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Emergence rate of seedlings from hard okra seed coats and seedling growth of some genotypes of West African okra (*Abelmoschus caillei*)

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Abstract. *In 2017 and 2018 cropping season, field experiment was conducted at the Food and Agricultural Organization and Tree Crop Plantation, Department of Crop Science, Adamawa State University, Mubi using fifteen genotypes of West African okra. The study was undertaken to study the emergence rate of seedlings from hard okra seed coats, seedling growth and their development. The seeds of the genotypes were soaked in NaCl solution for 24 hours to accelerate the breaking of seed dormancy and to ease seed germination. Tough seed coat usually impairs seed germination by establishing a permeability barrier which can interrupt water uptake required for imbibition, radicle and seedling emergence. The combined analysis results revealed a highly significant (P≤0.01) difference among these genotypes with respect to days to first and 50% flowering including days to first harvest. Furthermore, accession 3 (NG/SA/DEC/07/0448) and accession 11 (Yar kwadon) flowered earlier, had shortest days to first harvest, recorded the highest number of seedlings and emergence percentage than the other genotypes studied.*

Keywords: West African okra, seed coat, dormancy, NaCl solution, emergence rate

Introduction

Okra, also known as “lady’s finger”, is one of the most important nutritious vegetables extensively grown throughout the tropical and subtropical world for its immature pods. The two most important okra cultivated are *Abelmoschus esculentus* (Common okra) and *Abelmoschus caillei* (West African okra). Okra is an African vegetable that has been a staple of African and Indian cuisine for many years and also used for medicinal purposes (healthline.com and vanguardngr.com). The crop contains potassium, vitamin A, B and C, folic acid, calcium and iodine (Kochhar, 1986). Studies found that okra protects the body from liver disease, treats diabetes and helps to manage blood sugar and fights cancer, especially colorectal cancer (pixaby.com and healthline.com). This crop is propagated through seed, which loses its viability quickly (Thakur and Arora, 1993). Seed germination and dormancy are two adaptive traits in plants under the influence of genetic and environmental factors. Seed germination can be defined as the potential of a seed lot to germinate under defined conditions (Black et al., 2006), whereas dormancy refers to a state in which the viable seeds fail to germinate when provided with conditions normally favorable for germination such as adequate moisture, appropriate temperature regimes and light (Sahmidt, 2000). Abudureheman et al. (2014) reported that temperature and moisture are critical to overcoming seed dormancy and release of seed germination. Invariably dormancy and germination are key factors in the life cycle of a plant and reflect important survival strategies in natural population (Fenner and Thompson, 2005). In okra, the percentage of seed germination is relatively low, due to the occurrence of hard seed coat in most okra genotypes (Felipe et al., 2010; El Balla et al., 2011). Seed hardness interferes with seed germination and it regulates germination by establishing a permeability barrier which interferes with the water uptake required for imbibition and subsequent radicle emergence, gaseous exchange (oxygen) required for respiration and the outward diffusion of endogenous germination inhibitors (Mmolawa, 1987). Therefore, the slow and even germination of okra seed is the main hurdle in the early development of the crop (Pandita et al., 2010). Early seedling emergence, flowering and maturity of okra genotypes is usually preferred over late flowering because earliness certainly helps to get early maturing lines that could escape problems of insect pests and diseases that are common during cropping season. In addition, it ensures early supply of fruits to the market for the consumers.

In okra, seed germination is influenced by cultivar as trial by Batt and Srinivasa Rao (1998) reported considerable reduction in seed germination under field conditions compared with controlled conditions in different cultivars of okra. Also, with the advent of recent challenges in food security and insecurity of humans in the North East region of Nigeria, in addition to the rainfall variability from season to season which had led to numerous incidences of drought in these areas, there is the need to evaluate and select fast seedling emergence okra genotypes that can escape drought challenges and also genotypes with fast seedling growth and development to mitigate the prevailing food shortage.

