Research Article

Effect of seed priming on growth parameters of Okra (*Abelmoschus esculentus* L.)

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Abstract

To study the effect of seed priming on growth parameters of okra, a field experiment was conducted in 2013. For this experiment, seeds were primed in PEG-8000 (polyethylene glycol) and Mannitol solutions having 0, -0.4, -0.8, -1.2, -1.6, -2 and -2.4 Mpa osmotic potential while dry seeds were used as control. Randomized complete block design (RCBD) with two factors and sixteen treatments replicated three times was used for this experiment. Field experiment results showed that days to flowering, days to edible maturity, plant height, absolute growth rate and relative growth rate were unaffected by priming agents but significantly affected by osmotic potential, reduction in days to flowering and days to edible maturity occurred as osmotic potential increased from -2.4 to 0 Mpa. Maximum absolute growth rate was recorded at -1.2 Mpa osmotic potential. Significantly lowest plant height was recorded for plants raised from unprimed seeds followed by plants raised from seeds primed at lowest osmotic potential i.e at -2.4 and -2 Mpa osmotic potential respectively while highest plant height was recorded for -1.2 Mpa and above this osmotic potential. Highest relative growth rate was recorded for plants grown from unprimed seeds and seeds primed at lower osmotic potential while lowest relative growth rate was observed for plants raised from seeds which were primed at higher osmotic potential.

Keywords: Okra; Polyethylene glycol 8000; Mannitol; Osmotic potential; Seed priming

Introduction

Seed priming is a pre-sowing seed treatment in which seed is allowed to imbibe enough water to start pregerminative metabolic processes but insufficient for radicle protrusion because with radicle protrusion seed loses its desiccation tolerance [1]. After

hydration, treated seeds are dried back to their initial moisture content. This drying back process is called hydration dehydration and is practiced to minimize deterioration in seed during storage. Priming improves seed germination performance by starting early processes of germination but not cell

division [2]. Metabolism that occurs during priming is not enough to cause radicle emergence.

In the two types of seed priming, in one type water penetrate freely into seed which is called hydropriming while in other type seed hydration is controlled. If controlled hydration is achieved through the addition of solute to water then it is called osmopriming or if a solid matrix is used to provide controlled seed hydration then it is called solid matrix priming [3].

Seed priming improves germination performance of seed [3, 4]. Osmopriming strengthens the antioxidant system and increase seed germination potential, resulting in an increased stress tolerance in germinating seeds [5]. Response of seed to priming is affected by priming duration [5], osmotic potential of priming solution [6], priming agent [7] and oxygen supply to seed [8]. Priming also cause early flowering [9, 10], enhances growth rate [11-13] and increase plant height [12, 14].

Okra seeds contain proteins, unsaturated fattyacids, vitamin B6, folic acid, fibre and relatively low amount of copper, iron, manganese and zinc [15]. According to USDA Nutrient database, per 100 gm of okra contain 7.03 g carbohydrates, 1.20 g sugars, 3.2 g dietary fiber, 0.10 g fat, 2 g protein, 90.17 g water and 129 KJ energy.

Main problem in okra is slow growth and unsynchronized flowering and maturity. So the main goal of this research work was to overcome this problem through seed priming and to optimize osmotic potential and priming agent for okra seed priming.

Materials and methods

This experiment was conducted during 2013 at Agricultural Research Farm of Khyber Pukhtunkhwa Agricultural University, Peshawar (Pakistan). The experimental site was located at 34° N, 71.3° E and an altitude of 317 m above sea level. Soil of the experimental field was silty clay loam, low

