



Assessment of fruit positions and fruit retention loads on seed yield and seed quality parameters of okra (*Abelmoschus esculentus* L. Moench.)

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Abstract

Studies were carried out during kharif 2023 -2024 to assess the influence of fruit load in okra cv. Arka Anamika on seed quality and yield. Data on fruit and seed characters was recorded. Significant differences in all the growth parameters except days to flower initiation were noticed due to fruit retention load. R₁ (Retention of fruits borne on different nodes for seed purpose and harvesting remaining fruits for vegetable purpose) fruit retention load recorded significantly highest fruit length (10.01 cm), number of fruits/ plant (23.83) and number of seeds per fruit (52.58) respectively over R₂ (Retaining all fruits) fruit retention load. Fruit positions differed significantly among themselves in days to flower initiation, fruit length, number of fruits/ plant, and number of seeds per fruit. Fruit position P₁ (collection of seeds from fruits borne on 1-3 nodes) recorded significantly maximum fruit length (11.29 cm), number of fruits/ plant (23.83), number of seeds per fruit (58.72) and lowest days to flower initiation (40.71) over other fruit positions respectively while lowest fruit length (8.44 cm) and number of seeds per fruit (41.68) was recorded in fruit position P₂ (collection of seeds from fruits borne on above 8th node) and highest (42.30) days to flower initiation was also recorded in fruit position, P₃ respectively. Green fruit yield exhibited significant difference on fruit positions only because, in R₂ (retaining all fruits), green fruits were not harvested for vegetable purpose. Among the fruit positions, significantly highest green fruit yield (3624.00 Kg/ha) was recorded in P₁ (collection of seeds from fruits borne on 1-3 nodes) fruit position while was recorded respectively. Significant difference in seed yield was found due to fruit retention loads. The fruit retention load, R₁ (Retention of fruits borne on different nodes for seed purpose and harvesting remaining fruits for vegetable purpose) recorded significantly highest seed yield respectively. Seed yield differed significantly due to fruit position. The seed quality assessed by standard germination %, test weight, root length, shoot length, seedling dry weight, seed vigour index-I and II exerted significant differences due to fruit positions and fruit retention loads values. The fruit retention load R₁ recorded significantly higher values for standard germination % (79.11 %), test weight (62.84 g), root length (13.90 cm),

shoot length (19.22 cm), seedling dry weight (0.210 g), seed vigour index –I (2649.29), seed vigour index –II (16.80) over R₂ respectively.

Among the fruit positions, the fruit position, P₁ (collection of seeds borne on 1-3 nodes) recorded significantly maximum germination % (83.76%) test weight (72.21 g), root length (13.90 cm), shoot length (20.18 cm), seedling dry weight (0.264 g), seed vigour index-I (2936.72), seed vigour index –II (22.18) respectively while, lowest values for germination % (67.24 %) test weight (46.73 g), root length (12.04 cm), shoot length (17.43 cm), seedling dry weight (0.169 g), seed vigour index-I (2089.29) seed vigour index –II (11.37) were recorded in P₃ (From fruits borne on above 8th node) position of the fruit respectively.

Keywords: Fruit retention loads, fruit positions and seed yield.

Introduction

Okra (*Abelmoschus esculentus* L. Moench) is widely grown as a vegetable. The immature fruit is eaten green, either fresh or prepared by boiling or frying and used in soups and stews (Bleasdale, 1984) . Its nutritional value lies in its high amount of calcium and phosphorous. It also contains protein, carbohydrate and fibre and some amounts of vitamins (Tindall, 1983). Because of the nutritional and economic importance of okra, it is imperative that adequate attention be given to ways of producing the seed in such a way that high quality is ensured. The major aim of a gene bank curator is to conserve seeds in a way that would ensure high quality for a long time. Even if storage condition is ideal, seed longevity is still known to be affected by the crop production procedures which are adopted by the farmer. The physiological state at which a seed is harvested and the positions of the fruit on the mother plant are two of such pre-storage factors. Ability of seeds to produce more number of normal and vigorous seedlings depends on proper seed filling and maturation because the competition for assimilates between fruits and within fruit distresses seed set and development (Bertin, 1995) . Usually, distal fruits get less time to mature and often they are frequently subjected to aberrant high temperatures, untimely rains and severe pest and disease infestations. Late maturing fruits contain immature lighter seeds, which result in more dead, or hard seeds and less vigorous seedlings ultimately reducing the overall germinability (Getzin, 1983). In okra, seed quality is found affected by fruit position, seed maturity and growing season etc (Prabhakar et. al., 2003) . Among the vegetable crops in which green fruits are directly used as a vegetable, the scarcity of quality seed has always been observed. Okra being an indeterminate in nature it has peculiar fruiting behaviour. The next flowering and fruiting does not take place till previous fruits are not completed. Being it, the maturity of fruits happens in different interval and directly influences the source to sink system. The present investigation has been done to identify the best fruit position and fruit retention load for harvesting vigorous and quality seeds of okra.

