Turkish Journal of Agriculture - Food Science and Technology, 8(8): 1686-1691, 2020
DOI: https://doi.org/10.24925/turjaf.v8i8.1686-1691.3460

Turkish Journal of Agriculture - Food Science and Technology

Available online, ISSN: 2148-127X | www.agrifoodscience.com | Turkish Science and Technology

Effect of Primed and Un-Primed Seeds on Germination, Growth Performance and Yield in Okra [*Abelmoscus esculentus* (L.) Moench]

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A R T I C L E I N F O

Research Article

Received : 25/03/2020
Accepted : 28/06/2020

Keywords:
Okra
Priming
Germination
Yield
Growth

A B S T R A C T

This research was conducted to overcome the problem of slow and erratic emergence in okra and to find out the effects of priming on germination, growth performance and yield in okra at Research Field of Nepal Polytechnic Institute (NPI) Bharatpur-11, Chitwan, Nepal (April-July, 2019). Arka Anamika variety was used for experiment. The experiment was laid out in Randomize Complete Block Design with 5 treatments and 4 replications, i.e. T1 (hormonal priming with IBA), T2 (hydro priming with fresh tap water), T3 (halo priming with NaCl), T4 (chemo priming with liquid urea) and T5 (un-primed seeds). Field experiment results showed that priming proved effective in improving germination percent except the chemo priming, reducing the mean germination time (MGT), improving the growth parameters (plant height, number of branches, plant canopy and number of leaves) and improving yield contributing characters like fruit length, fruit diameter as compared to un-primed seeds. The highest and lowest germination percentages were found in hydro priming and hormonal priming respectively while better growth performance in hormonal and chemo priming. Similarly, hormonal and hydro priming resulted in higher yield. Hence, it is suggested that seed priming is important to improve the overall germination, growth performance and yield in okra.

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Introduction

Okra (*Abelmoschus esculentus* L.) is one of the most widely known dicotyledonous plants and utilized species of the family Malvaceae (Naveed et al., 2009) which is a tropical vegetable crop that grows up to 1.0-2.1 meters tall. The edible part of okra is the immature pod, which is harvested when tender and it is a warm season crop, requiring ample moisture for germination (Peet, 1992).

Different strategies related to improve the growth and development of plants have been investigated from many years. Among these, seed priming is universally used innovative technique to improve quality of seeds. Seed priming is a controlled hydration process followed by re-drying that allows seeds to imbibe water and begin internal biological processes necessary for germination; however which does not allow the seed to actually germinate. The priming process gives the seed a "head-start" at germination and emergence when planted in the soil (Glen and Wiltshire, 1988). It is a simple, low cost and effective approach for early seedling growth and yield under stressed and non-stressed conditions. Priming allows some of the metabolic processes to occur necessarily for germination before actual germination to get start. Priming triggers the synthesis or activation of some enzymes (protease, amylase and lipase) that catalyze the mobilization of storage reserves in seed, while endosperm weakens by hydrolase activities (Farooq et al., 2008).

The main purpose of the study was to test different priming techniques in okra seeds before sowing and analyze them in terms of growth performance and yield of plants. At the end of study, the best technique found is planned to be recommended to the farmers.

Materials and Methods

Experimental Site

This study was carried out at Nepal Polytechnic Institute (NPI) Research Field, Bharatpur-11, Chitwan, Nepal during between April and July of 2019. The geographic location of experimental site was at elevation of 256 meter above sea level.

Experimental Design

The experiment was laid out in Randomize Complete Block Design (RCBD) with 5 treatments and 4 replications. Detailed information about the experiment was presented in Table 1 and Table 2.

Table 1. Treatment details used in experiment

Table 1. Treatment details used in experiment

Serial Number	Treatments	Notations	Priming agents	Soaking duration (hours)
1	Hormonal priming	T1	IBA	24
2	Hydro priming	T2	Fresh tap water	24
3	Halo priming	T3	NaCl solution	24
4	Chemo priming	T4	Liquid urea	24
5	Control (un-primed)	T5	None	0

Table 2. Details of layout

1. Design: RCBD	7. Plot size: 1.8 m×2 m (3.6 m^2)
2. Name of crop: Abelmoschus esculentus	8. Total plot area: (10.7×14) m^2
3. Variety: Arka anamika	9. Row to row distance: 50 cm
4. No. of replications: 4	10. Plant to plant distance: 30 cm
5. No. of treatments: 5	11. Total number of plants / plot: 24
6. Total number of plots: 5×4 (20)	12. Sowing date: 16^{th} April, 2019

