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# Physiological maturity and its influence on seed yield and quality in cucumber (*Cucumis sativus*) under different growing environments

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ABSTRACT

To study the physical and physiological changes occurred during maturation in fruit and seeds of cucumber (*Cucumis sativus* L.) (cv. Pant Shankar Khira-1) grown under naturally ventilated polyhouse, insect proof net house and open field conditions at Centre for Protected Cultivation Technology (CPCT) farm, Indian Agricultural Research Institute (IARI), New Delhi during summer and *kharif* seasons 2011. The fruits were harvested at 25, 30, 35, 40 and 45 days from anthesis (DFA) and seeds were extracted following fermentation. Various physical parameters, viz. fruit weight, fruit length, fruit width, number of filled seeds, number of unfilled seeds, 100 seed weight, seed yield/fruit, seed fresh weight, seed dry weight were recorded. The physiological maturity was evaluated by germinating seeds before and after drying. There were only small, non-significant difference in germinability among seed harvested at 35, 40 and 45 DFA, all of which were of higher quality than seeds which had been harvested at 25 and 30 DFA. The analysis of data showed that the seeds attained physiological maturity at 35 DFA under naturally ventilated poly house and insect proof net house, whereas at 40 DFA under open field condition.

**Key words:** Cucumber, Germination, Insect proof net house, Naturally ventilated polyhouse, Pant Shankar Khira-1, Physiological maturity

The low productivity of the cucumber (*Cucumis sativus* L.) crop in India is due to lesser use of quality seed, high incidence of pests and diseases and low availability of high yielding hybrid/varieties. The production of quality seeds depend upon optimal harvest time and seed extraction technique in fleshy fruit. The physiological maturity of seed and their harvest time are closely related, promoting the preservation of the physiological quality of seed. This step is variable between species and even among the species, and that is not always easy to detect (Anon. 2011). Since cucumber is a fleshy fruit that can serve as a morphological marker of the point of harvest due to changes in colour of fruit over time. However, maturity of fruit could be identified by change in colour but variable responses of cultivar towards the colour of the fruits it has become difficult to estimate the optimal timing of seed maturation. The information on the physiological maturity of seeds of cucumber crop grown under protected growing conditions is not available. Thus, the present investigation was planned to standardize the optimum time of harvest of fruit for quality seed under different growing environments, viz. naturally ventilated poly house, insect proof net house and open condition.

## MATERIALS AND METHODS

The field experiment was conducted during summer 2011 and *kharif* 2011 at Centre for Protected Cultivation Technology (CPCT) and laboratory observations were carried out at Division of Seed Science and Technology, Indian Agricultural Research Institute (IARI), New Delhi. The experiment was laid out under three growing conditions, viz. naturally ventilated poly house, insect proof net house and open field.

The seedlings of the parental lines of cucumber cv. Pant Shankar Khira 1, was raised in plug tray with soil less medium in a modern nursery at CPCT farm. The 20 days old seedlings were transplanted at a spacing of 1.00 m × 0.60 m, with a ratio 3:1 of (female: male) following block method. The cross flowers were tagged, in seed parent block aiming to get fruits at different stages of maturity. Ten cross fruits of each age group 25, 30, 35, 40 and 45 days after anthesis (DFA) were selected from different growing environments. The fruit characters, viz. average weight (g), length (cm) and width (cm) were recorded on ten randomly selected fruits in each age group. The seeds were manually extracted and subjected to fermentation for one day at room temperature in order to eliminate the mucilage surrounding following thorrow washing with water. Number of seeds/

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fruit, number of filled seeds/fruit, number of unfilled seeds/ fruit, 100 seed weight (g), seed fresh weight and dry weight and seed yield/fruit (g) were recorded. The high constant temperature oven dry method at 130° C for one hour using 50 seeds of three replications was followed to estimate the seed moisture content (Anon 2011). The seed germination test was conducted as per ISTA procedure by adopting Between Paper (BP) method on freshly harvested 100 seeds in four replications. The first count on 4th day and final count on 8th day were made. To study the desiccation tolerance, seeds were targeted to 10 % moisture content using silica gel following procedure of Sun (2002). Four replications of 50 seeds were dried by silica gel and once they reached the targeted moisture content, they were sealed in Plastic containers with parafilm and seed germination was conducted following ISTA procedure (Anon 2011).

