_2N_2, C_2N_3 treatments at 40, 60 and 140 DAT, respectively. While the shortest vine (0.91 m, 2.06 m, 8.1 m) was recorded from C_0N_3, C_0N_2, C_0N_1 treatments at 40, 60 and 140 DAT respectively. The number of leaves per plant of bottle gourd at 20 DAT was not varied significantly. But at 40 DAT the treatment combination C_2N_2 gave highest number of leaves per plant (21.16) and lowest number of leaves per plant was observed in C_0N_3 (13.83). At 60 DAT the highest number of leaves per plant (60.16) was observed in treatment combination C_2N_2 and the lowest number of leaves per plant (38.33) was observed in C_0N_1 treatment combination. Finally at harvest (140 DAT), the highest number of leaves per plant (365.33) was observed in treatment combination C_2N_3 and the lowest number of leaves per plant (264.17) was observed in C_0N_1 treatment combination. The maximum leaf length (40.72 cm) was recorded from treatment combination C_2N_3 which is significantly different from other treatment combinations whereas the minimum leaf length (30.05 cm) was found from the treatment combination C_0N_1 which is statistically identical with C_0N_2 and C_0N_3 treatment combination. The highest leaf breadth (38.67 cm) was obtained from the treatment combination of C_2N_3. The lowest leaf breadth (26.04 cm) was obtained from treatment combination of C_0N_1 which was statistically identical to the treatment combination of C_0N_2 and statistically similar to the treatment combination of C_0N_3. At harvest (140 DAT) the highest number of branch (22.64) was counted from C_2N_3

treatment combination while the minimum number of branches per plant (14.02) was found from C_0N_1 treatment combination. It was observed that maximum days (71.88) to first male flowering was required in C_2N_3 treatment combination whereas minimum days (53.16) to first male flowering was required from C_1N_3 treatment combination. the maximum days (73.83) required to first female flowering was found from C_2N_3 treatment combination whereas minimum days to first female (58.16) was obtained from treatment combination C_1N_3. The maximum number of male flower per plant (57.78) was recorded from the treatment combination of C_1N_3 while the minimum number of male flower per plant (37.36) was recorded from combination treatment of C_0N_2 which is statistically similar to C_0N_1 treatment combination. The maximum number of female flower per plant (47.12) was recorded from the treatment combination of C_1N_3. On the other hand, the minimum (25.16) number of female flower per plant was recorded from treatment combination of C_0N_1, which is statistically similar to C_0N_2 treatment combination. The days required to first fruit harvest was maximum (89.06) in the treatment combination C_2N_3, while the days required to first fruit harvest was minimum (73.01) in the treatment combination of C_1N_3. The treatment combination of C_1N_2, C_0N_2 and C_0N_3 also showed that it require minimum days required to first fruit harvest but significantly different from treatment combination of C_1N_3. The maximum fruit length (38.08 cm) was recorded from treatment combination of C_2N_3 which is statistically similar to C_2N_2 treatment combination and the minimum fruit length (31.04 cm) was found from the treatment combination of C_0N_1 which is statistically similar to C_0N_3 treatment combination. The highest fruit diameter (14.27 cm) was obtained from the treatment combination of C_2N_3 which is statistically similar to the treatment combination of C_2N_2. The lowest fruit diameter (11.02 cm) was obtained from treatment combination of C_0N_1 which is statistically similar with the treatment combination of C_0N_2 and C_0N_3. The maximum (2.17 kg) in the treatment combination of C_2N_2 which is statistically similar to C_2N_3 and the individual fruit weight was minimum (1.89 kg) in the treatment combination of C_0N_1 which is statistically similar to C_2N_3 treatment combination. The maximum number of fruit harvested per plant (12.55) was recorded from treatment combination C_1N_3 which is significantly different from other treatment combinations. The minimum number of fruit harvested per plant (7.88) was found from the treatment combination C_0N_1 which is statistically identical to C_0N_2 and statistically similar to C_0N_3 treatment combination. The highest yield per plant (25.35 kg) was observed