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Material and methods

Experimental materials consisted of fifteen accessions of West African okra (Table 1). These comprised 12 okra accessions from National Centre for Genetic Resources and Biotechnology, Ibadan, Nigeria, while the remaining three accessions were obtained from Mubi market. The field experiment was conducted at the Food and Agricultural Organization and Tree Crop Plantation, Department of Crop Science, Adamawa State University, Mubi. To ensure that the seeds utilized for the experiment were viable, a seed viability test using tetrazolium according to Grabe (1970) was carried out. In order to study the accessions hardness, two gram of sodium chloride (NaCl) was dissolved in 225ml of water. The NaCl solution was poured into 15 beakers, then 180 seeds of each accession were imbibed in each beaker of salt solution for 24 hours as reported by Iqbal et al. (2006) and Khan et al. (2009). The soaked seeds were sown on a ploughed and harrowed field on August 5, 2017 and August 8, 2018 cropping season. In each replication, each accession was sown in four rows of 2m long with inter row spacing of 0.60m and intra-row spacing of 0.40m apart. Five seeds of each of the fifteen accessions were planted per hill giving a total of 60 seeds per plot and the experiment was laid in a Randomized Complete Block Design replicated three times. At 6 to 14 days after sowing (DAS), data for seedling emergence was taken, after which plants in each plot were thinned to one plant per stand. A compound fertilizer at 100kg/ha NPK 15:15:15 was applied by side placement to meet plant nutrient requirement at 2 weeks after sowing (WAS). In order to control insect pest damage to okra plants, cypermethrin 10% EC was sprayed at a rate of 50 mL/10 liters of water at vegetative growth stage 3 WAS and repeated at flowering stage using knapsack sprayer. Weeding was carried out manually using hand hoe to maintain weed-free plots. Data on days to first flowering, days to 50% flowering and days to first harvest were collected.

Table 1. Fifteen okra accessions collected for the study

Accession Number	Accession identification number	Source
1	NG/AA/SEP/09/040	NACGRAB, Ibadan
2	NG/SA/DEC/07/0483	NACGRAB, Ibadan
3	NG/SA/DEC/07/0448	NACGRAB, Ibadan
4	NG/AA/SEP/09/038	NACGRAB, Ibadan
5	NG/SA/DEC/07/0528	NACGRAB, Ibadan
6	NG/TO/JUN/09/007	NACGRAB, Ibadan
7	NG/SA/DEC/07/498	NACGRAB, Ibadan
8	NG/TO/JAN/09/116	NACGRAB, Ibadan
9	NG/SA/DEC/07/0475	NACGRAB, Ibadan
10	NG/SA/JAN/09/109	NACGRAB, Ibadan
11	Yar Kwadon (Mubi-1)	Mubi local cultivar
12	Syria (Mubi-2)	Mubi local cultivar
13	NG/MR/09/009	NACGRAB, Ibadan
14	Yar bala	Mubi Improved cultivar
15	NG/SA/DEC/07/0445	NACGRAB, Ibadan

* NACGRAB = National Centre for Genetic Resources and Biotechnology, Ibadan

The data collected were subjected to analysis of variance using computer statistical software and means were separated by Duncan Multiple Range Test (SAS Institute, 2010). The data on number of seedling emergence were expressed in percentage using the formula (Grabe, 1970):

Germination (%) = (Number of seeds germinated / Number of seeds sown).100.

Results and discussion

The effects of NaCl priming on seedling percentage of 15 accessions of West African okra at 6-14 DAS is presented in Table 2. These accessions of okra showed variation in their number of seedlings emergence and their respective emergence percentages. The results showed that at 6 DAS, accession 12 (Syria) had the highest number of emerged seedlings (37) with 20.56% emergence, followed by accession 11 (Yar kwadon), which recorded 36 seedlings and 20% emergence. The lowest seedlings and percentage emergence were recorded by accession 4 (NG/AA/SEP/09/038) and accession 3 (NG/SA/DEC/07/0448) with emergence percentage of 3.33% and 10.00%, respectively. At 8 DAS, accession 3 (NG/SA/DEC/07/0448) had the highest seedlings (70) and percentage emergence (38.89%), followed by accession 11 (Yar Kwadon) with 67 seedlings and 37.22% emergence. The lowest estimate was recorded by accessions (4 and 7) which had 34 seedlings each. At 10-14 DAS accession 11 recorded the highest seedlings and percentage emergence of 38.89%, 41.11% and 43.33%, respectively, followed by accession 3 (36.67%, 37.22% and 38.89%).

