THE STORAGE RESPONSE OF OKRA (*ABELMOSCHUS ESCULENTUS* L. MOENCH) SEEDS PRODUCED UNDER DIFFERENT NUTRIENT SOURCES TO PRE-STORAGE HYDROPRIMING

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ABSTRACT

The effects of different levels of poultry droppings, cow dung, recommended NPK fertilizer and hydropriming on the longevity of seeds of NHAe47-4 and LD88-1 varieties of okra were studied in 2012 at Federal University of Technology, Minna, Nigeria. Seeds samples of the two varieties produced under no fertilizer, 4 and 6 t ha^{-1} of cow dung and poultry droppings and 100 kg N, 50 kg P_2O_5, and 50 kg K_2O ha^{-1} were hydroprimed for 12 hours, dried back, packaged in plastic bottles and stored at 30 °C. Seed germination tests were conducted at two-weekly intervals using the top of paper method. Seeds from plants which received 6 t ha^{-1} of poultry droppings germinated and stored significantly better than those of the other fertilizer treatments. Hydropriming enhanced seed germination during the first two weeks of storage. It however reduced seed longevity as unprimed seeds germinated significantly higher than primed ones from 4 – 14 WAS. The study showed that freshly harvested okra seeds exhibited dormancy which was broken with hydropriming and time in storage.

Key words: Nutrient sources, hydropriming, germination, longevity, okra

INTRODUCTION

Okra occupies a significant portion of vegetable value chain in the diet of man. It is commonly cultivated in most parts of the world as a fruit vegetable, Nigeria inclusive (Adebisi *et al*., 2007). The crop is grown for the tender or immature pod which is eaten green, either fresh or prepared by boiling or frying and used as stew (Dauda *et al*., 2007). Consumption of 1 kg of the fruit is capable of supplying about 4550 kcal and sufficient quantity of vitamins, minerals and proteins (Katung, 2007). The dietary fibre intake of man which aids digestion and mopping up of carcinogenic substances in human system is enhanced thereby preventing the chances of cancer build up (Al-Wandawi, 2005).

Despite the numerous nutritional advantages of this crop, its production is faced with challenges of good quality seed procurement which has led to low fruit yield over the years. Good quality seed has been reported by Oladiran (2010) to be responsible for realizing the potential of all other inputs in agriculture. The author further reported that seeds are practically worthless if upon planting they fail to germinate and give adequately healthy and vigorous plants. Production of quality seed and maintenance of high seed germination are therefore, very important for sustainable vegetable production, which necessitates high seed quality. Adediran *et al*. (2003) reported that application of organic manure from different sources to mother-plants of some vegetables resulted in the production of high quality seeds. Singh (2006) also recorded high germination of about 90% under accelerated ageing for up to 20 weeks from seeds of egg plants when mother-plant received the application of poultry manure compared with low germination of 51% from seeds of the non fertilized plants. According to Bita and Divsalar (2011), nitrogen increased seed protein content in lettuce and rapes, which constitutes a good index for seed quality and vigour. The use of organic fertilizers is now being advocated in most parts of the world as a viable alternative to inorganic fertilizer because of their accessibility, slow releasing property and the positive effects on the environment compared to inorganic fertilizers (Olaniyi *et al*., 2010). Most researches on okra concentrate more on fruit yield and not quality seed production which has led to the paucity of information in respect of the effect of various nutrients and their sources on the quality of okra seeds.

Seed priming to obtain rapid and uniform germination has been employed in some vegetables with varying results (Rashid *et al*., 2006). The technology has presented promising and even surprising results for many crop seeds (Mondal *et al*., 2011). The rationale is that sowing soaked seeds decreases the time needed for germination and allows the seedling to escape deteriorating soil physical conditions (Farooq *et al*., 2008). Tavili *et al*. (2010) reported that priming treatments significantly increased germination and conferred high vigour on two genotypes of *Bromus*. Ghassemi *et al*. (2008) reported that though significantly higher germination percentages in both osmo-and hydroprimed seeds of lentil (*Lens culinaris*) compared with unprimed seeds prior to storage, faster decline in the germination capacity of the primed seeds was recorded with storage time, while Hill and

Cunningham (2007) reported that priming reduced longevity of okra seeds. In the context of the above, this work attempted to evaluate the effects of sources and rates of inorganic fertilizer, readily available organic manures and hydropriming on germination and relative longevity of okra seeds. This is aimed at providing an idea on the actual storage behaviour of primed and unprimed seeds of the varieties grown under organic and inorganic fertilization.

