Influence of Seedling Age and Training on Yield Performance of Cucumber (*Cucumis sativus*)

Mst. Arjuara Sumi a, Tahmina Mostarin a, Khaleda Khatun a, Md. Abdus Samad a, Sufia Akter a, Amina Khanom a, Md. Rafi Khan a and Md. Touhidujjaman b

a Department of Horticulture, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh. 

b Department of Agronomy, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

Authors’ contributions

This work was carried out in collaboration among all authors. Authors TM and KK planned the experiment and lead the research. Authors MA Sumi, TM and KK designed and carried out the research. Authors MA Samad performed the statistical analysis. Author MA Sumi, AK and MT carried out the research on the field. Authors SA, MRK and MT collected the data. Authors MA Sumi, SA and MA Samad wrote the manuscript. Authors MA Sumi, SA, AK and MRK managed the literature searches. All authors provided critical feedback and helped shape the research, analysis and manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/APRJ/2022/v9i130198

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/84078

Received 25 November 2021
Accepted 27 January 2022
Published 30 January 2022

ABSTRACT

An experiment was conducted during the period of April to July 2019 at Horticulture farm of Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh to evaluate the yield performance of cucumber influenced by seedling age and training. The experiment was laid out in the Randomized Complete Block Design with three replications. Treatment as three different age of seedling i.e. $S_1=15$ days old seedling, $S_2=20$ days old seedling, $S_3=25$ days old seedling; and four levels of training i.e. $T_0=Control$, $T_1=Removal of all branches up to 40 cm height$, $T_2=Removal of all branches up to 80 cm height$ and $T_3=Removal of all branches up to 120 cm height$ which in combination made 12 treatment combination. ‘Baromashi’ (local variety) was used in this experiment. Different seedling age and levels of training showed significant variations on most of the parameters. In case of seedling age, the maximum average fruits per plant (17.18), individual fruit weight (174.33 gm) and fruit yield (41.63 ton/ha) was recorded from $S_3$ treatment, whereas the lowest was recorded from $S_1$ treatment. On the other hand, the maximum average fruits per plant (15.93), individual fruit...
weight (160.87 gm) and fruit yield (35.97 ton/ha) was recorded from T1 treatment, while the lowest was recorded from T0 (control) treatment. In case of combined effect S3T1 produced the maximum average fruits per plant (19.45), weight of individual fruit (177.91 gm) and the highest yield (47.73 t/ha) while the lowest were (10.47, 132.40gm and 19.16 ton/ha) recorded from S1T0 treatment combination respectively. The highest net income (730827 tk/ha) and benefit cost ratio (2.58) was noted from S3T1 treatment. It may therefore be concluded that the 25 days old seedling and removal of all branches up to 40 cm height showed more economical than rest of the combinations in cultivation of cucumber.

**Keywords:** Cucumber; seedling age; training; yield and benefit cost ratio.

1. INTRODUCTION

Cucumber (Cucumis sativus) is broadly cultivated creeping vine plant in the gourd family (Cucurbitaceae) that bears cucumiform fruits which are used as vegetables. Cucumbers contain high levels of bitter-tasting nutrients known as cucurbitacin [1]. It is mostly cultivated for its little tender fruits. The origin of cucumber is in southern Asia, but a great number of cultivars have been introduced and are grown globally [2]. Cucumber is a vital vegetable crop of Bangladesh. It is mostly taken as fresh. It is a primary source of vitamins and mineral of man [3]. Cucumber fruits contain a great amount (95%) of water. It contains little amount of calories, different plant compounds and antioxidants that may help treat and even restrain some conditions [4]. Usually, in our country cucumber is reachable in all the year round. The total production of cucumber was 73220 M.ton during the year 2018-2019 [5]. But the production of cucumber is not satisfactory to fulfill the demand of the people. The performance of any crop depends upon the excellence of the seed used for sowing, kind of cultivar, cultural practices and different environmental factors, etc. In Bangladesh cucumber is mainly cultivated by direct sowing of seed. Transplantation of cucumber seedling is less popular among the farmers. For cucumber cultivation, transplantation of cucumber seedling is one of the factors, which affect growth and yield, but normally this factor is unnoticed by the farmers. The optimum seedling age depends on the soil, environmental factors (temperature, moisture), location and cultural practices [6]. Seedlings are used broadly to establish a range of vegetable crops. Young aged or over aged seedlings are not suitable for better yield. Older seedling are more long-lasting to stress and produce fruits earlier, while young transplants are less enduring [7]. Transplantation of different age of seedling effect a great impact on vegetative growth as well as reproduction phase of cucumber.

Optimum seedling age for better plant establishment could increase productivity of cucumber crop [8]. That’s why, optimum seedling age is required for early establishment of plant and production of cucumber as well as higher yield which helps the farmers to get top market price.

For getting higher yield of cucumber, training is an important cultural practices to boost up the production by removing excessive growth of the plant and maximum use of resources. For successful cucumber production training practices plays a great role for increase yield, early harvest, easy harvesting of fruits and amenities in intercultural operation without damage to the fruits or plants. Training system will not only good for better management of crops and uniform light to the plants but also higher yield of larger sized fruits and increasing higher yield of good quality seeds [9]. By training, plants get the required amount of sun light needed for growth of the plant which ultimately helps in higher yield of cucumber. The proper training method gave higher yield of cucumber [10]. So, by these proper training practices it may be help for good vegetative growth and yield of the cucumber plant.

Yet, very limited study was conducted to observe the effect of seedling age and training system to advance the growth and yield of cucumber. This experiment was carried out to find out the suitable seedling age for transplanting and training for maximum yield and economic benefit of cucumber in Bangladesh.