The topographical tetrazolium chloride test (TZ test) was conducted according to ISTA procedure (Anon 2011). Seeds were moistened for 18 hr and seeds were cut longitudinally to remove the seed coat and exposing the embryo. The excise embryos were soaked in TZ solution for 6 hr at $30^0$C. The analysis of the viable and non-viable seeds is done. The 100 % colored embryos are viable and 50% and/ or less coloured embryos as non-viable were categorized.

## RESULTS AND DISCUSSION

*Fruit characters*

Analysis of variance showed that there were significant difference in fruit weight, fruit length and fruit width under different growing environments at different stages of harvest in both summer and *kharif* 2011, presented in Table 1. The fruit weight, length and width showed increasing trend from 25 DFA to 45 DFA, whereas non-significant difference was recorded between 35 DFA and 45 DFA. The highest fruit weight, length and width (735 g, 21.83 cm and 8.23 cm respectively) at 40 DFA during *kharif* 2011, whereas highest fruit weight, length and width (641 g, 21.66 cm and 8.23 cm respectively) at 45 DFA during summer were recorded under insect proof net house. It

Table 1 Effect of time of harvest and growing conditions on fruit attributes of cucumber (Pant Shankar Khira 1)

| Days from anthesis | Summer 2011 | | | | *Kharif* 2011 | | | |
|---|---|---|---|---|---|---|---|---|
| | Open | Net house | Polyhouse | Mean | Open | Net house | Polyhouse | Mean |
| *Fruit weight (g)* | | | | | | | | |
| 25 DFA | 290.00 | 415.00 | 368.33 | $357.78_{c}$ | $312.66_{g}$ | $503.66_{e}$ | $495.00_{e}$ | $437.11_{c}$ |
| 30 DFA | 380.00 | 595.00 | 471.66 | $482.22_{b}$ | $446.66_{f}$ | $720.00_{ab}$ | $645.00_{d}$ | $603.88_{b}$ |
| 35 DFA | 483.33 | 616.66 | 518.33 | $539.44_{a}$ | $514.33_{e}$ | $732.33_{a}$ | $688.33_{c}$ | $645.00_{a}$ |
| 40 DFA | 576.66 | 633.33 | 526.66 | $578.89_{a}$ | $515.33_{e}$ | $735.00_{a}$ | $687.00_{c}$ | $645.44_{a}$ |
| 45 DFA | 533.33 | 641.66 | 535.00 | $570.00_{a}$ | $511.66_{e}$ | $729.00_{a}$ | $696.66_{bc}$ | $645.77_{a}$ |
| Mean | $452.67_{b}$ | $580.33_{a}$ | $484.00_{b}$ | | $459.93_{c}$ | $684.00_{a}$ | $642.40_{b}$ | |
| | Days | Condition | Interaction | | Days | Condition | Interaction | |
| CD (P=0.05) | 51.08 | 39.57 | NS | | 14.15 | 10.96 | 24.49 | |
| *Fruit length (cm)* | | | | | | | | |
| 25 DFA | 16.00 | 16.86 | 16.66 | $16.51_{d}$ | $15.66_{f}$ | $20.33_{d}$ | $20.33_{d}$ | $18.77_{c}$ |
| 30 DFA | 18.33 | 19.33 | 19.66 | $19.11_{c}$ | $19.33_{e}$ | $21.00_{a}$ | $20.66_{cd}$ | $20.33_{b}$ |
| 35 DFA | 20.16 | 20.83 | 19.83 | $20.27_{b}$ | $20.66_{cd}$ | $21.83_{a}$ | $21.33_{abc}$ | $21.27_{a}$ |
| 40 DFA | 21.33 | 21.50 | 20.33 | $21.05_{a}$ | $21.00_{bcd}$ | $21.83_{a}$ | $22.00_{a}$ | $21.61_{a}$ |
| 45 DFA | 21.50 | 21.66 | 20.33 | $21.16_{a}$ | $21.00_{bcd}$ | $21.66_{a}$ | $22.00_{a}$ | $21.55_{a}$ |
| Mean | $19.46_{b}$ | $20.04_{a}$ | $19.36_{b}$ | | $19.53_{b}$ | $21.53_{a}$ | $21.26_{a}$ | |
| | Days | Condition | Interaction | | Days | Condition | Interaction | |
| CD (P=0.05) | 0.62 | 0.48 | NS | | 0.39 | 0.30 | 0.69 | |
| *Fruit width (cm)* | | | | | | | | |
| 25 DFA | $5.26_{g}$ | $6.93_{e}$ | $7.03_{e}$ | $6.41_{d}$ | $5.30_{f}$ | $6.13_{e}$ | $6.26_{e}$ | $5.90_{c}$ |
| 30 DFA | $5.80_{f}$ | $7.63_{d}$ | $7.90_{cd}$ | $7.11_{c}$ | $5.40_{f}$ | $8.06_{a}$ | $7.16_{c}$ | $6.87_{b}$ |
| 35 DFA | $7.06_{e}$ | $8.33_{ab}$ | $8.30_{abc}$ | $7.90_{b}$ | $6.30_{e}$ | $8.13_{a}$ | $7.63_{b}$ | $7.38_{a}$ |
| 40 DFA | $7.90_{cd}$ | $8.60_{a}$ | $8.30_{abc}$ | $8.26_{a}$ | $6.63_{d}$ | $8.23_{a}$ | $7.73_{b}$ | $7.53_{a}$ |
| 45 DFA | $8.13_{bc}$ | $8.70_{a}$ | $8.33_{ab}$ | $8.38_{a}$ | $6.66_{d}$ | $8.13_{a}$ | $7.76_{b}$ | $7.51_{a}$ |
| Mean | $6.83_{b}$ | $8.04_{a}$ | $7.97_{a}$ | | $6.06_{c}$ | $7.74_{a}$ | $7.31_{b}$ | |
| | Days | Condition | Interaction | | Days | Condition | Interaction | |
| CD (P=0.05) | 0.24 | 0.18 | 0.41 | | 0.15 | 0.12 | 0.26 | |

