International Journal of Farm Sciences **8(2):** 28-32, 2018; doi: 10.5958/2250-0499.2018.00038.1

Studies on influence of stage of harvest and postharvest ripening of fruits on seed yield and quality in cucumber (*Cucumis sativus* L)

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 Received: 7.9.2017/Accepted: 23.12.2017

ABSTRACT

The present investigations were carried out during kharif season of 2014-15 on cucumber cv K-75. A completely randomized factorial design experiment was conducted with 15 treatments with three replications that comprised two factors viz stage of harvest (H) and postharvest ripening period (P). These factors were three stages of harvest viz fruit harvested at 30 days after anthesis (H_1), fruit harvested at 40 days after anthesis (H_2), fruit harvested at 50 days after anthesis (H_3) and five postharvest ripening periods viz no postharvest ripening (P_1), 7 days postharvest ripening (P_2), 14 days postharvest ripening (P_3), 21 days postharvest ripening (P_3) and 28 days postharvest ripening (P_5). The observations in laboratory were recorded on seed yield per fruit, per cent seed recovery, 1000-seed weight, per cent filled seeds, emergence, germination, seedling length, seed vigour index-I (SVI-I), seed moisture content and seed leachate conductivity. Analysis of variance showed significant differences among the treatment combinations for all the characters studied. The treatment combination fruit harvested at 40 days after anthesis and 14 days of postharvest ripening (H_2P_3) was significantly better over all other treatments in terms of seed quality characters and was at par with fruit harvested at 50 days after anthesis and 14 days of postharvest ripening (H_3P_3) in terms of seed yield traits. Therefore treatment combination fruit harvested at 40 days after anthesis and 14 days of postharvest ripening ie H_2P_3 can be recommended for commercial seed production of cucumber.

Keywords: Cucumber; stage of harvest; postharvest ripening; seed

INTRODUCTION

Cucumber (*Cucumis sativus* L) is an important cucurbitaceous vegetable grown for its fleshy fruits and seeds that possess cooling property good for brain and body. It is a widely cultivated plant in the gourd family. The cucumber is originally from South Asia but now grows on most continents. Owing to its indeterminate flowering habit cucumber fruits develop and attain physiological maturity at different times (Kanwar 2001). The seeds obtained from fruits harvested at physiological maturity produce higher seed yield as well as quality in terms of germination and vigour as compared to fruits harvested at earlier or later stages of maturity. Thus harvesting of fruits at optimum stage of maturity not only minimizes the loss of viability and vigour of seed but also prevents the seeds from field damage due to insect pests and diseases and adverse environmental conditions. Seeds continue to develop and mature in fleshy fruits until they get extracted from them which may affect the quality of seeds. It is also argued that fruits harvested before attainment of physiological maturity and subjected to postharvest ripening for few days produce seeds with higher yield and quality due to continuous development of both immature and mature embryos (Shamsheer Ahmed 2007).

The information on seed yield and quality as affected by stage of harvest and postharvest ripening in cucumber is meager. Thus present investigations were planned to standardize optimum stage of harvest and postharvest ripening period to obtain higher seed yield and quality in cucumber.

MATERIAL and METHODS

The present study was carried out at the experimental farm and laboratory of Department of Seed Science and Technology, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2014-2015. A field experiment was laid out as general crop sown during kharif season 2014. Seeds (2 to 3) were sown at a spacing of 60 cm within rows and spacing of 1.5 m between rows. Standard cultural practices for cucumber cultivation were followed (Anon 2010). The fruits were harvested at three different stages of harvest viz H_1 [fruits harvested at 30 days after anthesis (DAA)], H_2 (fruits harvested at 40 DAA) and H_3 (fruits harvested at 50 DAA) and subjected to different postharvest ripening periods viz P_1 [no pre-harvest ripening (PHR)], P_2 (7 days PHR), P_3 (14 days PHR), P_4 (21 days PHR) and P_5 (28 days PHR). The experiment comprised 15 different treatments (stage of harvest H x postharvest ripening P ie 3 x 5).

The laboratory experiment was conducted in completely randomized factorial design with 15 treatments replicated 3 times. The seeds were manually extracted and subjected to fermentation for two days at room temperature in order to eliminate the mucilage surrounding followed by thorough washing with water. The observations on seed yield characters viz seed yield per fruit (g), per cent seed recovery, 1000-seed weight (g) and per cent filled seeds were recorded. The seed quality traits recorded were emergence (%), germination (%), seedling length (cm), seed vigour index-I (SVI-I), seed moisture content (%) and seed leachate conductivity (µS/cm).

