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ORIGINAL RESEARCH ARTICLE

Influence of seed priming in the germination and yield performances of common buckwheat

Dipika Bhusal*, Dhirendra Pratap Thakur, Laxmeshwar Yadav and Prakash Ghimire

Institute of Agriculture and Animal Science, Tribhuvan University, Paklihawa Campus, Rupandehi, NEPAL
*Corresponding author's E-mail: bhusaldipika48@gmail.com

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ABSTRACT

The study, conducted from November 2019 to March 2020 at the Institute of Agriculture and Animal Science in Rupandehi, Nepal, aimed to evaluate the effects of seed priming techniques on common buckwheat. The experiment comprised eleven treatments with three replications each. Germination parameters were analyzed in the laboratory using a complete block design, while growth and yield parameters were assessed in the field using a randomized complete block design. The results indicated significant improvements in all germination and yield parameters of buckwheat due to seed priming. Notably, the 48-hour hydropriming treatment exhibited the highest performance, yielding a germination percentage of 87.167%, a speed of germination of 66.62, a vigor index of 52.78, a grain yield of 1518.988 $kgha^{-1}$, a test weight of 19.533 g, and a harvest index of 0.405. These findings suggest that priming seeds with water for 48 hours can effectively enhance the germination, growth, and yield attributes of common buckwheat.

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INTRODUCTION

Buckwheat is a minor food crop in the hilly areas of Europe, East Asia, and the Himalayas. It belongs to the family Polygonaceae, and both species of the genus *Fagopyrum* (*esculentum* and *tataricum*) are commonly cultivated in Nepal. Buckwheat ranks sixth among staple food crops in Nepal, following rice, wheat, maize, finger millet, and barley, in terms of cultivation area, production, yield, and uses (MoALD, 2017). It is cultivated in all ecological regions of Nepal but plays a crucial role as a major crop in supporting life in remote Himalayan areas (Rajbhandari & Bhatta, 2008). Buckwheat, as a nutritional multipurpose crop, demonstrates resilience to changing climatic conditions and is well-adapted to stressed temperature, moisture, and fertility regimes (Babu *et al.*, 2018). The demand for buckwheat production has increased in Nepal due to growing awareness of its multiple uses. However, the country has not been able to meet the domestic demand for buckwheat (Luitel *et al.*, 2017).

Rapid and uniform emergence, as well as root growth, are essential for successful seedling establishment. Seed Priming induces a physiological state that enables effective germination, growth, and productive capacity in crops (Misra *et al.*, 2019). It is a low-cost pre-sowing approach with minimal intervention costs, which increases and stabilizes yield, having a significant impact on the livelihoods of small-scale, marginal, and resource-poor farmers (Koirala, 2017). Seed Priming has been shown to increase the yield of various field crops, such as wheat, barley, upland rice, maize, pearl millet, chickpea, and sorghum (Leone, 2014). Tsegay & Andargie (2018) demonstrated the improvement in germination through seed priming, which facilitates the activation of genes for α-amylase mRNA transcription by the absorbed priming agents, thereby facilitating starch degradation in the cotyledons and making monosaccharides available to the newly germinating embryo. Seed priming has been successfully used to achieve uniform germination and stand establishment, resulting in higher yields (Nawaz *et al.*, 2013). Since cultivation of buckwheat in Nepal is marginal land with little or no irrigation, the seed priming techniques in buckwheat can be advantageous for increasing the yield for the resource-poor farmers. Hence, this research aims to assess the effectiveness of the seed priming technique in enhancing the performance of common buckwheat.

MATERIALS AND METHODS

Laboratory and field experiments were conducted at the Institute of Agriculture and Animal Science, Paklihawa Campus, Rupandehi, Nepal, during the 2019/2020 period. The site is situated at an altitude of 90 meters above sea level, at 27° 42' 245'' N Latitude and 83°16' 236'' E Longitude. In the laboratory experiment, germination parameters of Buckwheat seeds after priming were assessed. Additionally, a field experiment was conducted to evaluate the yield performance of common buckwheat after priming. Mithe Phaper (Common Buckwheat) seeds were obtained from a local farmer in the Chitwan District, Nepal. The soil of the experimental field was characterized as silt loam with very low organic matter (1.5%) and nitrogen content (0.07%).

