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Influence of Stage of Fruit Pickings on Seed Recovery and Quality of Paprika Chilli (*Capsicum annuum* L.)

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A B S T R A C T

The field experiment was conducted at M/S. Punya Koti Farm, Kotiganahalli, Kolar Karnataka, India, to know the influence of stages of harvesting (fruits harvesting at 6th week after anthesis to fruits harvesting at 12th week after anthesis) on seed recovery and quality of paprika chilli. This experiment was conducted with RCBD with three replications consistings even treatments. Among seven harvesting stages, fruits harvested at 10th week after anthesis (H5) recorded maximum fruit length (18.44 cm), fruit diameter (1.86 cm), number of seeds perfruit (87.57), seed recovery (95.05 %) and seed yield per hectare (414.11 kg) with lower totalnumber of fruits per plant (41.52). However, fruits harvested at 10th week after anthesis (H5), 11th week after anthesis (H6) and 12th week after anthesis (H7) are on par with each other. Seed quality parameters like germination (94%), mean seedling length (9.14cm) and mean seedling dry weight (0.35mg) significantly higher when fruits harvested at 12th week after anthesis (H7) with lower electrical conductivity (102.53µScm^{-1}g^{-1})

Introduction

Chilli (*Capsicum annuum* L.) is an important vegetable-cum-spice crop belonging to the family Solanaceae (2n = 24), originating from Mexico with secondary centres in Guatemala and Bulgaria. It was introduced to Europe in 1493 and later spread to Asia and Africa (Andrews, 1993; Abdel-Kader & El-Mougy, 2014). The crop is valued for its nutritional richness and capsaicin content, and includes types such as red pepper, paprika, and sweet pepper. Among the cultivated species, *Capsicum annuum* is the most widely grown and includes paprika types. Although paprika and chilli share similar botanical features, they differ in fruit size, shape, colour, pungency, and chemical composition (Joshi *et al.,* 1987).

Paprika fruits are generally large, thick-fleshed, and rich in red pigments, with mild to low pungency and high yield potential (Spice India, 1995). Paprika powder, derived from dried pods, is primarily valued for its colour

and flavour and has significant demand in international markets (Gopalakrishna, 2005; Mathew, 2008).

In solanaceous crops like chilli, indeterminate flowering results in fruits at different maturity stages on the same plant. Seed quality is highly influenced by the stage of fruit harvest, with seeds collected at physiological maturity exhibiting maximum viability and vigour (Chaudhari *et al.,* 1992). Therefore, determining the optimal stage of fruit picking is essential to improve seed recovery and quality in paprika chilli. Hence, the present investigation was conducted to determine the optimum stage of fruit picking for maximizing seed recovery and improving seed quality in paprika chilli.

Material and Methods

The experiment was conducted at M/S. Punya Koti Farm, Kotiganahalli, Kolar, Karnataka. Experiment was conducted under polyhouse condition, where seedlings were directly transplanted in to growbags containing cocopeat. The seeds of paprika chilli variety OAL-1 were collected from Omni Activa Pvt. Ltd., Bangalore used for the present study. The collected seeds of paprika chilli were fresh and untreated, stored under ambient conditions. The experiment was laid out in randomized complete block design with 3 replications. For this experiment, seven harvesting stages *viz*., fruits harvesting at 6th week after anthesis, at 7th week after anthesis, at 8th week after anthesis, at 9th week after anthesis, at 10th week after anthesis, at 11th week after anthesis and fruits harvesting at 12th week after anthesis are used.