Material and Methods

The present investigation was carried out in Factorial Completely Randomized Design with three replications at Organic Research Farm Karguanji, Department of Seed Science and Technology, Institute of Agricultural Sciences, Bundelkhand University, Jhansi during kharif 2023. The okra variety, Arka Anamika was tested with 12 treatment combinations (consisted of two fruit retention loads, R₁ and R₂ as factor – I and six fruit positions, P₁, P₂, P₃, P₄, P₅ and P₆ as factor – II) and replicated thrice. The description of 12 Treatment Combinations (TC) are as follows: TC1: R₁P₁ (Retention of fruits borne on 1-3 nodes for seed purpose and harvesting remaining fruits for vegetable purpose), TC2 : R₁P₂ (Retention of fruits borne on 4-8 nodes for seed purpose and harvesting remaining fruits for vegetable purpose), TC3 : R₁P₃ (Retention of fruits borne on above 8 th nodes for seed purpose and harvesting remaining fruits for vegetable purpose), TC4 : R₁P₄ (Retention of fruits borne on 1- 8 nodes for seed purpose and harvesting remaining fruits for vegetable purpose), TC5 : R₁P₅ (Retention of fruits borne on 4 th node & onwards for seed purpose and harvesting remaining fruits for vegetable purpose), TC6 : R₁P₆ (Retention of fruits borne on all nodes for seed purpose), TC7: R₂P₁ (Retention of all fruits and collection of seeds from fruits borne on 1-3 nodes), TC8 : R₂P₂ (Retention of all fruits and collection of seeds from fruits borne on 4-8 nodes), TC9 : R₂P₃ (Retention of all fruits and collection of seeds from fruits borne on above 8 th nodes), TC10: R₂P₄ (Retention of all fruits and collection of seeds from fruits borne on 1-8 nodes), TC11 : R₂P₅ (Retention of all fruits and collection of seeds from fruits borne on 4th node & onwards) and TC12: R₂P₆ (Retention of all fruits and collection of seeds from all nodes). Five plants in each treatment and replication were randomly selected and tagged for recording the observations on growth characters. The data on seed yield was collected after harvest of the crop.

Table 1: Influence of fruit positions and fruit retention loads on days to flower initiation and fruit length in okra

Treatments	Days to flower initiation			Fruit length(cm)		
	R ₁	R ₂	Mean	R ₁	R ₂	Mean
P ₁	40.87	40.55	40.71	11.86	10.73	11.29
P ₂	41.19	41.44	41.31	10.29	9.97	10.13
P ₃	42.13	42.47	42.30	8.67	8.21	8.44
P ₄	40.89	40.72	40.80	10.21	9.48	9.84
P ₅	42.78	42.89	42.83	9.77	8.91	9.34
P ₆	40.85	40.92	40.88	9.31	8.83	9.07
Mean	41.45	41.49	41.47	10.01	9.35	9.68
Comparing	P < 0.05		S.E. (d)	P < 0.05		S.E. (d)
R	N.S.		0.29	0.48		0.23
P	1.06		0.51	0.83		0.40

(a) Fruit retention (R)

R₁: Retention of fruits borne on different nodes for seed purpose & harvesting remaining fruits for vegetable purpose.

R₂: Retaining all fruits.

