RESEARCH ARTICLE

Post-fertilization Development of Seed in Okra Genotypes: Changes in Seed Quality

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Abstract

A research trail was conducted to assess qualitative changes of Okra genotypes at District Seed Farm "D" Block, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal during the summer season of both 2011 and 2012 to assess the post-fertilization changes in seed quality. All five genotypes were grown with an adequate population in three replications following randomized block design (RBD) for the purpose of developmental studies. Harvesting of developing pods was done at 3, 5, and 7 days after anthesis (DAA) and seven days interval thereafter up to 42 DAA. Harvested pods and seeds were utilized for this development program through total dry matter production, dry seed weight, germination, and vigor index. Lalu was identified as the variety for which total dry matter production was maximum, followed by Japani Jhar, Arka Anamika, Ramya, and Lady Luck when the average was made over stages of development, irrespective of the cropping seasons. Average germination was recorded to be maximum for Japani Jhar followed by Arka Anamika, Lalu, Lady Luck and Ramya irrespective of the year of experimentation, of which significantly similar performance was noted for Lady Luck and Ramya in the first year and Japani Jhar and Arka Anamika in the second year. Significantly highest magnitude of vigour index was derived for Arka Anamika in both the years followed by Japani Jhar, Lalu, Ramya, and Lady Luck, when the average was made over stages of development. Average vigor index of Lalu and Japani Jhar, as well as that of Lady Luck and Ramya, were statistically similar to each other.

Keywords: Genotypes, Germination, Seed development, Vigour Index.

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Introduction

Okra (*Abelmoschus esculentus* L. Moench*)* is one of the most important vegetable crops of the world grown almost throughout the year having total commercial production was estimated around 4.8 million tons (Eshiet and Brisibe, 2015). India occupies the first position in okra vegetable production and second in total vegetable production after China (Annual report, 2016-17, Ministry of Agriculture and Farmers Welfare, Govt. of India). It is quite popular in India because of its easy cultivation, almost assured yield and wider adaptability from tropical to sub-tropical as well as warmer regions of temperate zones (Saifullah & Rabbani, 2009; Rai and Basu, 2014).

A seed is the most valuable and important input among all essentials in crop production. The old says "Seed is the beginning of Life" and a good quality seed acts as a catalyst for realizing the potential of all other inputs in agriculture. Without good seed, the investment on fertilizer, water, pesticides, and other inputs cannot pay the desired dividend. It is important not only for internal consumption, but also as highest foreign exchange earner among the fruits and vegetables and for which quality is an important factor which must be taken (Bharti *et al.,* 2016).

Stage of maturity at harvest is one of the most important factors that can influence the quality of seeds (Demir *et al.,* 2008). So, that sound knowledge on seed development and physiological maturity (P.M.) ensure the good quality of seed, it also helps the plant breeders as well as seed growers to harvest seed crops on appropriate time avoiding the probable hazards like losses due to adverse weather condition during field maturity as well as due to threshing and cleaning (Dharmalingam and Basu, 1990). Maximum seed quality may be achieved at the end of seed filling period (Tek -rony and Hunter, 1995) or slightly after this phase (Demir and Samit, 2001; Ghassemi-Golezani and Mazloomi-Oskooyi, 2008; Ghassemi-Golezani and Hosseinzadeh-Mahootchy, 2009).

However, the time occurrence of maximum seed quality during development and its association with seed are greatly disputed and show variation among cultivars and locations. When seeds acquire maximum physiological quality regarding the development stage is also a dubious subject. Kwon and Bradford (1987) reported that germination

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rate and percentage of tomato seeds increased as fruits developed from green mature to the red-mature stage and then declined from red to overripe. On the other hand, Valdes and Gray (1998) found maximum germination of seeds from fruits harvested as early as the breaker stage of the fruit and thereafter did not as the fruit ripened. Demir and Ellis (1992) reported that maximum seed quality occurred after maximum seed dry matter accumulation. Seed germination potential reaches a peak at physiological maturity stage (Torres and Maecos-Fhilo, 2005) and seed deterioration starts after PM stage leads to losses of germination potential of seed (Dornbos, 1995). Although, Information on seed maturation as well as PM stage available for this crop is very limited.

In the view of all these aspects, the present research was carried out to investigate the changes in seed quality of okra cultivars at different stages of development and maturity to determine the appropriate time for harvest and quality improvement.