The growth parameters viz., fruit length, fruit diameter, total number of fruits per plant, number of seeds per fruit, seed to fruit ratio, fruit yield and seed yield per hectare. seed quality parameters viz., seed germination (%), mean seedling length (cm), mean seedling dry weight (mg), seedling vigour index-I, seedling vigour index-II, total dehydrogenase activity (OD at A_{480nm}), total soluble protein (%), protray emergence (%), speed of emergence, these parameters were recorded timely. The experiment data collected on growth, yield and seed quality parameters of plants were subjected to Fisher‟s method of Analysis of variance technique as outlined by Gomez and Gomez, 1984. The level of significance used in “F‟ and “T‟ tests was at P=0.05. Whenever F-test was significant for comparison amongst the treatments an appropriate value of critical difference (CD) was worked out. Otherwise against CD values abbreviation NS (Non-significant) was indicated.

Selection of plants

Ten plants were randomly selected in each plot, and flowers that were about to open were tagged. The tagged fruits were harvested at specified intervals as per the treatments to record observations on growth and yield attributes. The fruits were then subjected to dry extraction, and the extracted seeds were used for recording observations on seed yield and quality parameters.

Results and Discussion

The results pertaining to growth parameters viz., fruit diameter, total number of fruits per plant, number of seeds per fruit, seed to fruit ratio, seed yield per hectare and fruit yield, as influenced by different harvesting stages, are presented in Table 1. Most of these parameters differed significantly among the harvesting stages evaluated.

Fruit length (Fig. 1) did not differ significantly among the harvesting stages. Among the stages, fruits harvested at 10th week after anthesis (H_5) recorded maximum fruit diameter (1.86 cm) and number of seeds per fruit (87.57) with a lower total number of fruits per plant (41.52). Fruits harvested at 11th week after anthesis (H_6) showed fruit diameter of 1.81 cm, 87.51 seeds per fruit and 40.12 fruits per plant, while those harvested at 12th week after anthesis (H_7) recorded fruit diameter of 1.70 cm, 87.50 seeds per fruit and 39.20 fruits per plant. However, H_5, H_6 and H_7 were on par with each other. Fruits harvested at 6th week after anthesis (H_1) recorded the minimum fruit diameter (1.25 cm) and number of seeds per fruit (45.00) with the maximum number of fruits per plant (60.33).

Maturity stages showed a significant effect on seed yield per hectare and seed recovery. Fruits harvested at the 10th week after anthesis (H_5) recorded the highest seed yield (414.11 kg ha^{-1}) and seed recovery (95.05%), which were on par with fruits harvested at the 11th week (H6) (413.62 kg ha^{-1} and 95.08%) and 12th week after anthesis (H_7) (413.30 kg ha^{-1} and 95.10%).

In contrast, fruits harvested at the 6th week after anthesis (H_1) recorded significantly lower seed yield (99.13 kg ha^{-1}) and seed recovery (50.28%). However, the highest fruit yield (15.86 t ha^{-1}) was recorded in fruits harvested at the 6th week after anthesis, followed by the 7th week (15.38 t ha^{-1}).

Table.1 Effect of harvesting stages on fruit length, fruit diameter, total number of fruits per plant, number of seeds per fruit and seed to fruit ratio of paprika chilli

Treatments	Fruit diameter (cm)	Total number of fruits per plant	Number of seeds per fruit	Seed to fruit ratio	Seed yield per hectare (kg)	Fruit yield (ton/ha)
H_1- Harvesting fruits at 6th week after anthesis	1.25	60.33	45.00	0.012	198.58	**15.86**
H_2- Harvesting fruits at 7th week after anthesis	1.46	55.33	57.67	0.018	277.21	**15.38**
H_3- Harvesting fruits at 8th week after anthesis	1.67	51.66	69.33	0.022	334.66	**14.58**
H_4- Harvesting fruits at 9th week after anthesis	1.75	45.87	78.70	0.025	372.70	**14.09**
H_5- Harvesting fruits at 10th week after anthesis	1.86	41.52	87.57	0.030	414.11	**13.63**
H_6- Harvesting fruits at 11th week after anthesis	1.81	40.12	87.51	0.037	413.62	**9.89**
H_7- Harvesting fruits at 12th week after anthesis	1.70	39.20	87.50	0.044	413.30	**6.71**
Mean	**1.64**	**47.71**	**73.32**	**0.026**	**346.31**	**12.83**
S.Em±	**0.07**	**1.50**	**1.74**	**0.01**	**14.36**	**0.51**
CD(P=0.05)	**0.23**	**4.89**	**5.29**	**0.03**	**44.26**	**1.56**
CV(%)	**7.89**	**7.68**	**7.59**	**8.72**	**7.98**	**7.77**

