

Effect of Harvesting of Fruits at Different Maturity Stage on the Production of Cucumber (*Cucumis sativus* L) Under Plastic House Condition

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ABSTRACT

The experiment was carried out from 16th December 2016 to May 10, 2017, in the horticulture farm of Nepal Polytechnic Institute Bharatpur-11. Cucumbers were planted under plastic house conditions (23.90 ± 3.55 °C temp. and $59.15 \pm 10.33\%$ RH). Parthenocarpic cucumber variety Poyraz F1 was selected for the research. Fruits are harvested at four different maturity stages (Maturity stage 1, 2, 3, and 4) were treatments i.e. M1 – Immature stage 1 (harvesting of fruits after 2 weeks of fruit set), M2 – Immature stage 2 (harvesting of fruit after 3 weeks of fruit set), M3 – Mature stage (harvesting fruits after 4 weeks of fruit set) and M4 – Over-mature stage (harvesting fruits after 5 weeks of fruit set). Each treatment was replicated 5 times with 5 plants in each experimental unit and these experimental units were arranged in a completely randomized design. There was a significant difference among the selected treatments in the number of flowers per plant at 30, 45 & 60 DAT, the number of internodes per plant at 45 & 60 DAT, numbers of fruits per plant at 30, 45 & 60 DAT and number of harvest per plant. The total yield per plant was observed as not significant. Highest no. of flowers (6.88, 15.52 and 5.83 at 30, 45, and 60 DAT), nodes (5.44, 6.76, 10.53 and 15.53 at 15, 30, 45 and 60 DAT) and fruits (1.4, 5.6, 15 and 25.2 at 15, 30, 45 and 60 DAT) per plant were recorded in the plant in which fruits were harvested at immature stage 1 (harvesting fruits at 2 weeks of fruit set) whereas their values were minimum in the plants in which fruits were harvested at over-mature stage (harvesting fruits at 5 weeks of fruit set). A maximum number of harvests (6.40) were recorded in the plants in which fruits were harvested at an earlier maturity stage. Yield per plant did not vary significantly. Hence, it would be better to harvest cucumbers at an immature stage as the fruit harvested at an earlier stage of maturity had more number of harvests and the producer could enjoy the different market prices and higher prices by supplying tender fruits.

Keywords- Cucumber, Maturity stage, Parthenocarpy, Yield

I. INTRODUCTION

Cucumber (*Cucumis sativus* L.) is the most popular member of the Cucurbitaceae family (Lower and

Edwards). This is one of the oldest cultivated vegetables dating back to 5,000 years (Wehner and Guner, 2004). Cucumber is soft and succulent and is widely consumed both fresh and a portion of processed food (Jarrick, 1986). It is the fourth most important vegetable crop following tomato, cabbage, and onion in the Asian continent (Engelke et al., 1999).

Off-season cultivation of cucumber in ventilated poly houses is being practiced in more than fifty countries all over the world (Parvej et al., 2010). Cucumber is a warm-season vegetable and is very sensitive to frost because of which early and late season production of cucumber can be a challenge for the farmers. It can be grown successfully under high: light, humidity, soil moisture, temperature, and fertilizers in green-house (El-Aidy et al., 2007). Crop protection against unfavorable environmental conditions led to the development of protected agriculture. Favorable creation of micro-climate is the main objective of protected cultivation. Greenhouse operations create a favorable environmental condition for cucumbers; these conditions also favor growth of many plant pathogen and algae species.

Parthenocarpy trait makes crop production possible in greenhouses, in places where there is a shortage of pollinators, and in scenarios where there is inadequate synchronization between male and female flowers (Cardoso, 2003). It has the potential to increase yield, especially under unfavorable conditions, e.g. in protected cultivation. Therefore, the development of parthenocarpy cucumber is one of the most important targets in plant breeding. Parthenocarpic fruit of cucumber is produced without pollination and are all female, seedless varieties.

If this type of cucumber is planted near others, pollination will occur and seeds will form (Relf and McDaniel, 2000).

To encourage ongoing fruit production, harvesting cucumbers when they are still immature is essential. Usually, mature cucumbers are large, yellow with hard seeds; these are inedible and if fruit is allowed to ripen, the plant halts fruit production (Allman, 2017). Cucumbers should be ready to harvest in approximately 50-70 days. Since more than 50 percent of the cucumber

is water, the fruit must be picked when it is succulent and green (immature) for best taste. If the fruit starts to turn yellow, it is past its prime time and the seeds will be dark and ripe (many varieties will taste bitter or pithy even before they turn yellow). Harvest cucumbers every 2-3 days, and promptly pick the fruits as they reach the desired size. If any mature cucumbers are left on the plants, production will stop so a proper harvesting period is necessary (Veggie harvest, 2017). It is necessary to determine the appropriate maturity stage of fruit is harvested to get a higher yield along with the market price. Hence, in this study, the cucumber fruits were harvested at different stages of maturity to determine the economic stage of fruit to be harvested.