(b) Collection of seeds from different fruit positions (P)

P₁: From fruits borne on 1-3 nodes.

P₂: From fruits borne on 4-8 nodes.

P₃: From fruits borne on above 8th nodes.

P₄: From fruits borne on 1-8 nodes.

P₅: From fruits borne on 4th node & onwards.

P₆: From all nodes.

Table 2 Influence of fruit positions and fruit retention loads on number of fruits/plant and number of seeds/ fruit in okra.

Treatments	Number of fruits /plant			Number of seeds/ fruit		
	R ₁	R ₂	Mean	R ₁	R ₂	Mean
P ₁	33.66	14.00	23.83	60.21	57.23	58.72
P ₂	26.00	13.00	19.50	56.35	55.01	55.68
P ₃	27.66	12.00	19.83	44.22	39.15	41.68
P ₄	23.00	14.00	18.50	54.72	52.67	53.69
P ₅	19.33	12.00	15.66	50.96	47.09	49.02
P ₆	13.33	13.00	13.16	49.02	48.30	48.66
Mean	23.83	13.00	18.41	52.58	49.90	51.24
Comparing	P < 0.05		S.E. (d)	P < 0.05		S.E. (d)
R	3.67		1.81	0.79		0.38
P	2.26		1.12	1.36		0.66

(a) Fruit retention (R)

R₁: Retention of fruits borne on different nodes for seed purpose & harvesting remaining fruits for vegetable purpose.

R₂: Retaining all fruits.

(b) Collection of seeds from different fruit positions (P)

P₁ : From fruits borne on 1-3 nodes.

P₂ : From fruits borne on 4-8 nodes.

P₃ : From fruits borne on above 8th nodes.

P₄ : From fruits borne on 1-8 nodes.

P₅ : From fruits borne on 4th node & onwards.

P₆ : From all nodes.

Table 3: Influence of fruit positions and fruit retention loads on green fruit yield and seed yield in okra

Treatments	Green fruit yield (Kg/ha.)			Seed yield (Kg/ha.)		
	R ₁	R ₂	Mean	R ₁	R ₂	Mean
P ₁	3624.00	0.00*	3624.00	197.00	182.00	189.50
P ₂	3113.00	0.00	3113.00	456.00	425.00	440.50
P ₃	2446.00	0.00	2446.00	174.00	154.00	164.00
P ₄	1723.00	0.00	1723.00	652.00	603.00	627.50
P ₅	906.00	0.00	906.00	338.00	309.00	323.50
P ₆	0.00*	0.00	0.00*	791.00	768.00	779.50
Mean	2362.40	0.00	2362.40	434.66	406.83	420.74
Comparing	<i>P</i> < 0.05		S.E. (d)	<i>P</i> < 0.05		S.E. (d)
R	-----		-----	11.87		5.72
P	485.20		234.04	20.55		9.91

(a) Fruit retention (R)

R₁: Retention of fruits borne on different nodes for seed purpose & harvesting remaining fruits for vegetable purpose.

R₂: Retaining all fruits.

(b) Collection of seeds from different fruit positions (P)

P₁ : From fruits borne on 1-3 nodes.

P₂ : From fruits borne on 4-8 nodes.

P₃ : From fruits borne on above 8th nodes.

P₄ : From fruits borne on 1-8 nodes.

P₅ : From fruits borne on 4th node & onwards.

P₆ : From all nodes.

Table-4: Influence of fruit positions and fruit retention loads on standard germination % of okra

Treatments	Standard germination %		
	R ₁	R ₂	Mean
P ₁	85.40	82.13	83.76
P ₂	82.69	79.39	81.04
P ₃	68.77	65.71	67.24
P ₄	81.51	79.68	80.59
P ₅	78.96	75.09	77.02
P ₆	77.43	74.84	76.13
Mean	79.11	76.14	77.62
Comparing	$P < 0.05$		S.E. (d)
R	1.98		0.95
P	3.43		1.65

(a) Fruit retention (R)

R₁: Retention of fruits borne on different nodes for seed purpose & harvesting remaining fruits for vegetable purpose.

R₂: Retaining all fruits.