2. MATERIALS AND METHODS

2.1 Experimental Site and Experimental Framework

The research was conducted at the Horticultural Farm of Sher-e-Bangla Agricultural University.
(SAU), Sher-e-Bangla Nagar, Dhaka-1207, Bangladesh during the period of April 2019 to August 2019. The experiment was carried out in summer 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 sea level. The soil was having a texture of sandy loam with pH and organic matter 5.47 – 5.63 and 0.83%, respectively. The experiment comprised of two factors- Factor A: Seedling age (Three type): S1=15 days old seedling, S2 = 20 days old seedling, S3 = 25 days old seedling and Factor B: Training (Four type)- T0= Control, T1 = Removal of all branches up to 40 cm height, T2 = Removal of all branches up to 80 cm height, T3 = Removal of all branches up to 120 cm height. The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. An area of 30.3 m × 8.4 m and the total area of the experimental plot was 241.92 m². The total area is divided into three equal blocks. Each block was divided into 12 plots where 12 treatments combination were allotted at random. There was a total of 36 unit plots in the experiment. The size of each plot was 2.4 m × 1.8 m. The distance maintained between two blocks and two plots were 75cm and 50cm, respectively. Both the row to row and plant to plant distances were 60 cm and 60 cm, respectively.

2.2 Planting Materials and Raising of Seedling

Seeds of ‘Baromashi’ local variety cucumber was used as the test crops and the seeds were collected from LalTeer Seed Company, Siddique Bazar, Gulistan, Dhaka. Seeds were sown in the in polyethylene bags containing a mixture of equal proportion of well decomposed cowdung, sand and soil. Regular irrigation was done to bring moist condition for proper seed germination. The polybags were reserved in cool place. They were watered frequently during the seedling- raising period. Seedlings were transplanted at three different ages viz.; 15 days, 20 days and 25 days after germination.

2.3 Application of training treatment

Side branches on main stem were removed according to treatments. When the branches were appeared from the main stem and became 2-3 cm long then that was removed. Training was done according to treatments. In case of T1 treatment removed all branches up to 40 cm of plant height. In T2 and T3 treatment removed all branches up to 80 and 120 cm of plant height.

2.4 Methods of Data Collection

The plant height, fruit length were measured using meter scale. The fruit diameter was measured using slide calipers. The fruit weight was taken using a digital balance.

2.5 Economic Analysis

The cost of production was calculated to find out the most economic combination of seedling age and training. All input cost like the cost for land lease and interests on running capital were computing in the calculation. The interests were calculated @ 12% in simple rate. The market price of cucumber was considered for estimating the return. Analyses were done according to the procedure of [11]. 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.)

2.6 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 the least significant difference test (LSD) at 5% level of probability.

3. RESULTS AND DISCUSSION

3.1 Plant Height (cm)

Plant height was taken only at harvesting time. Plant height of cucumber varied significantly due to different seedling ages. At harvesting time, the highest plant height (244.59 cm) was obtained from S3 (25 days old seedling) whereas the lowest plant height (227.97cm) was found from S1 (15 days old seedling) treatment. Data indicated that the 25 days old seedling produced the longest plant (Table 1). Mainly cucumber is mostly cultivated by direct sowing in our country. But if transplantation of seedling can be done, it will affect the growth and yield of cucumber but generally, this factor is overlooked by the farmers. Corresponding findings was also observed from earlier experiment [12]. Results indicated that maximum vine length (242.24 cm) was recorded from T3 (removal of all branches up to 120 cm) treatment while the shortest plant
(226.98 cm) was recorded from T0 (control) treatment (Table 2). Training of cucumber improve growth and expand fruiting area. An appropriate training system will facilitate better management and uniform light to the plants. An appropriate training in cucumber will boost up the vegetative growth of cucumber [13]. Combined effect between seedling age and training has significantly effect on plant height. The highest value of plant height (250.89 cm) was recorded from the treatment combination of S3T3 (25 days old seedling and removal of all branches up to 120 cm height) and the minimum (220.24 cm) in the treatment combination of S1T0 (15 days old seedling and control) (Table 3) which is statistically identical to S2T0 treatment combination (Table 3).

3.2 Number of Branches per Plant

Variation on number of branches per plant of cucumber differed significantly due to different level of seedling ages. Data were taken at harvesting of cucumber. At harvest, the maximum average branches per plant (13.82) was recorded from S3 (25 days old seedling) treatment while the minimum average branches per plant (11.81) was recorded from S1 (15 days old seedling) treatment (Table 1). Significant influence was observed on average branches per plant of cucumber due to different level of training. At harvests, maximum average branches per plant (13.67) was found from T1 (removal of all branches up to 40 cm height) treatment while the minimum average branches per plant (11.61) was recorded from T0 (control) treatment (Table 2). Training helps minimizes overcrowding of branch at a single place. Similar findings also observed on earlier experiment [13]. Combined effect between different seedling age and training remarked statistically significant variation in terms of average branches per plant of cucumber. The greatest average branches per plant (14.90) was observed from S3T1 (25 days old seedling and removal of branches up to 40 cm height) treatment combination and the minimum average branches per plant (10.81) was recorded from S1T0 (15 days old seedling and control) treatment combination (Table 3).