The seed germination test was conducted as per ISTA procedure by adopting between-paper method (Anon 1985). The first and final count was made on 4^{th} and 8^{th} day respectively. Seed moisture was measured with the help of non-destructive type of moisture meter. Electrical conductivity of seed leachate was determined by digital conductivity meter at 25°C. The emergence was calculated by counting number of seedlings emerged up to eighth day after sowing in a well prepared raised seed bed and expressed in percentage. Statistical analysis was carried for each observed character under the study using MS-Excel. The mean value of data (two-way) was subjected to analysis of variance according to Gomez and Gomez (1984).

RESULTS and DISCUSSION

Seed yield characters

Analysis of variance showed that stage of harvest and postharvest ripening significantly affected seed yield characters viz seed yield per fruit (g), per cent seed recovery, 1000-seed weight (g) and per cent filled seeds (Table 1). In case of individual effect of stage of harvest and PHR these characters showed an increasing trend in values from fruit harvested 30 to 50 DAA (maximum at 50 DAA) and from 7 days to 14 days PHR (maximum at 14 days PHR). Similar results were obtained during seed production by Blay et al (1999) in garden egg (*Solanum gilo* Radii), Devi et al (2009) in bitter gourd and Matotan et al (1998) in cucumber.

Among the interaction effect highest values for seed yield per fruit, 1000-seed weight and per cent filled seeds (14.48 g, 27.44 g and 96.67% respectively) were obtained when fruits were harvested 50 DAA and subjected to 14 days PHR (H_3P_3). These results were statistically at par with fruits harvested 40 DAA and subjected to 14 days PHR (H_2P_3). It is evident from the results that the fruits harvested at 40 DAA were already matured in the field and the postharvest ripening period significantly enhanced the development of seeds inside the fruits. This leads to more accumulation of food reserves in the seeds as compared to the immature fruits harvest. These results on seed yield characters are in conformity with those of Kortse and Oladiran (2013) in egusi-itoo melon (*Cucumeropsis mannii* Naudin), Suresh Babu et al (2003) in brinjal, Demir and Yanmaz (1999) in cucumber and Kalyanrao et al (2014) in bottle gourd. Higher value of per cent seed recovery (3.13%) was obtained in treatment H_3P_2 ie fruits harvested 50 DAA and subjected to 14 days postharvest ripening. Similarly Hamsaveni (2002) also reported that higher per cent seed recovery was obtained in fruits harvested at physiologically mature stage and two days PHR in tomato.

Seed quality traits

The seed quality traits viz emergence (%), germination (%), seed vigour index-I (SVI-I) and seed leachate conductivity (µS/cm) were significantly affected by different stages of harvest and postharvest ripening period (Table 2). In case of individual effect of stage of harvest and PHR on seed quality traits it was found that values of these

Table 1. Influence of stage of harvest and postharvest ripening of fruits on seed yield characters of cucumber