(b) Collection of seeds from different fruit positions (P)

P₁ : From fruits borne on 1-3 nodes.

P₂ : From fruits borne on 4-8 nodes.

P₃ : From fruits borne on above 8th nodes.

P₄ : From fruits borne on 1-8 nodes.

P₅ : From fruits borne on 4th node & onwards.

P₆ : From all nodes.

Table 5: Influence of fruit positions and fruit retention loads on root length (cm) and shoot length (cm) of okra

Treatments	Root length (cm)			Shoot length (cm)		
	R ₁	R ₂	Mean	R ₁	R ₂	Mean
P ₁	15.19	14.56	14.87	21.11	19.26	20.18
P ₂	14.67	13.91	14.29	20.23	19.13	19.68
P ₃	12.45	11.63	12.04	17.85	17.02	17.43
P ₄	14.04	11.98	13.01	19.33	18.82	19.07
P ₅	13.26	12.26	12.76	18.46	17.59	18.02
P ₆	13.82	12.31	13.06	18.37	17.63	18.00
Mean	13.90	12.77	13.33	19.22	18.24	18.73
Comparing	$P < 0.05$		S.E. (d)	$P < 0.05$		S.E. (d)
R	0.53		0.25	0.56		0.27
P	0.92		0.44	0.97		0.47

(a) Fruit retention (R)

R₁: Retention of fruits borne on different nodes for seed purpose & harvesting remaining fruits for vegetable purpose.

R₂: Retaining all fruits.

(b) Collection of seeds from different fruit positions (P)

P₁ : From fruits borne on 1-3 nodes.

P₂ : From fruits borne on 4-8 nodes.

P₃ : From fruits borne on above 8th nodes.

P₄ : From fruits borne on 1-8 nodes.

P₅ : From fruits borne on 4th node & onwards.

P₆ : From all nodes.

Table 6: Influence of fruit positions and fruit retention loads on total seedling length (cm), seedling dry weight (g) and speed of germination of okra

Treatments	Seedling dry weight (g)		
	R ₁	R ₂	Mean
P ₁	0.285	0.244	0.264
P ₂	0.217	0.190	0.203
P ₃	0.180	0.158	0.169
P ₄	0.202	0.176	0.189
P ₅	0.189	0.169	0.179
P ₆	0.191	0.171	0.181
Mean	0.210	0.184	0.197
Comparing	<i>P</i> < 0.05		S.E. (d)
R	0.017		0.008
P	0.029		0.014

(a) Fruit retention (R)

R₁: Retention of fruits borne on different nodes for seed purpose & harvesting remaining fruits for vegetable purpose.

R₂: Retaining all fruits.

(b) Collection of seeds from different fruit positions (P)

P₁ : From fruits borne on 1-3 nodes.

P₂ : From fruits borne on 4-8 nodes.

P₃ : From fruits borne on above 8th nodes.

P₄ : From fruits borne on 1-8 nodes.

P₅ : From fruits borne on 4th node & onwards.

P₆ : From all nodes.

Table 7: Influence of fruit positions and fruit retention loads on test weight (g), seed vigour index-I and seed vigour index-II of okra

Treatments	Test weight (g)			Seed vigour index-I			Seed vigour index-II		
	R ₁	R ₂	Mean	R ₁	R ₂	Mean	R ₁	R ₂	Mean
P ₁	73.32	71.11	72.21	3012.05	2861.40	2936.72	24.33	20.03	22.18
P ₂	72.08	69.51	70.79	2849.49	2667.50	2758.49	17.94	15.08	16.51
P ₃	48.11	45.36	46.73	2187.57	1991.01	2089.29	12.37	10.38	11.37
P ₄	62.52	57.79	60.15	2764.00	2634.22	2699.11	16.46	14.02	15.24
P ₅	59.13	56.27	57.70	2565.41	2343.55	2454.48	14.92	12.69	13.80
P ₆	61.93	58.09	60.10	2517.24	2423.31	2470.27	14.78	12.79	13.78
Mean	62.84	59.68	61.26	2649.29	2486.83	2568.06	16.80	14.16	15.48
Comparing	$P < 0.05$		S.E. (d)	$P < 0.05$		S.E. (d)	$P < 0.05$		S.E. (d)
R	1.44		0.69	30.09		14.57	0.96		0.46
P	2.50		1.20	52.11		25.24	2.06		1.03

(a) Fruit retention (R)

R₁: Retention of fruits borne on different nodes for seed purpose & harvesting remaining fruits for vegetable purpose.