The combined analysis of variance (Table 3) indicated that the mean squares due to accessions and accession by year interaction were highly significant ($P<0.01$) for days to first and 50% flowering including days to harvest. The highly significant accession by year interaction effect for these traits indicated the diversity of the genotypes and their differences in environmental responses across the two years of evaluation (Bello et al., 2012). This invariably suggests that the West okra genotypes could be genetically manipulated for their improvement through simple selection. Similar results were observed for days to first and 50% flowering including days to first harvest among West African okra genotypes by Hazem et al. (2013) and Jonah et al. (2015, 2018).

The mean performance is presented in Table 4. There was significant variation among the 15 accessions for days to first and 50% flowering and also days to first harvest. Accession 14 (Yar bala) had the shortest days to first flowering (49.17), followed by accession 11 (Yar Kwadon), which recorded 50 days. The two accessions showed no significant difference statistically. Accession 7 (NG/SA/DEC/07/498) was late in days to first flowering. Jonah et al. (2018) similarly reported the same trend of results for days to first flowering for these three accessions. For days to 50% flowering, accession 1 (NG/AA/SEP/09/040) was the earliest (53.17), although it was not statistically different from the other accessions except accessions 7, 9, 8 and 10. Furthermore, accession 7 that recorded the longest time to first flowering was late to reach 50% flowering (63.33). As regards days to first harvest, accessions

3 (NG/SA/DEC/07/0448) and 13 (NG/SA/DEC/07/009) both recorded 57.17 days, followed by accession 11 with 57.33 days to first harvest. These three accessions were statistically at par with accessions 2 and 14. In contrast, accession 7 (71.67) and accession 8 (65.17); exhibited the longest days to first harvest. However, the two accessions differed significantly in their days to first harvest. The differences observed for days to first and 50% flowering including days to first harvest among the fifteen accessions of okra provided evidence of wide genetic variability among these genotypes as reported by Hazem et al. (2013) and Jonah et al. (2015, 2018) in West African okra genotypes. From the comparative field performance of the accessions studied, accessions 3 (NG/SA/DEC/07/0448) and 11 (Yar kwadon) which flowered earlier had short days to first harvest, the highest number of seedlings and emergence percentage and could be promising genotypes with respect to earliness. Therefore, the selection of these West African okra for improvement in North Eastern Nigeria can aid in alleviating poverty and hunger for the peasant farmers. This finding agrees with earlier trials of Nsimi et al. (2013) and Jonah et al. (2015, 2018) which revealed the discriminatory power of earliness (i.e. days to first and 50% flowering) in West African okra.

Table 2. Mean seedlings and emergence percentage of 15 accessions of West African okra at 6-14 days after sowing (DAS) during 2017 and 2018 evaluation