3.3 Days Required to 1st Flowering

The average days required for 1st flowering showed a significant variation in relation with different seedling age. The lowest (28.31) average days required for 1st flowering was obtained from S3 (25 days old seedling) treatment (Table 4) and the highest (31.79) average days required for 1st flowering was obtained from S1 (15 days old seedling) treatment. It can be inferred that later transplants tend to reproduce earlier as compared to earlier transplants [14]. Days required to first flower initiation of cucumber showed positively significance by the application of different level training. The lowest (28.70) average days required for 1st flowering was recorded from T1 (removal of all branches up to 40 cm height) treatment (Table 5) and the highest (31.36) average days required for 1st flowering was recorded from T0 (Control) treatment. It was significantly influenced by various levels of training. This result is in agreement with the findings of [13]. Significant variation was observed due to the combined effect of different seedling age and training in terms of average days required to 1st flowering. The minimum average days required to 1st flowering (27.05) was observed from S3T1 (25 days old seedling and removal of all branches up to 40 cm height) treatment combination and the maximum average days required to 1st flowering was recorded from S1T0 (15 days old seedling and control) (33.66) treatment combination (Table 6).

Table 1. Effect of seedling age on plant height and number of branch per plant of cucumber

| Treatment | Plant height (cm) At harvest | Branch number/plant At harvest |
|-----------|-----------------------------|-------------------------------|
| S1        | 227.97 c                    | 11.81 c                       |
| S2        | 234.07 b                    | 12.90 b                       |
| S3        | 244.59 a                    | 13.82 a                       |
| LSD(0.05) | 2.0046                      | 0.2357                        |
| CV%       | 1.01                        | 2.17                          |
Table 2. Effect of training on plant height and number of branch per plant of cucumber

| Treatment | Plant height (cm) At harvest | Branch number/plant At harvest |
|-----------|-----------------------------|--------------------------------|
| T₀        | 226.98 d                    | 11.61 d                        |
| T₁        | 235.15 c                    | 13.67 a                        |
| T₂        | 237.79 b                    | 13.23 b                        |
| T₃        | 242.24 a                    | 12.86 c                        |
| LSD(0.05) | 2.3147                      | 0.2722                         |
| CV%       | 1.01                        | 2.17                           |

Table 3. Combined effect of seedling age and training on plant height and number of branches per plant of cucumber

| Treatment combination | Plant height(cm) at harvest | Number of branch /plant at harvest |
|-----------------------|-----------------------------|-----------------------------------|
| S₁T₀                  | 220.24 h                    | 10.81 h                           |
| S₁T₁                  | 226.72 g                    | 12.72 de                          |
| S₁T₂                  | 231.16 f                    | 12.21 f                           |
| S₁T₃                  | 233.76 ef                   | 11.51 g                           |
| S₂T₀                  | 222.06 h                    | 11.74 g                           |
| S₂T₁                  | 235.94 de                   | 13.40 c                           |
| S₂T₂                  | 236.18 de                   | 13.36 c                           |
| S₂T₃                  | 242.09 bc                   | 13.08 cd                          |
| S₃T₀                  | 238.65 cd                   | 12.28 ef                          |
| S₃T₁                  | 242.79 b                    | 14.90 a                           |
| S₃T₂                  | 246.03 b                    | 14.13 b                           |
| S₃T₃                  | 250.89 a                    | 13.98 b                           |
| LSD(0.05)             | 4.0092                      | 0.4714                            |
| CV%                   | 1.01                        | 2.17                              |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability Here, S₁ = 15 days old seedling S₂ = 20 days old seedling S₃ = 25 days old seedling where, T₀ = Control T₁ = Removal of all branches up to 40 cm height T₂ = Removal of all branches up to 80 cm height and T₃ = Removal of all branches up to 120 cm height

3.4 Number of Male Flower per Plant

The data on number of male flower per plant was found to be significant in terms of different seedling age of cucumber. The maximum number of male flowers per plant (38.07) was observed from S₃ (25 days old seedling) treatment. On the other hand, the lowest number of male flowers per plant (28.24) was found from S₁ (15 days old seedling) treatment (Table 4). Application of different level of training on cucumber showed significant effect on number of male flowers per plant. The highest (34.91) number of male flowers per plant was observed from T₁ (removal of all branches up to 40 cm height) treatment (Table 5), treatment and the lowest (30.54) number of male flowers per plant was recorded from was recorded from T₀ (Control) treatment. It is indicated that training help to produce more male flower. Combined effect between different seedling age and training showed statistically significant variation in terms of number of male flowers per plant of cucumber. The maximum number of male flowers per plant (40.30) was observed from S₃T₁ (25 days old seedling and removal of all branches up to 40 cm height) treatment combination and the minimum number of male flowers per plant was found from S₁T₀ (26.33) (15 days old seedling and control) treatment combination (Table 6).

3.5 Number of Female Flower per Plant

Number of female flowers per plant showed statistically significant variation due to different seedling age of cucumber (Table 4). The maximum number of female flowers per plant (28.48) was recorded from S₃ (25 days old seedling) treatment. On the other hand, the lowest number of female flowers per plant (18.23) was found from S₁ (15 days old seedling) treatment (Table 4). Femaleness is increased in four weeks old cucumber transplants [15]. Number of female flowers per plant of cucumber influenced significantly by the application of different level of training. The highest (25.57) number of female flowers per plant was recorded from T₁ (remove all branch up to 40 cm height)
treatment (Table 5) and the lowest (20.08) number of female flowers per plant was recorded from T₀ (Control) treatment. It is indicated that training help to produce more female flower. It was significantly influenced by various levels of training. Training in cucumber increase female flower of cucumber [16]. Remarkable variation was found on number of female flower per plant influenced by of different seedling age and training of cucumber. It was verified that the maximum number of female flowers per plant (30.69) was observed from S₃T₁ treatment combination (25 days old seedling and removal of all branches up to 40 cm height) and the minimum number of female flowers per plant was recorded from S₁T₀ (14.88) treatment combination (15 days old seedling and control) (Table 6).