from C_1N_3 treatment combination while the lowest yield per plant (14.90 kg) was found from C_0N_1 (One spray) treatment which is significantly similar with treatment combination of C_0N_2. The highest yield per plot (50.70 kg) was observed from C_1N_3 treatment combination while the lowest yield per plot (29.81 kg) was found from C_0N_1 treatment combination which is significantly similar with treatment combination of C_0N_2. The highest fruit yield per hectare (63.38 t) was observed from C_1N_3 treatment combination while the lowest fruit yield per hectare (37.26 t) was found from C_0N_1 treatment which is significantly similar with treatment combination C_0N_2.

Conclusion:

Considering the above result of this experiment, the following conclusion and recommendations can be drawn:

1. In the experiment, treatment C_1 (nitrobenzene @ 2 ml/L) was superior to the others.
2. Number of spray was played an important role on the growth and yield of bottle gourd. In respect of all, the N_3 (three spray) showed better performance than others.
3. The treatment combination of C_1N_3 (nitrobenzene @ 2 ml/L with three number of spray) showed the best potentiality of 63.38 t/ha with TK. 5,87,384.7 net income and 2.23 BCR.

Considering the situation of the present experiment, further study might be conducted in different agro-ecological zones (AEZ) of Bangladesh for regional adaptability and other performances. The experiment was however, conducted in one season only and hence the results should be considered as a tentative. It is imperative that similar experiment should be carried out with more variables to reconfirm the recommendation.

REFERENCES

Agrawal, K. and Guhey, A. 2009. Growth and yield attributes of sunflower influenced by foliar application of nitrobenzene. *Int. J. Plant Sci*., **5**.1: 126-128.

Ahmad, H., Hassan, M. R., Laila, B., Mahbuba, S. and Jamal Uddin, A. F. M. 2017. Plant growth promoters on growth and yield of summer cherry tomato line (JP-27). *J. Bios. Agric. Res*., **12**(02):1041-1047.

Alam, M. S., Iqbal, T. M. T., Amin, M. and Gaffar, M. A. 1989. Krishitattic Fasaler Utpadan O Unnayan (in Bengali). T. M. Jubair Bin Iqbal, Sirajgonj. pp. 231-239.

Aziz, M. A. and Miah, M. A. M. 2009. Effect of flora on the growth and yield of wetland rice. *J. Agric. Rural Dev.*, **7**: 9-13.

Babu, C. R., Vanangamudi, M., Paramathma M. and Moorthi, K. S. 2009. Effect of growth regulators on flowering and fruit set in two jatropha (*Jatropha curcas*) genotypes. *Int. J. Appl. Agric. Res*., **4**(2) :151–154.

BBS 2018. Bangladesh Bureau of Statistics. Ministry of Planning. Government of People's Republic of Bangladesh. Yearbook of Agricultural Statistics-2017. Agargoan, Dhaka. pp. 249-290.

Begum, Y., Patil, R., Meena, M. K., Amaregouda, A. and Mahantashivayogayya. 2018. Effect of foliar and soil application of different agrochemicals on phenology, physiological parameters and productivity of rice (*Oryza sativa* L.). *J. Pharma. Phytoc.*, **7**(4): 2947-2952.

Chowdhury, B. Howlader, M. H. K. Hossain, M. K. Sikder, M. C. and Hasan, M. M. 2018. Effect of nitrobenzene on growth and yield of boro rice. *Prog. Agric.,* **29** (4): 304-312.

Choudhary, B. 1979. Vegetables. National Book Trust, New Delhi.

Cutler, H. C., and Whitaker, T. W. 1967. Cucurbits from the Tehuacan caves, In: Prehistory of the Tehucan Valley, (Eds. D.S. Byers), 212-219. University of Texas Press, Austin, Texas, USA.

Dogra, S., Pandey, R. K. and Bhat, D. J. 2012. Influence of gibberellic acid and plant geometry on growth, flowering and corm production in gladiolus (*Gladiolus grandiflorus*) under Jammu agro climate. *Int. J. Pharm. Bio. Sci*., **3**: 1083-1090.