Acc. No.	6 DAS		8 DAS		10 DAS		12 DAS		14 DAS	
	No. of seedlings emerged	% Emergence	No. of seedlings emerged	% Emergence	No. of seedlings emerged	% Emergence	No. of seedlings emerged	% Emergence	No. of seedlings emerged	% Emergence
1	28	15.56	53	29.44	51	28.33	55	30.56	61	33.89
2	20	11.11	44	24.44	42	23.33	48	26.67	52	28.89
3	18	10.0	70	38.89	66	36.67	67	37.22	70	38.89
4	6	3.33	34	18.89	36	20.00	43	23.89	47	26.11
5	22	12.22	45	25.00	44	24.44	48	26.67	55	30.56
6	21	11.67	49	27.22	47	26.11	50	27.78	61	33.89
7	26	14.44	34	18.89	40	22.22	47	26.11	52	28.89
8	25	13.89	58	32.22	57	31.17	64	35.56	63	35.00
9	26	14.44	37	20.56	39	21.67	44	24.44	49	27.22
10	24	13.33	37	20.56	40	22.22	47	26.11	51	28.33
11	36	20.00	67	37.22	70	38.89	74	41.11	78	43.33
12	37	20.56	53	29.44	57	31.67	63	35.00	69	38.33
13	25	13.89	35	19.44	43	23.89	40	22.22	45	25.00
14	22	12.22	48	26.67	52	28.89	55	30.56	59	32.78
15	24	13.33	60	33.33	65	36.11	66	36.67	71	39.44

*Acc. No. = Accession number, which corresponds to the Accession Identification number in Table 1;
Total number of seed of each accession = 180.

Table 3. Mean squares from combined analysis of variance for days to flowering and days to harvest traits of West African okra

Source of variation	Degree of freedom	Days to first flowering	Days to 50% flowering	Days to first harvest
Year	(y - 1) = 1	141.88**	313.6**	0.71^{NS}
Rep (Year)	(r - 1) (y) = 4	3.71^{NS}	48.09**	2.38^{NS}
Accession	(g - 1) = 14	129.18**	92.84**	97.33**
Accession x year	(g - 1) (y - 1) = 14	7.52**	11.89**	12.52**
Error	(r - 1) (g - 1) = 56	2.93**	8.42**	1.46**
Total	89			

** = Highly significant at 1% level of probability and NS = Not Significant

Table 4. The effect of NaCl priming on the 15 Accessions of West African Okra

Accession	Accession identification number	Days to first flowering	Days to 50% flowering	Days to first harvest
1	NG/AA/SEP/09/040	50.83[de]	53.17[d]	60.67[d]
2	NG/SA/DEC/07/0483	51.17[de]	53.67[d]	57.50[f]
3	NG/SA/DEC/07/0448	51.00[de]	54.00[d]	57.17[f]
4	NG/AA/SEP/09/038	50.67[de]	54.83[d]	58.50[ef]
5	NG/SA/DEC/07/0528	50.83[de]	54.00[d]	58.33[ef]
6	NG/TO/JUN/09/007	57.33[bc]	60.67[b]	63.33[c]
7	NG/SA/DEC/07/498	65.83[a]	68.33[a]	71.67[a]
8	NG/TO/JAN/09/116	58.17[bc]	59.17[bc]	65.17[b]
9	NG/SA/DEC/07/0475	59.00[b]	60.17[b]	63.00[c]
10	NG/SA/JAN/09/109	56.67[c]	59.17[bc]	61.50[d]
11	Yar Kwadon (Mubi-1)	50.33[de]	54.83[d]	57.33[f]
12	Syria (Mubi-2)	52.33[d]	56.17[cd]	59.17[e]
13	NG/MR/09/009	50.67[de]	56.33[cd]	57.17[f]
14	Yar bala	49.17[e]	55.83[cd]	57.50[f]
15	NG/SA/DEC/07/0445	52.17[d]	57.00[b-d]	58.33[ef]
	Mean	53.74	57.16	60.42
	CV, %	3.18	5.08	2.00
	SE±	0.698	1.185	0.493

*Means followed by the same letters within a column are not significantly different statistically at 5% level of probability using Duncan's Multiple Range Test

Conclusion

Halopriming using NaCl solution enhanced the breaking of seed hardness of seed coat of the genotypes of West African okra studied. Results from the investigation showed that okra accessions 3 (NG/SA/DEC/07/0448) and 11 (Yar kwadon) responded faster to seedling emergence, percentage emergence, uniform seedlings establishment and seedling development. Hence, seed priming using NaCl solution may be used for enhancing seedling emergence, better seedling growth and high yield in West African okra.

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