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RESEARCH ARTICLE

In-situ storage of cucumber (*Cucumis sativus*) fruits harvested at variable developmental stages for improving seed yield and quality

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Abstract

Field and laboratory studies were carried out to evaluate the impact of fruit harvest timing and *in-situ* storage duration on seed yield and quality in cucumber. Fruits were harvested at 30, 40, and 50 days after anthesis (DAA) with seeds extracted immediately or after 5, 10, and 15 days of *in-situ* storage. Results showed that delaying fruit harvest from 30 to 50 DAA and extending *in-situ* storage from 0 to 15 days significantly increased the percentage of developed seeds, seed weight per fruit, 100-seed weight, membrane stability index, germination rate, and seedling vigor index. Conversely, the percentage of undeveloped seeds and the relative water content of seeds decreased as the harvest stage was delayed and the *in-situ* storage duration increased. The study concluded that for optimal seed yield and quality in the cucumber variety Punjab Naveen, seeds should be extracted from fruits harvested at 50 DAA after 10 days of *in-situ* storage.

Keywords: Cucumber, *In-situ* storage, Seed weight, Germination, Vigor.

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Introduction

Cucumber is one of the important crops of Cucurbitaceae and is consumed as a salad pickle and also cooked as a vegetable. Seeds are used for the propagation of cucumber. It is a monoecious plant i.e., separate male and female flowers are produced on the same plant. Plants first produce 10-20 male flowers and then start producing female flowers shortly after 1 to 2 weeks of male flowering. The initiation of male and female flowers at the nodes continues for about 2 weeks. As a result, plants bear fruits of different developmental stages, which attain maturity at different periods (Ram, 2019). For seed production, seed growers and farmers harvest fruits at a single time after the complete senescence of plants. This is the major cause of poor seed yield and low germination rate in cucumbers, as harvested fruits belong to different developmental stages and the seeds extracted are a mixture of immature and mature seeds.

In cucurbits, the performance of seeds depends upon the age of harvested fruits, duration of fruit storage prior to seed extraction and environmental factors during pre- and postharvest stages. These factors individually or simultaneously influence seed vigor and viability. The seeds extracted from the fruits of an optimum developmental stage exhibit a high germination percentage and fast germination rate. The seeds extracted from immature or over-mature fruits have been reported to exhibit impaired

germination. Seeds should be harvested before the onset of fruit senescence to prevent the aging of the seeds inside the fruit. Thus, fruits should be hand-harvested at the optimal stage of development to obtain quality seeds (Welbaum, 1999). Devaraju et al. (2013) reported harvesting fruits at 50 DAA is optimum for better seed quality with high germination (95%), seedling length, seedling dry weight, seed vigor index and low electrical conductivity in cucumber cv. Hassan Local as compared to seeds harvested from other developmental stages of fruits *viz.,* 20, 30, 40 and 60 DAA. Nakada et al. (2011) reported that hybrid cucumber Omega produced seeds with lower germination (40%), vigor and higher electrical conductivity when extracted from younger fruits 30 days after the anthesis (DAA) stage of development, while seeds extracted from fruits harvested at 45 DAA stage had 100% germination. Mostly, farmers judge the seed maturity on the basis of fruit color, netting percentage, and senescence stage of the plant. Matotan et al. (1998) reported that large fruits had a high percentage of fully filled seeds and higher 1000 seed weight, and the small unripe fruits had a low yield of filled seeds and low 1000 seed weight, although they produced seeds of acceptable quality. They suggested that the optimum stage for harvesting is when most of the fruits in the field are orange-yellow with 20 to 30% green rind.

Cucumber is a fleshy fruited vegetable and seeds are held at relatively high moisture content throughout development. Seeds continue to mature and develop into fleshy fruits unless they get extracted from the fruit (Thakur, 2015). In cucurbits, after fruit harvest, a seed is allowed to ferment in the juicy endocarp and mesocarp of the fruit. Postharvest storage of fruits has been reported to improve germinability in many cucurbits. Fruits harvested even before the attainment of physiological maturity but allowed for postharvest fruit ripening for three to five days produce good quality seeds since the seed development continues in fleshy fruits owing to the continuous supply of nutrients and food reserves from fruit to seed (Pathania et al., 2022). Kalyanrao et al. (2014) reported that bottle gourd fruits should be harvested at 60 DAA and should be kept for 30 days postharvest ripening for a higher number of filled seeds per fruit, seed yield per fruit and germination in cv. Pusa Hybrid-3. Thakur (2015) reported that fruits harvested at 40 DAA and stored for 14 days postharvest ripening period were optimum for seed quality and yield in cucumber cv. K-75.