Edris, K. M., Islam, A. T. M. T., Chowdhury, M. S. and Haque, A. K. M. M. 1979. Detailed Soil Survey of Bangladesh, Dept. Soil Survey, Govt. People's Republic of Bangladesh. p. 118.

FAO. 1988. Production Year Book. Food and Agriculture Organizations of the United Nations. Rome, Italy. 190-193.

Gopalan, C., Sastri, B. V. and Balasubramanian, S. C. 1982. Nutritive value of indian foods, Indian Council of Medical Research, Nation Institute of Nutrition, Hyderabad.

Haque, E. M. 1985. Fal- Sabjr Chash "O" Pausti Parichiti, Departnent of Agricultural Extension. pp. 118-119.

Jeyakumar, P. 2005. Role of Growth Substances in Conservation Agriculture. Department of Crop Physiology, Tamil Nadu University, Coimbatore-641003.

Kohombange, S., Gunasekera, H. K. L. K. and Kirindigoda, S. 2017. Effect of various concentrations of nitrobenzene on bell pepper (*Capsicum annuum* L.) yield under green house condition. *J. Hort*., **4**: 219.

Kohombange, S., Eeswara, J. P. and Rathnasekara, N. 2019. Effect of nitrobenzene on sweet cucumber (*Lucumis sativus* L.) yield and yield quality under green house condition. *Int. J. Env. Agric. Biotec.*, **4**: 407-410.

Mithila, D., Sajal, R. and Huq, I. S. M. 2012. Effects of nitrobenzene on growth of tomato plants and accumulation of Arsenic. *Bangladesh J. Sci. Res*., **25**: 43-52.

Nuruzzaman, M., Islam, M. S., Shilpi, S., Mehraj H. and Jamal Uddin, A. F. M. 2015. Plant growth regulators to improve the growth and berry of strawberry. *Int. J. Sustain. Crop Prod.,* **10**(1): 33-39.

Pandita, M. L., Pandey, S. C., Mangal, J. K. and Singh, G. P. 1989. Effect of various concentrations of Planofix as foliar sprays in plant growth and fruit yield of chillies. *Haryan J. Hort. Sci.,* **9** (3 and 4): 170-174.

Pathan, V. 2014. Specification, benefits and recommendation of Nitrobenzene 20% liquid. A product of Royal Krushi Sci. Pvt. Ltd., F–204/205, Mega, Centre Magarpatta, Hadapsar, Pune– 411028, maharashtra, India. Developed and Managed by India MART Inter MESH Limited.

Pramoda, A. S., Sajjan, S., Malabasari, T. A. and Shashidhar, T. R. 2018. Effect of season and plant growth regulators on crop growth and yield in dolichos bean [*Lablab purpureus* (L.) Sweet]. *Int. J. Pure App. Bios*., **6** (4): 423-430.

Rambabu, E., Mandal, A. R., Hazra, P., Senapati, B. K. and Thapa, U. 2017. Morphological Characterization and Genetic Variability Studies in Bottle Gourd [*Lagenaria siceraria* (Mol.) Standley.]. *Int. J. Curr. Microb. Appl. Sci*., **6**(9): 3585-3592.

Saraswathi, T. and Praneetha, S. 2013. Effect of biostimulants on yield and quality in tomato. *J. Hort. Sci.,* **8**(1):107-110.

Sarkar, M. A. H., Hossain, M. I., Jamal Uddin, A. F. M., Uddin, M. A. N. and Sarkar, M. D. 2014.Vegetative, floral and yield attributes of gladiolus in response to gibberellic acid and corm size. *Scientia Agriculturae*, **3**:142-146.

Sircar, S. M. 1971. Flowering, parthenocarpy and fruit setting. Plant Hormone Research in India, 1 : 11.

