

# Effect of Picking Stages on Fruit and Seed Development in Okra [*Abelmoschus esculentus* (L.) Moench] Cultivars Kashi Pragati and Kashi Kranti

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## ABSTRACT

A field experiment was conducted to study the effect of picking on fruit and seed development in okra (*Abelmoschus esculentus* L. Moench) cv. Kashi Pragati and Kashi Kranti. Data on fruit and seed characters were recorded from 4 to 40 days after flowering (DAF) at an interval of 2 days. Quick fruit development occurs between 4 to 8 DAF and fruits picked at this stage were of optimum fresh weight, length, diameter and free from thick pericarp thus making it consumable. Fresh weight of filled seeds was found to be maximum at 18 days after flowering in Kashi Pragati (7.61 g) whereas it was 22 days after flowering in Kashi Kranti (6.90 g), while dry weight of seeds per pod and 100 seed weight were maximum at 24 days after flowering. The physiological maturity of seeds was attained after 26 days after flowering when the germination percentage in both the cultivars was above 75%. However, to obtain optimum seed yield with optimum germination percentage and vigour, the fruits should be picked on at 38 days after flowering stage.

## Highlights

- ① The investigation reflects that fruits of cultivar Kashi Pragati and Kashi Kranti should be picked at 7 days after flowering for marketing purpose.
- ② For seed purpose mature fruits should be picked at 38 days after flowering.

**Keywords:** *Abelmoschus esculentus*, days after flowering, edible quality, picking, Seed

Okra (*Abelmoschus esculentus* L. Moench) is one of the well-known and widely utilized species of the mallow family (Malvaceae) (Bayer and Kubitzki 2003). India is the global leader in the okra production (Saxena *et al.* 2016). Okra has a prominent position among vegetable fruits due to its high nutritive and medicinal value, ease of cultivation, wider adaptability to varying weathers, year-round cultivation, high yield, resistance to various diseases and pests and export potential (Reddy *et al.* 2012 and Meena *et al.* 2017). Okra generally picked at a tender stage of maturity, and yield of okra is directly correlated with the length and thickness of fruits

and number of fruits produced per plant (Ravat and Makani 2015). Whereas, seed quality is at its peak at the time of physiological maturity therefore, being able to identify this stage of development aids a seed grower in optimizing cultural operations to maximize the seed quality and yield.

Keeping all the things under consideration, present study was undertaken to study the effect of picking on fruit and seed development in okra cultivars Kashi Pragati and Kashi Kranti, the two varieties largely used by the farmers of Uttar Pradesh, Bihar and Orissa.



## MATERIALS AND METHODS

The present investigation was carried out at Vegetable Research Farm, Department of Horticulture, Institute of Agricultural Sciences, B.H.U., Varanasi, Uttar Pradesh and the field work was carried out during *Kharif* (rainy) season in year 2014. Two varieties largely in use by the farmers of Uttar Pradesh were used for the experiment *viz.*, Kashi Pragati (VRO-6) and Kashi Kranti (VRO-22). All the standard package of practices was followed to raise a healthy crop. At the time of anthesis, 200 flowers were tagged with details of tagging at picking. Later ten tagged fruits were picked on each picking date from 4 to 40 days after flowering (DAF) at an interval of 2 days and were analysed for various parameters *viz.*, fresh weight of fruit (g), dry weight of fruit (g), fruit moisture content (%), fruit length (cm), fruit diameter (cm), pericarp thickness (mm), seed diameter (mm), number of filled seeds per pod, fresh weight of seeds per pod (g), dry weight of seeds per pod (g), 100 seed weight (g), germination percentage (%), seedling length (cm), seed vigour index, fruit and seed yield per plant (g). Fruit moisture content was determined by using standard oven dry method, till the product attained the constant weight. The germination percentage was estimated seeds using the formula prescribed by ISTA (1999):

$$\text{Germination (\%)} = \frac{\text{Number of seeds germinate}}{\text{Number of seeds tested}} \times 100$$

The seed vigour index was calculated as per the Abdul-Baki and Anderson (1973) by the following formula:

$$\text{Seed vigour index} = \text{Germination percentage} \times \text{Total seedling length}$$

The trial was laid out in randomized block design (RBD) with four replications.