MATERIAL AND METHODS

A hydropriming trial (with and without priming) using seeds of NHAe47-4 and LD88-1 produced under six different fertilizer treatments was conducted between March and June in 2012 at Federal University of Technology, Minna. The treatments were factorially combined and fitted to Randomize Completely Block Design (RCBD) with four replicates. The six fertilizer treatments were poultry droppings at 4 and 6 tonnes ha^{-1}; cow dung manure at 4 and 6 tonnes ha^{-1}; NPK 15-15-15 + urea supplying 100-50-50 kg ha^{-1} of N, P_2O_5 and K_2O and untreated (no manure and no fertilizer) as control. Prior to sowing, well cured poultry droppings and cow dung at the rates detailed above were incorporated unto the ridges constructed 75 cm apart. Three seeds were sown during the raining season of 2011 at 50 cm apart on ridges. NPK 15-15-15 fertilizer was applied at 2 weeks after sowing to supply 50-50-50 kg ha^{-1} of N, P_2O_5 and K_2O. Urea was applied 3 weeks later to supply additional 50 kg ha^{-1} N. The fertilizers were applied by side placement in two small holes, 5 cm away from the base of each stand and covered up. Fruits were harvested for seed extraction at 42 days after anthesis (DAA) when the colour turned brown and ridges had split. The seeds were then left to dry at room temperature (27 °C) for seven days.

200 g of seed samples from each of the different treatment combinations were soaked (hydroprimed) in 350 ml distilled water for 12 hours (farmers practice); unprimed seeds served as the control. Hydroprimed seeds were dried back at room temperature (27 °C) for seven days followed by determination of moisture content using the hot oven method (130 °C for 60 minutes) and the percentage moisture content (on wet weight basis) was calculated as follows:

$$\frac{\text{Weight of wet seeds} - \text{weight of oven-dried seeds}}{\text{Weight of wet seeds}} \times 100$$

Seeds of the 24 treatment combinations (2 varieties × 6 fertilizer levels × 2 priming levels) were packaged in plastic bottles and stored at 30 °C for 14 weeks. Germination test was carried out at the onset of storage and at two weekly intervals for 14 weeks. Four replicates of 50 seeds each were counted and placed on 9 cm no 1 filter paper in plastic Petri-dishes and incubated at 30 °C for 28 days. Germination count was taken every-other day and expressed in percentages. Germination percentages were transformed to arcsin values for purpose of analysis of variance (ANOVA) using SAS Statistical Package 9.2. Means were separated using the Student-Newman-Keuls (SNK) test.

RESULTS

Percentage seed germination

Significant variations in viability maintenance between the two varieties were recorded. At the onset and up to 2 weeks of storage, NHAe47-4 germinated significantly higher (52%) than LD88-1 (34%). Following storage for 4 - 6 weeks, germination values for the two varieties became similar. However, as from 8 weeks up to the end of storage, seeds of LD88-1 germinated significantly better than NHAe47-4.

Germination also varied significantly among fertilizer treatments. Non-application of fertilizer resulted in significantly poorer seed germination of about 21% compared to 43-49% obtained at the onset of seed storage from fertilized plots. There were improvements in germination in all fertilizer treatments within the first two weeks after storage (2 WAS). A gradual decline was recorded as from 4 WAS except for the lot that was produced with 6 t ha^{-1} of poultry droppings in which decline set in as from 10 WAS.

Hydropriming resulted in enhanced germination of about 100% and the effect persisted for the first 2 weeks of storage (Table 1). It however reduced seed longevity as unprimed seeds germinated significantly higher (about 53-31%) than primed ones with a range of 41-15% from 4 – 14 WAS.

