Effect of Nitrobenzene Concentrations with Application Methods on Plant Growth and Yield of Cucumber

Abstract

The experiment was conducted in the Horticultural Farm of Sher-e-Bangla Agricultural University, Dhaka, Bangladesh to investigate the effect of nitrobenzene concentrations with application methods on growth and yield of cucumber. The experiment consisted of two factors viz. i) concentration of nitrobenzene (F_0= control, F_1= Nitrobenzene @ 500ppm, F_2= Nitrobenzene @ 600ppm, F_3= Nitrobenzene @ 700ppm), ii) application method (T_1= Foliar Application, T_2= Soil Application, T_3= Combined Application). In case of, different concentrations of nitrobenzene the maximum vine length (175.65 cm) at harvest was found in F_2 treatment and minimum (124.44 cm) were found in F_0 treatment. Nitrobenzene concentration of 600ppm showed better vine growth than concentration of 500ppm and 700ppm. However, the maximum number branches (12.02), female flower (25.61), fruit per plant (18.22), fruit weight (169.09 gm.) and yield (34.43 t/ha) were recorded from F_2 and F_3 treatment. The minimum values of the same parameters were observed in F_0 treatment or control. The minimum yield (14.71 kg/plot) was found in T_2 and maximum yield (16.16 kg/plot) was found in T_3 treatment. In the combination of nitrobenzene concentration and application method, the maximum yield (36.90 t/ha) was found in F_2T_3 treatment and minimum yield (19.90 t/ha) was recorded in F_0T_3 treatment. The second highest (35.49 t/ha) yield was obtained from F_3T_3 treatment. The highest benefit cost ratio (2.632) was attained from the treatment combination of F_2T_3 (nitrobenzene @ 600ppm with combined application) treated plants.

1. Introduction

Cucumber (*Cucumis sativus* L.) belongs to the family of cucurbitaceae, is a major vegetable crop worldwide and develops rapidly, with a shorter time from planting to harvest [1]. It is a sub-tropical vegetable crop that grows successfully under conditions of high light, high humidity and soil moisture, temperature with fertilizers in green-houses [2]. Cucumber is grown widely in different parts of the world. The crop is the second most important vegetable crop after tomato in Western Europe and is the fourth most cultivated vegetable in the world after tomatoes, brassicas and onions [3]. In Bangladesh, vegetable production is far below actual requirements. In 2019-20, total vegetable (summer and winter season) production area was 10.72 lac hectares of land with total production of 43.36 million tons. The total production of cucumber in Bangladesh was about 78,845 metric ton in 25,303 acres of land with an average yield of 7.69971 ton/ha [4]. It is good for people suffering from indigestion and biliousness [4].

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 numbers of male flowers and less numbers of pistillate and hermaphrodite flowers. 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 [5]. Different plant growth regulators are auxins, gibberellins, nitrobenzene, cytokinin, abscisic acid (ABA) and ethylene, etc. Among them, nitrobenzene (20% w/w) plays an important role for higher growth and yield of vegetables [6]. Nitrobenzene is a combination of nitrogen and plant growth regulators, extracted from seaweeds that act as plant energizer, flowering stimulant and yield booster. “Flora” is a commercially available plant growth substance containing 20% (w/w) nitrobenzene. Nitrobenzene 20% used to repair the hormonal function of a plant thus promotes the flowering activity and growth of roots [7].

The application of nitrobenzene produces the highest number of fruits and flowers per plant. It is quickly absorbed into the plants and influences the biochemical pathway of the plants to uptake more nutrients from the

soil [8]. 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 [9]. Unfortunately, very limited researches have been carried out regarding the use of nitrobenzene, the effect of various concentrations and application method on plants of cucucbitaceae family for higher growth and yield. A detailed and systematic study is needed to find out the suitable concentration, appropriate application method and suitable combination concentration of nitrobenzene and application method for maximum growth, yield and economic benefit of cucumber in Bangladesh.