## RESULTS AND DISCUSSION

The fresh weight of fruit increased rapidly up to 10 days after flowering (21.60g in Kashi Pragati and 21.21g in Kashi Kranti and increased thereafter slightly till 16 days after flowering in Kashi Pragati

and 18 days after flowering in Kashi Kranti). However, after that the fresh weight of fruit showed a declining trend which may be due to dehydration, maturity drying and conversion of fruit reserves and assimilation of seed reserves (Table 1). Maximum dry weight of fruit recovery was recorded from 8 to 10 days after flowering in Kashi Pragati (88.11%), whereas from 6 to 8 days after flowering in Kashi Kranti (104.11%) followed by a gradual increase up to 26 days after flowering (8.18 g) in Kashi Pragati and 22 days after flowering (7.88 g) in Kashi Kranti. These findings are in full agreement with those of Hussaini and Babu (2007) who observed that maximum dry weight of fruit accumulated from 7 to 9 days after flowering. The Table 1 indicated that the fruit moisture content increased up to 8 days after flowering in both the varieties, and then it marginally decreased with advancement of maturity. The findings are somewhat similar to the results obtained by Pилоo and Kabir (2011) who reported that the average fruit moisture content increased up to 6<sup>th</sup> day of fruit set, then it marginally decreased. The reduction in fruit moisture content with advancement of maturity might be due to the development of seeds and fibre in the fruit [Singh *et al.* (1990) and Samnotra *et al.* (2002)]. The fruit length was found to increase rapidly up to 8 days after flowering (13.82 cm in Kashi Pragati and 13.65 cm in Kashi Kranti) and increased steadily till 14 days after flowering in Kashi Pragati and 18 days after flowering in Kashi Kranti. However, after that, the fruit length showed a declining trend which might be attributed to the drying and shrinkage of fruits with maturity in both varieties. Similar results were also reported by Ekka *et al.* (2001).

The fruit diameter was found to be maximum at 14 days after flowering in Kashi Pragati (2.01 cm), while in Kashi Kranti it was attained at 16 days after flowering (2.13 cm). The decline in fruit diameter may be linked to the shrinkage of fruits reported by Myint *et al.* (2001)). In Kashi Pragati, the pericarp thickness was found to be maximum at 14 days after flowering (1.47 mm), whereas in case of Kashi Kranti, it was maximum (1.53 mm) at 16 days after flowering. The toughness of okra is attributed to the pericarp thickness and fibre development in the pericarp. The increase in pericarp thickness makes the fruit less crisp and undesirable. Similar results were obtained by Pилоo and Kabir (2011) who