Punjab Naveen is an important variety of cucumber recommended by Punjab Agricultural University for sowing in the spring season throughout Punjab. There is no information available on the optimum fruit stage and *in-situ* storage period for obtaining quality seeds of this variety. Therefore, the present study was conducted to standardize the ideal stage of fruit harvest combined with the *in-situ* storage period to get quality seed in cucumber variety Punjab Naveen.

Materials and Methods

The crop of *Cucumis sativus* L. cv. Punjab Naveen was raised at Research Farm, Office of Director (Seeds), Punjab Agricultural University, Ludhiana. The seeds were sown in the second fortnight of February 2019 and 2020 as per the recommended Package of Practices (Anonymous, 2018). The experiment was conducted in a factorial, completely randomized design with two factors- stages of fruit harvest (three) and *in-situ* storage duration of harvested fruits (four). Female flowers were tagged at anthesis to monitor fruit age and five fruits per treatment were tagged for recording observations. Harvesting of fruits was initiated in the last week of April, which continued up to the second week of June. The fruits were harvested at 30, 40 and 50 days after anthesis (DAA). After harvesting the fruits, seeds were either immediately extracted or fruits were stored for 5, 10 and 15 days before seed extraction. The color of fruits and fruit pedicel was noted at different stages of fruit harvest and seed extraction. The seeds were manually extracted by cutting the fruits. The seeds were properly washed in water and dried to 8% moisture content under shade. Seeds extracted from different treatments were stored in high-density polyethylene (HDPE) bags and tested for different seed yield and quality parameters as described below:

Number of seeds per fruit

After counting the total number of seeds from 5 fruits, the average seed number per fruit was calculated.

100-seed weight (g)

Hundred seeds were taken randomly from the total seeds collected from five fruits selected for each replication and weighed by using an electronic balance (Precisa 310 M).

Seed weight per fruit (g)

In each treatment, the seeds extracted from five fruits per replication were weighed using weighing balance and the average weight of seeds per fruit was calculated.

Percent of developed seeds

The seeds extracted from five fruits per replication were used to calculate the percent of developed seeds using the formula:

$$\text{Percentage of developed seeds} = \frac{\text{Number of filled seeds}}{\text{Total number of seeds}} \text{ x } 100$$

Percent of undeveloped seeds: It was estimated as:

$$\text{Percentage of undeveloped seeds (\%)} = \frac{\text{Number of unfilled seeds}}{\text{Total number of seeds}} \times 100$$

Seed germination

The germination of four replicates of 100 seeds from each treatment was assessed using the between-paper method (ISTA, 2008) at 25°C in the dark. The final germination data were recorded on the 8th day. The emergence of a 2 mm

radicle was taken as the criteria of germination. Germination was expressed in terms of percent based on normal seedlings using the following formula:

$$\text{Germination (\%)} = \frac{\text{Number of seed germinated}}{\text{Total seed number}} \times 100$$

Seedling vigor index (SVI)

The germinated seedlings on the 8th day were assessed for vigor index. The seedlings were dried to a constant weight in an oven at 65 ± 2°C and were weighed using an electronic balance (Precisa 310 M), and the vigor index (SVI) was calculated as described by Abdul-Baki and Anderson (1973) by using the following formula:

$$\text{SVI} = \text{Germination (\%)} \times \text{Dry weight of Seedlings (g)}$$

Relative water content (RWC)

The seeds were weighed to determine their fresh weight. The weighed seeds were soaked in a test tube containing distilled water for 24 hours; blotted dry and saturated weight was recorded. To record their dry weight, seeds were dried at 60°C to constant weight in the oven. The relative water content of the seeds was measured by using the following formula:

$$\text{Relative water content (\%)} = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Saturated weight} - \text{Dry weight}} \times 100$$

Membrane stability index (MSI)