Interaction effects of variety×fertilizer on seed viability at storage times

Germination percentages of NHAe47-4 seeds were generally significantly higher than those of LD88-1 within the first two weeks of storage; the reverse was the case of 8 to 12 WAS (Table 2). Before storage of NHAe47-4 seeds, the highest germination of 59 – 68 % were recorded in seeds produced under application of cow dung at 4 and 6 t ha^{-1} and NPK 15-15-15 + urea respectively, while the best germination values of 54 and 51% were respectively recorded with the application of poultry droppings at 4 and 6 t ha^{-1} respectively in LD88-1 (Table 2). As from 2 WAS NHAe47-4 seeds produced with poultry droppings of 6 t ha^{-1} survived generally better than those produced

Table 1: Main effects and interaction of variety, fertilizer and hydropriming on percentage germination of NHAe47-4 and LD88-1 seeds at different storage periods

Treatment	Storage period (weeks)							
	0	2	4	6	8	10	12	14
Variety								
NHAe47-4	52a	58a	48a	42a	35b	27b	21b	20b
LD88-1	34b	49b	46a	49a	49a	42a	32a	28a
Fertilizer								
Control	21b	32c	21c	18d	17d	13c	10d	9c
4 t ha^{-1} PD	47a	58b	49b	50bc	37c	36b	21c	28b
6 t ha^{-1} PD	49a	68a	69a	68a	67a	49a	46a	38a
4 t ha^{-1} CD	43a	54b	44b	42c	43c	36b	28bc	21b
6 t ha^{-1} CD	45a	60ab	53b	58b	56b	41ab	32b	25b
NPK	48a	54b	49b	42c	41c	32b	26bc	21b
Hydropriming								
Unprimed	28b	42b	53a	52a	51a	43a	31a	32a
Primed	57a	61a	41b	39b	34b	26b	15b	15b
Interaction								
V×F	**	**	**	**	**	NS	**	**
V×P	NS	NS	NS	NS	NS	NS	NS	NS
F×P	**	**	**	**	NS	**	NS	**
V×F×P	NS	NS	NS	NS	NS	NS	NS	NS

PD= poultry droppings; CD= cow dung; means followed by the same letter(s) for same factor in a column are not significantly different (p=0.05) by Student-Newma Keuls (SNK) test; NS= Not significant

Table 2: Interaction effect of variety × fertilizer on percentage germination of NHAe47-4 and LD88-1 seeds

Variety	Fertilizer	Storage period (weeks)						
		0	2	4	6	8	12	14
NHAe47-4	Control	35cd	40c	21d	16d	11e	8c	8c
	4t h^{-1}PD	40c	51c	38c	37c	24d	18d	14c
	6t h^{-1}PD	50b	76a	69a	67a	62b	41bc	38a
	4t h^{-1}CD	59a	60b	53b	36c	28d	25d	18bc
	6t h^{-1}CD	60a	62b	54b	47b	42c	34c	23b
	NPK	68a	64b	61ab	53b	47c	35c	21b
LD88-1	Control	7e	24d	21d	21d	17e	18d	11c
	4t h^{-1}PD	54b	65b	60ab	63a	61b	54d	42a
	6t h^{-1}PD	51b	62b	63a	62a	72a	58a	43a
	4t h^{-1}CD	27d	43c	42c	44bc	41c	45b	26b
	6t h^{-1}CD	38c	58b	62a	70a	70a	51ab	28b
	NPK	28d	45c	38c	36c	32d	32c	21b

PD= poultry droppings; CD= cow dung; means followed by the same letter(s) for same factor in a column are not significantly different (p=0.05) by Student Newman-Keuls (SNK) test; NS= Not significant

under other fertilizer treatments. In contrast to the trend described above, LD88-1 seeds produced with application of 4 and 6 t ha^{-1} of poultry droppings and cow dung at 6 t ha^{-1} germinated significantly better than those of others at 2 to 6 WAS. Beyond this point, survival was generally the best in seeds produced under application of poultry droppings and cow dung at 6 t ha^{-1}.