Figures sub scripted in interaction with days and conditions or subscripted in main effects by same alphabet are at par at 0.05 level of significance

was evident from the results that harvesting of fruits at 40 DFA resulted in higher fruit development attributes compared to other harvesting stages owing to accumulation of food reserves with the increased period of harvest. The results were in agreement with Barbedo *et al.* (1993) in cucumber cv. Nazare. Similarly, decreased fruit weight in early harvested fruits was also reported by Sureshbabu *et al*. (2003) in brinjal and Hamsaveni *et al*. (2003) in tomato.

*Seed yield characters*

The seed yield parameters, viz. number of seeds/fruit, number of filled or unfilled seeds, seed yield/fruit and 100 seed weight were significantly higher under naturally ventilated polyhouse and insect proof net house compared to open condition. The similar results were obtained during hybrid seed production by Flemine (2010) in pumpkin, Gograj (2011) in bitter gourd and Kunj Bhihari (2012) in summer squash. The number of seeds/fruit could not recorded significant increase between 35 DFA (173.11-summer and 184.44-*kharif*) to 45 DFA (174.11-summer and 190.33.44- *kharif*), but during same period the number of filled seeds increased significantly (Table 2). The 100 seed weight at 25 DFA (1.61g -summer and 1.93g -*kharif*) was significantly increased and reached maximum at 45 DFA (3.02g -summer and 3.07g -*kharif*). The 100 seed weight, seed yield/fruit were highest at 40 DFA (3.02 g, 5.18 g summer and 3.07 g, 5.67 g, -*kharif*, respectively). Harvesting fruits at 40 DFA established complete development of fruits and seeds on account of continuous supply and accumulation of metabolites (food reserves) from mother plant into fruits and seeds. These results are in conformity with the reports of Biradar (1994) in brinjal, Chaudhari *et al*. (1992) in tomato, Nandeesh *et al.* (1995) in cucumber cv. Japanese Green Long.