Experimental design, treatments, and crop management

To investigate the impact of seed priming on common buckwheat, single factorial experiments were conducted with three replications. The experiments comprised eleven treatments: T_1= Control (No Priming) T_2= Hydropriming for 12 hours T_3= Hydropriming for 24 hours T_4= Hydropriming for 36 hours T_5=Hydropriming with livestock urine (10%) for 12 hours T_6= Hydropriming with compost (1:1) for 24 hours T_7= Hydropriming with $CaCl_2$ (1%) for 12 hours T_8= Hydropriming with MOP (4%) for 12 hours T_9= Hydropriming with PEG (10%) for 12 hours T_{10}= Hydropriming with GA_3 (0.2 g/l) for 12 hours T_{11}= Hydropriming for 48 hours. Following the priming duration, the seeds were rinsed 3-4 times with water, air-dried for up to six hours, and then immediately sown. The laboratory and field experiments adhered to the following design and management practices:

Laboratory experiment: For laboratory conditions, a Complete Block Design was employed. Three replications, each consisting of 400 seeds per treatment, were arranged in plastic baskets filled with a mixture of sand and garden soil to a depth of 2 cm. Emergence was monitored daily from the third day after sowing until a constant count was achieved. At 14 days after sowing (DAS), ten seedlings from each treatment were carefully uprooted with minimal damage, and their roots were washed to remove soil residues. Subsequently, the seedlings from each treatment were individually placed in Petri dishes and subjected to oven-drying at 72°C for 24 hours. After drying, the seedlings were weighed using an analytical balance.

Field experiment: The field experiment was arranged using a Randomized Complete Block Design. Each treatment comprised three replications, with 30-gram seeds sown in each plot. Continuous spacing of 25 cm was maintained between the seeds. The land underwent a single deep plowing followed by harrowing and leveling. Individual plot sizes were 6m² (2m x 3m). As part of the final land preparation, 5 tons of Farm Yard Manure (FYM) per hectare and chemical fertilizers at a ratio of 30:20:10 N, P_2O_5, and K_2O were applied. Hand weeding was carried out once at 25 days after sowing (DAS), and irrigation was applied at 28 DAS.

Data observation and analysis: Line sowing of pretreated seeds was carried out on 12th of November 2019 and harvesting was done on 15th of February 2020. Data on seeds germinated per day, economical yield, straw yield, and test weight were collected. Grain yield and straw yield were collected from the net plot area (4.8 m^2). The germination percentage and speed of germination were calculated using the formula reported by Al-Ansari & Ksiksi (2016); vigor index given by Kandasamy *et al.* (2020); harvest index used by Amanullah & Inamullah (2016).

Statistical analysis

Data entry was done using Microsoft Excel. The analysis of data was performed with R studio, interpretation was done according to ANOVA (Analysis of Variance) and DMRT (Duncan's Multiple Range Test) at 5% level of significance.