The membrane integrity of seeds was determined by the method of Fletcher and Drexler (1980). The seeds were washed with distilled water and put into the test tube containing 30 ml of distilled water, followed by incubation at 25°C in the BOD incubator. The seed leachate was collected after 24 hours in a separate beaker. The electrical conductivity of seed leachate was determined by using a digital conductivity meter (Systronics Conductivity Meter 304). Seed leachate, along with seeds, was placed in a boiling water bath for 15 minutes. After cooling, the conductivity of seed leachate was measured again. The membrane stability index was measured by the extent of electrolyte leakage by using the following formula given by Sullivan (1972):

$$\text{Membrane stability index (\%)} = 1 - \frac{C1}{C2} \times 100$$

(C1-conductivity of seed leachate before boiling; C2-conductivity of seed leachate after boiling)

The experiment was conducted in a factorial, completely randomized design with two factors, namely stages of fruit harvest (three) and stages of *in-situ* storage duration of fruits (four). Similar results were reported during both years, so the two years' data were pooled and data was subjected to ANOVA in a completely randomized block design. The treatments were compared at a 5% level of significance.

Results and Discussion

Since there were no significant differences between the results of the years 2019 and 2020 with respect to different parameters, pooled analyses were done and discussed accordingly.

Morphological parameters of fruit

The color of the pedicel was greenish brown when fruits harvested at 30 DAA were *in-situ* stored for 5 days, while the color was brown when fruits harvested at 30 DAA were stored for 10 to 15 days. The color of the pedicel was brown and dark brown when fruits harvested at 40 and 50 DAA, respectively, were *in-situ* stored for 5 to 15 days (Table 1). The dark color of the pedicel indicates the senescence stage of the plant and the physiological maturity of the seed. Fruits harvested at 30 DAA had light brown skin rind color with netting, while fruits harvested at 40 DAA had golden-brown skin color with netting. Fruits harvested at 50 DAA exhibited dark brown skin color with intensive netting of whitish color (Figure 1 and Table 2). Dark brown rind color with intensive netting can be considered as the maturity index for harvesting fruits for seed production in cucumber var. Punjab Naveen.

Seed yield parameters

The fruit harvest stage and *in-situ* storage duration did not have a significant effect on the total seed number per fruit (Figure 2). This is due to the fact that seed formation in cucumber, like other cucurbits, *viz*., bottle gourd, sponge gourd, pumpkin, bitter gourd, etc., takes place before or within 10-15 days after anthesis, and after that, only seed filling takes place. Seed formation begins with the process of fertilization; however, seed development starts when fruits attain their full size. Fruits of cucumber attain maximum size in 15–18 DAA. Therefore, seed number per fruit was not influenced by the fruit harvest stage and *in-situ* storage duration. Similar observations were reported on the total seed number per fruit in bottle gourd (Sharma, 2016).

The percentage of developed seeds per fruit increased with a delay in a stage of fruit harvest from 30 to 50 DAA and increased *in-situ* storage duration of harvested fruits from 0 to 15 days. The percentage of undeveloped seeds per fruit decreased with a delay in the stage of fruit harvest. The lowest percentage of undeveloped seeds was recorded in fruits harvested at 50 DAA. There was a significant decrease in the percentage of undeveloped seeds with increased *in-situ* storage duration and the lowest percentage of undeveloped seeds was recorded in fruits kept for 15 days of *in-situ* storage duration. The interaction effect between the stage of fruit harvest and *in-situ* storage duration of harvested fruits was significant w.r.t. percentage of developed and undeveloped seeds. The percentage of undeveloped seeds was statistically at par with each other when seeds were extracted either from fruits harvested at

Table 1: Effect of fruit harvest stage and *in-situ* storage of harvested fruits on color of fruit pedicel of cucumber cv. Punjab Naveen

Stage of fruit harvest (DAA)	*In-situ storage duration of harvested fruits (Days)*			
	0	*5*	*10*	*15*
30	Green	Greenish-brown	Brown	Brown
40	Brownish-green	Brown	Brown	Brown
50	Dark brown	Dark brown	Dark brown	Dark brown

DAA, Days after anthesis

Table 2: Effect of fruit harvest stage and in-situ storage of harvested fruits on fruit color of cucumber cv. Punjab Naveen at the time of seed extraction

Stage of fruit harvest (DAA)	*In-situ storage duration of harvested fruits (Days)*			
	0	*5*	*10*	*15*
30	Light brown skin color with netting	Light brown skin color with netting	Light brown skin color with netting	Light brown skin color with netting
40	Golden-brown skin color with netting	Golden-brown skin color with netting	Golden-brown skin color with netting	Golden-brown skin color with netting
50	Dark brown skin color with conspicuous intensive netting of whitish color	Dark brown skin color with conspicuous intensive netting of whitish color	Dark brown skin color with conspicuous intensive netting of whitish color	Dark brown skin color with conspicuous intensive netting of whitish color

DAA, Days after anthesis

40 DAA with an *in-situ* storage duration of 5 days or from fruits harvested at 50 DAA without *in-situ* storage (Figure 3).