*Seed quality characters*

The seed fresh weight, seed dry weight and moisture content showed that the physiological status of seeds at each maturation stage shown in Fig 1. The seed fresh weight per 50 seeds was highest at 25 DFA (3.79g -summer and 4.34g -*kharif*) decreased significantly at each level and become constant between 40-45 DFA (2.22g -summer and

Table 2 Effect of time of harvest and growing conditions on seed parameters of cucumber (Pant Shankar Khira 1)

| Days from anthesis | Summer 2011 | | | | *Kharif* 2011 | | | |
|---|---|---|---|---|---|---|---|---|
| | Open | Net house | Poly house | Mean | Open | Net house | Poly house | Mean |
| *Number of seeds/fruit* | | | | | | | | |
| 25 DFA | 103.66 | 165.00 | 130.33 | $133.00_{c}$ | $113.33_{g}$ | $171.00_{c}$ | $151.33_{e}$ | $145.22_{c}$ |
| 30 DFA | 132.33 | 184.33 | 167.66 | $161.44_{b}$ | $134.66_{f}$ | $206.00_{a}$ | $185.00_{b}$ | $175.22_{b}$ |
| 35 DFA | 152.33 | 190.33 | 176.66 | $173.11_{a}$ | $153.66_{de}$ | $202.66_{a}$ | $197.00_{a}$ | $184.44_{a}$ |
| 40 DFA | 154.33 | 184.66 | 185.00 | $174.66_{a}$ | $168.33_{c}$ | $201.33_{a}$ | $202.66_{a}$ | $190.77_{a}$ |
| 45 DFA | 150.66 | 186.00 | 185.66 | $174.11_{a}$ | $165.33_{c}$ | $201.66_{a}$ | $204.00_{a}$ | $190.33_{a}$ |
| Mean | $138.66_{c}$ | $182.06_{a}$ | $169.06_{b}$ | | $147.06_{c}$ | $196.53_{a}$ | $188.00_{b}$ | |
| | Days | Condition | Interaction | | Days | Condition | Interaction | |
| CD (P=0.05) | 9.08 | 7.03 | NS | | 6.92 | 5.36 | 11.97 | |
| *Number of filled seeds/fruit* | | | | | | | | |
| 25 DFA | $45.00_{h}$ | $86.33_{g}$ | 71.66 | $67.66_{d}$ | $45.33_{e}$ | $85.66_{d}$ | $81.00_{d}$ | $70.66_{d}$ |
| 30 DFA | $71.66_{g}$ | $149.33_{cd}$ | $133.00_{e}$ | $118.00_{c}$ | $80.00_{d}$ | $162.66_{b}$ | $157.00_{b}$ | $133.22_{c}$ |
| 35 DFA | $113.00_{f}$ | $179.33_{a}$ | $163.00_{bc}$ | $151.77_{b}$ | $131.00_{c}$ | $199.33_{a}$ | $195.00_{a}$ | $175.11_{b}$ |
| 40 DFA | $147.00_{de}$ | $178.00_{ab}$ | $180.00_{a}$ | $168.33_{a}$ | $164.33_{b}$ | $199.33_{a}$ | $200.66_{a}$ | $188.11_{a}$ |
| 45 DFA | $147.33_{de}$ | $179.33_{a}$ | $182.00_{a}$ | $169.55_{a}$ | $163.33_{b}$ | $199.66_{a}$ | $202.33_{a}$ | $188.44_{a}$ |
| Mean | $104.80_{c}$ | $154.46_{a}$ | $145.93_{b}$ | | $116.80_{b}$ | $169.33_{a}$ | $167.20_{a}$ | |
| | Days | Condition | Interaction | | Days | Condition | Interaction | |
| CD (P=0.05) | 8.93 | 6.9 | 15.46 | | 6.93 | 5.37 | 11.99 | |
| *100 seed weight (g)* | | | | | | | | |
| 25 DAA | $1.38_{f}$ | $1.76_{e}$ | $1.68_{e}$ | $1.61_{d}$ | $1.39_{g}$ | $2.23_{f}$ | $2.18_{f}$ | $1.93_{c}$ |
| 30 DAA | $1.74_{e}$ | $2.82_{c}$ | $2.70_{d}$ | $2.42_{c}$ | $2.69_{e}$ | $2.92_{bc}$ | $2.82_{d}$ | $2.81_{b}$ |
| 35 DAA | $2.67_{d}$ | $3.10_{b}$ | $3.09_{b}$ | $2.95_{b}$ | $2.91_{c}$ | $3.11_{a}$ | $3.08_{a}$ | $3.03_{a}$ |
| 40 DAA | $2.69_{d}$ | $3.12_{ab}$ | $3.19_{ab}$ | $3.00_{ab}$ | $2.97_{bc}$ | $3.11_{a}$ | $3.11_{a}$ | $3.06_{a}$ |
| 45 DAA | $2.69_{d}$ | $3.18_{ab}$ | $3.20_{a}$ | $3.02_{a}$ | $2.98_{b}$ | $3.11_{a}$ | $3.11_{a}$ | $3.07_{a}$ |
| Mean | $2.24_{b}$ | $2.80_{a}$ | $2.77_{a}$ | | $2.58_{b}$ | $2.89_{a}$ | $2.86_{a}$ | |
| | Days | Condition | Interaction | | Days | Condition | Interaction | |
| CD (P=0.05) | 0.05 | 0.04 | 0.09 | | 0.04 | 0.03 | 0.05 | |