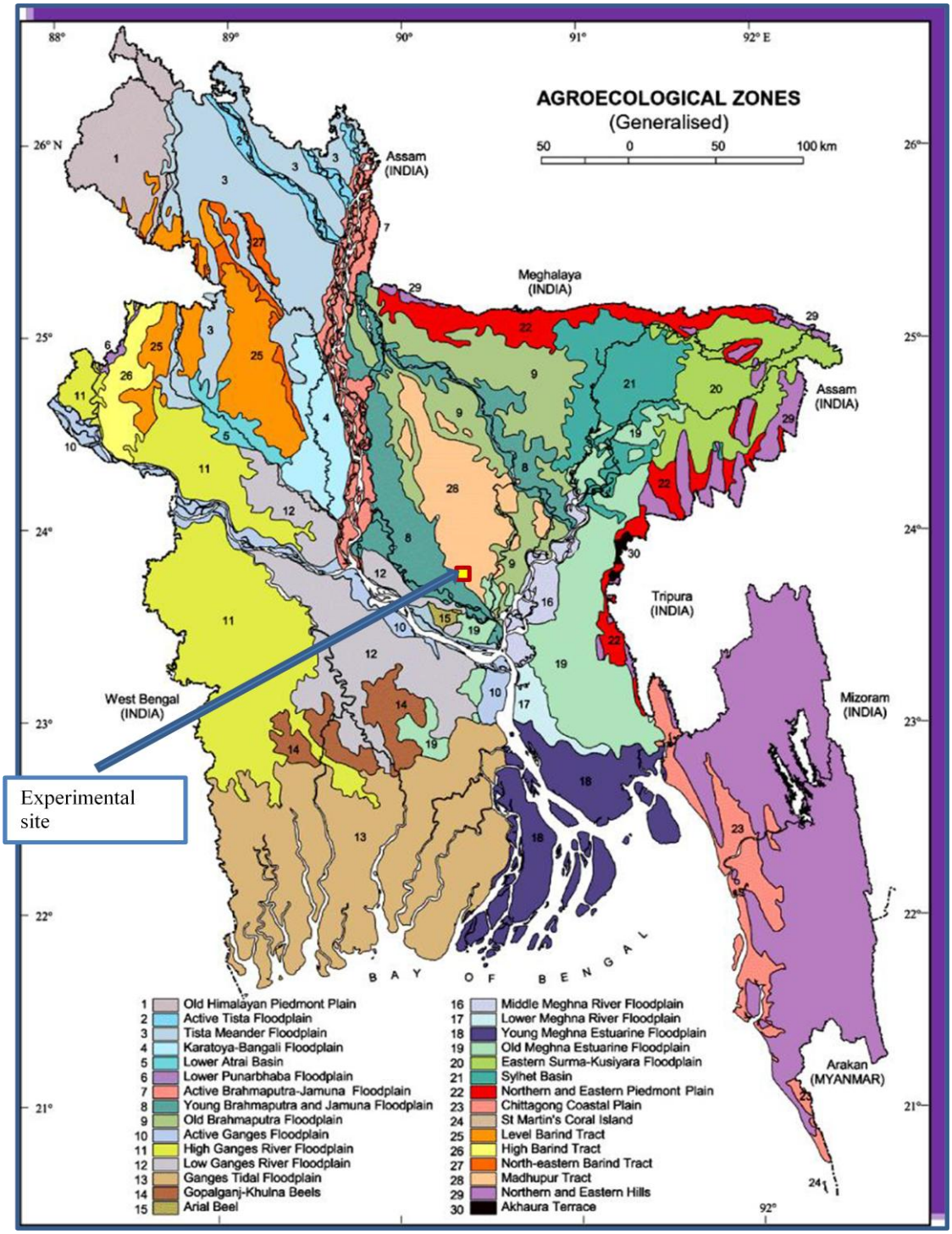
Sudhakar, M. and Kumar, S. R. 2012. Effect of growth regulators on growth, flowering and corm production of gladiolus (*Gladiolus grandiflorus* L.) cv. white friendship. *Indian J. Plant Sci*., **1**: 133-136.