2. Materials and Methods

2.1 Experimental site and experimental framework: The research work was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh, in robi season during the period of October 2019 to March 2020. The experimental site is situated between 23°74" N latitude and 90°35" E longitude and at an elevation of 8.2 m from sea level. The experimental site was a medium high land and pH of the soil was 5.4 to 5.6. The morphological characters of the soil are given below: AEZ No. 28, Soil series- Tejgaon, General soil - Non -calcareous dark gray. The experiment consists of two factors- Factor A: Concentration of Nitrobenzene as F_0= Control, F_1= Nitrobenzene @ 500ppm, F_2= Nitrobenzene @ 600ppm, F_3= Nitrobenzene @ 700ppm and Factor B: Application Method as T_1= Foliar Application, T_2= Soil Application, T_3= Combined Application. It was a factorial experiment. The experiment was laid out in a two factorial Randomized Complete Block Design (RCBD) with three replications. Total land was divided into three equal blocks. Each block was divided into twelve plots. Every replication had twelve plots where 12 treatments were allotted at random. The size of each plot was 1.8m x 1.8m. The distance between two blocks and two of the plots both were 1m.

2.2 Planting materials and Nitrobenzene (20% w/w): Seed of "Baromashi" local variety of cucumber were obtained from BADC, Dhaka. 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). About 2.5ml/L flora contains 500ppm nitrobenzene, 3.0ml/L flora contains 600ppm nitrobenzene and 3.5ml/L flora contains 700ppm nitrobenzene.

2.3 Application of nitrobenzene: Flora was applied in 4 different concentrations: control, 500ppm, 600ppm and 700ppm. Total four sprays were done, first nitrobenzene dose was applied at 25 days after sowing, and rest three doses were applied at 15 days interval.

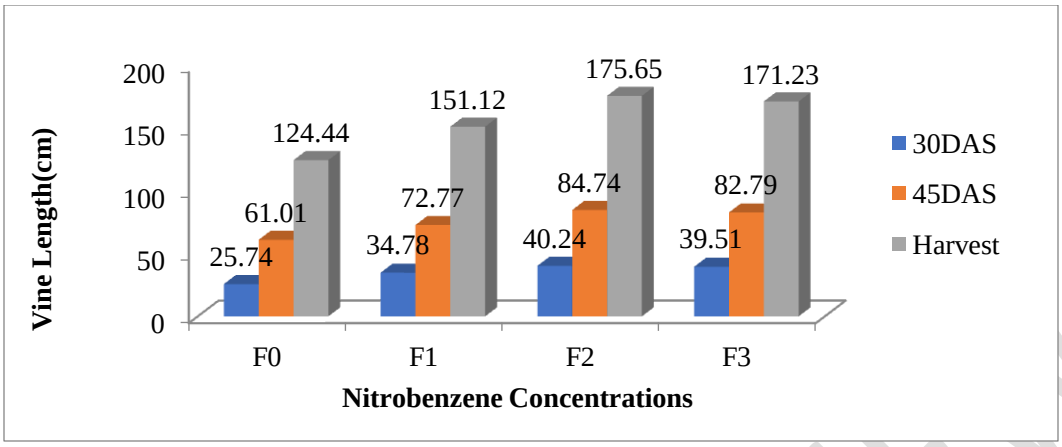
2.4 Economic analysis: The cost of production was calculated to find out the most economic combination of the concentration of nitrobenzene and application method. All input cost like the cost for land lease and interest in running capital was computing in the calculation. The benefit-cost ratio (BCR) was calculated as follows:

$$BCR = \frac{\text{Gross return per hectare (Tk)}}{\text{Total cost of production per hectare (Tk)}} \times 100$$

2.5 Statistical analysis: The recorded data on different parameters were statistically analyzed using Statistix-10 software. The significance of the difference among the treatment combinations of means was estimated by Duncan's Multiple Range Test (DMRT) at 5% level of probability [10].

3. Results and Discussion

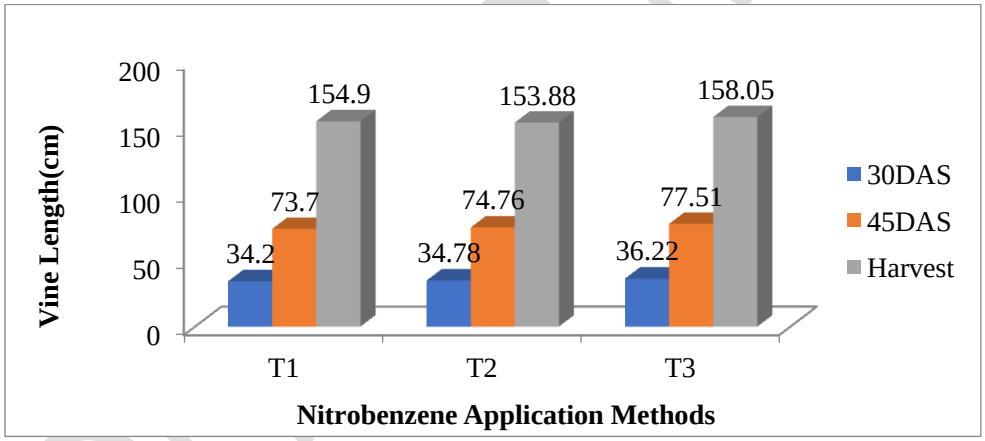
3.1 Vine length (cm) A statistically significant variation was found in vine length due to different levels of nitrobenzene concentration at 30 DAS, 45 DAS and harvesting stage. At harvest the maximum vine length (175.65 cm) was recorded from F_2 (nitrobenzene @ 600ppm) treatment and the minimum vine length (124.44cm) was recorded from F_0 (control) treatment (Fig.01). The result indicated that nitrobenzene application increased plant height comparing with the control, which might be due to increases the nutrient use efficiency thus improves the vegetative growth. [9] Observed similar trend of results.