Figures sub scripted in interaction with days and conditions or subscripted in main effects by same alphabet are at par at 0.05 level of significance

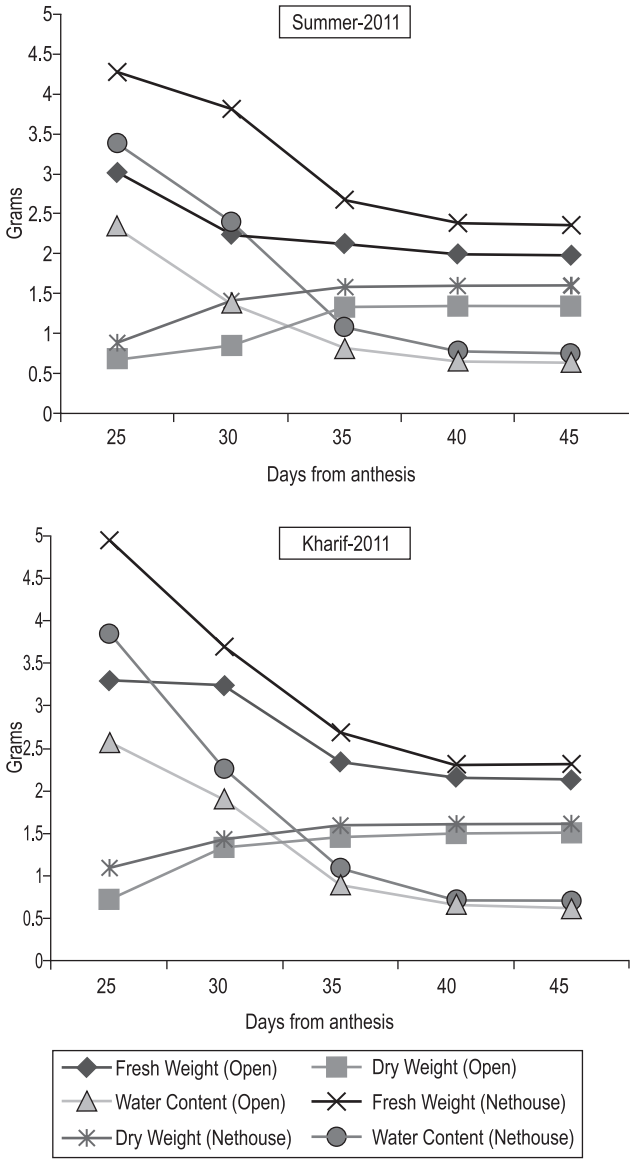


Fig 1 Effect of time of harvest and growing conditions seed development of cucumber (Pant Shankar Khira 1) during 2011