Thamburaj, S. and Singh, N. 2003. Vegetables and tuber crops and spices. ICAR, New Delhi. pp. 271-272.

UNDP. 1988. Land Resources Appraisal of Bangladesh for Agricultural Development. Report 2: Agro-ecological Regions of Bangladesh, FAO, Rome. p. 212.

APPENDICES

Appendix I. Map showing the experimental site



Appendix II: Characteristics of Sher-e-Bangla Agricultural University soil is analysed by Soil Resources Development Institute (SRDI), Khamar Bari, Farmgate, Dhaka.

A. Morphological characteristics of the experimental field

Morphological features	Characteristics
Location	Sher-e-Bangla Agricultural
AEZ	Madhupur Tract (28)
General soil type	Shallow Red Brown Terrace Soil
Land Type	High land
Soil Series	Tejgaon
Topography	Fairly leveled
Flood level	Above flood level
Drainage	Well drained
Cropping pattern	Fellow-Tomato

B. Physical and chemical properties of initial soil

CHARACTERISTICS	VALUE
Partial Size Analysis	
% Sand	27
% Silt	43
% Clay	30
Textural Class	
PH	5.47 – 5.63
Organic carbon (%)	0.46
Organic matter (%)	0.83
Total N (%)	0.05
Available P (ppm)	20.00
Exchangeable K (me/100 gm soil)	0.12
Available S (ppm)	46

Source: Soil Resources Development Institute (SRDI)

Appendix III: Monthly record of annual temperature, rainfall, relative humidity, soil temperature and sunshine of the experimental site during the period from September 2018 to March 2019 (Site-Dhaka).

Year	Month	Air temperature			Relative humidity (%)	Rainfall (mm)	Sunhine
		Max.	Mini.	Average			
2018	September	31.35	25.15	28.25	71.02	26	20.33
	October	30.60	24.2	27.40	75.87	04	206.9
	November	29.85	18.50	24.17	70.12	00	235.2
	December	26.76	16.72	21.74	70.63	00	190.5
2019	January	24.05	13.82	18.93	62.04	00	197.6
	February	28.90	18.03	23.46	68.79	09	220.5
	March	32.24	22.10	27.17	78.82	68.5	208.2

Source: Bangladesh Meteorological Department (Climatic Division), Agargaon, Dhaka-1212.

Appendix IV: Analysis of variance of the data on vine length at different days after transplanting (DAT) of bottle gourd as influenced by different concentrations and number of spray of nitrobenzene.

Source of variation	Degree of freedom	Mean square			
		Vine length (cm) at different days after transplanting			
		20 DAT	40 DAT	60DAT	140 DAT
Replication	2	0.001889	0.00126	0.01229	0.0064
Different concentrations (A)	2	0.00007315 ^{NS}	0.31761**	3.78951**	33.805**
Different number of spray (B)	2	0.001229 ^{NS}	0.0021 ^{NS}	0.57118**	8.1186**
Interaction (AxB)	4	0.003243 ^{NS}	0.00452**	0.11379**	1.0376**
Error	18	0.001562	0.00359	0.01285	0.1075

** **:** Significant at 0.01 level of probability and ^{NS} **:** Non-significant

Appendix V: Analysis of variance of the data on number of leaves at different days after transplanting (DAT) of bottle gourd as influenced by different concentrations and number of spray of nitrobenzene.

Source of variation	Degree of freedom	Mean square			
		Number of leaves per plant at different days after transplanting			
		20 DAT	40 DAT	60DAT	140 DAT
Replication	2	1.03704	4.5278	1.791	92.4
Different concentrations (A)	2	0.39815 ^{NS}	54.3611**	469.848**	10002.8**
Different number of spray (B)	2	0.7037 ^{NS}	6.5833 ^{NS}	176.721**	3594.7**
Interaction (AxB)	4	5.00926 ^{NS}	2.4861**	21.265**	704**
Error	18	2.42593	4.213	0.968	76.1

** **:** Significant at 0.01 level of probability and ^{NS} **:** Non-significant

Appendix VI: Analysis of variance of the data on leaf length, leaf breadth and number of primary branches of bottle gourd as influenced by different concentrations and number of spray of nitrobenzene.