Here, F_0: Control, F_1: Nitrobenzene @ 500ppm, F_2: Nitrobenzene @ 600ppm, F_3: Nitrobenzene @ 700ppm.

Fig.1. Performance of Nitrobenzene Concentrations on Vine Length (cm) at Different DAS

In terms of vine length in relation with nitrobenzene application method at 30 DAS, 45 DAS and harvest a statistically significant difference were recorded under the trial. At harvest, the maximum vine length (158.05 cm) was recorded from T_3 (foliar + basal application) treatment and the minimum vine length (153.88 cm) was recorded from T_2 (basal application) treatment (Fig.02).



Here, T_1: Foliar application, T_2: Soil application, T_3: Combined application.

Fig.2. Performance of Nitrobenzene Application Methods on Vine Length (cm) at Different DAS

Combined effects of different nitrobenzene doses and application methods showed statistically significant variation in terms of plant height of cucumber 30 DAS, 45 DAS and harvest. At harvest, the highest vine length (178.41cm) was recorded from the treatment combination F_2T_3 and the minimum vine length (122.98 cm) was recorded from the treatment combination of F_0T_1 treatment (Table 01). The results indicated that plant growth regulator application ensures the maximum growth and development of cucumber plant and ultimate result is the maximum plant height.

Table 1: Combined effect of nitrobenzene concentration and application method on vine length (cm) of cucumber

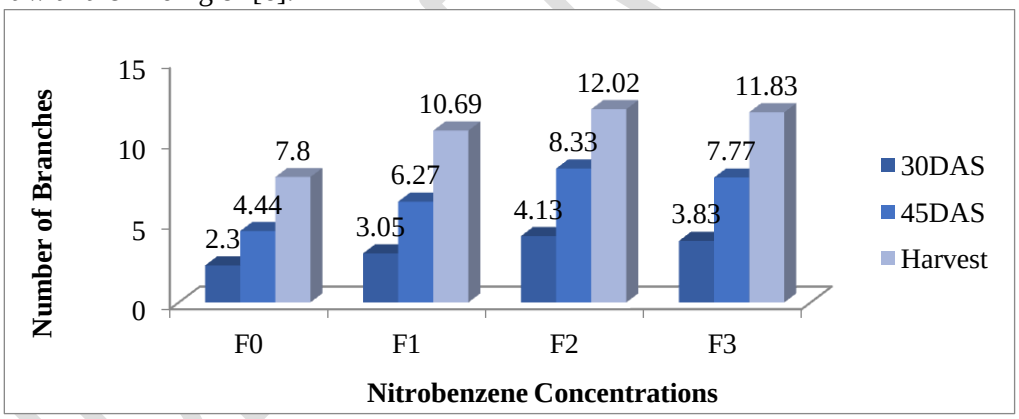
Treatment	30 DAS	45 DAS	Harvest
F_0T_1	25.09k	59.96l	122.98l

F_0T_2	26.20i	60.34k	125.78j
F_0T_3	25.94j	62.73j	124.57k
F_1T_1	33.83h	71.61i	150.26h
F_1T_2	34.53g	72.26h	148.75i
F_1T_3	35.98f	74.44g	154.35g
F_2T_1	38.34e	82.61d	176.15b
F_2T_2	40.15c	84.27c	172.39d
F_2T_3	42.23a	87.33a	178.41a
F_3T_1	39.55d	80.63f	170.22e
F_3T_2	38.24e	82.18e	168.62f
F_3T_3	40.75b	85.56b	174.86c
CV%	6.41	7.67	8.25
$LSD_{(0.05)}$	0.50	0.73	0.58

Means in a column followed by same letter do not differ significantly at 5% level. Here, F_0: Control, F_1: Nitrobenzene @ 500ppm, F_2: Nitrobenzene @ 600ppm, F_3: Nitrobenzene @ 700ppm and T_1: Foliar application, T_2: Soil application, T_3: Combined application.