Devaraju et al. (2013) reported in cucumber cv. Hassan local that fruits harvested at 50 and 60 DAA (without *in-situ* storage) had the least number of unfilled seeds. The fruits of cucumber cv. K-75 had the least number of unfilled seeds when fruits were harvested at 50 DAA with a postharvest storage duration of 14 days (Thakur, 2015). In the present study, *in-situ* storage significantly reduced the number of undeveloped seeds when fruits were harvested at 30 DAA, but no beneficial effect was observed when fruits were harvested at 40 or 50 DAA. This can be attributed to the fact that seeds harvested from mature fruits have enough time for dry matter accumulation owing to the synthesis of assimilates and/or remobilization of assimilates from fruit pulp to developing seeds, leading to a lower number of undeveloped seeds (Devaraju et al., 2013; Pathania et al., 2022).

Seed weight per fruit and 100 seed weight increased with an increase in the stage of fruit harvest from 30 to 50 DAA and increased *in-situ* storage duration from 0 to 15 days. The interaction effect between the stage of fruit harvest and *in-situ* storage duration of harvested fruits was significant. Seed weight per fruit was statistically at par with each other when seeds were extracted from either fruits harvested at 40 DAA with *in-situ* storage of 15 days or from fruits harvested at 50 DAA with *in-situ* storage period of 5 days. 100-seed weight was statistically similar when seeds were extracted either from fruits harvested at 40 DAA with *in-situ* storage of 10 days or from fruits harvested at 50 DAA

Figure 1: Colour of cucumber (*Cucumis sativus* L.) fruit rind at different stages of fruit harvest (a) 30 DAA (b) 40 DAA (c) 50 DAA

Table 3: Effect of stage of fruit harvest and *in-situ* storage duration of harvested fruits on relative water content and membrane stability index of seeds at the time of seed extraction

Stage of fruit harvest (DAA)	*In-situ storage duration of harvested fruits (Days)*									
	Relative water content					*Membrane stability index*				
	0	5	10	15	Mean	0	5	10	15	Mean
30	12.67^{a}	10.17^{b}	8.22^{cd}	7.41^{def}	9.62	20.74^{g}	25.38^{f}	29.82^{e}	32.08^{de}	27.01
40	8.93^{c}	7.81^{de}	7.20^{efg}	6.47^{g}	7.60	28.87^{ef}	33.73^{d}	35.33^{cd}	38.62^{bc}	34.14
50	7.42^{def}	6.71^{fg}	5.44^{h}	4.72^{h}	6.07	35.14^{cd}	39.16^{b}	44.49^{a}	47.98^{a}	41.69
Mean	9.68	8.23	6.95	6.20		28.25	32.76	36.55	39.56	

DAA, Days after anthesis; means with the same superscript are not significantly different at p ≤ 0.05 according to Tukey's HSD test.

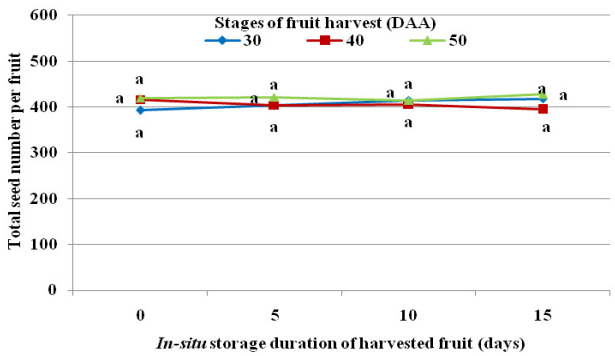
Table 4: Effect of stage of fruit harvest and *in-situ* storage duration of harvested fruits on germination and seedling vigor index after 2 months of seed storage