Source of variation	Degree of freedom	Mean square		
		Leaf length (cm)	Leaf breadth (cm)	Number of primary branches per plant
Replication	2	0.0662	0.301	0.4204
Different concentrations (A)	2	99.2912**	216.232**	60.537**
Different number of spray (B)	2	40.9174**	20.032**	30.7083**
Interaction (AxB)	4	10.3587**	1.906**	5.7861**
Error	18	0.4947	1.359	0.3383

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

Appendix VII: Analysis of variance of the data on day requireds to first male flower, days required to first female flower, number of male flower, number of female flower of bottle gourd as influenced by different concentrations and number of spray of nitrobenzene.

Source of variation	Degree of freedom	Mean square			
		Days required to first male flower	Days required to first female flower	Number of male flower	Number of female flower
Replication	2	1.126	0.911	2.331	5.058
Different concentration (A)	2	344.313**	182.186**	347.912**	387.673**
Different number of spray (B)	2	52.567**	18.808**	117.73**	167.824**
Interaction (AxB)	4	52.118**	51**	41.086**	34.24**
Error	18	1.265	2.108	1.078	2.168

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

Appendix VIII: Analysis of variance of the data on days required to first fruit harvest, fruit length (cm), fruit diameter (cm) of bottle gourd as influenced by different concentrations and number of spray of nitrobenzene.

Source of variation	Degree of freedom	Mean square		
		Days required to first fruit harvest	Fruit length (cm)	Fruit diameter (cm)
Replication	2	1.181	0.8442	0.4653
Different concentrations (A)	2	168.054**	45.6862**	10.0028**
Different number of spray (B)	2	25.825**	17.0788**	2.6524**
Interaction (AxB)	4	64.497**	1.8332**	1.1955**
Error	18	0.887	0.4753	0.2262

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

Appendix IX: Analysis of variance of the data on individual fruit weight (kg), number of fruit harvested, yield per plant (kg), yield per plot (kg) and yield per hectare (ton) of bottle gourd as influenced by different concentrations and number of spray of nitrobenzene.

Source of variation	Degree of freedom	Mean square				
		Individual fruit weight (kg)	Number of fruit harvested	Yield per plant(kg)	Yield per plot (kg)	Yield per hectare (ton)
Replication	2	0.00574	0.06	2.565	10.261	16.032
Different concentrations (A)	2	0. 0548**	19.454**	102.43**	409.71**	640.17**
Different number of spray (B)	2	0. 0224**	6.586**	39.554**	158.22**	247.21**
Interaction (AxB)	4	0. 0032**	2.477**	7.965**	31.861**	49.783**
Error	18	0. 00308	0.2561	0.561	2.242	3.504

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

Appendix X: Effect of different concentrations of nitrobenzene on leaf length (cm), number of primary branches per plant at harvest, number of female flower per plant, yield per hectare (t) of bottle gourd.

Treatment	Leaf length (cm)	Number of primary branches per plant at harvest	Number of female flower per plant
C_0	30.48 c	14.82 c	27.15 c
C_1	34.07 b	17.66 b	40.18 a
C_2	37.11 a	19.99 a	35.02 b
LSD(0.05)	0.6966	0.576	1.4582
CV%	2.08	3.32	4.32

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L

Appendix XI: Effect of different number of spray of nitrobenzene on leaf length (cm), number of primary branches per plant at harvest, number of female flower per plant, yield per hectare (t) of bottle gourd.

Treatment	Leaf length (cm)	Number of primary branches per plant at harvest	Number of female flower per plant
N_1	31.65 c	15.44 c	29.50 c
N_2	34.12 b	17.99 b	34.80 b
N_3	35.89 a	19.03 a	38.05 a
LSD(0.05)	0.6966	0.576	1.4582
CV%	2.08	3.32	4.32

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, N_1= One spray, N_2= Two spray, N_3= Three spray

Appendix XII: Cost of production of bottle gourd per hectare as influenced by different concentrations and number of spray of nitrobenzene.