3.2 Number of branches

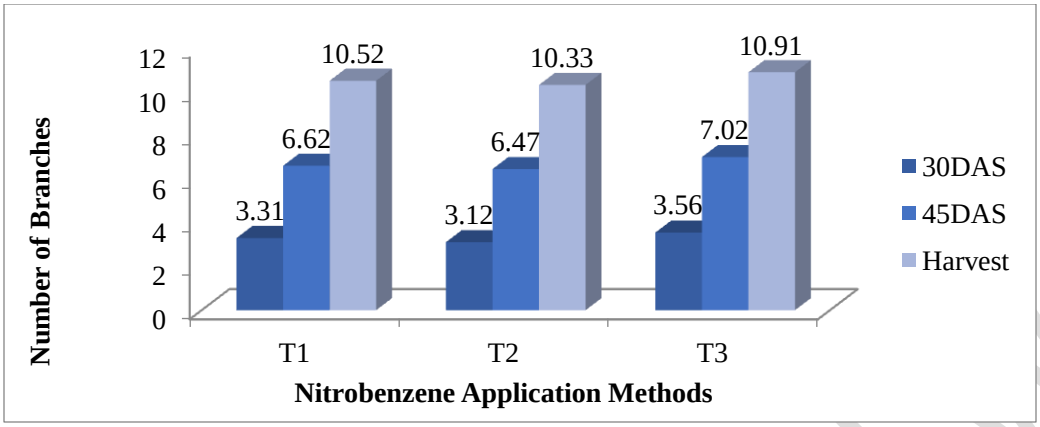
Number of branches per plant of cucumber showed statistically significant differences due to different levels of nitrobenzene concentration at 30DAS, 45 DAS and harvesting. At harvesting, the maximum number of branches per plant (12.02) was found from F_2 (nitrobenzene @ 600ppm) treatment, whereas the minimum number of branches per plant (7.80) was recorded from F_0 (control) treatment (Fig.03). The result also indicated that the increasing concentration of nitrobenzene significantly increased the number of branches of cucumber. This result is in agreement with the finding of [6].



Here, F_0: Control, F_1: Nitrobenzene @ 500ppm, F_2: Nitrobenzene @ 600ppm, F_3: Nitrobenzene @ 700ppm.

Fig.3. Performance of Nitrobenzene Concentrations on Branch Number at Different DAS

In terms of the number of branches in relation to the nitrobenzene application method, a statistically significant difference was recorded. The maximum number of branches (10.91) were recorded from T_3 (combined application) and the minimum number of branches (10.33) were produced by the T_2 (soil application) treatment (Fig.04).



Here, T_1: Foliar application, T_2: Soil application, T_3: Combined application.

Fig.4. Performance of Nitrobenzene Application Method on Branch Number at Different DAS

Combined effect of different nitrobenzene doses and application methods showed statistically significant variation in terms of number of branches per plant of cucumber at 30 DAS, 45 DAS and harvest. At harvest, the maximum number of branches per plant (12.50) was observed from F_2T_3 treatment combination and the minimum number of branches per plant (7.66) was recorded from F_0T_3 treatment combination (Table 02). This might be due to the fact that application of nitrobenzene maintained balanced absorption of nutrients improve physiological activities resulted the maximum number of branches per plant of cucumber.

Table 2: Combined effect of nitrobenzene concentration and application method on branch number of cucumber

Treatment	30 DAS	45 DAS	Harvest
F_0T_1	2.33gh	4.41gh	7.91g
F_0T_2	2.41g	4.33h	7.83gh
F_0T_3	2.16h	4.58g	7.66h
F_1T_1	2.91f	6.16f	10.50e
F_1T_2	2.83f	6.08f	10.25f
F_1T_3	3.41e	6.58e	11.33d
F_2T_1	4.16b	8.33b	11.83c
F_2T_2	3.66cd	8.08c	11.75c
F_2T_3	4.58a	8.58a	12.50a
F_3T_1	3.83c	7.58d	11.83c
F_3T_2	3.58de	7.41d	11.50d
F_3T_3	4.08b	8.33b	12.16b
CV%	10.68	11.58	10.45
$LSD_{(0.05)}$	0.40	0.42	0.37

Means in a column followed by same letter do not differ significantly at 5% level. Here, F_0: Control, F_1: Nitrobenzene @ 500ppm, F_2: Nitrobenzene @ 600ppm, F_3: Nitrobenzene @ 700ppm and T_1: Foliar application, T_2: Soil application, T_3: Combined application.