Priming of Seeds

Arka Anamika variety of okra purchased from "Sahayogi Agro Vet" (Sahidchok, Narayangarh, Nepal) was used for the experiment. The seeds were hand sorted to eliminate broken and damaged seeds. Twenty gram (20 g) of seeds was weighed for each treatment. For hormonal priming, 5 g of IBA powder was weighed and 10 mL of ethyl alcohol was added to it in beaker to dissolve the powder. Then, 100 mL of water was added to it and seeds were soaked in the solution for 24 hours following air dried for over-night. Hydro priming was performed by soaking the seeds in fresh tap water for 24 hours following air dried for over-night. For halo priming, 10 g of NaCl was mixed in 100 mL of tap water to prepare salt solutions to which the seeds were soaked for 24 hours and left air dried for over-night. For chemo priming, 10 g of urea ball was added to 100 mL of water in a beaker to which the seeds were soaked for 24 hours following the air dried for over-night. The dried seeds were used as controlled (un-primed) seeds.

Agronomic Practices

The land was ploughed and harrowed to bring to fine tilt and leveling was done. Single Super Phosphate (SSP) and Murat of Potash (MOP) were applied as the source of nitrogen, phosphorus and potassium respectively to meet the recommended dose of Nitrogen-Phosphorus-Potassium (NPK) for okra cultivation (i.e. 200:180:60 kg ha^{-1}). The primed seeds were sown on 16^{th} April, 2019 using local dibbling stick to make holes. Seeds were sown as 2 seeds per hole at the depth of 5cm. Necessary agricultural practices (thinning, weeding, irrigation) were done through the cropping season for proper growth and development of the plant. Four plants tagged with thread, one from each row in all the plots were taken as sample plants.

Data Collected

Various data sets were obtained from measurements done for a number of traits. The following data were collected.

Germination Percent

Each treatment was observed every day for emergence of seedling from date of sowing until complete emergence. The number of seedlings germinated per plot on that day was counted and recorded and germination percent was calculated according to the formula presented below.

$$\text{GP}=\frac{\text{Total number of seeds emerged}}{\text{Total number of seeds sown}}\times 100$$

Mean of Germination Time

Each treatment was observed every day for emergence of seedling from date of sowing until complete emergence. Similarly number of seedlings germinated on a particular day was recorded and mean of germination time was calculated using formula presented below.

$$\text{MGT}=\frac{\sum(\text{T1n1+T2n2+T3n3+Tknk})}{\sum(\text{n1+n2+n3+nk})}$$

n = Number of new germinated seed

T = Time from the beginning of the experiment (days)

Plant Height

Plant height was measured from the ground level to the tip of the last leaf on sample plant by a scale at 25, 40, 55 and 70 days after sowing (DAS). The average height was computed and expressed as m.

Number of Leaves Per Plant

Numbers of leaves were counted from 4 tagged plants (sample plants) at 25, 40, 55 and 70 days after sowing (DAS). All the leaves of each sample plant were counted separately. Only smallest young leaves of the plant were excluded from counting.

Number of Branches Per Plant

Number of branches from the sample plants was counted at 40, 55, and 70 days after sowing (DAS). All the branches of selected plants were counted separately.

Plant canopy per plant

Lengths of the alternate leaves were measured with the help of a scale to record the data on plant canopy of plant. Plant canopy was measured in centimeter (cm) by a scale at 25, 40, 55 and 70 days after sowing (DAS).

Fruit Length

At the time of each harvesting, 4 fruits from all replications were collected randomly and their length was measured with the help of scale. The average was calculated and expressed in cm.

Fruit Diameter

At the time of harvesting, same fruits which were used for measurement of fruit length were used for calculating of fruit diameter. The diameter of the fruit was measured at the center of fruit with the help of vernier-caliper and average was calculated in mm.

Fruit Yield

Fruit yield was recorded from two middle rows at three days interval. The obtained fruits were weighed with the help of weighing balance. The recorded data were then summed and expressed in ton ha^{-1}.

Statistical Analysis

The recorded data was systematically arranged in Ms-Excel which was used for simple statistical analysis, constructing graphs and tables. The compiled data were subjected to analysis of variance (ANOVA) using Gen-stat statistical package 15th edition. ANOVA was constructed and significant data were subjected to DMRT for mean separation with reference to Gomez and Gomez (1984).