II. METHODOLOGY

Selection of the variety

The parthenocarp variety of Cucumber selected for the research is Poyraz F1, one of the seedless varieties which develops female blooms and referred for the plastic house cultivation.

Collection of seed

The seeds were collected from the agro-vet which was located in Ratnanagar, Tandi.

Location and time of the experiment

The experiment was conducted under the plastic house of Nepal Polytechnic Institute (NPI) Bhojad-11, Bharatpur, Chitwan, Nepal. The experimental site lies in 27°41'35"N latitude and 84°26'57" E longitude. The experimental site lies in the tropical belt of the country with hot summer and cold winter. The experiment was conducted in late winter and ends in mid-spring. The experiment was carried out from 16th December 2016 to May 10, 2017.

Seeding and transplanting

A pit of breadth 1m, length 2m, and depth 35cm was dug for making a hotbed. Seeded Polybags were placed inside the hotbed and the bamboos were staked over the pit in as half-circle and covered with a plastic sheet. The transplanting pots were made out of the clay and filled with top black soil and FYM mixed in the ratio of 1:1. The pots were filled equally with the transplanting media near to the top of the pot and seedlings were transplanted on 28th Feb 2016 at the center of each pot at 5cm depth. The seed was covered with media and irrigated soon after planting.

The pots were space 1m*0.5m R-R and P-P respectively and were staked with bamboo sticks to prevent lodging of the seedling. Irrigation was given as per the plant requirement during the late morning. Fungicide king mill 72% WP, to prevent the fungal infection and micronutrient multiplier, to fulfill the demand of plant nutrient was sprayed @ 2gm/liter water. N: P: K (20:20:20) @ 3gm.liter water was also weekly used as a foliar spray for the proper growth and development of the plant.

Design of Experiment

The experiment was laid out in Completely Randomized Design (CRD) with four treatments and each treatment will be replicated five times.

Treatments details

M1- Immature stage 1 (Harvesting fruits after 2 weeks of fruit set)

M2- Immature stage 2 (Harvesting fruits after 3 weeks of fruit set)

M3- Mature stage (Harvesting fruits after 4 weeks of fruit set)

M4 – Over-mature stage (Harvesting fruit after 5 weeks of fruit set)

III. STATISTICAL ANALYSIS

Data entry was done through Microsoft excel 2010 and analyzed by using R-STAT statistical software package by analysis of variance (ANOVA). Duncan Multiple Range Test (DMRT) was done at 5% level of significance.

IV. RESULTS AND DISCUSSION

4.1 Effect of harvesting cucumber fruits at different maturity stages on a number of flowers per plant

Effect of harvesting cucumber fruits at different maturity stages on the number of flowers per plant at 15, 30, 45, and 60 DAT is presented in table 1. Harvesting cucumber fruits at different maturity stages showed a non - significant effect on nos. of flowers per plant at 15 DAT. But, at 30, 45 and 60 DAT harvesting cucumber fruits at different maturity stages showed a significant effect on nos. of flowers per plant.

Number of flowers per plant was recorded maximum i.e. 6.88, 15.52, 5.83 on the cucumber plant in which fruit were harvested at (M1) the immature stage at 30, 45 and, 60 DAT resp. Likewise, the minimum number of flowers was recorded on the cucumber plant in which fruits were harvested at over-mature stage (6.042) and mature stages (6.048) at 30 DAT whereas cucumber plant harvested at over-mature stage (M4) i.e. 9.34 and 2.18 at 45 and 60 DAT respectively showed the minimum number of flowers.

Table 1: Effect of harvesting cucumber fruits at different maturity stages on number of flowers per plant at Bharatpur-11, 2017

Treatments	No. of flowers per plant			
	15 DAP	30DAP	45DAP	60DAP
M1 (Immature stage 1)	2.55	6.88 ^a	15.52 ^a	5.83 ^a
M2 (Immature stage 2)	2.58	6.56 ^{ab}	12.19 ^b	4.07 ^b
M3 (Mature stage)	2.32	6.042 ^b	10.35 ^c	2.91 ^c

M4 (over-mature stage)	2.22	6.048 ^b	9.34 ^d	2.18 ^d
Mean	2.42	6.38	11.85	3.75
CV %	10.598	7.04	3.17	6.14
LSD _{0.05}	0.34	0.60*	0.50***	0.30***
SEM (±)	0.12	0.19	0.17	0.11

Means within the column followed by the same letter do not differ significantly by DMRT (P=0.05)

4.2 Effect of harvesting cucumber fruits at different maturity stages on the numbers of nodes per plant

The effect of harvesting cucumber fruits at different maturity stages on number of nodes per plant is presented in table 2. At 15 DAT, the maximum and minimum nos. of nodes per plant was recorded on the plant in which fruit were harvested at an immature stage 1(M1) and over-mature stage (M4) resp. At 30 DAT, the maximum and minimum number of nodes per plant was recorded on the plant in which fruit were harvested at the mature stage (M3) and immature stage 2 (M2) resp.