3.3 Number of male flowers per plant

Number of male flowers per plant showed statistically significant variation due to different nitrobenzene concentration. The maximum number of male flowers per plant (26.63) was recorded from F_2 treatment, whereas

the minimum number of male flowers per plant (23.41) was found from F_1 treatment (Table 03). The result indicates that minimum male flower was produced from low concentration of nitrobenzene applied plant comparing with others. [13] found almost same result in his earlier experiment.

Number of male flowers per plant of cucumber varied significantly in terms of nitrobenzene application method. The maximum number of male flowers per plant (26.00) was found from T_3 treatment while the minimum number of male flowers per plant (25.37) was found from T_1 treatment which was statistically identical (25.27) with T_2 treatment (Table 04).

Combined effects of different nitrobenzene doses and application method showed statistically significant variation in terms of number of male flowers per plant of cucumber. The maximum number of male flowers per plant (27.08) was observed from F_2T_3 treatment combination and the minimum number of male flowers per plant (22.66) was recorded from F_1T_1 treatment combination, which was statistically identical (22.91) to F_1T_2 treatment combination (Table 05).

3.4 Number of female flowers per plant

Different nitrobenzene concentrations varied significantly in terms of number of female flowers per plant of cucumber. The maximum number of female flowers per plant (25.61) was recorded from F_2 treatment whereas the minimum number of female flowers per plant (18.38) was found from F_0 treatment (Table 03). The results indicated that maximum female flower was produced by the application of plant growth regulator compared to control. [14] reported similar trends from their experiment.

In terms of the number of female lowers per plant, the nitrobenzene application method varied significantly in cucumber. The maximum number of female flowers per plant (23.27) was found from T_3, while the minimum number of female flowers (22.56) was found from T_2 treatment (Table 04).

Combined effects of different nitrobenzene doses and application method showed statistically significant variation in terms of number of female flowers per plant of cucumber. The maximum number of female flowers per plant (26.33) was observed from F_2T_3 treatment combination and the minimum number of female flowers per plant (18.16) was recorded from F_0T_2 treatment combination (Table 05). The result indicated that combination of nitrobenzene with their application method produces the maximum number of female flower per plant. [8] reported that application of nitrobenzene results quickly absorbed into the plants and influences the biochemical pathway of the plants to uptake more nutrient use efficiency thus improve vegetative and reproductive growth of plants.

3.5 Ratio of male and female flowers

Statistically significant variation was recorded in terms of ratio of male and female flowers of cucumber due to different nitrobenzene concentration. The highest ratio of male and female flowers (1.43) was recorded from F_0 treatment, whereas the lowest ratio of male and female flowers (1.03) was found from F_3 treatment which was statistically identical (1.04) to F_1 and F_2 treatment (Table 03). The result indicated that minimum ratio of male and female flower were produced by application of nitrobenzene compared to control.

Ratio of male and female flowers of cucumber varied insignificantly in terms of nitrobenzene application method. The ratio of male and female flowers (1.13) was found from all the T_1, T_2 and T_3 treatments (Table 04).

Table 3: Effect of nitrobenzene concentrations on floral character of cucumber

Treatment A	Male Flower	Female Flower	Ratio
F_0	26.33 b	18.38 d	1.43

F_1	23.41 d	22.44 c	1.04
F_2	26.63 a	25.61 a	1.04
F_3	25.80 c	24.90 b	1.03
CV%	8.62	9.35	13.65
LSD	0.48	0.12	0.04^{NS}

Here, F_0: Control, F_1: Nitrobenzene @ 500ppm, F_2: Nitrobenzene @ 600ppm, F_3: Nitrobenzene @ 700ppm.