3.6 Days Required to First Fruit Harvest

The days required to first harvesting of cucumber fruit was significantly influenced by various levels of seedling age (Table 3). The lowest (39.36) days required for harvest of green fruit was recorded from S₃ treatment (25 days old seedling) and the highest (48.19) days required for harvest of green fruit was recorded from S₁ (15 days old seedling) treatment (Fig 1). Older transplant are help in getting reproductive phase earlier than young transplant [14]. Application of different levels of training showed significant variation on days required to first harvesting of cucumber (Fig 2). Due to application of different training system the lowest (41.42) days required for harvest of green fruit was recorded from T₁ (removal of all branch up to 40 cm height) treatment and the highest (45.16) days required for harvest of green fruit was recorded from T₀ (control) treatment (Fig 2). The above results are supported with the conclusions drawn by [13], [17].

Significant variation was recorded from the combined effect of different seedling age and training in terms of days required to first fruit harvest of cucumber (Table 6). The minimum days required to first fruit harvest (37.09) was observed from S₃T₁ (25 days old seedling and removal of all branches up to 40 cm height) treatment combination and the minimum days required to first fruit was recorded from S₁T₀ (49.88) treatment combination (15 days old seedling and control) which is statistically identical to the S₁T₃ treatment combination (48.96). This is might be due that old age seedling develop early reproduction phase than young seedling.

Table 4. Effect of seedling age on days to first flowering, number of male and female flower per plant

| Treatment | Days to first flowering | Number of male flower/plant | Number of female flower/plant |
|-----------|-------------------------|-----------------------------|-----------------------------|
| S₁        | 31.79 a                 | 28.24 c                     | 18.23c                      |
| S₂        | 29.70 b                 | 32.24 b                     | 23.39 b                     |
| S₃        | 28.31 c                 | 38.07 a                     | 28.48 a                     |
| LSD(0.05) | 0.5188                  | 0.644                       | 0.5932                      |
| CV%       | 2.05                    | 2.41                        | 3.00                        |

Table 5. Effect of training on days to first flowering, number of male and female flower per plant

| Treatment | Days to first flowering | Number of male flower/plant | Number of female flower/plant |
|-----------|-------------------------|-----------------------------|-----------------------------|
| T₀        | 31.36 a                 | 30.54 d                     | 20.08 d                     |
| T₁        | 28.70 d                 | 34.91 a                     | 25.57 a                     |
| T₂        | 29.46 c                 | 33.29 b                     | 24.38 b                     |
| T₃        | 30.21 b                 | 32.85 c                     | 23.44 c                     |
| LSD(0.05) | 0.5991                  | 0.7438                      | 0.6849                      |
| CV%       | 2.05                    | 2.41                        | 3.00                        |
Fig. 1. Effect of seedling age on days required to first fruit harvest of cucumber
Where, $S_1 = 15$ days old seedling $S_2 = 20$ days old seedling $S_3 = 25$ days old seedling

Fig. 2. Effect of training on days required to first fruit harvest of cucumber
Where, $T_0 = \text{Control}$ $T_1 = \text{Removal of all branches up to 40 cm height}$ $T_2 = \text{Removal of all branches up to 80 cm height}$ $T_3 = \text{Removal of all branches up to 120 cm height}$

Table 6. Combined effect of seedling age and training on days to first flowering, number of male and female flower per plant, and days to first fruit harvest of cucumber

| Treatment combination | Days to first flowering | Number of male flower/plant | Number of female flower/plant | Days required to first fruit harvest |
|-----------------------|-------------------------|------------------------------|-------------------------------|-------------------------------------|
| $S_1 T_0$             | 33.66 a                 | 26.33 i                      | 14.88 g                       | 49.88 a                             |
| $S_1 T_1$             | 30.47 cde               | 29.74 g                      | 20.22 e                       | 46.90 b                             |
| $S_1 T_2$             | 31.35 bc                | 29.12 gh                     | 20.03 e                       | 47.02 b                             |
| $S_1 T_3$             | 31.68 b                 | 28.54 h                      | 17.81 f                       | 48.96 a                             |
| $S_2 T_0$             | 30.80 bcd               | 29.42 g                      | 19.77 e                       | 44.02 c                             |
| $S_2 T_1$             | 28.58 gh                | 34.70 e                      | 25.81 c                       | 40.28 f                             |
| $S_2 T_2$             | 29.47 efg               | 32.18 f                      | 24.19 d                       | 42.13 de                            |
| $S_2 T_3$             | 29.94 def               | 32.50 f                      | 23.78 d                       | 43.59 cd                            |
| $S_3 T_0$             | 29.60 efg               | 35.89 d                      | 25.58 c                       | 41.58 ef                            |
| $S_3 T_1$             | 27.05 i                 | 40.30 a                      | 30.69 a                       | 37.09 h                             |
| $S_3 T_2$             | 27.55 hi                | 38.58 b                      | 28.92 b                       | 38.93 g                             |
| $S_3 T_3$             | 29.02 fg                | 37.50 c                      | 28.73 b                       | 39.83 g                             |
| LSD(0.05)             | 1.0376                  | 0.6376                       | 1.1863                        | 1.7535                              |
| CV%                   | 2.05                    | 1.14                         | 3.00                          | 2.39                                |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, $S_1 = 15$ days old seedling $S_2 = 20$ days old seedling $S_3 = 25$ days old seedling, $T_0 = \text{Control}$ $T_1 = \text{Removal of all branches up to 40 cm height}$ $T_2 = \text{Removal of all branches up to 80 cm height}$ and $T_3 = \text{Removal of all branches up to 120 cm height}$.
3.7 Number of Fruit per Plant