**Table 1:** Effect of different picking stages on fruit characteristics of okra

Picking stages (DAF)	Fresh weight of fruit (g)		Dry weight of fruit (g)		Fruit moisture content (%)		Fruit length (cm)		Fruit diameter (cm)		Pericarp thickness (mm)	
	Kashi Pragati	Kashi Kranti	Kashi Pragati	Kashi Kranti	Kashi Pragati	Kashi Kranti	Kashi Pragati	Kashi Kranti	Kashi Pragati	Kashi Kranti	Kashi Pragati	Kashi Kranti
4	3.42	2.53	0.40	0.32	88.26	87.20	4.23	3.91	1.03	1.01	0.66	0.61
6	7.50	6.93	0.77	0.73	89.59	89.43	8.80	7.69	1.26	1.22	1.02	1.00
8	15.50	15.33	1.43	1.49	90.95	90.26	13.82	13.65	1.62	1.73	1.18	1.15
10	21.60	21.21	2.69	2.63	87.57	87.60	14.54	14.10	1.83	1.80	1.23	1.23
12	22.40	21.70	3.77	3.80	83.12	82.45	16.08	14.32	1.87	1.86	1.35	1.35
14	26.57	23.90	5.50	4.97	79.27	79.17	16.33	14.81	2.01	2.07	1.47	1.48
16	27.64	25.10	7.10	6.26	74.28	75.03	15.86	15.49	1.82	2.13	1.34	1.53
18	25.81	27.15	7.52	7.57	70.84	72.08	15.66	15.72	1.72	2.02	1.26	1.47
20	23.81	24.19	7.50	7.67	68.46	68.27	15.36	14.53	1.65	1.95	1.22	1.35
22	24.21	22.52	7.59	7.88	65.11	65.00	15.20	14.31	1.56	1.91	1.19	1.25
24	21.50	20.46	8.11	7.73	62.24	63.20	15.28	13.63	1.55	1.85	1.16	1.20
26	19.34	18.61	8.18	7.61	57.68	59.16	15.08	12.46	1.51	1.75	1.11	1.14
28	15.02	12.69	7.56	6.20	51.24	51.23	15.03	12.35	1.46	1.67	1.01	0.94
30	10.49	10.06	5.75	5.51	45.15	45.04	14.98	12.29	1.42	1.61	0.79	0.64
32	8.73	6.25	5.09	3.61	41.88	42.08	14.83	12.22	1.32	1.51	0.66	0.54
34	7.79	5.67	4.81	3.44	38.15	40.30	14.14	12.13	1.24	1.48	0.55	0.44
36	7.34	5.55	4.73	3.42	35.38	38.14	14.05	11.85	1.20	1.46	0.45	0.38
38	6.49	5.43	4.40	3.26	32.06	36.21	13.93	11.68	1.17	1.42	0.35	0.35
40	6.04	5.22	4.32	3.23	28.22	35.12	13.70	11.26	1.11	1.38	0.31	0.32
C.D. (p=0.05)	1.67	0.05	0.12	0.04	0.26	0.12	0.34	0.09	0.02	0.02	0.03	0.02

observed an initial increase in pericarp thickness with maturity.

The seed diameter was found to increase as the fruit advanced towards maturity and was maximum at 28 days after flowering in Kashi Pragati (5.37 mm), Kashi Kranti (5.82 mm). The slight reduction in seed diameter may be attributed to the loss of moisture from the seeds with maturity.

Similar results have been reported by Sajjan and Jamadar (2003) who observed that the seed diameter increased with advancement of maturity. The number of filled seeds was found to increase from the days after flowering onwards and was maximum at 10 days after flowering in Kashi Pragati and at 18 days after flowering in Kashi Kranti and decreased thereafter. Similar results were obtained by Samnotra *et al.* (2002). Fresh weight of seeds is an important character that determines the seed quality. Fresh weight of filled seeds was found to be maximum at 18 days after flowering

in Kashi Pragati (7.61 g) whereas it was 22 days after flowering in Kashi Kranti (6.90 g), beyond that a gradual decrease in fresh weight of filled seeds (Table 2). The decrease in fresh weight of seeds may be linked with the reduction in moisture content of seeds with maturation and the results are in conformity with that of Anitha *et al.* (2001).

Kashi Pragati and Kashi Kranti showed maximum (2.60 g and 2.74 g, respectively) dry weight of seeds per pod at 24 days after flowering. The initial increase in dry weight may be attributed to the decrease in moisture content and accumulation of seed reserves with advancement of physiological maturity. These findings are in agreement with those of Anitha *et al.* (2001), Alan and Esar (2008). Increasing trend was observed in 100 seed weight up to 24 days after flowering where 100 seed weight was maximum in both cultivars (5.83 g in Kashi Pragati and 5.59 g in Kashi Kranti). The data corroborates with the findings of Ibrahim and