Table 4: Effect of nitrobenzene application method on floral character of cucumber

Treatment B	Male Flower	Female Flower	Ratio
T_1	25.37 b	22.67 b	1.13
T_2	25.27 b	22.56 c	1.13
T_3	26.00 a	23.27 a	1.13
CV %	8.62	9.35	13.65
$LSD_{(0.05)}$	0.41	0.11	0.03^{NS}

Here, T_1: Foliar application, T_2: Soil application, T_3: Combined application

Table 5: Combined effect of nitrobenzene concentrations and application methods on floral character of cucumber

Combination	Male Flower	Female Flower	Ratio
F_0T_1	26.08 d	18.33 j	1.42 b
F_0T_2	26.33 cd	18.16 j	1.45 a
F_0T_3	26.58 bc	18.66 i	1.42 b
F_1T_1	22.66 h	22.41 g	1.01 e
F_1T_2	22.91 h	22.08 h	1.03 d
F_1T_3	24.66 g	22.83 f	1.07 c
F_2T_1	26.16 d	25.41 b	1.03 d
F_2T_2	26.66 b	25.08 cd	1.06 c
F_2T_3	27.08 a	26.33 a	1.02 de
F_3T_1	26.58 bc	24.55 e	1.08 c
F_3T_2	25.16 f	24.91d	1.01 e
F_3T_3	25.66 e	25.25 bc	1.02 de
CV%	8.62	9.35	13.65
$LSD_{(0.05)}$	0.84	0.46	0.07

Means in a column followed by same letter do not differ significantly at 5% level. Here, F_0: Control, F_1: Nitrobenzene @ 500ppm, F_2: Nitrobenzene @ 600ppm, F_3: Nitrobenzene @ 700ppm and T_1: Foliar application, T_2: Soil application, T_3: Combined application.

Combined effect of different nitrobenzene doses and application methods showed statistically significant variation in terms of ratio of male and female flowers of cucumber. The highest ratio of male and female flowers (1.45) was observed from F_0T_2 treatment combination and the lowest ratio of male and female flowers (1.01) was recorded from F_1T_1 treatment combination which was statistically identical with F_3T_2 treatment combination (Table 05).

3.6 Number of fruits per plant

Significant variation was recorded due to different nitrobenzene concentration in terms of number of fruits per plant of cucumber. The maximum number of fruits per plant (18.22) was recorded from F_2 treatment which was statistically identical (18.16) to F_3 treatment, whereas the minimum number of fruits per plant (13.30) was found from F_0 treatment (Table 06).

Table 6: Effect of nitrobenzene concentration on fruit characters of cucumber

Treatment	No. of fruit per plant	Fruit weight (g)
F_0	13.30 c	135.35 d

F_1	15.36 b	155.50 c
F_2	18.22 a	169.09 a
F_3	18.16 a	166.01 b
CV%	11.66	8.56
$LSD_{(0.05)}$	0.34	1.06

Here, F_0: Control, F_1: Nitrobenzene @ 500ppm, F_2: Nitrobenzene @ 600ppm, F_3: Nitrobenzene @ 700ppm.

Table 7: Effect of nitrobenzene application method on fruit characters of cucumber

Treatments	No. of fruit per plant	Fruit weight (g)
T_1	16.41 b	156.21 b
T_2	15.66 c	154.78 c
T_3	16.70 a	158.47 a
CV%	11.66	8.56
$LSD_{(0.05)}$	0.29	0.87

Here, T_1: Foliar application, T_2: Soil application, T_3: Combined application

Table 8: Combined effect of nitrobenzene concentration and application method on fruit characters of cucumber

Treatment	No. of fruit per plant	Fruit weight (g)
F_0T_1	13.41 j	135.33 k
F_0T_2	13.33 jk	134.75 l
F_0T_3	13.16 k	135.97 j
F_1T_1	15.33 h	155.52 h
F_1T_2	15.08 i	154.29 i
F_1T_3	15.66 g	156.69 g
F_2T_1	18.58 c	168.60 c
F_2T_2	16.91 f	166.41 d
F_2T_3	19.16 a	172.27 a
F_3T_1	18.33 d	165.41 e
F_3T_2	17.33 e	163.66 f
F_3T_3	18.83 b	168.96 b
CV%	11.66	8.56
$LSD_{(0.05)}$	0.59	1.07

Means in a column followed by same letter do not differ significantly at 5% level. Here, F_0: Control, F_1: Nitrobenzene @ 500ppm, F_2: Nitrobenzene @ 600ppm, F_3: Nitrobenzene @ 700ppm and T_1: Foliar application, T_2: Soil application, T_3: Combined application.

Number of fruits per plant of cucumber varied significantly in terms of the nitrobenzene application method. The maximum number of fruits per plant (16.70) was found from T_3 treatment while the minimum number of fruits per plant (15.66) was found from T_2 treatment (Table 07).