Parameter	Character			
	Seed yield per fruit (g)	Seed recovery (%)*	Seed weight (g)	Per cent filled seeds#
Main effect (stage of harvest (H)				
H_1 (30 DAA)	6.52^{c}	1.28 (1.12)^{b}	17.79^{b}	32.27 (33.87)^{b}
H_2 (40 DAA)	13.17^{a}	1.38 (1.17)^{b}	25.03^{a}	80.94 (65.02)^{a}
H_3 (50 DAA)	12.06^{b}	2.02 (1.40)^{a}	25.32^{a}	85.73 (69.03)^{a}
$CD_{0.05}$	0.72	0.10	1.04	5.33
Main effect postharvest ripening (P)				
P_1 (no PHR)	9.79^{d}	1.35 (1.14)^{b}	21.81^{b}	58.22 (49.82)^{b}
P_2 (7 days PHR)	10.05^{c}	2.00 (1.38)^{a}	21.84^{b}	58.45 (50.67)^{b}
P_3 (14 days PHR)	12.21^{a}	1.60 (1.26)^{ab}	24.33^{a}	72.22 (61.25)^{a}
P_4 (21 days PHR)	11.11^{b}	1.45 (1.20)^{b}	23.75^{a}	70.45 (59.11)^{a}
P_5 (28 days PHR)	9.76^{d}	1.41 (1.18)^{b}	21.86^{b}	72.22 (59.02)^{a}
$CD_{0.05}$	0.92	0.13	1.34	6.88
Interaction (H x P)				
T_1 (H_1P_1)	6.41^{e}	1.08 (1.03)^{d}	14.82^{g}	13.33 (21.09)^{e}
T_2 (H_1P_2)	6.41^{e}	1.41 (1.19)^{cd}	17.37^{f}	18.00 (25.08)^{d}
T_3 (H_1P_3)	8.38^{d}	1.30 (1.13)^{cd}	19.74^{e}	33.33 (35.25)^{cd}
T_4 (H_1P_4)	6.77^{e}	1.47 (1.20)^{cd}	19.72^{e}	46.67 (42.95)^{c}
T_5 (H_1P_5)	4.61^{f}	1.14 (1.06)^{d}	17.32^{f}	50.00 (45.00)^{c}
T_6 (H_2P_1)	12.12^{c}	1.15 (1.06)^{d}	25.43^{abc}	78.00 (62.22)^{b}
T_7 (H_2P_2)	11.95^{c}	1.46 (1.20)^{cd}	23.74^{cd}	80.67 (65.12)^{b}
T_8 (H_2P_3)	13.76^{ab}	1.43 (1.20)^{cd}	25.80^{abc}	86.67 (68.91)^{ab}
T_9 (H_2P_4)	14.17^{a}	1.48 (1.22)^{bcd}	24.75^{bcd}	74.67 (61.70)^{b}
T_{10} (H_2P_5)	13.84$^{a}_{b}$	1.39 (1.18)^{cd}	25.44^{abc}	84.67 (67.14)^{b}
T_{11} (H_3P_1)	10.83^{c}	1.81 (1.34)^{bc}	25.18^{abcd}	83.33 (66.14)^{b}
T_{12} (H_3P_2)	11.78^{c}	3.13(1.76)^{a}	24.40^{cd}	76.67 (61.80)^{b}
T_{13} (H_3P_3)	14.48^{a}	2.07 (1.44)^{b}	27.44^{a}	96.67 (79.60)^{a}
T_{14} (H_3P_4)	12.38^{bc}	1.39 (1.18)^{cd}	26.79^{ab}	90.00 (72.67)^{ab}
T_{15} (H_3P_5)	10.83^{c}	1.69 (1.30)^{bc}	22.81^{d}	82.00 (64.92)^{b}
$CD_{0.05}$	1.60	0.22	2.32	11.91

*Figures in parentheses represent square root transformation, #Figures in parentheses represent arc sine transformation, NS= Non-significant, DAA= Days after anthesis, PHR= Postharvest ripening period
Values followed by same alphabets are on par with one another

characters showed an increasing trend from H_1 (fruit harvested 30 DAA) to H_2 (fruit harvested 40 DAA) (maximum at 40 DAA) and from 7 days PHR to 14 days PHR (maximum at 14 days PHR) thereafter it decreased due to fruit decay in the field. Similar results were obtained during seed production by Nakada et al (2011) in cucumber and Bertin et al (2012) in *Lagenaria siceraria*.

Among the interaction effect highest values of emergence, germination and SVI-I (74.00%, 92.67% and 2551.01 respectively) were obtained at fruits harvested 40 DAA and 14 days PHR period (H_2P_3). Harvesting of fruits 40 DAA established complete development of fruits and a PHR period of 14 days resulted in development of both mature and immature embryos in the seeds which led to higher seed quality at this stage. The treatment combination H_2P_3 also showed lowest seed leachate conductivity (44.09 µS/cm) which confirms the high vigour of the seeds under this treatment combination. These results on seed quality traits are in agreement with those of Sanchez et al (1993) in pepper (*Capsicum annuum* L) and Kanwar (2001) in cucumber. Similarly Hamsaveni et al (2002) reported lowest electrical conductivity of seed at full red stage of fruits subjected to four days PHR in tomato. The analysis of seed yield characters and seed quality traits as affected by different stages of harvest and postharvest ripening period inferred that higher seed yield and quality of cucumber cv K-75

Table 2. Influence of stage of harvest and postharvest ripening of fruits on seed quality traits of cucumber