A(1). Input Cost

Treatment combination	Labour Cost (Tk.)	Ploughing cost (Tk.)	Seed cost (Tk.)	Trellis cost (Tk.)	Nitrobenzene cost (Tk.)	Total (Tk.) A(1)
C_0N_1	49500	7500	4000	302000	0	363000
C_0N_2	49500	7500	4000	302000	0	363000
C_0N_3	49500	7500	4000	302000	0	363000
C_1N_1	49500	7500	4000	302000	810	363810
C_1N_2	49500	7500	4000	302000	1620	364620
C_1N_3	49500	7500	4000	302000	2430	365430
C_2N_1	49500	7500	4000	302000	1215	364215
C_2N_2	49500	7500	4000	302000	2430	365430
C_2N_3	49500	7500	4000	302000	3645	366645

Note: C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L and N_1= One spray, N_2= Two spray, N_3= Three spray

Cost per labour = 300 tk

Ploughing cost = 2500 tk/ploughing Nitrobenzene (Flora) = 810 tk/liter

Appendix XII: Cost of production of bottle gourd per hectare as influenced by different concentrations and number of spray of nitrobenzene.

A. (2). Input Cost

Treatment combination	Insecticide cost (Tk.)	Cowdung (Tk.)	Manure and fertilizers cost (Tk.)				Total Cost (Tk) A(2)	Total input (Tk.) [A(1)+ A(2)]
			TSP	Urea	MoP	Zypsum		
C_0N_1	2000	20000	5200	2400	1000	200	30800	393800
C_0N_2	2000	20000	5200	2400	1000	200	30800	393800
C_0N_3	2000	20000	5200	2400	1000	200	30800	393800
C_1N_1	2000	20000	5200	2400	1000	200	30800	394610
C_1N_2	2000	20000	5200	2400	1000	200	30800	395420
C_1N_3	2000	20000	5200	2400	1000	200	30800	396230
C_2N_1	2000	20000	5200	2400	1000	200	30800	395015
C_2N_2	2000	20000	5200	2400	1000	200	30800	396230
C_2N_3	2000	20000	5200	2400	1000	200	30800	397445

Note: C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L and N_1= One spray, N_2= Two spray, N_3= Three spray

Cowdung = 2 Tk/Kg

Urea = 16 Tk/Kg

TSP = 30 Tk/Kg

MoP = 10 Tk/Kg

Zypum = 20 Tk/Kg

Appendix XII: Cost of production of bottle gourd per hectare as influenced by different concentrations and number of spray of nitrobenzene.

B. Fixed cost

Treatment combination	Cost of lease of land for 6 months (12% of value of land Tk. 600000/ Year)	Miscellaneous cost (Tk. 5% of the input cost)	Interest on running capital for 6 months (Tk. 12% of cost/year)	Sub total (Tk) (B)	Total cost of production (Tk./ha) [Total input cost [A(1)+ A(2)] + overhead cost (B)]
C_0N_1	36000.00	19690.00	23628	79318.00	473118.00
C_0N_2	36000.00	19690.00	23628	79318.00	473118.00
C_0N_3	36000.00	19690.00	23628	79318.00	473118.00
C_1N_1	36000.00	19730.50	23676.6	79407.10	474017.10
C_1N_2	36000.00	19771.00	23725.2	79496.20	474916.20
C_1N_3	36000.00	19811.50	23773.8	79585.30	475815.30
C_2N_1	36000.00	19750.75	23700.9	79451.65	474466.70
C_2N_2	36000.00	19811.50	23773.8	79585.30	475815.30
C_2N_3	36000.00	19872.25	23846.7	79718.95	477164.00

Note: C_0= Control (Water only), C_1= Nitrobenzene @ 2 ml/L, C_2= Nitrobenzene @ 3 ml/L and N_1= One spray, N_2= Two spray, N_3= Three spray