in nitrogen (0.03-0.04%), low in organic matter (0.7-0.9%) and alkaline in reaction (pH 7.3-7.5). Seeds were primed in PEG 8000 and Mannitol solutions having osmotic potential 0, -0.4, -0.8, -1.2, -1.6, -1.2 and -2.4 Mpa while dry seeds were used as control. After priming, the seeds were rinsed with water and then dried to initial moisture content at room temperature. After drying, 100 seeds of each treatment were sown on 20th April, 2013 in well prepared plots of 6.75 m² with seed to seed distance of 15 cm and row to row distance of 45cm. Weeding was done twice and the field was irrigated four times. Osmotic potentials of priming solutions were determined according to [15]. Aquarium pump was used for adequate supply of oxygen to the priming solution. The experiment was laid out in Randomized Complete Block Design (RCBD), with two factors for analyzing 16 treatments replicated three times (Two priming agents with seven levels of each while dry seeds were used as the eighth level). Data were recorded on the following parameters.

Days to flowering

Days to flowering were determined from date of sowing to date of flowering.

Days to maturity

Like days to flowering days to maturity were determined from date of sowing to date of maturity.

Plant height in cm

For plant height determination four plants were randomly selected in each plot after 80 days of sowing and plant height of each plant was noted from which average plant height was calculated.

Absolute growth rate (AGR)

It was determined from the dry matter content of plant through the following formula:

$$AGR = \frac{W_2 - W_1}{T_2 - T_1}$$

Relative growth rate (RGR)

$$RGR = \frac{\ln W_2 - \ln W_1}{T_2 - T_1}$$

Where

W_1 = 1st weight
 W_2 = 2nd weight
 $\ln W_1$ = natural log of 1st weight
 $\ln W_2$ = natural log of 2nd weight
 T_1 and T_2 , show 1st and 2nd time.

Results

Seed priming effect on days to flowering

Statistical analysis of the data indicated that osmotic potential significantly ($P \leq 0.05$) affected earliness to flowering while insignificant effect was found for priming agents and their interaction with osmotic

potential.

Table 1 represents data on days to flowering as a function of priming versus dry seeds. Statistically plants raised from sowing dry seeds took maximum days (36.1) to flowering. It was statistically similar to those plants raised from seeds primed at -2 and -2.4 Mpa osmotic potential. Priming with just water (0 Mpa osmotic potential) has enhanced flowering by two days as compared to dry seeds and seeds primed at lowest osmotic potential.

Table 1. Days to flowering as affected by seed priming

Priming Agent	Osmotic potential								Mean
	0 Mpa	-0.4 Mpa	-0.8 Mpa	-1.2 Mpa	-1.6 Mpa	-2 Mpa	-2.4 Mpa	Unprimed	
PEG	34	35	35.3	35.3	34.6	36.3	36	36	35.33
Mannitol	34.6	35	35.6	35.6	35.6	35.6	36.3	36.3	35.62
Mean	34.3 C	35 bc	35.5 ab	35.5 Ab	35.1 B	36 A	36.1 a	36.1 a	

LSD at 5% level of probability for osmotic potential =0.78

Days to edible maturity as affected by seed priming

It is evident from the data in Table 2 that priming agents and their interaction with osmotic potential had non-significant effect on days to maturity whereas osmotic potential had significant ($P \leq 0.05$) effect on days to maturity.

Table 2 represents data on number of days from seed sowing to first pod harvest.

Overall, it took 41 to 44 days to first pod harvest. Sowing dry seeds took 43.6 days to pods harvest compared to priming with pure water which took 40.8 days. Effect of osmotic potential from -1.2 to -2.4 Mpa is at par with unprimed seed. The difference of a day or two to first pod harvest may not be important to small farmers but may have a big difference for commercial farmers.

Table 2. Days to maturity as affected by seed priming

Priming Agent	Osmotic potential								Mean
	0 Mpa	-0.4 Mpa	-0.8 Mpa	-1.2 Mpa	-1.6 Mpa	-2 Mpa	-2.4 Mpa	Unprimed	
PEG	40.6	42.3	41.6	42.6	42.6	43.3	43.6	43.3	42.54
Mannitol	41	42	43	43	43	43.3	43.3	44	42.83
Mean	40.8 C	42.1 B	42.3 b	42.8 ab	42.8 ab	43.3 A	43.5 A	43.6 a	

LSD at 5% level of probability for osmotic potential=0.84

Plant height (cm) as affected by seed priming

Statistical analysis of the data revealed that osmotic potential of the priming solution significantly ($P \leq 0.05$) affected plant height but no significant effect of priming agents and its interaction with osmotic potential was found on plant height.