Combined effect of different nitrobenzene doses and application methods showed statistically influence in terms of number of fruits per plant of cucumber. The maximum number of fruits per plant (19.16) was observed from F_2T_3 treatment combination and the minimum number of fruits per plant (13.16) was recorded from F_0T_3 treatment combination which was statistically identical to F_0T_2 treatment combination (Table 08).

3.7 Individual Fruit Weight (g)

Statistically significant variation was recorded in individual fruit weight of cucumber due to different nitrobenzene concentration. The maximum individual fruit weight (169.09 g) was recorded from F_2 treatment, whereas the minimum individual fruit weight (135.35 g) was found from F_0 treatment (Table 06).

Individual fruit weight of cucumber varied significantly in terms of nitrobenzene application method. The maximum individual fruit weight (158.47 g) was found from T_3 treatment, while the minimum individual fruit weight (154.78 g) was found from T_2 treatment (Table 07).

Combined effect of different nitrobenzene doses and application methods showed statistically significant variation in terms of individual fruit weight of cucumber. The maximum weight of individual fruits (172.27 g) was observed from F_2T_3 treatment combination, while the minimum individual fruit weight (134.75 g) was recorded from F_0T_2 treatment combination (Table 08). It was observed that the individual fruit weight was gradually increased with the higher level of nitrobenzene concentration up to a limit. This might be due to that nitrobenzene improve physiological activity like photosynthesis and translocation of food materials to the fruits. This result is also in agreement with the findings of [8].

3.8 Fruit Yield (Kg) Per Plant

Different nitrobenzene concentration showed statistically significant variation in terms of fruit yield per plant of cucumber. The maximum fruit yield per plant (3.10kg) was recorded from F_2 treatment, whereas the minimum fruit yield per plant (1.80 kg) was found from F_0 treatment (Table 09).

Fruit yield per plant of cucumber varied significantly in terms of nitrobenzene application method. The maximum fruit yield per plant (2.69 kg) was found from T_3 treatment, while the minimum fruit yield per plant (2.45 kg) was found from T_1 treatment (Table 10).

Combined effect of different nitrobenzene doses and application methods showed statistically significant variation in terms of fruit yield per plant of cucumber. The maximum fruit yield per plant (3.32 kg) was observed from F_2T_3 treatment combination and the minimum fruit yield per plant (1.78 kg) was recorded from F_0T_3 treatment combination which was statistically identical (1.81 kg and 1.79 kg) to F_0T_1 and F_0T_2 treatment combination respectively (Table 11). The increased fruit yield per plant might be due to increasing concentration of nitrobenzene with balanced foliar application which improves the nutrient use efficiency along with vegetative growth, induces profuse flowering and helped in retention of flower and fruit [9].

3.9 Fruit Yield (ton) Per Hectare

Different nitrobenzene concentration showed significant variation in terms of fruit yield per hectare of cucumber. The maximum fruit yield per hectare (34.43 ton) was recorded from F_2 treatment, whereas the minimum fruit yield per hectare (20.01 ton) from F_0 treatment (Table 09).

Fruit yield per hectare of cucumber varied significantly in terms of nitrobenzene application method. The maximum fruit yield per hectare (29.93 ton) was found from T_3 treatment, while the minimum fruit yield per hectare (27.25 ton) was found from T_2 treatment (Table 10).

Combined effect of different nitrobenzene doses and application methods showed statistically significant variation in terms of fruit yield per hectare of cucumber. The maximum fruit yield per hectare (36.90 ton) was observed from F_2T_3 treatment combination and the minimum fruit yield per hectare (19.90 ton) from F_0T_3 treatment combination which was statistically identical (20.18 ton and 19.94 ton) to F_0T_1 and F_0T_2 treatment combinations respectively (Table 11).

Table 9: Effect of nitrobenzene concentration on yield of cucumber

Treatment	Yield/plant (kg)	Yield/ha (ton)
F_0	1.80 d	20.01 d
F_1	2.40 c	26.69 c

F_2	3.10 a	34.43 a
F_3	3.02 b	33.57 b
CV%	12.87	11.42
$LSD_{(0.05)}$	0.058	0.74

Here, F_0: Control, F_1: Nitrobenzene @ 500ppm, F_2: Nitrobenzene @ 600ppm, F_3: Nitrobenzene @ 700ppm.