R₂: Retaining all fruits.

(b) Collection of seeds from different fruit positions (P)

P₁ : From fruits borne on 1-3 nodes.

P₂ : From fruits borne on 4-8 nodes.

P₃ : From fruits borne on above 8th nodes.

P₄ : From fruits borne on 1-8 nodes.

P₅ : From fruits borne on 4th node & onwards.

P₆ : From all nodes.

Results and Discussion

Fruit length, number of fruits per plant and number of seeds per fruit recorded significant differences due to fruit positions and fruit retention loads, while, the days to flower initiation was non-significant for fruit retention loads. The fruit retention load R₁ (Retention of fruits borne on different nodes for seed purpose and harvesting remaining fruits for vegetable purpose) recorded higher growth as compared to R₂ (Retaining all fruits for seed purpose). Significantly maximum fruit length (10.01cm), number of fruits/plant (23.83) and number of seeds per fruit (52.58) were recorded in R₁ over R₂ fruit retention load. Hence, the R₁ fruit retention load being considered as the best may be used to achieve higher growth response in okra crop. This might be due to the fact that under low fruit load, the competition for assimilates reduced. Kumari *et al.* (2013) observed that retaining six fruits per plant resulted in increased fruit length in okra. The results are also in accordance with the findings of Mohammadi *et al.* (2015) and Moniruzzaman and Quamruzzaman (2009) in okra. The days to flower initiation, fruit length, number of fruits per plant and number of seeds per fruit differed significantly due to the fruit positions. Among the different fruit positions, P₁ (Collection of seeds from fruits borne on 1-3 nodes) recorded significantly minimum days (40.71) for anthesis and maximum number of fruits per plant (23.83) and fruit length (11.29cm) while, lowest values of these traits were recorded in P₃ (Collection of seeds from fruits borne on above 8th node). P₁ (Collection of seeds from fruits borne on 1-3 nodes) fruit position recorded significantly maximum (58.72) number of seeds followed by P₂ (Collection of seeds from

fruits borne on 4-8 nodes) (55.68) and P4 (Collection of seeds from fruits borne on 1-8 nodes) (53.69) and minimum number of seeds (41.68) were in P3 (Collection of seeds from fruits borne on above 8th node). It happened due to the reason that lower position fruits remained on the plant for longer period subsequently absorbed more nutrients and minerals and gradually decreases in apex direction. Yadav and Dhankar (2001) reported higher values of seeds per fruit from lower positions of plant closely followed by middle position and significantly lower values were observed in seeds of upper position fruits of okra. These findings are in line with those of Prabhakar *et al.* (2003) and Ibrahim and Oladiran (2011) in okra.

Significant difference in green fruits yield was found due to the fruit positions. The P1 fruit position was found to be highest (3624.00 Kg/ha) contributor of green fruits yield followed by P2 (3113.00 Kg/ha) and P3 (2446.00 Kg/ha) while the minimum was recorded with P5 (906.00 Kg/ha). The increase in green fruit yield in case of P1 (collection of

seeds from 1-3 nodes) may be due to the higher number of green fruits harvested for vegetable purpose. Moniruzzaman and Quamruzzaman (2009) reported that the treatment of picking of 10 green fruits produced the highest green fruit yield/ha. In okra. As far as the fruit retention loads are concerned, green fruits were not harvested in R2 fruit retention load (Retaining all fruits for seed purpose). Seed yield exhibited significant differences due to fruit retention loads and variation in growth parameters. The fruit retention load R1 recorded significantly highest seed yield (434.66 kg/ha) over the R2 (406.83kg/ha). The P6 fruit position recorded significantly highest (779.50 kg/ha) seed yield followed by P4 (627.50 Kg/ ha.) and P2 (440.50 Kg./ha.) while, minimum (164.00 kg/ha) seed yield was recorded in P3 fruit position. The increase in seed yield in case of P6 (collection of seeds from all fruits) may be due to the higher number of fruits were taken for collection of seeds. These findings are in agreement with the findings of Bhanuje and Raikar (2016) in brinjal and Kumari *et al.* (2013) in okra.

