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RESEARCH ARTICLE

EFFECT OF SEED PRIMING ON GERMINATION OF OKRA *(Abelmoschus esculentus var. Arka Anamika)*

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ABSTRACT

Seed priming is an effective, eco-friendly method to promote seed germination and seedling vigor of okra to overcome the reduced and delayed germination in fresh or stored okra seeds caused by seed hardness. An experiment was carried to evaluate the effects of different priming on okra seeds germination and seedling vigor using Arka Anamika variety at Horticulture lab of Agriculture and Forestry University, Rampur, Chitwan, Nepal. Investigation was carried out with 6 treatments (T_1: seed priming with tap water, T_2: seed priming with 200ppm NAA solution, T_3: seed priming with 10% PEG-200 solution, T_4: seed priming with 200ppm GA_3 solution, T_5: seed priming with 5% *Trichoderma* solution and T_6 no priming) with 4 replications in Complete Randomized Design (CRD). Seeds primed with T_1 to T_5 were soaked for 24 hours and shade dried for 6 hours before sowing. Priming with T_4 was found to be best in terms of maximum seed germination (60.12%), seed vigor index (5772.68 cm), mean germination rate (7.53 seeds per day). The highest shoot length (81.40 mm) was observed at T_1 whereas enhancement of root length occurred with the priming with T_3. All treatments had a significant positive effect on all the germination parameters in comparison to control. The study concluded that GA_3 priming enhanced germination as well as seed vigor in okra and hydro priming and tricho-priming can be used as an alternative to GA3 priming among farmers in Nepal.

KEYWORDS

Abelmoschus esculentus; okra; priming; seed germination; seed vigor.

1. INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Moench] is a native crop of Tropical Africa that belongs to the family Malvaceae. For its robust nature, dietary fibers and distinct seed protein balanced in both lysine and tryptophan amino acids; it is also called "a perfect villager's vegetable" (Kumar et al., 2010). It is an important summer vegetable of Nepal and is mainly cultivated for its tender pods and is consumed in many different forms; raw, steamed, boiled, or fried (Farinde et al., 2007; Maurya et al., 2013).

Germination is considered a critical stage in the life cycle of weed and crop plants (Radosevich et al., 1997). Genotype, sowing date, time of pod harvest, seed moisture content, and micronutrient applications affect the germination of okra seeds. (Purquerio et al., 2010; El Balla et al., 2011; Mohammadikenarmereki, 2014). Okra seeds germinate very slowly and unevenly although they are viable seeds. Reduced, delayed, and erratic emergence is a serious problem in okra cultivation caused by seed hardness as it creates problems in rapid germination and uniform field stand (Purquerio et al., 2010). The hard seed coat restricts the water imbibition and uniform growth and development of the embryo and as a result interferes with seed germination (Mereddy et al., 2015).

The problem of low germination due to the hard seed coat in okra can be overcome by seed priming. Seed priming is the process of controlled hydration of seeds which is potentially able to promote rapid and more uniform seed germination and plant growth (Sharma et al., 2014). Priming allows some of the metabolic processes necessary for germination to occur without germination taking place. Seed priming induced synchronized germination, increased seed vigor, and growth of seedlings under stressful conditions i.e. increase in germination and emergence rate (Bajehbaj, 2010). Different seed priming methods has been used to enhance germination and seed vigor of okra. Among them, Hydro-priming i.e. seed soaking in pure water and re-drying to original moisture content before sowing; Osmo-priming i.e. soaking the seed in a solution of osmoticum; Hormonal priming i.e. soaking of seeds in different plant growth regulators(GA_3, NAA, etc); halo-priming i.e. use of salt solutions for seed soaking, bio-priming i.e. seed imbibition together with biological inoculation(bacteria, fungi, etc.) of seed and solid-matrix priming i.e. seed soaking in solid medium(matrix) for controlled water uptake; are commonly used seed priming methods (Lutts et al., 2016).

The experiment aimed to study the effect of various priming treatments on the germination of okra seeds for overcoming the germination hindrance of okra seeds.

2. METHODOLOGY

2.1 Experiment design and Treatments

An experiment was carried out in the Horticulture Lab (27°38' N latitude and 84°20' E longitude) at Agriculture and Forestry University in March 2020 to evaluate the effect of different priming methods on the seed germination and seedling development of okra in Complete Randomized Design (CRD).

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The seeds of Okra [*Abelmoschus esculentus* (L.) Moench var. Arka Anamika] was used as research material. The experiment consisted of 6 treatments (Table 1) with 4 replications.