Materials and methods

The selected five genotypes of okra i.e., Lalu, JapaniJhar, ArkaAnamika, Ramya and Lady Luck were raised during summer 2011and 2012 at District Seed Farm "D" Block, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal. All the genotypes were grown with an adequate population in three replications following randomized block design (RBD) for developmental studies. On the day of anthesis, sufficient numbers of the flower (aprox. -400) of each genotype were tagged. Harvesting of developing pods were done at 3, 5, and 7 DAA and seven days interval thereafter up to 42 DAA. Harvested pods and seeds were utilized for development program through total dry matter production, dry seed weight, germination, and vigor index. Seeds harvested at initial three stages, i.e., at 3, 5, and 7 DAA did not respond at all irrespective of the genotypes. Vigour index was considered here as a joint function of germination (%) and seedling length (Abdul-Baki and Anderson, 1973). Statistical analysis was done with factorial completely randomized design (Gomez and Gomez, 1983).

Result and discussion

Total dry matter production was maximum for Lalu, when the average was made over stages of development followed by Japani Jhar, Arka Anamika, Ramya and Lady Luck, irrespective of the years. The maximum rate of enhancement concerning total dry matter accumulation could be noticed at 3 to 5 DAA after which enhancement in this parameter happened with decreasing rate during both summer seasons. Critical analysis on average performance of individual genotypes indicate that the highest enhancement in total dry matter accumulation occurred at 28 DAA for Lalu, Arka Anamika, and Ramya and it was 21 DAA for Lady Luck and Japani Jhar, though the magnitude at both 21 and 28 DAA were statistically at par for Lady Luck during first year of experimentation (Table1).

The overall dry weight of seeds per pod of individual genotypes, when the average was made over the stages of development, exhibited that maximum dry matter accumulation in seed happened for Japani Jhar followed by Arka Anamika and it was minimum for Lady Luck during the summer season of both the years. When average was made over the genotypes, maximum dry matter accumulation within seed occurred at 28 DAA, similar to that for total dry matter production, irrespective of the years of experiment; it was almost similar at 3 DAA in both the years, then slightly higher magnitude was noted in second years with the advancement of development. Rapid enhancement at early stages was recorded, and it continued with decreasing rate, after which reduction was noted at both 35 and 42 DAA, may be due to the degradation in different biochemical constituents within the seed structure. The trend in dry matter accumulation noted for all genotypes, excepting Lady Luck, was similar to the average picture. Enhancement was observed up to 21 DAA for Lady Luck and then reduced at a lower rate up to 42 DAA, though initial dry matter accumulation was of the highest magnitude for this genotype (Table 2).

Average germination was recorded to be maximum for Japani Jhar followed by Arka Anamika, Lalu, Lady Luck and Ramya irrespective of the year of experimentation, of which significantly similar performance was noted for Lady Luck and Ramya in the first year and JapaniJhar and ArkaAnamika in the second year. Average highest magnitude of this parameter was noted at 28 DAA in the first year and at 35 DAA in the second year, when average was made over the genotypes, though the germination % was statistically at par at both the stages of development, i.e., at 28 and 35 DAA in both the years (Table 3).

When behavior of individual genotypes for seed development was critically clarified, genotype-specific pattern could be noticed, though some variation could be recognized with the change in environmental condition over the years of experiment: the highest germination of seeds for Lalu was recorded at both 28 and 35 DAA in the first year and at 35 DAA for the second year; it was highest at 28 DAA for ArkaAnamika over the years; both 28 and 35 DAA could be identified as the stages producing seeds with significantly highest germination for Lady Luck potential and JapaniJhar with the exception in second year for Japani Jhar, and it was 35 DAA for Ramya over the years with significantly similar germination potential at three different stages (28, 35 and 42 DAA) of development, indicating genotype-specificc pattern in seed development and maturation with respect to its germination potential. Germination potential of okra seed enhanced with progress in development (Pandita *et al.,* 2012) and it attained 35 to 36 DAA as well as germination of seed attains its peak at physiological maturity (Demir and Samit, 2001; Torres and Maecos-Fhilo, 2005).