**Table 2:** Effect of different picking stages on seed characteristics of okra

Picking stages (DAF)	Seed diameter (mm)		Number of filled seeds per pod		Fresh weight of filled seeds per pod (g)		Dry weight of filled seeds per pod (g)		100 seed weight (g)	
	Kashi Pragati	Kashi Kranti	Kashi Pragati	Kashi Kranti	Kashi Pragati	Kashi Kranti	Kashi Pragati	Kashi Kranti	Kashi Pragati	Kashi Kranti
4	2.12	1.90	41.75	39.50	0.59	0.61	0.03	0.04	0.06	0.12
6	3.30	3.56	42.25	38.75	1.89	1.54	0.18	0.17	0.41	0.46
8	4.33	4.23	44.00	39.75	3.98	2.86	0.46	0.44	1.03	1.26
10	5.03	4.43	47.00	40.25	5.34	4.67	0.74	0.85	1.59	2.19
12	5.11	4.60	46.25	39.75	5.95	5.38	1.09	1.08	2.36	2.69
14	5.16	5.05	45.25	42.75	6.69	5.78	1.44	1.29	3.19	3.06
16	5.21	5.11	44.75	45.25	7.48	6.00	1.72	1.50	3.96	3.35
18	5.28	5.15	43.75	46.50	7.61	6.18	1.89	1.88	4.54	4.09
20	5.29	5.25	42.75	45.75	7.41	6.28	2.28	2.18	5.03	4.80
22	5.31	5.31	43.25	44.75	7.33	6.90	2.47	2.55	5.71	5.29
24	5.32	5.38	42.25	45.25	7.24	6.17	2.60	2.74	5.83	5.59
26	5.35	5.61	42.25	43.50	5.70	5.59	2.49	2.66	5.49	5.31
28	5.37	5.82	41.75	43.25	4.78	4.64	2.40	2.44	5.29	5.06
30	4.70	5.56	42.00	44.50	4.57	3.63	2.23	2.05	5.10	4.53
32	4.38	5.31	41.00	41.75	4.27	2.92	2.11	1.81	4.71	4.40
34	4.06	4.95	41.25	40.75	4.13	2.79	2.02	1.93	4.84	4.82
36	3.88	4.60	41.00	41.00	3.63	2.46	1.95	1.83	4.76	4.57
38	3.65	4.33	40.75	41.50	3.26	2.35	1.91	1.79	4.55	4.45
40	3.45	4.02	40.50	40.75	2.99	2.17	1.88	1.76	4.63	4.38
C.D. (p=0.05)	0.02	0.11	1.98	1.99	0.20	0.07	0.06	0.04	0.19	0.06

Oladiran (2011) who observed that 100 seed weight increased between 14 and 35 days after anthesis.

Germination percentage and seedling vigour are important parameters for determining the physiological maturity of seeds (Singh and Sindhu, 1985). Maximum germination percentage was found in seeds from pods picked at 40 days after flowering in both cultivars, Kashi Pragati (97.27%) and Kashi Kranti (97.25%). It was observed that seeds from early picking (up to 12 days after flowering) completely failed to germinate and after this stage the germination started to occur. Devadas *et al.* (1998) reported that the developing seeds attained germinable maturity at 21 days after anthesis and highest germination was recorded at 30 to 36 days after anthesis. This was also supported with findings of Berchie *et al.* (2004) and El Balla *et al.* (2011). The poor germination of early picked seeds could have been due to the large proportion of immature seeds in these sets of seeds, while seeds become viable and vigorous due to proper and proportionate development of embryo and endosperm by about

26 days after flowering (75% or more germination occurred). Seedling length was found to increase with seed maturity and maximum seedling length was measured at 40 days after flowering stage in both cultivars *viz.*, 29.67 cm in Kashi Pragati and 24.07 cm in Kashi Kranti. The results from this study are in full agreement with those of Anitha *et al.* (2001) who reported that with advancement of physiological maturity there is an increase in the shoot and root length. Both the cultivars showed increasing seed vigour index with the seed maturity with highest at 40 days after flowering in Kashi Pragati (2886.72) and Kashi Kranti (2340.77). These results are in conformity with those of Sajjan and Jamadar (2003), who observed that harvesting of okra fruits at 40 days after flowering was statistically significant over all the harvesting stages in terms of seed vigour index.

The maximum increase in fruit yield was observed from 4 to 6 days after flowering in both the cultivars. The fruit yield per plant was found to be maximum at 16 days after flowering stage in Kashi Pragati

