Original Research Article

Seed priming's effectiveness in improving okra germination and seedling growth

Abstract

Seed priming is a pre-sowing seed treatment technique that enables the seed to emerge fast, raise vigor, and increase yield potential. Field research was done to evaluate the efficacy of seed priming on germination and seedling growth of okra in Nawalpur–, Nepal. Open-pollinated variety Arka Anamika with four treatments (T1; priming with tap water for 24 hours, T2: priming with hot water at 50^0c for 5 minutes, T3: priming with cow's urine at 2% concentration for 3 hours, and T4: priming with NaCl at 3% concentration for 12 hours) was evaluated in a Randomized Complete Block Design that included five replications for each treatment. The germination study was done for 10 days after sowing whereas the seedling growth parameter was done after germination up to 15 DAS. The result of the study showed that the highest germination percentage (72%), seed vigor (1451.56cm), and Plant height (9.19cm) was observed in seed primed with hot water. Similarly, the lowest mean germination time MGT (1.66days) and highest shoot length (10.68cm) were observed in seeds primed with NaCl. Overall, seed priming with hot water and NaCl were found effective to ameliorate germination and seedling growth in okra under field conditions in Nawalpur.

Keywords-: Germination, priming, seedling, vigor

1. Introduction

Okra (*Abelmoschus esculentus* (L). Moench) is the pivotal vegetable crop of the family Malvaceae and originated in tropical America (Maurya, Bailey, & Chandler, 2013). It is cultivated in tropical as well as warm temperate region throughout the world (Farinde, Owolarafe, & Ogunghemi, 2007). It is amongst the heat and drought-tolerant vegetable species which can tolerate heavy soils but cannot tolerate frost. Okra fruits are used for making curry, soup, salad, and as a flavoring agent (Jha, Neupane, Khatiwada, Pandit, & Dahal, 2018). In addition, okra has nutritive and medicinal properties. Seed priming can be defined as a pre-sowing seed treatment activity in which the seed is soaked in some kind of solution. Seed priming enables seeds to emerge fast, and uniformly even under different agro-climatic conditions, brings uniformity to optimize harvesting efficiency, raises vigor, and increases yield potential. It is an economic method to efficiently improve germination and seedling characteristics. However, only a few priming methods are in practice. Hydro-priming which means water soaking of seeds (Afzal, Ahmad, Basra, Ahmad, & Iqbal, 2002), osmo-priming, which involves the soaking of seed in a solution of osmoticum (Rouhi, Ali, Farzad, Reza, Mohammad, & Goudarz, 2011), halo-priming which denotes soaking of seed in salt solution (Nawaz, Muhammad, Muhammad, & Afzal, 2011) and solid-matrix priming (SMP) i.e. priming

using solid carriers (Khan, 1992) are most commonly used. Priming results in beneficial physiological changes in seeds (Basra, Farooq, Tabsassam, & Ahmad, 2005). Priming results, early flowering, enhances growth rate and shoot up the plant height (Rahman I. U., Ali, Adnan, Ibrahim, Saleem, & Khan, 2015). (Sedghi, Nemati, & Esmaielpou, 2010) Reported priming as a way of the seed enhancement which might be a factor for increasing seed performance under stress conditions like salinity, temperature, and drought stress. Seed priming has been commonly used to minimize the time between the sowing of seeds and emergence of seedlings and to bring uniform emergence (Parera & Cantliffe, 1994)

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In Nepal, the productivity of okra is 11.3MT/ha (Moald, 2018/19) which is low compared to the production potential of the okra varieties cultivated in Nepal. Despite the fact that numerous researches have been carried out regarding the germination of okra, there is a rift between researcher and farmer's field which is responsible for low production. Germination is the primary factor for cultivation that determines production (yield). Low germination is one of the major problems in okra cultivation. In most vegetable crops such as okra, an appropriate priming method could lead to optimized plant growth and yield. Therefore, this field study was undertaken to elucidate the effect of various seed treatments on the germination of seeds of okra.