Significantly highest magnitude of vigor index was derived for ArkaAnamika in both the years followed by Japani

Table 1: Average total dry matter production per pod (g) at different maturity stages

Genotypes (V)	Days after anthesis 3DAA I	3DAA II	5DAA I	7DAA II	7DAA I	7DAA II	14DAA I	14DAA II	21DAA I	21DAA II	28DAA I	28DAA II	35DAA I	35DAA II	42DAA I	42DAA II	Mean I	Mean II
Lalu	0.379	0.415	1.383	1.425	1.762	1.864	4.286	4.365	5.191	5.380	6.567	6.725	5.190	5.285	5.274	5.342	3.754	3.850
ArkaAnamika	0.361	0.438	1.374	1.462	1.717	1.729	4.325	4.396	4.943	5.004	6.510	6.631	5.536	5.657	3.822	4.210	3.573	3.691
Lady Luck	0.612	0.654	1.210	1.284	1.480	1.525	3.359	3.444	4.767	4.930	4.705	4.861	4.406	4.529	2.811	3.021	2.919	3.031
Ramya	0.349	0.389	1.529	1.606	1.922	2.005	4.328	4.430	5.229	5.394	5.514	5.665	4.156	4.303	3.207	3.465	3.279	3.407
JapaniJhar	0.358	0.388	1.837	1.878	2.327	2.355	4.235	4.353	5.990	5.944	5.303	5.458	5.182	5.286	3.964	4.125	3.650	3.723
Mean	0.412	0.457	1.467	1.531	1.842	1.896	4.107	4.198	5.224	5.330	5.720	5.868	4.894	5.012	3.816	4.033		
	V						S						VXS					
	I			II			I			II			I			II		
SEm (±)	0.009			0.006			0.011			0.022			0.024			0.018		
CD at 5%	0.024			0.018			0.031			0.080			0.069			0.050		

I: 1st year; II: 2nd year; 3DAA-42 DAA = stages of development (S); V x S = genotype x stages of development interaction.

Table 2: Average dry seed weight (g) per pod at different maturity stages

Genotypes (V)	Days after anthesis 3DAA I	3DAA II	5DAA I	5DAA II	7DAA I	7DAA II	14DAA I	14DAA II	21DAA I	21DAA II	28DAA I	28DAA II	35DAA I	35DAA II	42DAA I	42DAA II	Mean I	Mean II
Lalu	0.053	0.058	0.286	0.295	0.355	0.361	1.370	1.385	2.046	2.130	2.587	2.625	2.150	2.175	2.174	2.162	1.378	1.399
ArkaAnamika	0.047	0.051	0.346	0.352	0.469	0.472	1.715	1.726	2.273	2.284	2.640	2.681	2.276	2.347	1.926	2.190	1.461	1.513
Lady Luck	0.071	0.077	0.212	0.221	0.311	0.318	1.139	1.144	2.057	2.130	1.725	1.821	1.546	1.579	1.384	1.441	1.056	1.091
Ramya	0.047	0.052	0.512	0.519	0.779	0.782	1.558	1.620	2.049	2.174	2.624	2.745	1.756	1.820	1.627	1.715	1.369	1.428
JapaniJhar	0.051	0.055	0.427	0.431	0.627	0.635	1.495	1.553	2.450	2.324	2.883	2.958	2.492	2.514	1.934	2.015	1.545	1.561
Mean	0.054	0.059	0.357	0.364	0.508	0.514	1.455	1.486	2.175	2.208	2.492	2.566	2.044	2.087	1.809	1.905	1.362	1.398
	V						S						VXS					
	I				II		I			II			I			II		
SEm (±)	0.002				0.0006		0.003			0.0008			0.007			0.0018		
CD at 5%	0.007				0.0018		0.008			0.0023			0.019			0.0051		

I: 1st year; II: 2nd year; 3DAA-42 DAA = stages of development (S); V x S = genotype x stages of development interaction.