The average number of fruit per plant showed statistically significant variation due to different seedling age of cucumber (Table 7). The maximum average fruit per plant (17.18) was recorded from S3 (25 days old seedling) treatment. On the other hand the lowest average fruit per plant (11.97) was found from S1 (15 days old seedling treatment (Table 7). The vigorous vegetative growth might be the contributing factor towards reduced number of fruits in 15 days and 21 days old seedlings. Maximum average fruits was found from 28 days old seedlings reported by [18]. Older seedlings produce more fruit per plant than others. The result is similar with [19]. There was significant variation on average number of fruit per plant due to different level of training (Table 8). The maximum average fruit per plant (15.93) was recorded from T1 (removal of all branches up to 40 cm height) treatment. On the other hand, the lowest average fruit per plant (12.88) was found from T0 (control). The present finding is agreed with the findings of [9] [13]. Combined effect of different seedling age and training showed statistically significant variation in terms on average fruit per plant (Table 9). The highest total average fruit per plant (19.45) was recorded from S1T0 (25 days old seedling and removal of all branches up to 40 cm height) treatment combination and the lowest average fruit per plant (10.47) was recorded from S1T0 (15 days old seedling and control) treatment combination.

3.8 Fruit Length (cm)

Fruit length of cucumber showed statistically significant variation due to different seedling age (Table 7). The longest fruit (18.08cm) was recorded from S3 (25 days old seedling) and shortest fruit length was recorded (13.92cm) from S1 (15 days old seedling) treatment (Table 7). Statistically significant variation was obtained in fruit length due to different level of training (Table 8). The longest fruit (17.03cm) was recorded from T1 (removal of all branches up to 40 cm height) treatment. The shortest fruit length (15.51 cm) was recorded from T0 (control) treatment which was statistically similar to T3 (15.93 cm) treatment (removal of all branches up to 120 cm height). Combined effect between different seedling age and training showed significant variation in terms of fruit length of cucumber (Table 9). The longest fruit length (18.77cm) was recorded from S2T1 (25 days old seedling and removal of all branches up to 40 cm height) treatment combination which was statistically similar to (17.85cm and 17.91cm) S2T0 and S3T3 treatment combination and the shortest fruit length (12.91cm) was recorded from S1T0 treatment combination which was statistically similar to (13.69) S1T3 treatment combination.

3.9 Fruit Diameter (cm)

The highest diameter of fruits (5.59 cm) was recorded from S3 (25 days old seedling) treatment and lowest diameter of fruits (3.72 cm) was found from S1 (15 days old seedling) treatment (Table. 7). Different training levels showed significant impact on the diameters of fruits. The highest diameter of fruits (5.29 cm) was found from T1 (removal of all branches up to 40 cm height) treatment ( Table 8).The lowest diameter of fruits (4.28 cm) was found from T0 treatment which is statistically similar to (4.53 cm) T3 (removal of all branches up to 120 cm height) treatment. Combined effect between different seedling age and training noted significant variation in terms of fruit diameter of cucumber (Table 9). The highest fruit diameter (6.22 cm) was recorded from S1T1 (25 days old seedling and removal of all branches up to 40 cm height) treatment combination and the lowest diameter of fruit (3.18 cm) was recorded from S1T0 treatment combination which was statistically similar to S1T1 (3.65 cm) treatment combination.

3.10 Individual Fruit Weight (gm)

Statistically significant variation was obtained in terms of different age of seedling in individual fruit weight of cucumber. The highest individual fruit weight (174.33 gm) was obtained from S3 (25 days old seedling). Whereas the lowest individual fruit weight (138.10 gm) was found from S1 (15 days old seedling) treatment (Table 7). This result is also similar with [20]. Weight of cucumber was greatest when seedlings were 25 days old at transplanting. Different levels of training remarked statistically significant variation in individual fruit weight of cucumber (Table 8). The highest individual fruit weight (160.87gm) was recorded from T1 treatment (Table 8) whereas the lowest individual fruit weight (151.64 gm) was found from T0 treatment.Similar findings was also noted in their early experiment[13] [17].

Combined effect of different seedling age and training showed remarkable significant variation in terms of individual fruit weight (Table 9). The
highest individual fruit weight (177.91 gm) was recorded in the $S_3T_1$ treatment combination (25 days old seedling and removal of all branches up to 40 cm height) and the lowest (132.40 gm) was recorded in the $S_1T_0$ treatment combination (Table 9).

**Table 7. Effect of seedling age and on number of fruit per plant, length of fruit, diameter of fruit and individual fruit weight of cucumber**

| Treatment | Total no of fruit per plant | Length of fruit(cm) | Diameter of fruit(cm) | Individual fruit weight(gm) |
|-----------|-----------------------------|---------------------|-----------------------|-----------------------------|
| $S_1$     | 11.97 c                     | 13.92 c             | 3.72 c                | 138.10 c                    |
| $S_2$     | 14.13 b                     | 16.56b              | 4.74b                 | 155.53 b                    |
| $S_3$     | 17.18a                      | 18.08a              | 5.59a                 | 174.33a                     |
| LSD(0.05) | 0.3635                      | 0.4784              | 0.2543                | 0.2543                      |
| CV%       | 2.97                        | 3.49                | 1.42                  |                             |

**Table 8. Effect of training on number of fruit per plant, length of fruit, diameter of fruit and individual fruit weight of cucumber**

| Treatment | Total no of fruit per plant | Length of fruit(cm) | Diameter of fruit(cm) | Individual fruit weight(gm) |
|-----------|-----------------------------|---------------------|-----------------------|-----------------------------|
| $T_0$     | 12.88 d                     | 15.51 c             | 4.28 c                | 151.64 c                    |
| $T_1$     | 15.93a                      | 17.03a              | 5.29a                 | 160.87a                     |
| $T_2$     | 14.77 b                     | 16.28 b             | 4.64 b                | 156.51 b                    |
| $T_3$     | 14.12 c                     | 15.93 bc            | 4.53bc                | 154.93 b                    |
| LSD(0.05) | 0.4197                      | 0.5524              | 0.2936                | 2.1593                      |
| CV%       | 2.97                        | 3.49                | 1.42                  |                             |