2. Materials and Method

2.1 Experimental Details

The experiment was conducted in Gaidakot-5, Nawalpur, Gandaki province, Nepal, geographically located at 27.73^{o} longitude and 84.39^{o} latitude. The variety used for the study was Arka anamika, an open-pollinated variety of okra. The experiment used was Randomized Complete Block Design (RCBD) analyzing 4 treatments: Tap water, Hot water, Cow urine, and NaCl replicated five times. Okra seeds were primed before sowing and the duration of priming varied according to the priming agent. For tap water treatment, seeds were soaked/ dipped in tap water for 24 hours before sowing. Regarding hot water treatment, seeds were soaked/ primed in hot water at 50^{o}c for 5 minutes before sowing. For cow urine treatment, seeds were treated with cow urine of 2% concentration for 3 hours and then dried in shade before sowing. For NaCl treatment, seeds were soaked in NaCl solution of 3% concentration for 12 hours before sowing. All of the seeds were shade dried for 5 minutes after priming. Thirty seeds were sown in a plot with the spacing of 8cm× 8cm (plant to plant) and 8cm×8cm (row to row). Seeds were sown at the depth of 2-3 cm from the soil surface.

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2.2 Measurement of data

Germination percentage: Number of seeds germination was noted up to 10 days on daily basis after the beginning of experiment. Germination was considered in seeds with recognizable radicle whereas seeds with observable cotyledons were taken as emerged. And the calculation of final germination percentage was carried out at the termination of the experiment. Germination percentage was determined based on the following formula (Bajehbaj, 2010):

~~Germination % = $\frac{\text{No.of total germinated seed}}{\text{No.of total seed sown}} \times 100$~~

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Final germination is measured as daily cumulative germination percentages of five replications in last counting day in each treatment.

Mean Germination Time (MGT): Mean germination time (MGT) was calculated by using the given formula (Ellis & Roberts, 1981):

$$\text{MGT} = \frac{\sum(\text{Dn})}{\sum \text{n}}$$

~~MGT = $\frac{\sum(Dn)}{\sum n}$~~

where n = the number of seeds germinated on each day
D = day of counting.

Plant height (cm): Plant height was assessed at 10 DAS and 15 DAS from ten sample plants from every plot using a measuring scale from the soil surface to the tip of plant.
Shoot length (cm): Shoot length was measured by measuring scale from collar to the tip of growing point.
Shoot mass: The fresh weight of shoot (in grams) was determined by the destructive sampling of the sapling and measuring by using the weighing balance.
Seed vigor index: After 15 days from the start of the experiment, ten seedlings from each treatment were randomly selected. Seedling length is taken as the sum of root and shoots length. Seedling vigor index (SVI) was estimated using the following formula given by, Abdul-Baki & Anderson(1973) using Mean seedling length

~~Seed Vigor Index (SVI) = Germination % × Seedling length (cm)~~Seed Vigor Index (SVI) = Germination % × Seedling length (cm)

Vigorous seed is the one with high seedling vigor (Abdul-Baki & Anderson, 1973).

2.3 Statistical analysis

Data entry, compilation and arrangement were achieved by using MS-Excel 2010. The ANOVA was run by using R Studio V 1.1. Mean separation was done by using Least Significance Difference (LSD) by using the package 'agricolae' in R environment. Graphical representations were obtained from R Studio and MS-Excel 2010.

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3. Result and Discussion

Table 1: Germination and seedling growth parameter of okra under different priming agent.

Treatments	Germination %	MGT (days)	Shoot mass(cm)	Height (cm)	Seed vigor index (cm)	Shoot length (cm)
Tap water	36.00 c	1.664 b	1.603 b	7.994 ab	631 c	10.37 b
Hot water	72.00 a	3.674 a	2.446 a	9.196 a	1451 a	12.57 a
Cow's urine	48.00 bc	3.350 a	1.500 b	7.880 b	820 bc	10.37 b
Nacl	62.00 ab	3.984 a	1.709 b	9.100 ab	1119 ab	10.68 b
Lsd	15.55	1.652	0.4794	1.200	339.3	0.023
F-probability	0.002	0.042	0.004	0.060	0.001	1.522
CV %	20.7	37.8	19.2	10.2	24.5	10.0
Grand mean	54.5	3.17	1.814	8.54	1005	11.00

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Effect on germination

Significantly higher germination percentage (72%) was obtained in hot water treatment plots as compared to other plots. Germination percentage in salt water treatment plot was statistically similar to results obtained in the hot water treatment plot. A similar result was obtained by Tania, Hossain, & Hossain (2019) in their research on okra where they reported the highest germination percentage in treatment with hot water at 50ºC for 5 min whereas non-primed seeds showed the lowest germination percentage. These results indicate that seed priming improves the germination percentage of seeds as compared with non-primed seeds.