Results and Discussion

Germination Percent

The data on germination percentage as influenced by the primed and un-primed seeds have been presented in Table 3. Analysis of the data revealed that germination percentage of okra was significantly ($P<0.001$) influenced by primed and un-primed seeds. The highest germination percentage was found in hydro primed seeds (84.38%) which were statistically at par with hormonal primed seeds (82.29%). Primed seeds (except chemo primed seeds) resulted into higher germination percentage as compared to un-primed seeds.

The possible reason for improved germination through priming may be due to that during seed priming extensive biochemical changes i.e. dormancy breakage, metabolism or hydrolysis of inhibitors, enzymes activation and imbibition occur that are critical for seed germination (Ajouri et al., 2004). The finding that priming improved percent germination is in line with Arif et al. (2008) who had reported that priming improved germination process in crop seed.

Mean of Germination Time (MGT)

The results on the effect of primed and un-primed seeds on the mean germination time have been presented in Table 4. Mean germination time was significantly ($P<0.01$) influenced by primed and unprimed seeds. Significantly minimum MGT was found in hormonal primed seeds (9.337 days), whereas the maximum MGT was found in un-primed seeds (12.590 days). Priming reduced significantly mean germination time (MGT) over un-primed seeds.

Varierf et al. (2010) reported that priming activate and synthesize hydrolytic enzymes e.g. lipases, amylases and proteases which mobilize storage materials in seed. On rehydration quick emergence take place because all pre-germinated processes had already taken place. Similar results were shown by Farooq et al. (2008) reported that seed priming decreased the germination time that may allow the seedling to escape from deteriorating soil.

Plant Height

The results pertaining to the effect of primed and un-primed seeds on plant height have been presented in Table 5. Analysis of the data revealed that plant height per plant of okra was significantly influenced by primed and un-primed seeds at 25 DAS, 40 DAS, 55 DAS and 70 DAS. Primed seeds resulted into higher plant height as compared to un-primed seeds. The highest plant height was determined in hormonal primed seeds whereas the lowest plant height was determined in un-primed seeds.

Mohammadi (2009) and Bakare and Ukwungwu (2009) have reported that seed priming causes increase in plant height. This can be explained on the basis of emergence. Plants from unprimed seed may take more days to emergence than primed seed which may result in above ground age difference and this above ground age difference may cause difference in plant height. Shah et al. (2011) reported that primed seeds gave maximum plant height in okra, which is also in agreement with our result.

Table 3. Effect of primed and un-primed seeds on emergence (germination %) of okra

Treatments	Germination (%)
Hormonal	82.29^{a}
Hydro	84.38^{a}
Halo	78.13^{a}
Chemo	48.96^{c}
Control (un-primed)	69.79^{b}
SEm (±)	2.013
LSD (0.05)	6.202
CV%	5.5
Grand mean	72.71
Significance level	***

Table 4. Effect of primed and un-primed seeds on mean germination time (days) of okra

Treatments	MGT (days)
Hormonal	9.337^{d}
Hydro	10.10^{c}
Halo	11.61^{b}
Chemo	9.592^{cd}
Control (un-primed)	12.590^{a}
SEm (±)	0.1841
LSD (0.05)	0.5674
CV%	3.5
Grand mean	10.646
Significance level	***

Table 5. Effect of primed and un-primed seeds on plant height of okra

Treatments	Plant height (m)			
	25 DAS	40 DAS	55 DAS	70 DAS
Hormonal	0.2125^{a}	0.4769^{a}	0.876^{a}	1.180^{a}
Hydro	0.1725^{c}	0.4244^{b}	0.761^{ab}	1.106^{ab}
Halo	0.1600^{d}	0.4025^{b}	0.724^{b}	1.059^{bc}
Chemo	0.1950^{b}	0.4300^{b}	0.871^{a}	1.30^{ab}
Control	0.1450^{e}	0.3687^{c}	0.716^{b}	1.008^{c}
SEm (±)	0.00332	0.01041	0.0408	0.0283
LSD (0.05)	0.1024	0.03207	0.1257	0.0872
CV%	3.8	4.9	10.3	5.2
Grand mean	0.1770	0.4205	0.789	1.097
Significance	***	***	*	**

Number of Leaves Per Plant

The results on the effect of primed and unprimed seeds on number of leaf per plant have been presented in Table 6. Analysis of the data revealed that number of leaves per plant of okra was significantly influenced by primed and un-primed seeds at 25 DAS, 40 DAS, 55 DAS and 70 DAS. Primed seeds resulted into maximum number of leaves per plant as compared to un-primed seeds. Maximum number of leaves per plant was found in hormonal primed seeds whereas the minimum number of leaves per plant was found in un-primed seeds. Basra et al. (2003) reported that priming increases number of tillers and leaves in different crops. They correlated these improvements with faster and uniform emergence and better seedling vigour and growth of primed seeds, which is in line with our findings.