Table 1: Treatments and their concentration used in this research

	Treatment	Concentration
T_1	Hydro-Priming	
T_2	NAA-Priming	200ppm NAA solution
T_3	PEG-Priming	10% PEG-200 solution
T_4	GA_3-Priming	200 ppm GA_3 solution
T_5	*Trichoderma*-Priming	5% solution of *Trichoderma*
T_6	Control (No Priming)	

The treatment solutions were prepared and seeds were primed with respective treatments for 24 hours followed by shade drying for 6 hours. The primed seeds were then sown in a germination tray and were watered. All the replicate-trays were watered at 5 PM daily until the experiment was completed.

2.2 Data Collection

There were 42 seeds sown on each plot. The data on the number of germinated seeds was taken daily until the number of germinated seeds remains the same in two consecutive counts. The root and shoot length of seedlings was measured at the end of the germination counting day by randomly selecting 7 seedlings from each plot. SGP, SGR, MGT, SVI and AC were calculated according the Table 2 (Tompsett & Pritchard, 1998; Ranal & De Santana, 2006; Rezaie & Yarnia, 2009; Vashisth & Nagarajan, 2010).

Table 2: Formulas related to the variables related to seed germination used in this research

	Variable	Formula	References
SGP	Germination Percentage	$GP = \frac{N}{Nt} \times 100$	(Rezaie & Yarnia, 2009)
SGR	Germination Rate	$GR = \sum_{i=1}^{d} \frac{Ni}{Di}$	(Ranal & De Santana, 2006)
MGT	Mean Germination Time	$MGT = \frac{\sum(nD)}{\sum n}$	(Tompsett & Pritchard, 1998)
SVI	Seedling Vigor Index	$SVI = \frac{(SL+RL)}{2} \times G$	(Vashisth & Nagarajan, 2010)
AC	Allometric Coefficient	$AC = \frac{RL}{SL}$	(Ranal & De Santana, 2006)

Note: N (The number of germinated seeds), N_t (Number of seeds used), D (The number of days after germination), RL (Root length), SL (Shoot length), G (Ultimate germination), n(nth day), SGP (Seed Germination Percentage), SGR (Seed Germination Rate), MGT (Mean Germination Time), SVI (Seedling Vigor Index), AC (Allometric Coefficient)

2.3 Statistical analysis

Obtained data were analyzed by using MS-Excel and RStudio software and mean comparisons were done by Duncan multiple range tests (DMRT) at 0.05 level of significance.

3. Result and Discussion

3.1 Effect on the shoot and root length of seedlings

The shoot length and root length of seedlings showed significant variation with the application of various priming treatments (Table 3). The maximum shoot length (81.40 mm) was recorded in T_1, and the minimum shoot length (56.08 mm) was observed in the control condition (Fig1). Similarly, the maximum (125.03 mm) and minimum (61.43 mm) root lengths were observed in T_3 and T_2 respectively. Increment in root and shoot length were also observed by other researchers due to seed priming treatment (Dubey et al., 2007; Tian et al., 2014). Though auxin (NAA) is believed to have a certain role in the root initiation (Štefančič et al., 2005), this study showed it had an adverse effect on the root length of the seedling compared to control. Similar observations were also reported by other researchers (Sevik & Guney, 2013; Jyoti et al., 2016).

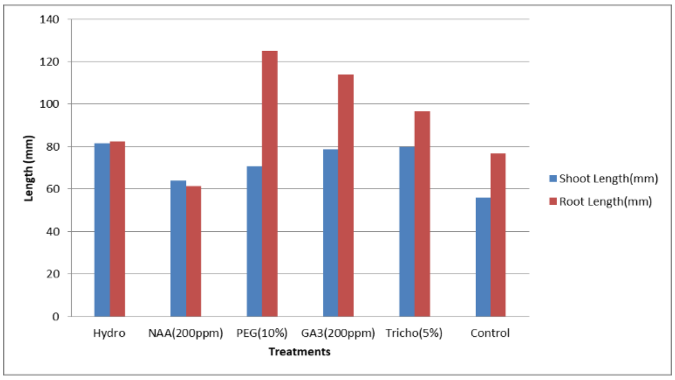

Figure 1: Effect of different priming treatments on root length and shoot length of okra seedlings.

Table 3: Effect of different seed priming on germination and its parameter.