At 45 DAT, the maximum and minimum number of nodes per plant was recorded on the plant in which fruit were harvested at immature stage 1(M1) and over-mature stage (M4) resp. Likewise, at 60 DAT maximum and minimum nos. of nodes per plant was recorded on the plant in which fruit was harvested at an immature stage 1 (M1) and over-mature stage (M4) respectively.

Table 2: Effect of harvesting cucumber fruits at different maturity stages on number of nodes per plant at Bharatpur-11, 2017

Treatments	No. of nodes per plant			
	15DAP	30DAP	45DAP	60DAP
M1 (Immature stage 1)	5.44	6.76	10.53 ^a	15.53 ^a
M2 (Immature stage 2)	5.26	6.26	9.43 ^b	14.41 ^b
M3 (Mature stage)	5.12	6.81	8.37 ^c	12.79 ^c
M4 (over-mature stage)	5	6.46	7.14 ^d	10.34 ^d
Mean	5.2	6.57	8.87	13.27
CV %	9.44	5.07	2.57	2.32
LSD _{0.05}	0.65	0.44	0.30**	0.30**
SEM (±)	0.23	0.15	0.1	0.41

Means within the column followed by the same letter do not differ significantly by DMRT (P=0.05)

4.3 Effect of harvesting cucumber fruits at different maturity stages on a number of fruits per plant

Harvesting of cucumber at different maturity stages did not show a significant effect on the number of fruits per plant at 15 DAT but showed significant results at 30, 45, and 60 DAT in table 3. At 15 DAT, maximum no. of fruits per plant was 1.4 on the plant in which the fruit was harvested at immature stage 1 (M1) and immature stage 2(M2) whereas the minimum no. of fruits per plant was 0.4 on the plant in which fruit was harvested at the over-mature stage (M4).

The maximum nos. of fruits per plant was 5.8 on the plant in which fruit was harvested at immature stage 2 (M2) and the minimum no. of fruits per plant was 3.8 on the plant in which fruits were harvested at over-mature stage at 30 DAT. Fruits harvested at 45 and 60 DAT showed maximum no. of fruits per plant on the plant in which the fruit was harvested at immature stage 1 (M1) while minimum no. of fruits per plant was recorded on the plant in which the fruit were harvested over-mature stage (M4).

Fruit-set and development become a problem when pickling cucumbers are grown at a high population for once-over mechanical harvesting (Cantliffe, 1972). In the cucumber, seed development in the fruits restricts the development of additional fruits (McCullum, 1934). So, the treatments in which fruits were harvested at the mature stage had fewer nos. fruits in the plant.

Table 3: Effect of harvesting cucumber fruits at different maturity stages on number of fruits per plant at Bharatpur-11, 2017

Treatments	No. of fruits per plant			
	15 DAP	30DAP	45DAP	60DAP
M1 (Immature stage 1)	1.4	5.6 ^a	15.0 ^a	25.2 ^a
M2 (Immature stage 2)	1.4	5.8 ^a	13.4 ^b	23.0 ^b
M3 (Mature stage)	0.6	4.4 ^{ab}	12.2 ^c	21.8 ^c
M4 (over-mature stage)	0.4	3.8 ^b	10.6 ^d	20.2 ^d
Mean	0.95	4.9	12.8	22.55
CV %	86.48	23.93	4.45	3.57
LSD _{0.05}	1.1	1.57*	0.76***	1.08***
SEM (±)	0.4	0.53	0.27	0.39

Means within the column followed by the same letter do not differ significantly by DMRT (P=0.05)

4.4 Effect of harvesting cucumber fruits at different maturity stages on length of the fruit (cm)

Effect of harvesting cucumber fruits at different maturity stages on length of fruit is presented in table 4. Harvesting cucumber at different maturity stages showed a highly significant effect on the length of the fruit. The longest fruit was recorded on the plants in which fruit was harvested at over-mature stage (28.30 cm) whereas the shortest fruits were 19.20cm on the fruit of

the plant in which fruits were harvested at immature stage 1 (M1). The late harvested fruits recorded longer which might be due to the growth of the fruit for a longer period time.