Plant Canopy Per Plant

The results pertaining to the effect of primed and unprimed seeds on leaf canopy of plant have been presented in Table 7. Analysis of the data revealed that number of plant canopy of okra was significantly influenced by primed and un-primed seeds at 25 DAS, 40 DAS, 55 DAS and 70 DAS. Primed seeds resulted into maximum plant canopy as compared to un-primed seeds. Maximum plant canopy was found in hormonal primed seeds whereas the minimum plant canopy was determined in un-primed seeds.

The results are in agreement with Farooq et al. (2008). Plants from unprimed seeds may take more days to emergence than primed seed which may result in above ground age difference and this above ground age difference may cause difference in plant canopy.

Number of Branches Per Plant

The results pertaining to the effect of primed and un-primed seeds on number of branches per plant have been presented in Table 8. Analysis of the data revealed that number of branches per plant of okra was significantly influenced by primed and un-primed seeds at 40 DAS, 55 DAS and 70 DAS. Primed seeds resulted into maximum number of branches per plant as compared to un-primed seeds. Maximum number of branches per plant was found in hormonal primed seeds whereas the minimum number of branches per plant was found in un-primed seeds.

These findings are also in agreement with results reported by Shah et al. (2011) who stated that primed okra seeds gave higher number of branches per plant. This may be due to early emergence in primed seeds which resulted early growth and increase in number of branches.

Fruit Length

The data on fruit length as influenced by the primed and un-primed seeds have been presented in Table 9. Analysis of the data revealed that fruit length of okra was significantly ($P<0.001$) influenced by primed and un-primed seeds. Primed seeds resulted into higher fruit length as compared to un-primed seeds. The highest fruit length was detected in hormonal primed seeds (19.459 cm) whereas the lowest fruit length was found in un-primed seeds (17.363 cm).

The results are in agreement with Rashid et al. (2002) who reported an increase in ear length of primed seeds in wheat. This may be due to accumulation of more dry matter content due to healthy crop growth which leads to increase in fruit length (Aravindkumar et al., 1991).

Table 6. Effect of primed and un-primed seeds on number of leaves per plant of okra

Treatments	Number of leaf			
	25 DAS	40 DAS	55 DAS	70 DAS
Hormonal	7.312[a]	19.42[a]	35.62[a]	55.44[a]
Hydro	6.562[b]	17.06[c]	31.88[b]	54.56[a]
Halo	6.625[b]	15.94[d]	28.69[d]	49.19[b]
Chemo	6.938[ab]	18.06[b]	33.56[b]	54.56[a]
Control	6.00[c]	13.81[e]	26.12[e]	49.00[b]
SEm (±)	0.1326	0.255	0.380	1.243
LSD (0.05)	0.4085	0.785	1.180	3.829
CV%	4.0	3.0	2.5	4.8
Grand mean	6.688	16.86	31.18	52.25
Significance	***	***	***	**

Table 7. Effect of primed and un-primed seeds on plant canopy per plant of okra

Treatments	Canopy (m)			
	25 DAS	40 DAS	55 DAS	70 DAS
Hormonal	0.2388[a]	0.477[a]	0.856[a]	0.8940[a]
Hydro	0.2169[b]	0.415[abc]	0.712[b]	0.8106[b]
Halo	0.2038[c]	0.397[bc]	0.669[b]	0.8025[bc]
Chemo	0.2213[b]	0.445[ab]	0.724[b]	0.8481[ab]
Control	0.1831[d]	0.367[c]	0.654[b]	0.7431[c]
SEm (±)	0.00330	0.0231	0.0265	0.01928
LSD (0.05)	0.01016	0.0712	0.818	0.05941
CV%	3.1	11.0	7.3	4.7
Grand mean	0.2128	0.420	0.723	0.8199
Significance	***	*	**	**

Table 8. Effect of primed and un-primed seeds on number of branches per plant of okra