Treatments	**Root length (mm)**	**Shoot length (mm)**	**Mean days to germination**	**Germination Percentage (%)**	**Germination Rate**	**Seed Vigor Index (mm)**	**Allometric Coefficient**
Hydro-priming	82.35^{d}	81.40^{a}	7.23^{c}	54.17^{b}	6.54^{b}	4447.26^{b}	1.01^{d}
NAA-priming (200ppm)	61.43^{e}	63.93^{cd}	9.88^{ab}	47.62^{c}	4.70^{d}	2982.65^{c}	0.96^{d}
PEG priming (10%)	125.03^{a}	70.70^{bc}	10.69^{a}	50.60^{bc}	4.09^{e}	4949.29^{b}	1.77^{a}
GA3-priming (200ppm)	113.93^{b}	78.75^{ab}	6.80^{c}	60.12^{a}	7.53^{a}	5772.68^{a}	1.45^{b}
Tricho-priming (5%)	96.63^{c}	79.85^{a}	8.89^{b}	52.98^{b}	5.56^{c}	4676.43^{b}	1.21^{c}
Control (No-priming)	76.70^{d}	56.08^{d}	8.96^{b}	34.52^{d}	2.95^{f}	2291.19^{d}	1.37^{b}
LSD (0.05)	10.41	8.11	1.10	4.20	0.57	521.48	0.15
SE_M(±)	1.42	1.11	0.15	0.58	0.076	71.35	0.02
F-probability	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
CV,%	7.53	7.58	8.44	5.64	7.30	8.34	7.52
Grand Mean	92.68	71.78	8.74	50.00	5.23	4186.58	1.30

Note: the common letter(s) within the column indicate a non-significant difference based on the Duncan multiple range test (DMRT) at 0.05 level of significance

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3.2 Effect on Seed Germination Percentage (SGP)

Statistical analysis of Figure 2 showed significant differences in treatments at $P \leq 0.05$ levels. Results showed that all seed priming treatments were found effective in enhancing the germination percentage compared to control. However, among them, the T_4 i.e. priming with 200ppm GA_3 solution showed a maximum seed germination percentage of 60.12% (Table3). T_1, T_3, and T_5 increased germination percentage but were non-significant among themselves (LSD=4.09). Generally, seed germination occurs in three phases: imbibition, lag phase, and radicle growth and emergence. The lag phase is prolonged due to seed priming so that pre-germination physiological and biochemical processes take place which keeps the seed from germination. In agreement with other researchers, our result also marked a notable increase in germination percentage on account of seed priming (Muhammad & Shik Rha, 2007; Mohammadi et al., 2014; Oliveira et al., 2019).

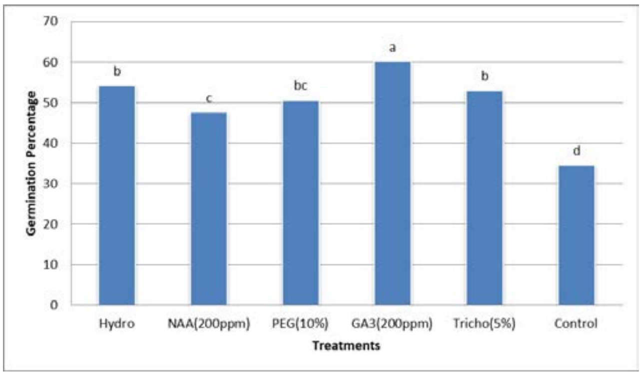

Figure 2: Effect of different priming treatments on germination percentage of okra seeds.

3.3 Effect on Germination Rate (GR) and Mean Germination Time (MGT)

The germination rate and mean germination time varied with different treatments significantly ($p<0.05$). The maximum germination rate of 7.53 seeds/day was observed in the 4th treatment (T_4) and the minimum germination rate was 2.95 seeds/day in control. Similarly, mean germination time was found lowest for the 4th treatment (T_4) i.e. 6.80 days, and highest for the 3rd treatment (T_3) i.e. 10.69 days. The endosperm is rapidly utilized for the synthesis of various amino acids and amides in GA3 treated seeds (Gupta & Mukherjee, 1982), which could be the cause for the elevated germination rate and reduced mean germination time in T_4. A highly significant ($P \leq 0.01$) negative correlation ($r = -0.675^{**}$) was found between GR and MGT representing a trend of increase in Mean Germination Time (MGT) with a decrease in Germination Rate (GR) (Figure3).