Table 3 represents data on plant height as affected by priming okra seed versus sowing dry seeds. Increase or decrease in plant height is a complex phenomenon and is a result of cumulative effects of many factors, planting densities, light, plant growth pattern, availability of nutrients and age play their role in increase or decrease in plant

height.

In our experiment (Table 3), plants raised from dry seeds had attained significantly less height at the 80th day as compared to other treatments. This period of 80 days starts from date of sowing the seeds. Plants in other treatments grew comparatively taller. Irrespective of the priming agents (PEG and Mannitol), Plants raised from seeds primed with PEG or Mannitol solutions at 0 to -1.2 Mpa osmotic potential, had attained statistically maximum plant height. Priming seeds with solution having -2 Mpa or below osmotic potential had resulted in dwarf okra plants.

Table 3. Okra plant height (cm) as affected by seed priming

Priming Agent	Osmotic potential								
	0 Mpa	-0.4 Mpa	-0.8 Mpa	-1.2 Mpa	-1.6 Mpa	-2 Mpa	-2.4 Mpa	Unprimed	Mean
PEG	92.04	91.74	91.43	94.48	89.91	88.39	84.73	78.02	88.84
Mannitol	92.04	91.74	92.35	94.45	92.96	85.34	82.29	76.60	88.47
Mean	92.04 ab	91.74 ab	91.89 ab	94.47 a	91.43 b	86.86 c	83.51 d	77.31 e	

LSD at 5% level of probability for osmotic potential=2.95

Absolute growth rate (AGR) of Okra plant as affected by seed priming

Statistical analysis of the data (Table 4) indicated that priming agents and their interactions with osmotic potential had insignificant effect on absolute growth rate whereas osmotic potential had significant ($P \leq 0.05$) effect on absolute growth rate (Dry matter production plant⁻¹ day⁻¹).

Data in Table 4 regarding the effect of osmotic potential on absolute growth rate

(AGR) showed that significantly higher absolute growth rate of 0.92 to 1.01 g was recorded for osmotic potential from 0 to -1.2 Mpa as compared to other treatments. It was followed by 0.79 and 0.67g AGR under osmotic potential of -1.6 and -2 Mpa respectively while the least absolute growth rate of 0.52g was observed for plants from unprimed seeds which were statistically at par with the AGR of plants from seeds primed at -2.4 Mpa osmotic potential.

Table 4. Absolute growth rate of Okra plant as affected by seed priming (gm)

Priming Agent	Osmotic potential								
	0 Mpa	-0.4 Mpa	-0.8 Mpa	-1.2 Mpa	-1.6 Mpa	-2 Mpa	-2.4 Mpa	Unprimed	Mean
PEG	.96	.95	.93	1.05	.81	.68	.50	.51	.80
Mannitol	.96	.90	.91	.97	.77	.67	.61	.53	.79
Mean	.96 a	.92 a	.92 a	1.01 a	.79 b	.67 c	.55 d	.52 d	

LSD at 5% level of probability for osmotic potential=0.09

Relative growth rate (RGR) of Okra plant as affected by seed priming

It is evident from statistical analysis of the data relating to RGR that osmotic potential significantly ($P \leq 0.05$) affected RGR while priming agents and its interaction with osmotic potential had insignificant effect on RGR.

Table 5 represent data on Relative growth rate, which here mean per day increment (expressed in milligrams) for a gram of plant

dry weight. The figures represented in Table 5 are mathematical manipulation of actual data represented in Table 5.