Treatments	Number of branches		
	40 DAS	55 DAS	70 DAS
Hormonal	3.75[a]	4.562[ab]	6.188[ab]
Hydro	3.06[ab]	4.250[b]	5.812[b]
Halo	2.94[b]	4.188[b]	5.312[c]
Chemo	3.81[a]	4.688[a]	6.625[a]
Control	2.50[b]	3.688[c]	4.875[c]
SEm (±)	0.234	0.1186	0.1552
LSD (0.05)	0.721	0.3654	0.4782
CV%	14.6	5.5	5.4
Grand mean	3.21	4.275	5.763
Significance	**	***	***

Table 9. Effect of primed and un-primed seeds on fruit length of okra

Treatments	Fruit length (cm)
Hormonal	19.459[a]
Hydro	18.615[b]
Halo	18.306[b]
Chemo	18.435[b]
Control (un-primed)	17.363[c]
SEm (±)	0.1826
LSD (0.05)	0.5625
CV%	2.0
Grand mean	18.436
Significance level	***

Fruit Diameter

The results pertaining to the effect of primed and un-primed seeds on fruit diameter have been presented in Table 10. Analysis of the data revealed that fruit length of okra was significantly (P<0.001) influenced by primed and un-primed seeds. Primed seeds resulted into higher fruit diameter as compared to un-primed seeds. The highest fruit diameter was found in hormonal primed seeds (20.240 mm) which was statistically at par with chemo primed seeds (20.088 mm) whereas the lowest fruit diameter was determined in un-primed seeds (18.093 mm).

Fruit Yield

The results pertaining to the effect of primed and un-primed seeds on fruit yield have been presented in Table 11. Analysis of the data revealed that fruit yield was significantly (P<0.001) influenced by primed and un-primed seeds. The highest fruit yield was found in hormonal primed seeds (17.74 ton ha^{-1}). Primed seeds resulted into higher fruit yield (except chemo primed seeds) as compared to un-primed seeds. The highest fruit yield was found in hormonal primed seeds (17.74 ton ha^{-1}).

Seed priming with hormones and tap water had generally encouraged smooth germination over controlled and other priming treatments due to which more yield was obtained from plants raised from hormonal and hydro primed seeds. Bakht et al. (2010) reported that priming agents affect the yield of crops which is also in agreement with our results. The results are also in conformity with some studies carried out in hot pepper (Dabrowska et al., 2005), in maize (Harris et al., 1999), in wheat (Rashid et al., 2002) and in okra (Sharma et al., 2014). They reported that increase in fruit yield may be due to early emergence, higher total emergence, increase in fruit weight and more number of fruit per plant.

Table 10. Effect of primed and un-primed seeds on fruit diameter of okra

Treatments	Fruit diameter (mm)
Hormonal	20.240[a]
Hydro	19.224[b]
Halo	18.606[c]
Chemo	20.088[a]
Control (un-primed)	18.093[c]
SEm (±)	0.1970
LSD (0.05)	0.6072
CV%	2.0
Grand mean	19.250
Significance level	***

Table 11. Effect of primed and un-primed seeds on fruit yield of okra

Treatments	Yield (ton ha^{-1})
Hormonal	17.74[a]
Hydro	15.67[b]
Halo	13.63[c]
Chemo	9.82[d]
Control (un-primed)	11.50[d]
SEm (±)	0.596
LSD (0.05)	1.836
CV%	6.9
Grand mean	17.31
Significance level	***

Conclusion

It has been concluded from this research work that seed priming treatments resulted in increase in germination (except chemo priming) and decrease in mean of germination time (MGT) as compared to un-primed seeds. Among the priming treatments, hydro priming and hormonal priming increased the germination while hormonal priming and chemo priming significantly decreased MGT. Similarly various growth parameters (plant height, number of leaves, plant canopy and number of branches) were enhanced by primed seeds than un-primed seeds. Hormonal priming, chemo priming and hydro priming significantly enhanced growth parameters. Similarly, it was found that seed priming increased fruit yield and yield contributing characters such as fruit length and fruit diameter. It was revealed that hormonal priming and hydro priming enhanced the fruit yield and yield contributing characters as compared to other priming treatments and un-primed seeds. In this study, it is concluded that although hormonal priming and hydro priming were found to be best seed priming methods in terms of germination and yield, hydro priming method may be suggested to the farmers as it is simple and cheap technique compared to other priming techniques.

Acknowledgement

I would like to convey my sincere gratitude, appreciation and thanks to Nepal Polytechnic Institute for supporting in my research. I am thankful to our research team, Program coordinator & Dr. Nawaraj Devkota sir for their regular support, guidance and suggestions throughout my research and preparation for this manuscript. I also owe my gratitude to my parents, friends and all helping hands for their moral and spiritual support.

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