Table 10: Effect of nitrobenzene application method on yield of cucumber

Treatment	Yield/plant (kg)	Yield/ha (ton)
T1	2.59 b	28.84 b
T2	2.45 c	27.25 c
T3	2.69 a	29.93 a
CV%	12.87	11.42
$LSD_{(0.05)}$	0.051	0.29

Here, T_1: Foliar application, T_2: Soil application, T_3: Combined application

Table 11: Combined effect of nitrobenzene concentration and application method on fruit characters of cucumber

Treatment	Yield/plant (kg)	Yield/ha (ton)
F_0T_1	1.81 i	20.18 i
F_0T_2	1.79 i	19.94 ij
F_0T_3	1.78 i	19.90 j
F_1T_1	2.39 g	26.64 g
F_1T_2	2.33 h	25.98 h
F_1T_3	2.47 f	27.45 f
F_2T_1	3.14 c	34.97 c
F_2T_2	2.83 e	31.42 e
F_2T_3	3.32 a	36.90 a
F_3T_1	3.02 d	33.56 d
F_3T_2	2.85 e	31.66 e
F_3T_3	3.20 b	35.49 b
CV%	12.87	11.42
LSD(0.05)	0.10	1.08

Means in a column followed by same letter do not differ significantly at 5% level. Here, F_0: Control, F_1: Nitrobenzene @ 500ppm, F_2: Nitrobenzene @ 600ppm, F_3: Nitrobenzene @ 700ppm and T_1: Foliar application, T_2: Soil application, T_3: Combined application.

3.10 Economic analysis

Input costs for land preparation, seed cost, fertilizers, nitrobenzene, pesticides, irrigation and manpower required for all the operations from planting to harvesting of cucumber were recorded for unit plot and converted into cost per hectare. Price of cucumber was considered as per market rate. The economic analysis presented under the following headings-

Gross return

The combination of sowing time and phosphorus showed different gross returns. The highest gross return (922500 Tk./ha) was obtained from F_2T_3 treatment combination and the second highest gross return (887250 Tk./ha) was found in F_3T_3. The lowest gross return (497500 Tk./ha) was obtained from F_0T_3 treatment combination (Table 12).

Net return

In case of net return different treatment combinations showed different net return. The highest net return (571940 Tk. /ha) was found from the F_2T_3 treatment combination and the second highest net return (535577 Tk./ha) was obtained from the F_3T_3 treatment combination. The lowest (151948 Tk./ha) net return was obtained F_0T_3 treatment combination (Table 12).

Table 12. Cost and returns of cucumber cultivation as influenced by different treatments.

Treatments	Total cost of production	Yield /ha (ton)	Gross Return (taka)	Net Return (taka)	Benefit cost Ratio
F_0T_1	339987	20.18	504500	164513	1.484
F_0T_2	334422	19.94	498500	164078	1.491
F_0T_3	345552	19.90	497500	151948	1.439
F_1T_1	343882	26.64	666000	322118	1.937
F_1T_2	338332	25.98	649500	311168	1.919
F_1T_3	349447	27.45	686250	336803	1.964
F_2T_1	344995	34.97	874250	529255	2.456
F_2T_2	339430	31.42	785500	446070	2.317
F_2T_3	350560	36.90	922500	571940	2.632
F_3T_1	346108	33.56	839000	492892	2.424
F_3T_2	340543	31.66	791500	450957	2.324
F_3T_3	351673	35.49	887250	535577	2.523

Here, F_0: Control, F_1: Nitrobenzene @ 500ppm, F_2: Nitrobenzene @ 600ppm, F_3: Nitrobenzene @ 700ppm and T_1: Foliar application, T_2: Soil application, T_3: Combined application.

Benefit cost ratio

The combination of sowing time and phosphorus highest benefit cost ratio (2.632) was noted from F_2T_3 treatment combination and the second highest benefit cost ratio (2.523) was estimated from F_3T_3 treatment combination. The lowest benefit cost ratio (1.439) was obtained from F_0T_3 treatment combination (Table 12). From an economic point of view, it was apparent from the above results that the F_2T_3 treatment combination was more profitable than the rest of the combination.

4. Conclusion

From the results of the study, following conclusion and recommendations may be followed:

i. Treatment F_2 (nitrobenzene @ 600ppm) was superior to others; this nitrobenzene concentration may be used to get desirable yield of cucumber.

ii. The treatment T_3 (foliar + soil application method), showed better performance on growth and yield of cucumber.

iii. The treatment combination F_2T_3 (nitrobenzene @ 600ppm with foliar + soil application) may be used to get more fruits per plant and total yield of cucumber. It may provide best substantial benefit to the farmers. So it may be recommended to the farmer level for cucumber cultivation in winter season.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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