It is well known that different priming agents and time period affect germination percentage because seeds of each species need a particular quantity of water to initiate the lag phase of germination in which all the pre-germination metabolic processes occurs (Rahman, Ali, Adnan, Ibrahim, Saleem, & Khan, 2016). Treating seeds with hot water helps to remove some surface pathogens of seeds (Nega, Ulrich, Werner, & Jahn, 2003) and also better activation of enzymes

which induces better germination, and treatment with salt solution helps to absorb water easily. Therefore, the results are justified by the given facts.

Effect on seed vigor

Maximum seed vigor index was recorded in hot water treatment (1450.56cm) followed by NaCl treatment (1118.99cm) followed by cow's urine treatment (-819.79cm) and minimum seed vigor index was observed in tap water treatment (630.83cm). This result is supported by finding of (Tanial, Rahman, & Hossain, 2020) who reported that highest seed vigor was recorded in hot water treatment (50^{o}c for 5 minutes) and the lowest seed vigor index was found in tap water treatment (for 12 hours). Priming seed with water and salt solution it helps to absorb water but when seeds are primed with hot water, it helps to eradicate the surface pathogens of seeds (Nega, Ulrich, Werner, & Jahn, 2003). In addition, it also causes better activation of enzymes which may induce germination. These findings are in resemblance with the previous finding of (Kaur, Chawla, & M, 2015). Rapid germination, uniform seedling emergence and increased shoot length and root length of seedlings observed in primed seed are the result of the induction of different metabolic activities in the embryo of seed (Wahid **et al.** 2008). Seedling vigor index of germinating seeds possess immense influence on the establishment and yield of crops (Tabrizian & Osareh, 2007). Optimum plant establishment of seedling is ensured in the field by maintaining proper hydro-prime duration (Mahmoodi, Ghassemi-Golezani, Habibi, Paknezhad, & Ardekani, 2011). Vigorous plant could be produced from rapid emergence of seedlings (Ghassemi-Golezan, Sheikhzadeh-Mosaddegh, & M, 2008). Considering all the results together, we can conclude that hydro-and halo priming improves seed vigor and helps to establish profound crop stand. Hence, hot water used treatment resulted in highest seed vigor.

The experiment showed that the highest plant height was observed in hot water treatment (9.169cm) followed by NaCl treatment (9.100cm) ~~followed by ~~, tap water treatment (7.994cm**)** ~~followed by~~and cow urine (7.880cm). Plant height is a role of the genetic as well as the environmental condition. It is considered as expression of its full vegetative potential and reproductive cycle. The enhanced plant height in primed seed plots may be due to improved and faster emergence in primed seed plots which created cooperative competition among the plants for light, water and nutrients and resulted in taller plants. Probable reason could be that priming might have increased seedling vigor which had enhanced the competitiveness for light, water and nutrients. The results are in parallel with the work of (Rashid, Harris, Hollington, & Khattak, 2002) who reported that seed priming improves the plant stands. (Asgedom & Becker, 2001) also reported that Zinc primed seeds showed higher vigor than unprimed seed as reflected in maximum plant height (Shah, et al., 2011). (Ghiyasi, Amirnia, Damalas, & Moghaddam, 2019), reported that the effects of seed priming treatment and osmotic stress were significant on plant height. Therefore, priming with hot water used resulted highest plant height.

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4. Conclusion

Priming of seed with hot water and NaCl were found effective for increasing the germination percentage of okra. Seeds priming with tap water took less time to germinate than other seeds priming method. However, it did not contribute for improved germination percentage and other seedling growth parameters. Seed priming with hot water and NaCl improved seedling growth parameters in terms of seed vigor and plant height. Seed priming with hot water significantly increased shoot weight and shoot length of okra seedling at 15 DAS. Hence, it is concluded that priming with hot water (50^0 C) for five minutes and NaCl (3% concentration) before sowing are best seed priming methods to improve germination and growth of okra under field conditions in Nawalpur, Nepal.

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