Stage of fruit harvest (DAA)	*In-situ storage duration of harvested fruits (Days)*									
	Germination (%)					*Seedling vigor index*				
	0	5	10	15	Mean	0	5	10	15	Mean
30	32.83^{g}	40.83^{f}	57.50^{e}	66.50^{d}	49.42	2.90^{k}	4.74^{j}	8.10^{h}	10.23^{g}	6.49
40	56.67^{e}	67.83^{d}	76.67^{c}	81.33^{b}	70.62	7.40^{i}	9.81^{g}	12.68^{e}	14.30^{c}	11.05
50	73.67^{c}	81.33^{b}	88.67^{a}	92.33^{a}	84.00	11.73^{f}	13.45^{d}	16.66^{b}	17.36^{a}	14.80
Mean	54.39	63.33	74.28	80.06		7.34	9.33	12.48	13.97	

DAA, Days after anthesis; means with the same superscript are not significantly different at p ≤ 0.05 according to Tukey's HSD test.

with *in-situ* storage of 5 days. Notably, seed weight per fruit and 100-seed weight were statistically similar when seeds were extracted from fruits harvested at 50 DAA with either an *in-situ* storage period of 10 or 15 days (Figure 4).

In the present study, the highest seed weight per fruit and 100 seed weight were obtained when seeds were extracted from fruits harvested at 50 DAA with an *in-situ* storage period of 10 or 15 days. Fruits of cucumber cv. K-75 harvested at 50 DAA with postharvest storage duration of 14 days yielded the highest seed weight per fruit and 100 seed weight as compared to seeds extracted from fruits harvested at other developmental stages, i.e. 30 and 40 DAA and kept for other postharvest ripening periods *viz*., 0, 7, 14, 21 and 28 days (Thakur, 2015). Khan et al. (2016) reported in pumpkin that seeds extracted from fruits harvested at 45 DAA with *in-situ* storage of 30 days had the highest seed weight per fruit and 100 seed weight as compared to seeds extracted from fruits harvested at early developmental stages and kept for other postharvest ripening periods *viz*., 0, 10 and 20 days. The increase in seed weight per fruit and 100 seed weight during *in-situ* storage may be attributed to the accumulation of assimilates within the seed by remobilization of assimilates from fruit pulp (Pathania et al., 2022). Moreover, Devaraju et al. (2013) reported that cucumber cv. Hassan local that seeds extracted fruits harvested at 50 DAA had the highest seed weight per fruit and 100 seed weight.



DAA, Days after anthesis; means with the same superscript are not significantly different at p ≤ 0.05 according to Tukey's HSD test.

Figure 2: Effect of stage of fruit harvest and *in-situ* storage duration of harvested fruits on total seed number per fruit in cucumber cv. Punjab Naveen

Seed quality parameters

Relative water content of seeds declined with an increase in the stage of fruit harvest from 30 to 50 DAA and increased *in-situ* storage duration (Table 3). The interaction effect between the stage of fruit harvest and the *in-situ* storage duration of harvested fruits was significant. The relative water content of seeds was statistically at par with each other when seeds were extracted from either fruits harvested at 40 DAA with *in-situ* storage of 15 days or from fruits harvested at 50 DAA with *in-situ* storage of 5 days. The decrease in the

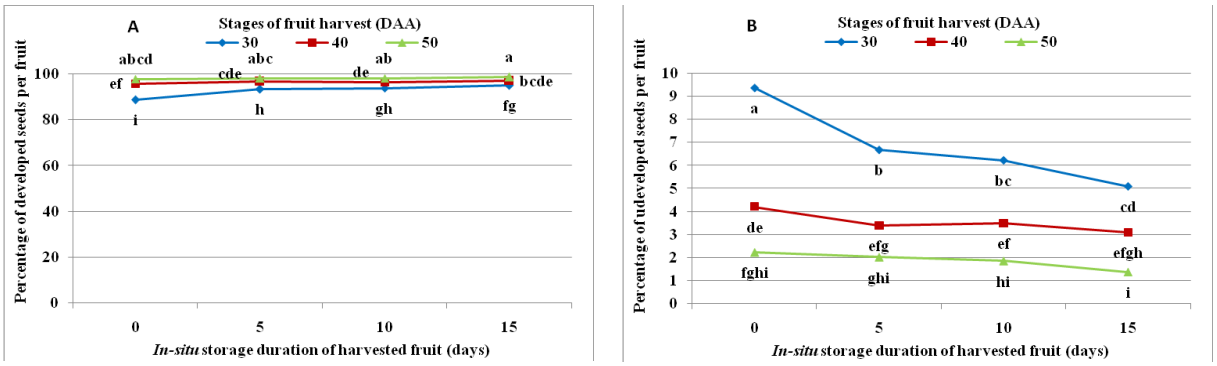


Figure 3: Effect of stage of fruit harvest and *in-situ* storage duration of harvested fruits on percentage of developed (A) and undeveloped seeds (B) per fruit in cucumber cv. Punjab Naveen. DAA, Days after anthesis. Means with the same superscript are not significantly different at $p \leq 0.05$ according to Tukey's HSD test