RESULTS AND DISCUSSION

Germination performance

A comparison of treatment mean showed a significant ($p<0.01$) effect of seed priming on germination percent (Table 1). The results indicated the highest germination percentage in seeds primed for 48 hours in water (87.167%) but the result was with par among many treatments as shown in Table 2. There was no significant effect of seed priming done with hydro-primed for 24 hours, PEG, calcium chloride, and GA_3 with that of control. A similar result of germination percentage was obtained by Mahajan *et al.* (2011) in rice seeds primed for 48 hours in water. Grain yield was positively influenced by germination percentage. The correlation coefficient between grain yield and germination percentage was found to be 0.66. It was observed that a 44 % variation in grain yield was accounted for by germination percent. The data on the speed of germination was significantly ($p<0.01$) influenced by the effect of seed priming (Table 1). Results revealed a significant difference between primed seed with that of control except for seeds primed with Gibberellic acid whose result was at par with control. The highest speed of germination (66.62) was observed in T_{11} but the results were at par with T_4 (59.10) and T_6 (60.49). Speed of germination was positively correlated with germination percentage. The correlation coefficient between the speed of germination and germination percent was 0.89. It was observed that 79% variation in speed of germination was accounted for by germination percent. Similarly, the seed priming of common buckwheat by different priming methods had a significant ($p<0.05$) effect on the vigor index (Table 1). The highest vigor index (52.78) was observed in the case of T_{11} and the results were significantly different among all other treatments. The maximum vigor index was also obtained by Prasad & Prasad (2011) in rice and Basra *et al.* (2002) in wheat at 48 hours water priming. Vigor index was positively correlated

Table 1. Germination performance of common buckwheat as influenced by seed priming treatments at Paklihawa.

Treatments	Germination percent	Speed of germination	Vigor index
Control	66.750^{c}	37.710^{f}	25.409^{c}
12-hour Water	82.583^{ab}	51.507^{cde}	38.491^{b}
24-hour Water	72.500^{bc}	48.953^{de}	35.037^{bc}
36-hour Water	84.000^{ab}	59.097^{abc}	34.507^{b}
Livestock urine	86.167^{a}	56.750^{bcd}	38.915^{b}
Compost slurry	82.583^{ab}	60.487^{ab}	39.222^{bc}
Calcium chloride	70.167^{c}	46.677^{e}	28.729^{bc}
Potassium chloride	75.667^{abc}	48.860^{de}	34.468^{bc}
Polyethylene glycol	76.500^{abc}	48.867^{de}	26.908^{bc}
Gibberellic acid	68.250^{c}	43.490^{ef}	25.847^{c}
48-hour Water	87.167^{a}	66.623^{a}	52.776^{a}
SEm(±)	3.495	2.765863	3.691432
LSD(α=0.05)	10.31	8.159290	10.88971
Cv	7.81	9.26097	18.493
F test (α=0.05)	**	***	**
Grand mean	77.48485	51.72909	34.57359

Note: SEm: Standard error of mean, LSD: least significant difference, CV: coefficient of variation, *: significant (α=0.05), **: significant (α=0.01), ***: significant (α=0.001), NS –non significant DAS-Days After Sowing, values with same letters on columns are not significantly different at 5% DMRT (Duncan multiple Range Test).

Table 2. Yield performance of common buckwheat as influenced by seed priming treatments at Paklihawa.

Treatments	Yield (kg/hectare)	Harvest index	Test weight (g)
Control	751.156^{e}	0.289^{b}	13.667^{e}
12-hour Water	1002.823^{d}	0.342^{ab}	14.467^{de}
24-hour Water	1053.975^{cd}	0.347^{ab}	15.8^{bcd}
36-hour Water	1242.182^{bc}	0.391^{ab}	16.2^{bc}
Livestock urine	1340.068^{b}	0.398^{a}	18.6^{a}
Compost slurry	1146.628^{cd}	0.346^{ab}	16.4^{bc}
Calcium chloride	1039.448^{d}	0.334^{ab}	15.067^{cd}
Potassium chloride	1160.358^{bcd}	0.359^{ab}	16.8^{b}
Polyethylene glycol	1051.565^{cd}	0.329^{ab}	15.8^{bcd}
Gibberellic acid	1006.338^{d}	0.308^{ab}	14.633^{de}
48-hour Water	1518.988^{a}	0.405^{a}	19.533^{a}
SEm(±)	59.476	0.030561	0.415532
LSD(α=0.05)	175.453	0.090156	1.225818
Cv	9.203	15.13963	4.473692
F test (α=0.05)	***	*	**
Grand mean	1119.412	0.349638	16.08788

Note: SEm: Standard error of mean, LSD: least significant difference, CV: coefficient of variation, *: significant (α=0.05), **: significant (α=0.01), ***: significant (α=0.001), NS –non significant DAS-Days After Sowing, values with same letters on columns are not significantly different at 5% DMRT (Duncan multiple Range Test).

with germination percent and speed of germination. The correlation coefficient between the vigor index and germination percent and speed of germination was 0.67 and 0.75, respectively. It was observed that 45% and 56% variations in vigor index were accounted for by germination percent and speed of germination.