**Table 9. Combined effect of seedling age and training on number of fruit per plant, length of fruit, diameter of fruit and individual fruit weight of cucumber**

| Treatment combination | Total no of fruit per plant | Length of fruit(cm) | Diameter of fruit(cm) | Individual fruit weight(gm) |
|-----------------------|-----------------------------|---------------------|-----------------------|-----------------------------|
| $S_1T_0$              | 10.47 i                     | 12.91i              | 3.18e                 | 132.40g                     |
| $S_1T_1$              | 13.10 g                     | 14.8 fg             | 3.65 de               | 140.92 f                    |
| $S_1T_2$              | 12.22 h                     | 14.27 gh            | 3.74 d                | 140.18 f                    |
| $S_1T_3$              | 12.08 h                     | 13.69 hi            | 4.33 c                | 138.92 f                    |
| $S_2T_0$              | 12.36 h                     | 15.76 ef            | 4.46 c                | 150.48 e                    |
| $S_2T_1$              | 15.26de                     | 17.53 bc            | 4.56 c                | 163.77 c                    |
| $S_2T_2$              | 14.84 e                     | 16.77 cd            | 4.61 c                | 155.31 d                    |
| $S_2T_3$              | 14.07 f                     | 16.18 de            | 5.20 b                | 152.55 de                   |
| $S_3T_0$              | 15.81 cd                    | 17.85ab             | 5.29 b                | 172.03 b                    |
| $S_3T_1$              | 19.45a                      | 18.773a             | 6.22a                 | 177.91a                     |
| $S_3T_2$              | 17.25b                      | 17.81 b             | 5.66 b                | 174.05 b                    |
| $S_3T_3$              | 16.22 c                     | 17.91ab             | 5.34b                 | 173.33 b                    |
| LSD(0.05)             | 0.7269                      | 0.9568              | 0.5086                | 3.7400                      |
| CV%                   | 2.97                        | 3.49                | 6.40                  | 1.42                        |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, $S_1$ = 15 days old seedling $S_2$ = 20 days old seedling $S_3$ = 25 days old seedling where, $T_0$ = Control $T_1$ = Removal of all branches up to 40 cm height $T_2$ = Removal of all branches up to 80 cm height and $T_3$ = Removal of all branches up to 120 cm height.
3.11 Yield per Plant (kg)

Significant variation was noted on yield per plant of cucumber influenced by different seedling age. The highest fruit yield per plant (2.99 kg) was observed from $S_3$ (25 days old seedling) treatment whereas the lowest fruit yield per plant (1.65 kg) was found from $S_1$ treatment (Table 10). The higher fruit yield per plant can be positively correlated with more number of fruits per plant. Higher fruit yield with 25 days old seedling also agreed by [18][21]. Different levels of training varied significantly in terms of fruit yield per plant of cucumber. The highest fruit yield per plant (2.59 kg) was found from $T_1$ (Removal of all branches up to 40 cm height) treatment whereas the lowest fruit yield per plant (1.98 kg) was found from $T_0$ treatment (Table 11). Combined effect between seedling age and training showed statistically significant variation in terms of fruit yield per plant of cucumber (Table 12). The highest fruit yield per plant (3.43 kg) was observed from $S_3T_1$ treatment (25 days old seedling and removal of all branches up to 40 cm height). Whereas the lowest fruit yield per plant (1.38 kg) was found from $S_1T_0$ (15 days old seedling and control) treatment combination.

3.12 Yield/ Plot (kg)

The total yield per plot showed statistically significant variation due to different seedling age of cucumber (Table 10). The maximum number of fruits yield per plant (17.98 kg) was recorded from $S_3$ treatment (25 days old seedling age). The lowest number of fruit yield per plant (9.90 kg) was found from $S_1$ (15 days old seedling age) treatment. Vegetables cultivated from older seedlings produced higher yields [8]. Different levels of training varied significantly in terms of total yield per plot of cucumber. The highest yield per plot (15.54 kg) was found from $T_1$ treatment (removal of all branches up to 40 cm height). Whereas the lowest yield per plot (11.91 kg) was found from $T_0$ (control) treatment (Table 11). By appropriate training system, it will helps for improving growth and increase fruiting area. Results indicated that seedling age and training showed statistically significant variation in terms of total fruit yield per plot of cucumber. The highest fruit yield per plot (20.62 kg) was observed from $S_3T_1$ (25 days old seedling and removal of all branches up to 40 cm height) treatment combination. Whereas the lowest fruit yield per plot (8.28 kg) was found from $S_1T_0$ (15 days old seedling and control) treatment combination.