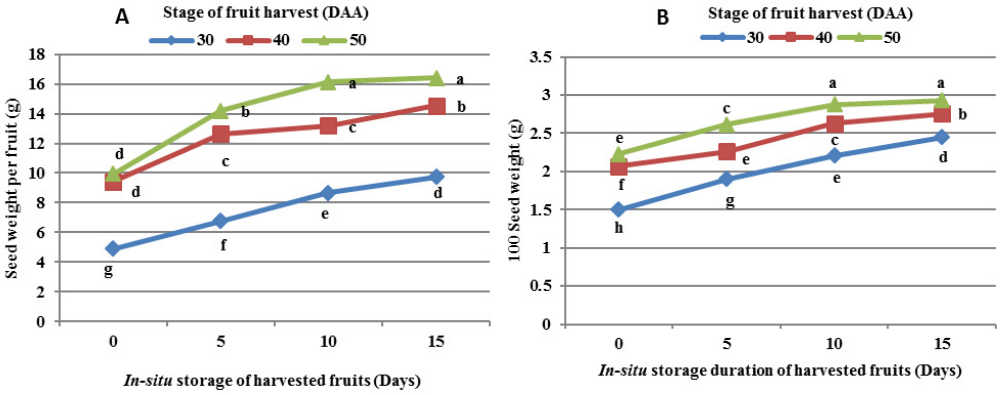


Figure 4: Effect of stage of fruit harvest and *in-situ* storage duration of harvested fruits on seed weight per fruit (g) (A) and 100-seed weight (g) (B) in cucumber cv. Punjab Naveen. DAA, Days after anthesis. DAA, Days after anthesis. Means with the same superscript are not significantly different at $p \leq 0.05$ according to Tukey's HSD test

relative water content of seeds when extracted from mature fruits may be attributed to the accumulation of higher seed reserves, leading to an increase in the dry weight of seeds (Pathania, 2020). The membrane stability index of seeds increased with an increase in the stage of fruit harvest and increased *in-situ* storage duration. The interaction between the stage of fruit harvest and *in-situ* storage duration was non-significant (Table 3).

The cucumber seeds were dormant immediately after their extraction from fruits. Seed dormancy was overcome after one month of their extraction from fruits. There was a significant increase in the germination percentage of seeds with an increase in the stage of fruit harvest from 30 to 50 DAA (Table 4). The seeds extracted from fruits harvested at 50 DAA had the highest germinability. There was a significant increase in the germination percentage of seeds with increased *in-situ* storage duration. The highest germination was recorded in seeds extracted from fruits kept for 15 days of *in-situ* storage. The interaction effect between the stage of fruit harvest and the *in-situ* storage duration of harvested fruits was significant. The seeds extracted from fruits harvested at 30 DAA with *in-situ* storage of 0 to 10 days failed to meet IMSCS (60%); however, seeds extracted from 30 DAA fruits with *in-situ* storage of 15 days had germination higher than 60%. Germination percentages were statistically at par with each other when seeds were extracted from either fruits harvested at 40 DAA with *in-situ* storage duration of 15 days or fruits harvested at 50 DAA with *in-situ* storage of 5 days. The seeds extracted from fruits harvested at 50 DAA with an *in-situ* storage period of 15 days exhibited the highest germination percentage (more than 90%) and it was statistically at par with seeds extracted from fruits harvested at 50 DAA with an *in-situ* storage period of 10 days. The seedling vigor index increased with an increase in the stage of fruit harvest from 30 to 50 DAA and increased *in-situ* storage duration (Table 4). The interaction effect between the stage of fruit harvest and the *in-situ* storage duration of harvested fruits was significant.

The seeds had the highest SVI when seeds were extracted from fruits harvested at 50 DAA with *in-situ* storage of 15 days.