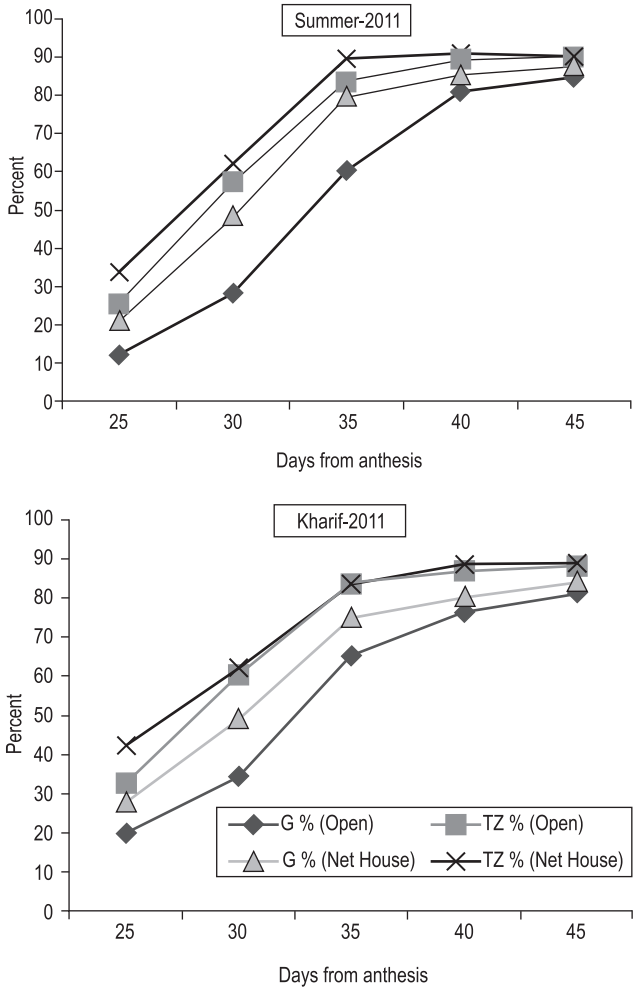


Fig 2 Effect of time of harvest and growing conditions on onset of germination and viability in cucumber (Pant Shankar Khira 1) during 2011

2.24g -*kharif*). The seed dry weight of 50 seeds increased significantly from 25 DFA (0.79g -summer and 0.98g -*kharif*) to 45 DFA (1.52g -summer and 1.56g -*kharif*). Seed water content (fresh weight basis) declined from 77% to 30% between 25 DFA and 40 DFA (when maximum dry weight was attained). The results are in corroboration with Marcos (2005) in cucurbits and Pamela *et. al.* (2011) in cucumber.

*Germination and viability*

The significant increase in germination (%) was recorded at each maturation stage. Onset of germination occurred after 25 DFA and reached to 70 % at 35 DFA under naturally ventilated poly house and insect proof net house however, to attain 70% germination in open condition it took 40 DFA (Fig 2). Sanhewe and Ellis (1996) stated that immature bean seeds had acquired the ability to germinate well before mass maturity. The view that water loss (i.e. desiccation) alone or in combination with time from ovule abscission enables developing seeds to switch from a developmental mode to a mode in which germination is possible (Misra and Bewley 1985, Bewley *et al.* 1989 and Jiang and Kennode 1994). The results of tetrazolium test revealed that the viability at 25 DFA was 32 % in summer and 40 % in *kharif*, but it increased rapidly between 25-35 DFA and reached to 86 % in both the seasons. The results are in conformity with Nerson H (2002) in water melon, Maria *et al.* (2010) in gherkin and Pervej *et al*. (2010) in tomato.

The physical and physiological analysis inferred that the superior physiological quality of seeds of hybrid cucumber Pant Shankar Khira 1 could be obtained at 35 DFA under naturally ventilated polyhouse and insect proof net house and at 40 DFA under open field condition during both summer and *kharif* season.

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