3.13 Yield per Hectare (ton)

Different Seedling age showed significant variation in terms of fruit yield per hectare of cucumber (Fig3). The highest fruit yield per hectare (41.63 ton) was recorded from $S_3$ treatment (25 days old seedling age) treatment, whereas the lowest fruit yield per hectare was recorded from (22.92 ton) $S_1$ (15 days old seedling age) treatment. Similar result was also reported by [20][21][22][23]. They also found that older seedling produced higher yield production in different vegetables crops. Different levels of training varied significantly in terms of total yield per hectare of cucumber (Fig 4). The highest yield per hectare (35.97 ton) was found from $T_1$ treatment. On the other hand, the lowest yield per hectare (27.57 ton) was found from $T_0$ treatment compared to other treatments. This results are in line with the findings of [13][17][10]. By proper training method plants are capable of produced maximum production of yield by removing unnecessary growth of the plant and using maximum resources.

| Treatment | Yield/plant(kg) | Yield/plot(kg) |
|-----------|----------------|---------------|
| $S_1$     | 1.65 c         | 9.90 c        |
| $S_2$     | 2.19 b         | 13.17 b       |
| $S_3$     | 2.99 a         | 17.98 a       |
| LSD(0.05) | 0.0627         | 0.3760        |
| CV%       | 3.24           | 3.24          |
Table 11. Effect of training on yield per plant, yield per plot of cucumber

| Treatment | Yield /plant(kg) | Yield /plot(kg) |
|-----------|-----------------|-----------------|
| T₀        | 1.98 d          | 11.91 d         |
| T₁        | 2.59a           | 15.54a          |
| T₂        | 2.33b           | 14.03 b         |
| T₃        | 2.21c           | 13.26 c         |
| LSD(0.05) | 0.0724          | 0.4341          |
| CV%       | 3.24            | 3.24            |

Fig. 3. Effect of seedling age on yield per hectare of cucumber
Where, S₁ = 15 days old seedling S₂ = 20 days old seedling S₃ = 25 days old seedling

Fig. 4. Effect of training on yield per hectare of cucumber
Where, T₀ = Control T₁ = Removal of all branches up to 40 cm height T₂ = Removal of all branches up to 80 cm height and T₃ = Removal of all branches up to 120 cm height

Combined effect between different seedling age and training remarked statistically significant variation in terms of total yield per hectare of cucumber. The highest yield per hectare (47.73 ton) was observed from S₃T₁ treatment combination (Table 12). Whereas the lowest yield per hectare (19.16 ton) was found from S₁T₀ treatment combination.
Table 12. Combined effect of seedling age and training on yield per plant, yield per plot and yield per hectare of cucumber

| Treatment combination | Yield/plant (kg) | Yield/plot (kg) | Yield/ha (ton) |
|-----------------------|-----------------|----------------|---------------|
| S₁T₀                  | 1.38 i          | 8.28 i         | 19.16i        |
| S₁T₁                  | 1.83g           | 11.02 g        | 25.50g        |
| S₁T₂                  | 1.70h           | 10.24 h        | 23.74h        |
| S₁T₃                  | 1.68 h          | 10.08 h        | 23.33 h       |
| S₂T₀                  | 1.86 g          | 11.16 g        | 25.83g        |
| S₂T₁                  | 2.49d           | 14.98 d        | 34.67d        |
| S₂T₂                  | 2.28 e          | 13.70 e        | 31.71 e       |
| S₂T₃                  | 2.14f           | 12.86 f        | 29.76f        |
| S₃T₀                  | 2.71c           | 16.34 c        | 37.73c        |
| S₃T₁                  | 3.43a           | 20.62a         | 47.73a        |
| S₃T₂                  | 3.02 b          | 18.16 b        | 42.03 b       |
| S₃T₃                  | 2.81c           | 16.86c         | 39.02c        |
| LSD(0.05)             | 0.1253          | 0.7520         | 1.7406        |
| CV%                   | 3.24            | 3.24           | 3.24          |

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. Here, S₁= 15 days old seedling S₂= 20 days old seedling S₃= 25 days old seedling where, T₀= Control T₁= Removal of all branches up to 40 cm height T₂= Removal of all branches up to 80 cm height and T₃= Removal of all branches up to 120 cm height.

Table 13. Cost and returns of cucumber cultivation as influenced by seedling age and training

| Treatment combination | Cost of production (Tk./ha) | Yield of Cucumber (ton/ha) | Gross return (Tk./ha) | Net return (Tk./ha) | Benefit cost ratio |
|-----------------------|----------------------------|---------------------------|-----------------------|---------------------|-------------------|
| S₁T₀                  | 445728                     | 19.16                     | 479000                | 33272               | 1.07              |
| S₁T₁                  | 462423                     | 25.5                      | 637500                | 175077              | 1.37              |
| S₁T₂                  | 462423                     | 23.74                     | 593500                | 131077              | 1.28              |
| S₁T₃                  | 462423                     | 23.33                     | 583250                | 120827              | 1.26              |
| S₂T₀                  | 462423                     | 25.83                     | 645750                | 200022              | 1.44              |
| S₂T₁                  | 462423                     | 34.67                     | 866750                | 404327              | 1.87              |
| S₂T₂                  | 462423                     | 31.71                     | 792750                | 330327              | 1.71              |
| S₂T₃                  | 462423                     | 29.76                     | 744000                | 281577              | 1.60              |
| S₃T₀                  | 445728                     | 37.73                     | 943250                | 497522              | 2.11              |
| S₃T₁                  | 462423                     | 47.73                     | 1193250               | 730827              | 2.58              |
| S₃T₂                  | 462423                     | 42.03                     | 1050750               | 588327              | 2.27              |
| S₃T₃                  | 462423                     | 39.02                     | 975500                | 513077              | 2.10              |

Note: S₁= 15 days old seedling S₂= 20 days old seedling S₃= 25 days old seedling T₀= Control T₁= Removal of all branches up to 40 cm height T₂= Removal of all branches up to 80 cm height. Price of cucumber 25 TK/kg.

3.14 Economic Analysis

Input costs for land preparation, seed cost, fertilizers, 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:

3.14.1 Gross return

The combination of seedling age and training showed different gross return. The highest gross return (1193250 Tk./ha) was obtained from S₃T₁ treatment combination and the second highest gross return (1050750 Tk./ha) was found in S₃T₂. The lowest gross return (479000 Tk./ha) was obtained from S₁T₀ treatment combination (Table 13).