Influence of fruit positions and fruit retention loads on standard germination % and per cent hard seeds exhibited significant differences. Significantly highest (79.11%)

germination was recorded with R1 (Retention of fruits borne on different nodes for seed purpose and harvesting remaining fruits for vegetable purpose) over R2 (Retaining all fruits for seed purpose) (76.14%). Kumari *et al.* (2013) found out that retaining six fruits per plant in okra crop resulted to increase the seed germination percentage. These results are in agreement with the findings of Victor *et al.* (1993) in bell pepper. Fruit positions also exhibited significant differences on standard germination (%). The P1 (Collection of seeds from fruits borne on 1-3 nodes) position of the fruit recorded significantly highest (83.76%) germination, while minimum (67.24%) germination was recorded in P3 (Collection of seeds from fruits borne on above 8 th nodes) position of the fruit . Lowest germination percentage in the seeds of top position fruits may be due to poor supply of photosynthates at maturity and resultant shrivelled seeds which are affected by insects at later periods of crop harvesting. Seeds obtained from lower and middle position fruits were found to be of better vigour and viability as compared to seeds of upper position fruits. Francis and Opondo (2011) reported that the seeds harvested from bottom fruits and middle fruits showed higher germination than those from top fruits in Spider plant. These findings are in accordance with the findings of Yadav and Dhankhar (2001)[13] in okra.

Significantly lowest per cent hard seeds were recorded in R1 fruit retention load (6.42%) over R2 (8.54%). The seed quality assessed by test weight, root length, shoot length, total seedling length, seedling dry weight, seed vigour index-I and II, seed density and speed of

germination exhibited significant differences due to fruit retention loads (Table-5, 6 and 7). The R1 (Retention of fruits borne on different nodes for seed purpose and harvesting

remaining fruits for vegetable purpose) fruit retention load recorded significantly higher values for test weight (62.84g), root length (13.90cm), shoot length (19.22 cm), total seedling length (34.00 cm), seedling dry weight (0.229 g), seed vigour index –I (2762.39), seed vigour index –II (18.46). It may be attributed to the reason that retaining selected fruits for seed purpose on the plant absorbed more nutrients and minerals as compared to

retaining all fruits for seed purpose on the same plant. The similar findings were also reported by Kumar *et al.*, (2007) in sweet pepper, Jolli *et al.*, (2009) in tomato, Kumari *et al.* (2013) and Bhat and Singh (1996) in okra. Shoot length, root length, total seedling length, seedling dry weight, test weight and seed vigour index-I, II

exhibited significant differences due to positions of fruit. Among the fruit positions, the P1 (Collection of seeds from 1-3 nodes) fruit position recorded significantly maximum root length (14.87 cm), shoot length (20.18 cm), total seedling length (35.06 cm) seedling dry weight (0.264 g), test weight (72.21 g), seed vigour index-I (2936.72) and seed vigour index –II (22.18). It may be attributed to the reason that lower position fruits remained on the plant for longer period of time and thus absorbed more nutrients and minerals which go on decreasing towards the top of the plant, there by resulting in lower seed weight, reduced vigour and viability in seeds of upper position fruits. Similar results were also recorded by Yadav and Dhankhar (2001) [13] in okra, and Rao *et al.* (2004) in okra.

Conclusions

Thus, it is concluded that treatment combination, R1P1 (Retention of fruits borne on 1-3 nodes for seed purpose and harvesting remaining fruits for vegetable purpose) was found

to be superior for most of the yield contributing traits, green fruit yield and seed quality parameters whereas, R1P6 (Retention of all fruits for seed purpose) was found to be best

for seed yield. Finally, for harvesting the vigorous seed, the treatment combination R1P1 and for getting the highest seed yield, the treatment combination R1P6 may be adopted.

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