Interaction effects of fertilizer×priming on seed viability at different storage times

Prior to the storage of unprimed seeds, the highest germination values of 28 - 38% were recorded when poultry droppings at 6 t ha^{-1}, cow dung at 4 and 6 t ha^{-1} and inorganic fertilizers were applied to the mother-plant, whereas the best germination of 71 and 73% were recorded in primed seed samples when poultry

Table 3: Interaction effect of fertilizer × priming on percentage germination of NHAe47-4 and LD88-1 seeds in 2011 (%)

Priming	Fertilizer	Storage period (weeks)					
		0	2	4	6	10	14
Unprimed	Control	10d	25e	26e	25e	21d	20c
	4t h^{-1}PD	12d	41d	61ab	61c	43bc	31bc
	6t h^{-1}PD	28c	65b	69a	74a	60a	48a
	4t h^{-1}CD	35c	47cd	49c	45d	43bc	36b
	6t h^{-1}CD	38c	52c	57b	63b	50b	29bc
	NPK	38c	52c	57b	51c	44bc	31bc
Primed	Control	33c	39d	16f	11f	5e	2d
	4t h^{-1}PD	71a	75a	37d	39d	29d	25c
	6t h^{-1}PD	73a	73a	62ab	55c	39c	36b
	4t h^{-1}CD	50b	56bc	42cd	39d	30d	8d
	6t h^{-1}CD	60b	68ab	49c	53c	21d	22c
	NPK	57b	57bc	41cd	21e	21d	11d

PD= poultry droppings; CD= cow dung; means followed by the same letter(s) for same factor in a column are not significantly different ($p=0.05$) by Student Newman-Keuls (SNK) test; NS= Not significant

droppings were applied at 4 and 6 t ha^{-1} respectively (Table 3). As from 2 WAS, unprimed seeds samples from the lot produced with application of poultry droppings at 6 t ha^{-1} generally had the best longevity. Though primed seeds of this same fertilizer treatment also generally germinated higher than other fertilizer treatments they did not perform significantly better than 4 t ha^{-1} of poultry droppings and 6 t ha^{-1} of cow dung at 2 WAS, and was also at par with 6 t ha^{-1} of cow dung at 6 WAS. Primed seeds germinated significantly higher than the unprimed at 0 WAS, but the reverse was generally the case from 4 to 14 WAS (Table 3).

DISCUSSION

The germination and longevity of seeds were best maintained in seeds from plants to which 6 t ha^{-1} of poultry droppings was applied to their mother-plants during growth on the field. This may be due to adequate nutrition of the mother-plants during growth supplied by poultry droppings at that rate. Mishra and Ganesh (2005), organic manure at higher rate (6-8 t ha^{-1}) recorded higher seed germination when was applied to tomato plants. They suggested that the performance was because organic manure contains most of the essential nutrients for proper seed development. The enhancement of germination by hydropriming as recorded in this study is in agreement with other studies. The technology has been reported to result in high germination in *Bromis* seeds (Tavili *et al.*, 2010). Priming is reported to trigger the synthesis of some enzymes which help to initiate the oxidation of storage reserves in seeds during germination (Varier *et al.*, 2010). Abdulraziq *et al.* (2011) are of the opinion that the splitting or softening of okra seed coat might be responsible for synchronized germination of hydroprimed seeds.

Reduced longevity of hydroprimed seeds as recorded in this study agrees with the findings of others. Membrane damages resulting in ion leakages have been reported to be responsible for rapid deterioration in primed seeds (Tarquis and Bradford, 1992; Khan *et al.*, 2003; Basra *et al.*, 2006; Hill and Cunningham, 2007; Rina and Wahida, 2008; Copeland and MacDonald, 2011; Inayat-ur *et al.*, 2013.).

CONCLUSION

It is concluded from this study that viability was best maintained during storage in seeds of the two varieties (NHAe47-4 and LD88-1) with the application of 6 t ha^{-1} of poultry droppings to mother-plants during growth. Okra seeds exhibited dormancy when freshly harvested and hydropriming for 12 hours resulted in rapid and uniform germination. However, seed longevity was significantly reduced by hydropriming.

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