Table 3: Germination (%) of seed at different maturity stages

Genotypes (V)	Days after anthesis											
	14DAA		21DAA		28DAA		35DAA		42DAA		Mean	
	I	II	I	II	I	II	I	II	I	II	I	II
Lalu	0.00 (4.05)	0.00 (4.05)	53.33 (47.20)	55.56 (48.49)	84.00 (66.93)	82.22 (65.53)	84.00 (66.93)	84.44 (67.27)	75.56 (60.75)	77.78 (62.27)	59.38 (49.17)	60.00 (49.52)
ArkaAnamika	13.33 (21.79)	13.33 (21.83)	70.67 (57.53)	71.11 (57.84)	86.67 (69.06)	88.89 (71.21)	81.33 (64.80)	82.22 (65.53)	68.89 (56.51)	73.33 (59.36)	64.18 (53.94)	65.78 (55.15)
Lady Luck	0.00 (4.05)	6.67 (15.53)	50.67 (45.67)	57.78 (49.77)	76.00 (61.06)	75.56 (60.75)	73.33 (59.25)	75.56 (60.75)	71.11 (57.84)	71.11 (57.84)	54.22 (45.57)	57.33 (48.93)
Ramya	22.67 (28.75)	20.00 (26.92)	41.33 (40.28)	42.22 (40.81)	65.33 (54.24)	64.44 (53.71)	68.00 (55.89)	68.89 (56.44)	64.44 (53.71)	66.67 (55.04)	52.36 (46.58)	52.44 (46.58)
JapaniJhar	32.00 (34.76)	28.89 (32.80)	53.33 (47.20)	53.33 (47.20)	82.67 (65.81)	80.00 (63.79)	86.67 (69.06)	88.89 (71.21)	77.78 (62.27)	80.00 (64.01)	66.49 (55.22)	66.22 (55.80)
Mean	13.60 (18.68)	13.78 (20.23)	53.87 (47.58)	56.00 (48.82)	78.93 (63.42)	78.22 (63.00)	78.67 (63.18)	80.00 (64.24)	71.56 (58.22)	73.78 (59.70)		
	V				S				VXS			
	I		II		I		II		I		II	
SEm (±)	0.565		0.661		0.565		0.661		1.264		1.478	
CD at 5%	1.061		1.877		1.061		1.877		3.589		4.197	

Figures in parentheses are arc-sine transformed values;I: 1st year; II: 2nd year; 3 DAA–42 DAA = stages of development (S); V x S = genotype x stages of development interaction.

Table 4: Vigor Index at different maturity stages

Genotypes (V)	Days after anthesis											
	14DAA		21DAA		28DAA		35DAA		42DAA		Mean	
	I	II	I	II	I	II	I	II	I	II	I	II
Lalu	0.00	0.00	802.00	843.89	1561.56	1543.31	1478.40	1506.49	1220.98	1261.56	1012.59	1031.05
Arka Anamika	101.38	104.53	1281.89	1280.00	1756.73	1779.56	1589.25	1580.31	1306.13	1398.49	1207.08	1228.58
Lady Luck	0.00	9.67	505.15	584.13	1110.36	1121.24	1443.20	1518.67	1176.18	1187.56	846.98	884.25
Ramya	191.31	180.27	705.35	726.64	1215.85	1213.49	1354.90	1392.24	1232.18	1264.69	939.92	955.47
Japani Jhar	256.97	234.19	435.20	436.27	1588.03	1563.20	1643.20	1713.78	1330.00	1482.42	1050.68	1085.97
Mean	109.93	105.73	745.92	774.19	1446.51	1444.16	1501.79	1542.30	1253.09	1318.94	1011.45	1037.06
	V				S				VXS			
	I		II		I		II		I		II	
SEm (±)	14.97		17.07		14.97		17.07		33.47		38.16	
CD at 5%	42.51		48.47		42.51		48.47		95.06		108.39	

I: 1st year; II: 2nd year; 3 DAA–42 DAA = stages of development (S); V x S = genotype x stages of development interaction.

Jhar, Lalu, Ramya, and Lady Luck when the average was made over stages of development. Average vigor index of Lalu and JapaniJhar, as well as that of Ramya, were statistically similar to each other (Table 4). Highest vigor index was assessed at 35 DAA in both the years when the average was made over the genotypes (Anitha *et al.,* 2001). It is remarkable to note that the vigor index estimated at 28 DAA was greater than that of 42 DAA, may be due to reduction in both germination potential and seedling length at final stage of maturity.

As physiological maturity is determined through joint consideration of higher germination percentage, vigor index and dry matter accumulation in seed, 28 DAA could be identified as a stage of physiological maturity for Lalu and ArkaAnamika, but it was 35 DAA for Ramya and JapaniJhar.

It becomes difficult for Lady Luck as the attainment of the highest value for these three parameters varied. Change in vigor index with the advancement in developmental stages clearly express unique mode for individual genotypes; the same at 42 DAA, expected to be the stage of field maturity, was found to be less than that of 28 and 35 DAA for Lalu, ArkaAnamika and JapaniJhar in both the years, while it was less than 35 DAA but greater than 28 DAA for Lady Luck and Ramya. The stage of 35 DAA could be identified as the stage of physiological maturity in *lablab* bean (Murthy and Kumar, 2004; Basu and Moharana, 2012).

Conclusion

Qualitative changes of genotypes differed due to their genetic makeup of individual genotype. Harvesting at 28 DAA may be recommended for early genotypes while 35 for another one to achieve seeds with better quality in general.

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