The germination performance of seed was evaluated in terms of germination percentage, speed of germination, and vigor index. Soaking seeds for 48 hours allowed for the proper performance of the most important physiological functions, resulting in the best germination performance. The 48 hours hydro-primed buckwheat seeds had the largest and the fastest germination which was followed by compost priming and then 36 hours hydro-primed seeds and their results were with par with each other while the unprimed seeds took the longest duration and had the lowest speed of germination as shown in Table 1. Seed priming accelerated the mobilization of embryonic tissue that triggered the enzyme activities for rapid seed germination as well as of the compounds like free amino acids, proteins, soluble sugar from storage organs positively influenced the germination performances (Ashraf & Foolad, 2005). The results revealed an increase in the performance of buckwheat with the increased duration of priming treatments.

Yield performance

A perusal of the data depicted that different seed priming treatments resulted in significant ($p<0.01$) differences about the grain yield and significantly ($p<0.05$) influenced test weight and harvest index (Table 2). The maximum grain yield of 1518.988 kgh^{-1} was obtained with the treatment of T_{11} (48 hours water priming) while the lowest number of 751.156 kgh^{-1} was recorded with no-priming treatment. The result showed a highly significant effect of seed priming on the grain yield over the control. Grain yield was positively influenced by germination percentage, speed of germination, vigor index, and test weight. The correlation coefficient between grain yield and germination percentage, speed of germination, vigor index, and test weight were found to be 0.66, 0.74, 0.57, and 0.83 respectively. It was observed that 44%, 55%, 33%, and 68% variations in grain yield were accounted for by germination percentage, speed of germination, vigor index, and test weight respectively. The harvest index was statistically with par among all the priming treatments. Among the treatments highest was observed in T_{11}. Similar is the case for test weight which was also highest for T_{11} (19.533 g) but the result was at par with T_5 (18.6 g). The differences among the treatments were not significant statistically. Minimum test weight (13.667g) was recorded for control. Grain yield was positively influenced by the test weight. The correlation coefficient between grain yield and test weight was found to be 0.83. It was observed that 68% variations in grain yield were accounted for by test weight. The result of the present study is in line with Ahammad *et al.* (2014) in the case of maize and Tadesse *et al.* (2008) in the case of rice.

Conclusion

Priming seeds in water for 48 hours notably enhanced crop establishment compared to non-primed seeds. The highest levels of germination and yield attributes were observed with this method. The study indicates a positive correlation between grain yield and factors like germination percentage, speed of germination, vigor index, and test weight, emphasizing the potential of hydropriming to advance buckwheat cultivation and increase yields. Since hydropriming is a straightforward and cost -effective technique, its adoption at the farmer level could significantly contribute to boosting common buckwheat production in Nepal.

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DECLARATIONS

Author contribution statement

Conceptualization: D.B., D.P.T., L.Y. and P.G. Methodology D.B., D.P.T., L.Y. and P.G.; Software and validation: D.B., D.P.T., L.Y. and P.G.; Formal analysis and investigation: D.B. and D.P.T.; Resources: D.B., D.P.T., L.Y. and P.G.; Data curation: X.X.; Writing-original draft preparation: D.B. and D.P.T.; Writing—review and editing: L.Y. and P.G..; Visualization: D.B., D.P.T., L.Y. and P.G..; Supervision: L.Y. and P.G.; Project administration: L.Y. and P.G.; Funding acquisition: D.B. All authors have read and agreed to the published version of the manuscript.

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