Particular	Character			
	Emergence (%)	Germination (%)	Seedling vigour index I	Seed leachate conductivity (µS/cm)
Main effect of stage of harvest (H)				
H_1 (30 DAA)	51.07 (45.66)^{c}	55.20 (48.43)^{c}	943.50^{c}	81.49^{b}
H_2 (40 DAA)	66.47 (54.68)^{a}	81.13 (66.52)^{a}	1962.52^{a}	49.25^{a}
H_3 (50 DAA)	57.93 (49.63)^{b}	65.87 (54.77)^{b}	1385.76^{b}	49.57^{a}
$CD_{0.05}$	1.70	4.05	172.01	7.49
Main effect postharvest ripening (P)				
P_1 (no PHR)	47.89 (43.72)^{d}	59.56 (51.23)^{c}	1243.91^{cd}	67.86^{b}
P_2 (7 days PHR)	55.89 (48.43)^{c}	67.78 (57.84)^{b}	1543.41^{b}	57.55^{a}
P_3 (14 days PHR)	64.55 (53.66)^{a}	77.78 (64.33)^{a}	1896.32^{a}	53.48^{a}
P_4 (21 days PHR)	64.00 (53.25)^{a}	68.33 (55.91)^{bc}	1352.14^{bc}	57.64^{a}
P_5 (28 days PHR)	60.11 (50.90)^{b}	63.56 (53.56)^{bc}	1117.19^{d}	63.99^{b}
$CD_{0.05}$	2.20	5.23	222.06	9.67
Interaction (H x P)				
T_1 (H_1P_1)	32.67 (34.84)^{j}	34.67 (36.07)^{h}	500.93^{f}	105.19^{d}
T_2 (H_1P_2)	43.00 (40.98)^{i}	36.67 (37.26)^{h}	566.93^{ef}	69.05^{b}
T_3 (H_1P_3)	49.33 (44.62)^{hi}	54.33 (47.49)^{fg}	950.27^{de}	71.62^{bc}
T_4 (H_1P_4)	67.33 (55.31)^{bc}	65.67 (54.19)^{def}	1293.70^{cd}	73.42^{bc}
T_5 (H_1P_5)	63.00 (52.55)^{cd}	84.67 (67.14)^{bc}	1405.67^{c}	88.19^{cd}
T_6 (H_2P_1)	58.33 (49.80)^{def}	82.00 (65.59)^{c}	1958.40^{b}	49.35^{a}
T_7 (H_2P_2)	63.67 (52.94)^{cd}	91.67 (76.26)^{ab}	2513.97^{a}	44.39^{a}
T_8 (H_2P_3)	74.00 (59.35)^{a}	92.67 (77.20)^{a}	2551.01^{a}	44.09^{a}
T_9 (H_2P_4)	68.67 (55.98)^{abc}	77.00 (61.37)^{cd}	1540.73^{c}	51.45^{a}
T_{10} (H_2P_5)	67.67 (55.35)^{bc}	62.33 (52.18)^{ef}	1248.50^{cd}	56.99^{ab}
T_{11} (H_3P_1)	52.67 (46.53)^{fgh}	62.00 (52.04)^{ef}	1272.40^{cd}	49.05^{a}
T_{12} (H_3P_2)	61.00 (51.36)^{de}	75.00 (60.00)^{cde}	1549.33^{c}	59.22^{ab}
T_{13} (H_3P_3)	70.33 (57.00)^{ab}	86.33 (68.31)^{abc}	2187.67^{ab}	44.72^{a}
T_{14} (H_3P_4)	56.00 (48.45)^{efg}	62.33 (52.16)^{ef}	1222.00^{cd}	48.05^{a}
T_{15} (H_3P_5)	49.67 (44.81)^{gh}	43.67 (41.36)^{gh}	697.40^{ef}	46.79^{a}
$CD_{0.05}$	3.81	9.06	384.63	16.76

Figures in parentheses represent arc sine transformation, NS= Non-significant, DAA= Days after anthesis, PHR= Postharvest ripening period

Values followed by same alphabets are on par with one another

could be obtained at fruit harvested 40 DAA and subjected to 14 days PHR ie H_2P_3 during Kharif season.

CONCLUSION

From the present investigations it can be concluded that two treatment combinations viz fruit harvested at 40 days after anthesis and stored for 14 days postharvest ripening (H_2P_3) and fruit harvested at 50 days after anthesis and stored for 14 days postharvest ripening (H_3P_3) showed better results in terms of seed yield characters and seed quality traits. However H_2P_3 was proved best treatment as it is early in the field by 10 days as compared to H_3P_3. It had highest seed quality in terms of germination and emergence per cent and it was also at par with H_3P_3 in seed yield traits. Therefore treatment combination H_2P_3 can be recommended for commercial cultivation after multi-location testing for getting the higher yield of quality seeds of cucumber in Himachal Pradesh.

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