3.14.2 Net return

In case of net return different treatment combination showed different net return. The highest net return (730827 Tk.) was found from S₁T₁ treatment combination and the second highest net return (588327 Tk./ha) was obtained.
from $S_3T_2$ treatment combination. The lowest (33272Tk/ha) net return was obtained from $S_1T_0$ treatment combination (Table 13).

3.14.3 Benefit cost ratio

In the combination of seedling age and training highest benefit cost ratio (2.58) was noted from $S_3T_1$ treatment combination and the second highest benefit cost ratio (2.27) was estimated from $S_3T_2$ treatment combination. The lowest benefit cost ratio (1.07) was obtained from $S_1T_0$ treatment combination (Table 13). From economic point of view, it was apparent from the above results that the combination of $S_3T_1$ treatment combination was more profitable than rest of the combination.

4. CONCLUSION

In the experiment, treatment $S_3$ (25) days old seedling was excellent to the others treatment. For obtaining the maximum fruit yield of cucumber, 25 days old seedling was performed the best among the others ages of seedling. Among different training system $T_1$, was found best for higher yield of cucumber than others. The treatment combination of $S_2T_1$ comprising of 25 days old seedling and removal of all branches up to 40 cm height showed the best capability of 47.73 ton/ha with TK730827 net income and 2.58 BCR. This type of experiment need to be carried out in different parts of the country to increase the production of cucumber.

DISCLAIMER

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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Horie H, Ito H, Ippoushi K, Azuma K, Sakata Y, Igarashi I. Cucurbitacin C-bitter principle in cucumber plants. Japan Agricultural Research Quarterly. 2007;41(1): 65-68.
2. Cucumber. Retrieved 28 December 2021, from https://en.wikipedia.org/wiki/Cucumber
3. AVRDC. 1999. Cucurbits report for 1998. Shanhua, Taiwan. 2019;76.
4. Link R. 7 health benefits of eating cucumber; 2017. Available: www.healthline.com.
5. BBS. Bangladesh Bureau of Statistics. Ministry of Planning. Government of People’s Republic of Bangladesh. Yearbook of Agricultural Statistics-2019. Dhaka. 2020:315.
6. Weston LA. Effect of flat cell size, transplant age, and production site on growth and yield of pepper transplants. Hort Science. 1988;23:709-711.
7. Vavrina CS. Transplant age in vegetable crops. Horticultural Technology. 1998;8(4):550-555.
8. Handley D, Hutton M. Effect of seeding date, transplant size and container on growth and yield of pickling cucumbers. Journal of the American Society for Horticultural Science. 2003;38: 672.
9. Lal M, Kanwar HS, Kanwar R.. Impact of spacing and training on seed yield of capsicum, Capsicum annuum L. under protected conditions. International Journal of Farm Sciences. 2014;4(3):42-48.
10. Hebert M. Greenhouse Cucumber Production; 1998. Available: http://www.uaf.edu
11. Alam MS, Iqbal TMT, Amin M, Gaffar MA., Krishitattik Fasaler Utpadon O Unnayan (In Bengali). T.M. Jubair Bin Iqbal , Sirajgong. 1989;231-239.
12. Jankauskiene J, Brazaityte A. Influence of transplant age on the earliness of yield and productivity of short-fruit cucumbers. Acta Hortic. 2019;24(3):138-146.
13. Kapuriya VK, Ameta KD, Teli SK, Chittora A, Gathala S, Yadav S. Effect of spacing and training on growth and yield of polyhouse grown cucumber (Cucumis sativus L.). International Journal of Current Microbiology and Applied Sciences. 2017;6(8):299-304.
14. Orzolek M. Evaluating vegetable transplants. Vegetable, small fruit and specially crops. Virginia Cooperative Extension. 2004;3(3): 9.
15. Lorenz OA, Maynard DN. Knott’s Handbook for Vegetable Growers, 3rd Ed.. Wiley, New York; 1988:14.
16. Kumar S, Patel NB, Saravaiya S.. Influence of fertigation and training systems on yield and other horticultural traits in greenhouse cucumber. Indian Journal of Horticulture. 2018;75(2): 252.

17. Haque MA, Sarker BC, Rahman M, Akter A, Rahman H.. Effects of spacing and training on the growth and yield of capsicum. Eco-friendly Agricultural Journal. 2019;12(01):01-06.

18. Nesmith DS. Transplant age influences summer squash growth and yield. HortScience, 1993;28(6): 618–620.

19. Jellani G, Atif MJ, Ullah H, Khan TN, Saleem N..Seedling age impact on growth and yield of bitter gourd. Science, Technology and Development. 2016;35 (2):94-97.

20. Grimstads SO, Frimanslund E. Effect of transplant age on growth and yield of cucumber (Cucumis sativus L var. Ventura). Scientia Horticulturae. 2002;53:192–196.

21. Sahar T, Hafiz IA, Abbasi NA, Sajjad Z. Effect of seedling age and different levels of phosphorus on growth and yield of cucumber (Cucumis sativus L). International Journal of Agriculture & Biology. 2005;7(2):311-314.

22. Jellani G, Atif MJ, Ullah H, Ali M, Musa M. Influence of seedling age on cucumber (cucumis sativus L.) production. SAARC Journal of Agriculture. 2015;13(2): 214-221.

23. Hasandokht MR, Nosrati SZ. Effect of transplant age and fruit pruning on earliness and total yield of greenhouse cucumber (Cucumis sativus L. cv. Sultan). Plant Ecophysiology. 2010:2: 21-25.