**Table 3:** effect of different picking stages on seed characteristics of okra

Picking stages (DAF)	Germination %		Seedling length (cm)		Seed Vigour Index		Fruit yield per plant (g)		Seed yield per plant (g)	
	Kashi Pragati	Kashi Kranti	Kashi Pragati	Kashi Kranti	Kashi Pragati	Kashi Kranti	Kashi Pragati	Kashi Kranti	Kashi Pragati	Kashi Kranti
4	00.00	00.00	00.00	00.00	00.00	00.00	75.87	40.58	0.67	0.72
6	00.00	00.00	00.00	00.00	00.00	00.00	166.04	115.99	4.12	2.84
8	00.00	00.00	00.00	00.00	00.00	00.00	333.28	249.18	7.55	7.22
10	00.00	00.00	00.00	00.00	00.00	00.00	461.68	355.38	15.79	14.33
12	00.00	00.00	00.00	00.00	00.00	00.00	470.47	341.80	22.67	17.13
14	12.43	8.00	6.13	5.68	76.22	45.48	577.41	358.57	31.72	19.32
16	13.60	17.00	6.37	6.10	86.70	103.77	597.73	401.59	36.23	24.07
18	24.18	32.75	17.35	9.22	419.70	302.06	538.86	441.32	39.77	30.62
20	56.73	53.25	19.19	10.80	1088.78	575.23	520.93	405.30	48.44	36.51
22	68.16	60.50	20.64	11.87	1406.97	718.33	519.09	337.88	53.74	38.34
24	72.28	70.50	21.43	12.73	1549.15	897.30	459.64	332.55	55.58	44.62
26	76.52	75.50	22.71	14.53	1738.18	1097.25	415.96	288.54	53.66	41.34
28	82.32	78.50	23.78	15.53	1958.18	1219.25	322.33	215.82	51.16	41.47
30	87.45	77.50	25.69	18.14	2247.12	1391.44	233.57	168.50	48.52	34.43
32	92.11	85.00	26.72	20.18	2447.00	1715.73	192.15	101.60	46.51	29.44
34	94.53	89.50	27.49	21.89	2599.16	1959.38	169.58	97.92	43.03	33.36
36	95.19	95.00	28.72	22.57	2734.41	2144.00	159.76	88.80	42.42	29.39
38	97.00	96.00	29.32	23.51	2844.96	2256.96	143.44	91.09	42.56	30.07
40	97.27	97.25	29.67	24.07	2886.72	2340.77	131.39	84.96	40.41	28.63
C.D. (p=0.05)	1.33	1.24	0.12	0.11	35.43	23.70	46.65	28.91	2.86	2.87



A: 4 days after flowering



B: 6 days after flowering



C: 8 days after flowering



D: 36 days after flowering



E: 40 days after flowering

Fig. 1: Okra fruits picked at different days after flowering

(597.73 g), while in Kashi Kranti, it was maximum (441.32 g) at 18 days after flowering (Table 3). In case of seed yield per plant it was found to be maximum at 24 days after flowering in both the cultivars viz., 55.58 g in Kashi Pragati and 44.62 g in Kashi Kranti. The results obtained are in conformity with those of Muhammad *et al.* (2001) who reported an average seed yield of 42.06 g in Sabz Pari okra.

## CONCLUSION

On the basis of above results, it can be concluded that in the rainy season grown okra in this region; quick fruit development occurs between 4 to 8 DAF for successful production of most tender fruits for maximum commercial yield. The fruits picked at this stage were of optimum fresh weight, length, diameter, and free from thick pericarp thus making it consumable. Based on these findings, it can be concluded that fruits should be picked at 7 days after flowering in Kashi Pragati and Kashi Kranti for market purpose. The findings show that the physiological maturity of seeds was attained after 26 days after flowering when the germination percentage in both the cultivars was above 75%, however, the maximum seed vigour index, germination percentage and seedling length were obtained at 40 days after flowering. Based on these results, it can be concluded that in the cultivars under study, the fruits for seed purpose can be picked on and after 34 days after flowering which gives around 90% or more germination. The findings obtained suggests that picking of fruits at

7 days after flowering in Kashi Pragati and Kashi Kranti will give an average of 200g marketable fruit yield per plant in these cultivars, whereas for seed purpose, the optimum stage of picking is based on the stage that gives optimum germination percentage along with optimum yield. Based on these findings, the mature fruits for seed purpose should be picked at 38 days after flowering in all the okra cultivars under study for obtaining good quality seed providing seed yield per plant around 42.56 g in Kashi Pragati and 30.07 g in Kashi Kranti.

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