Plants from unprimed seeds have maximum relative growth rate (RGR) compared to plants from seeds primed with solution at higher osmotic potential. Plants from seeds primed with solution at -2 to -2.4 Mpa osmotic potential have statistically similar behavior to those from unprimed seeds.

Table 5. Relative growth rate of okra plant in mg

Priming Agent	Osmotic potential								Mean
	0 Mpa	-0.4 Mpa	-0.8 Mpa	-1.2 Mpa	-1.6 Mpa	-2 Mpa	-2.4 Mpa	Unprimed	
PEG	44.35	45.47	44.55	44.10	44.84	48.99	46.10	50.65	46.1
Mannitol	44	45	46.33	45.66	47.50	48	49.66	50.66	47.1
Mean	44.17 D	45.2 Bcd	45.4 bc	44.8 Bc	46.1 bc	48.49 Ab	47.8 Abc	50.65 a	

LSD at 5% level of probability for osmotic potential= 4.15

Discussion

Seed priming effect on days to flowering and maturity

Data in table-1 and 2 shows that priming at high osmotic potential significantly reduced days to edible maturity as compared to unprimed seeds and seeds primed at lower osmotic potential, this may be due to early emergence of seeds by priming. Our results agree with Murungu *et al.*, [9], Barlow and Haig [10] who reported that priming reduce days to flowering and edible maturity.

Okra plant height (cm) as affected by seed priming

Plant height of primed seed plots was significantly higher than unprimed seed plots. Which is in line with the findings of Mohammadi [12], Bakare and Ukwungwu [14] who have reported that seed priming causes increase in plant height. This can be explained on the basis of emergence. Plants from unprimed seeds may take more days to emerge than primed seeds which may

results in above ground age difference and this above ground age difference may cause differences in plant height.

Seed priming effect on absolute growth rate (AGR)

Data in Table 4 indicate that AGR in plants from unprimed seeds is statistically at par with those primed at -2.4 Mpa osmotic potential (0.52 and 0.55 respectively). It could be that the lowest osmotic potential did not allow water penetration into seed and thus behaved like unprimed seeds.

The data also indicate gradual improvement in AGR as solution osmotic potential increases from -2 Mpa toward zero. Significantly higher AGR was recorded at osmotic potential in the range of 0 to -1.2 Mpa. Arif *et al.*, [16] had also reported similar results.

Differences in AGR of plants may be due to differences in their above ground age because figures in Table 5 are the averages of data recorded at 30 and 60 days after seed

sowing in field. Plant actually had differences in their life above ground, though the seeds were sown on the same date (day) due to variation in days to germination.

Relative growth rate (RGR) of okra plant as affected by seed priming

More RGR was recorded for plants from unprimed seeds as compared to plants from primed seeds. Plants from unprimed seeds have delayed flowering and time to edible pod harvest as compared to plants in rest of the treatments. These plants had an increase in RGR at the cost of delayed formation sink for photosynthates (flowers and pods), while plants in other treatments were sending photosynthates to their sinks (flowers and pods), when these plants were focusing on enhancing vegetative growth.

Conclusion and recommendation

It is concluded that flowering and edible maturity may be speed up and synchronized through seed priming. Growth rate may also be improved through seed priming. Early flowering and edible maturity could be obtained through hydropriming i.e at 0 Mpa while more plant height and absolute growth rate may be obtained through priming seeds at -1.2 Mpa osmotic potential. Maximum relative growth rate may be obtained from unprimed seeds.

Authors 'contributions

Conceived and designed the experiments: I Rahman, Performed the experiments: I Rahman & S Ali, Analyzed the data: I Rahman, S Ali & I Rahman, Contributed reagents/materials/analysis tools: I Rahman, S Ali, I Rahman, M Adnan, M Ibrahim, N Saleem & IA Khan, Wrote the paper: I Rahman, S Ali, I Rahman, M Adnan, M Ibrahim, N Saleem & IA Khan.

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