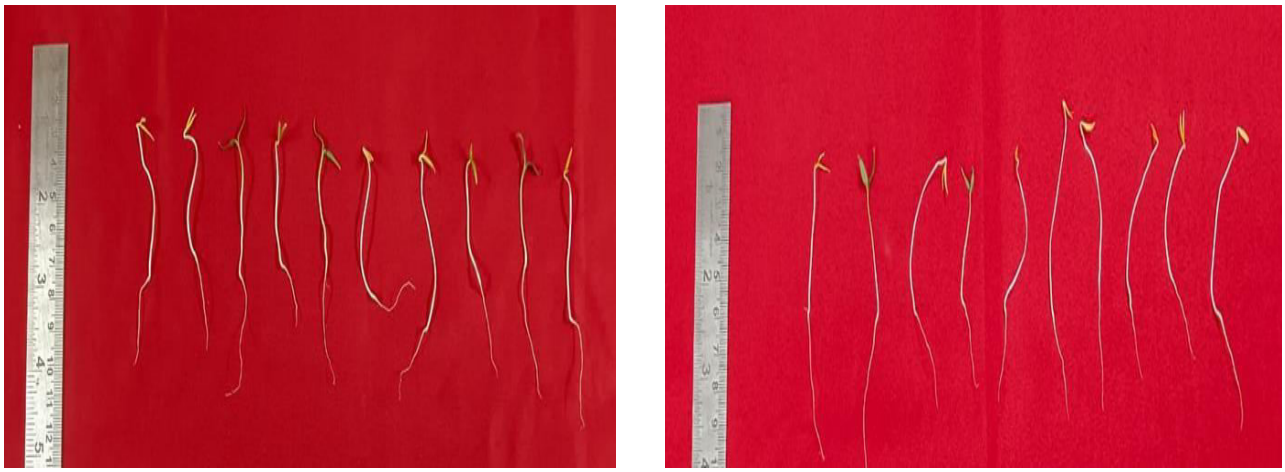
Table.2 Effect of harvesting stages on germination, mean seedling length, mean seedling dry weight, electrical conductivity and total dehydrogenase activity of paprika chilli

Treatments	Seed recovery (%)	Germination (%)	Mean seedling length (cm)	Mean seedling dry weight (mg)	Electrical conductivity ($\mu Scm^{-1}g^{-1}$)	Total dehydrogenase activity (OD at A_{480nm})
H_1- Harvesting fruits at 6th week after anthesis	50.26	27	5.93	0.16	338.23	**0.414**
H_2- Harvesting fruits at 7th week after anthesis	64.25	46	6.24	0.24	268.27	**0.450**
H_3- Harvesting fruits at 8th week after anthesis	76.17	58	6.74	0.25	251.36	**0.493**
H_4- Harvesting fruits at 9th week after anthesis	85.58	79	7.15	0.27	178.25	**0.694**
H_5- Harvesting fruits at 10th week after anthesis	95.05	89	8.05	0.30	150.68	**1.262**
H_6- Harvesting fruits at 11th week after anthesis	95.08	91	8.72	0.32	129.89	**1.340**
H_7- Harvesting fruits at 12th week after anthesis	95.10	94	9.14	0.35	102.53	**1.428**
Mean	**80.21**	**69.14**	**0.16**	**0.01**	**202.74**	**0.868**
S.Em±	**3.38**	**1.13**	**0.53**	**0.03**	**2.90**	**0.03**
CD (P=0.05)	**10.42**	**3.47**	**2.19**	**3.55**	**8.56**	**3.08**
CV (%)	**7.29**	**2.82**	**5.93**	**0.16**	**2.89**	**0.41**