Table 4: Effect of harvesting cucumber fruits at different maturity stages on length of the fruit (cm) at Bharatpur-11, 2017

Treatments	Length of the fruits (cm) per plant
M1 (Immature stage 1)	19.20 ^c
M2 (Immature stage 2)	23.40 ^b
M3 (Mature stage)	22.50 ^b
M4 (over-mature stage)	28.30 ^a
Mean	23.33
CV %	8.33
SEM (±)	0.83
LSD _{0.05}	3.84***

Means within the column followed by the same letter do not differ significantly by DMRT (P=0.05)

4.5 Effect of harvesting cucumber fruits at different maturity stages on the diameter of the fruit (cm)

Effect of harvesting cucumber fruits at different maturity stages on diameter of the fruit (cm) is presented in table 5. Harvesting fruit at different maturity stages showed a highly significant effect on the diameter of the fruits.

The thickest diameter of fruits were recorded on the plants in which fruits were harvested at over-mature stage (M4) and mature stage (M3) which were statistically similar with the treatment M2 (immature stage 2) whereas the diameter of the fruit was a minimum of 3.41 in the treatment M1 (immature stage 1).

Matured fruits had a wider diameter which might be due to the availability of more time for fruit growth and development.

Table 5: Effect of harvesting cucumber fruits at different maturity stages on diameter of the fruit (cm) at Bharatpur-11, 2017

Treatments	Diameter of the fruits (cm)
M1 (Immature stage 1)	3.41 ^b
M2 (Immature stage 2)	4.80 ^a
M3 (Mature stage)	4.90 ^a
M4 (over-mature stage)	4.90 ^a
Mean	4.5
CV %	7.14
SEM (±)	0.14
LSD _{0.05}	0.43***

Means within the column followed by the same letter do not differ significantly by DMRT (P=0.05)

4.6 Effect of harvesting cucumber fruits at different maturity stages on a number of harvests per plant

Effect of harvesting cucumber fruits at different maturity stages on numbers of harvests per plant is presented in table 6. Different fruiting stages of cucumber showed a highly significant effect the harvests per plant. The maximum no. of harvests 6.40 per plant was recorded on the plant in which fruits were harvested at immature stage 1 (M1) whereas a minimum of 2.80 was recorded on the plant in which fruits were harvested at the over-mature stage (M4).

The number of harvests was more as the fruit were harvested at earlier maturity stage. It might be due to the inhibitory effect of mature fruits on the initiation of successive flowers, fruit set and growth and development of successive fruits which reduce the number of harvests.

Table 6. Effect of harvesting cucumber fruits at different maturity stages on number of harvest per plant at Bharatpur-11, 2017

Treatment	No. of harvest per plant
M1 (Immature stage 1)	6.40 ^a
M2 (Immature stage 2)	5.20 ^a
M3 (Mature stage)	3.80 ^c
M4 (over-mature stage)	2.80 ^d
Mean	4.55
CV %	10.42
SEM (±)	0.21
LSD _{0.05}	0.64***

(Means within the column followed by the same letter do not differ significantly by DMRT (P=0.05))

4.7 Effect of harvesting cucumber fruits at different maturity stages on yield of fruits ton per hectare

Effect of harvesting cucumber fruits at different maturity stages on yield of fruits ton per hectare. Harvesting fruits at different maturity stages of cucumber did not show a significant effect on yield ton per hectare is presented in table 7. The maximum yield 90.84 ton per hectare per the plant was recorded on the plants in which fruits was harvested at immature stage 1 (M1) whereas minimum was recorded on the plant in which fruit were harvested at over-mature stage i.e. 61.93 ton per hectare.

Although yield of the cucumber did not vary significantly by the harvesting of the fruits at different maturity stages, yield in cucumber is conditioned by interrelated traits that are affected by the environment (Dijkhuizen, 2008). Yields and profit could be greatly increased by increasing the fruit load on each plant (Cantliffe, 1972).

Table 7. Effect of harvesting cucumber fruits at different maturity stages on yield of fruit ton/ha at Bharatpur-11, 2017

Treatment	Fruit yield (ton/ha)
M1 (Immature stage 1)	90.84 ^a
M2 (Immature stage 2)	74.78 ^a
M3 (Mature stage)	68.99 ^a
M4 (over-mature stage)	61.93 ^a
Mean	74.13
CV %	28.72
SEM (±)	8.31
LSD _{0.05}	28.54

Means within the column followed by the same letter do not differ significantly by DMRT (P=0.05)

V. CONCLUSION

Harvesting time significantly affects the production of the parthenocarpic cucumber. To encourage ongoing fruit production, cucumbers should be harvested when they are still immature.

Maximum number of fruits and fruit yield were recorded in early harvesting of fruit (2nd weeks after fruit set) under plastic house condition. Yields and profit could be greatly increased by increasing the fruit load on each plant.

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