Devaraju et al. (2013) reported in cucumber cv. Hassan Local that seeds extracted from fruits harvested at 50 DAA (without *in-situ* storage) had the highest germination percentage and seedling vigor index relative to seeds harvested at other developmental stages *viz*., 20, 30, 40 and 60 DAA. Thakur (2015) observed in cucumber cv. K-75 that seeds extracted from fruits harvested at 40 DAA with postharvest ripening of 14 days had the highest germination percentage and seedling vigor index relative to seeds extracted from fruits harvested at 30 and 50 DAA and kept for different postharvest ripening periods *viz*., 0, 7, 21 and 28 days. In the present study, we observed the highest germination and seedling vigor index when seeds were extracted from fruits harvested at 50 DAA which were *in-situ* stored for 15 days. In cucurbits, the germination percentage of seeds extracted from fruits harvested at early stages is usually less than seeds extracted from fruits harvested at later stages (Nerson, 2007). Less germination of seeds extracted from fruits harvested at early stages may be due to the presence of a high number of immature and unfilled seeds. The increase in germination and seedling vigor with an increase in the stage of fruit harvest and increased *in-situ* storage duration may be correlated with higher accumulation of assimilates in seeds by either biosynthesis of assimilates at later stages of fruit harvest or by remobilization of assimilates from fruit pulp during the ripening period (Pathania et al., 2022). It may also be due to a higher membrane stability index, as observed in the present study, or lower electrical conductivity of seeds when extracted from mature fruits, as reported by Devaraju et al. (2013) in cucumber and Sharma (2016) in bottle gourd. Higher electrolyte leakage or lower membrane stability index observed in seeds extracted from fruits harvested at early developmental stages without after ripening may be linked to leakage of soluble compounds from immature seeds due to poor development of cell membranes.

The number of developed seeds, seed germination and seedling vigor were considerably enhanced with an increased *in-situ* storage period when fruits were harvested at an early developmental stage, i.e., 30 DAA. However, only a little beneficial effect of *in-situ* storage was observed on these parameters when fruits were harvested at 40 or 50 DAA. It may be concluded from the present study that for obtaining higher seed yield and quality in cucumber var. Punjab Naveen, fruits should be harvested at 50 DAA with *in-situ* storage of 10 days. If, due to some unavoidable conditions, harvesting has to be done at early developmental stages of fruits (before 50 DAA), then *in-situ* storage of harvested fruits should be done for at least 15 days.

Conclusion

The present study concluded that seeds should be extracted from fruits harvested at 50 DAA after *in-situ* storage for 10 days to obtain the highest seed yield and quality in cucumber var. Punjab Naveen. This practice resulted in an increased percentage of developed seeds (98.3%) with a concomitant increase in seed weight per fruit (16.13 g), 100-seed weight (2.88 g), membrane stability index (44.5%), germination percentage (88.7%) and seedling vigor index (16.66).

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सारांश

खीरे में फलों की कटाई के चरण और काटे गए फलों की यथास्थान (इन-सीटू) भंडारण अवधि के संबंध में बीज की उपज और गुणवत्ता निर्धारित करने के लिए भूमि और प्रयोगशाला अध्ययन किए गए। फलों की कटाई एंथेसिस के 30, 40 और 50 दिनों के बाद की गई और पौधों से फल अलग होने के तुरंत बाद तथा 5, 10 और 15 दिनों के बाद बीज निकाले गए। फलों की कटाई चरण 30 से 50 डीएए और फलों की यथास्थान भंडारण अवधि 0 से 15 तक वृद्धि के साथ विकसित बीज प्रतिशत, प्रति फल बीज का वजन, 100 बीज का वजन, झिल्ली स्थिरता सूचकांक, अंकुरण और अंकुर शक्ति सूचकांक में अर्थपूर्ण वृद्धि हुई और अविकसित बीज प्रतिशत और बीजों में सापेक्ष जल की मात्रा कम हो गई। वर्तमान अध्ययन से यह निष्कर्ष निकाला गया कि खीरे की किस्म 'पंजाब नवीन' में उच्चतम बीज उपज और गुणवत्ता प्राप्त करने के लिए फलों को 50 डीएए के बाद तोड़े और उन्हें 10 दिनों तक यथास्थान भंडारण करने के बाद किए फलों से बीज निकाले जाने चाहिए।