Fig.1 Effect of stage of harvesting on fruit length and fruit diameter of paprika chilli

Fruits harvested at 6th week after anthesis (H1) **Fruits harvested at10th week after anthesis (H5)**

Fig.2 Effect of stage of harvesting on mean seedling length of paprika chilli



Fruits harvested at 12th week after anthesis (H7) **Fruits harvested at 6th week after anthesis (H1)**

The results pertaining to seed quality parameters *viz*., germination (%), mean seedling length (cm), mean seedling dry weight (g), total dehydrogenase activity and electrical conductivity (µS cm^{-1} g^{-1}), as influenced by different harvesting stages, are presented in Table 2.

Seed quality parameters such as germination (94.52%), mean seedling length (9.14 cm), mean seedling dry weight (0.35 g) and total dehydrogenase activity (1.41) were significantly higher in fruits harvested at the 12th week after anthesis (H_7), along with minimum electrical conductivity (102.53 µS cm^{-1} g^{-1}). In contrast, fruits harvested at the 6th week after anthesis (H_1) recorded the lowest seed quality parameters, viz., germination (27%), mean seedling length (5.93 cm), mean seedling dry weight (1.60 mg), total dehydrogenase activity (0.414) and the highest electrical conductivity (338.23 µS cm^{-1} g^{-1}).

The increase in fruit diameter and number of seeds per fruit with advancing maturity may be attributed to greater accumulation of assimilates during fruit development (Raz *et al.,* 2001). Lower seed to fruit ratio at early stages is due to the presence of immature and poorly developed seeds along with lower fruit weight, which increases at later stages, as reported in muskmelon (Roopa, 2006). The reduction in number of fruits at later harvest stages may be due to fruit drop.
Higher seed yield per hectare observed in fruits harvested at the 10th, 11th and 12th weeks after anthesis

may be due to attainment of physiological maturity, resulting in better accumulation of storage reserves and efficient nutrient translocation to seeds. These findings are in agreement with Blay *et al.,* (1999). In contrast, fruits harvested at the 6th week after anthesis recorded lower seed yield due to immature seed development, as also reported by Sureshbabu *et al.,* (2003) in brinjal. Maximum seed recovery at later stages may be attributed to a higher proportion of fully matured seeds (Ravat, 2018). Higher fruit yield during early harvests may be due to better assimilate supply and translocation, leading to greater accumulation of metabolites in fruits (Krishnamurthy, 1995).

Higher seed quality parameters observed in fruits harvested at the 12th week after anthesis (H_7) may be attributed to complete development of fruits and seeds, owing to continuous supply and accumulation of food reserves from the mother plant to the developing seeds (Ravat, 2018). At later stages, seeds are well developed with intact cell membranes in the seed coat, which prevent leaching of solutes, thereby resulting in lower seed leachate and reduced electrical conductivity.

It can be concluded from the present investigation that fruits harvested at the 10th, 11th and 12th weeks after anthesis recorded higher fruit diameter, number of seeds per fruit and seed to fruit ratio. However, fruits harvested at the 12th week after anthesis recorded superior seed quality parameters viz., germination, mean seedling length, mean seedling dry weight and total dehydrogenase activity, along with lower electrical conductivity. Therefore, harvesting fruits at the 12th week after anthesis can be recommended for commercial seed production to obtain higher seed yield and quality.

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Author Contributions

Sunil Sidhram Yaragal: Investigation, formal analysis, writing—original draft. K. Vishwanath: Validation, methodology, writing—reviewing. N. Lokeshwari:—Formal analysis, writing—review and editing. B. Basavaraja: Investigation, writing—reviewing. B. N. Radha: Resources, investigation writing—reviewing. M. B. Darshan: Validation, formal analysis, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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