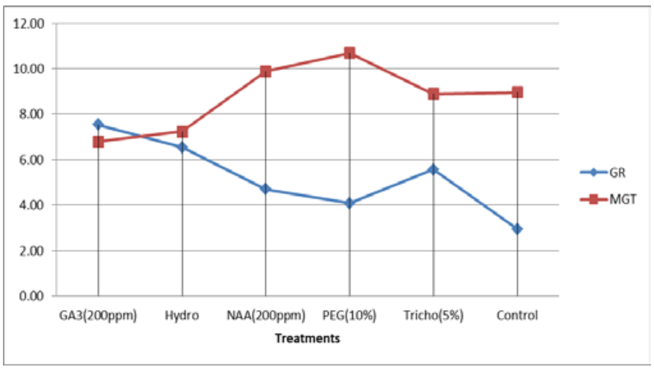

Figure 3: Effect of different priming treatments on germination rate and mean germination time of okra seeds.

3.4 Effect on Seed Vigor Index (SVI)

Significant variations were observed due to various seed priming treatments as compared to the control group on seed vigor index (Table 3). T_4 (200ppm GA_3 priming) showed a greater influence on seed vigor index, and the germination rate was slightly elevated in T_1, T_3, and T_5 when compared with other treatments. The maximum seed vigor index was found 5772.68 in the 4th treatment (T_4) and minimum SVI was found 2291.19 in control (Figure 4). Correlation between SVI and GP was found positive ($r = 0.885^{**}$) and highly significant ($P \leq 0.01$). The enhancement in seed vigor in primed seeds might be due to low membrane injury coupled with high enzyme activities (dehydrogenase and amylase) (Pandey et al., 2017). The enhancement in seed vigor index due to seed priming holds close conformity to other researchers (Maiti et al., 2011; Tania & Rhaman, 2020).

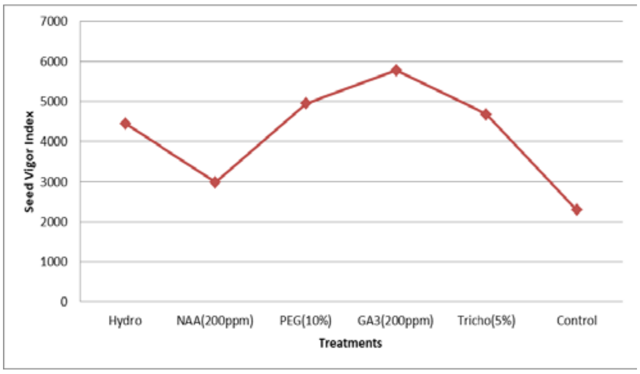

Figure 4: Effect of different priming treatments on the Seed Vigor Index of okra seeds

3.5 Effect on Allotropic Coefficient (AC)

A significant effect was reported in the AC value at a 5% level of significance due to the seed priming treatments according to our research. The lower AC value suggests that root growth was lower than the shoot growth; also, it means that plumule/shoot is more receptive to seed priming than the radicle/root. Similarly, a higher AC value suggests that seed priming has a productive impact on radicle or root growth in comparison to plumule or shoot because AC is resulting from root length/shoot length. The maximum AC value observed was 1.77 in the 3rd treatment(T_3) and the minimum AC value observed was 0.97 in the 2nd treatment (T_2) (Figure 5).

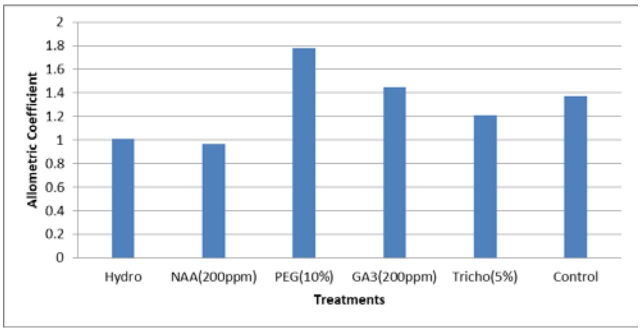

Figure 5: Effect of different priming treatments on Allotropic Coefficient of okra seedlings.

4. Conclusion

Priming of okra seeds might be the best option to overcome the reduced and delayed germination in fresh or stored okra seeds caused by seed hardness. Priming of seed before sowing facilitates the plant growth and development and its yield. Okra seed priming with different treatments on seed germination and seedling vigor revealed that the GA_3 priming was better than any other treatment whereas hydro priming and tricho-priming can be used as an alternative to GA_3 priming. So, seed priming is a useful technique for improving the germination percentage, germination rate, seedling growth, mean germination time and tolerant to different abiotic and biotic factors. However, further research needs to be done to know the impact of seed priming on the morphological characters and yield of okra.

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