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Effect of Halo, Osmo and Hydro-Priming on Yield and Yield Related Traits of Common Bean at Raya Valley of Tigray Region, Ethiopia

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Abstract: This study was carried out in order to evaluate effect of seed priming on seed yield and yield components of common bean (*Phaseolus vulgaris L.*) at Tigray region, Mehone agricultural research center. Low quality seed causes poor seedling emergence, which is one of the biggest barriers to closing the enormous yield gap, particularly in environments that are prone to drought. In order to assess the impact on germination and yield of the Nasr variety of common bean, hydro, osmo, and halo priming methods were applied, along with priming durations of 6, 12, and 18 hours using RCBD design. ANOVA analysis showed that between all experimental traits there was significant difference. Minimum emergency date (6.94) was recorded by priming with potassium nitrate and priming duration of 18hr (7.11). The shortest (77.77) and longest date (82.44) flowering date was registered by priming with manitol and water respectively. Maximum value of Pod per plant, seed per plant and seed yield was obtained from hydro priming and 6hr priming duration. In general this study reveal that seed priming enhance seed germination quality and improve the yield and yield related traits so that accelerate over all yield and yield related of the common bean.

Keywords: Common Bean, Germination, Priming, Seed Quality, Seed Physiology

1. Introduction

One of the most significant common leguminous crops in the world is the common bean (*Phaseolus vulgaris L.),* which is primarily grown for its dry beans, shell beans, and green pods for direct human consumption. Common bean seeds have sufficient amounts of many vitamins and minerals, as well as protein, fat, and carbohydrates. It is well established that the quality of the seed alone accounts for at least a 10-15% boost in productivity. But one of the biggest barriers to closing the enormous yield gap is still a lack of good seed. Thus, it is crucial to produce and distribute high-quality seed if one wants to approach the cultivar's potential realizable yield.

Seed treatment before sowing is the foundation for activation of seed resources that in combination with external ingredients could contribute to the efficient plant growth and high yield. Various physiological and non-physiological techniques are available for enhancing seed performance as well as to combat environmental constraints. The physiological treatments for improving seed germination and stand establishment are composed of seed hydration techniques such as humidification, wetting, and presoaking. The other techniques for promoting germination are comprised of chemical treatments, seed inoculation with beneficial microbes, and seed coating.

A physiological strategy known as "seed priming" involves hydrating and drying seeds to speed up the pre-germinative metabolic process for increased germination, seedling growth, and eventual yield in both normal and stressful environments. It is a quality improvement strategy for quick, uniform seed germination and the best plant stand possible in the field [9]. Seed priming can be done with water or various chemical compounds to improve the quality and germination of the seed. In low vigor lots, this method is frequently employed as a seed invigoration therapy to improve germination and vigor [26]. Researchers employ a variety of seed priming approaches to improve seed germination potential. Traditional seed priming techniques include halo priming, osmo priming, bio priming, nutritional priming, chemical priming, priming with plant growth regulators, and priming with plant extract. Advanced seed priming techniques include nanoparticle and physical agent priming.

Before they fully germinate, seeds can be soaked in solution and then dried again. This process uses fewer chemicals and prevents the disposal of elements that could be harmful to the environment [21]. The advantageous effects of priming have been linked to a variety of biochemical, cellular, and molecular activities, such as the creation of RNA and proteins [5, 10, 12, 4]. Older seeds that have been primed have their activity of cell detoxifying enzymes including glutathione reductase, catalase, and super oxide dismutase restored [1]. Better stand establishment, robust plants, improved drought tolerance, earlier blooming, earlier harvest, and higher grain yield can all result from these impacts. This study was done to determine the impact of hydro, osmo, and halo priming time on the seed quality and grain yield components of the common bean variety since the effects of priming on field performance of common beans are not well understood.

2. Material and Method

2.1. Description of Study Area

The study was conducted at Mehoni Agricultural Research Center (MhARC) Fachagama testing site in the Raya Valley, Northern Ethiopia from August 2019 to June 2020. It is located at 668Km from the capital Addis Ababa and about 125Km south of Mekelle, the capital city of Tigray regional state. Geographically, the experimental site is located at 12° 41’50’’ North latitude and 39° 42’08’’ East longitude with an altitude of 1578 m.a.s.l. Data from the meteorological class of the center shows mean annual rainfall of 539.32mm with an average minimum and maximum temperature of 12.81 and 23.24°C, respectively. The soil textural class of the experimental area was clay loam with pH of 7.9.

2.2. Seed Materials

The Nasir variety seed of common bean was used as research materials in this study. The seed source was obtained from the Melkasa Agricultural Research Center.

2.3. Experimental Design

The design used for field data collection was RCBD with three replications. The field experiment was conducted at Mehone Agricultural Research Center. Field, the experiment was conducted on area (8m×39m= 312m^2) of land. The space between plants, rows, and block was 20cm, 40cm and 1m respectively with harvestable area of 1.2m^2. The total number of rows were five per plot with three rows for data collection. The row length of the plot was 3m×2m with plot size of 6m^2. The total number of entries were 10 with 30 total numbers of treatments.

2.4. Seed Priming Treatments

The common bean type of seeds was surface-sterilized with 2% sodium hypochlorite for 10minutes, washed with distilled water, and then redried to remove any fungi [2]. The three priming media were distilled water (50ml), KNO_3 (2%) and manitol (4%) used only for field and laboratory experiments. The variety was rinsed in priming solution for 6, 12, and 18hr of priming duration [11]. These priming media were selected due to their positive effect on germination, emergence, seedling growth, and grain yield of according to previous investigations [22, 10, 7, 16]. Unprimed seeds were used as the control. After the priming application, seeds were washed with distilled water, dried on paper towels at room temperature, and ventilated until they regained their original moisture content [7].

2.5. Seed Priming and Re-Drying

Prior to the hydro-priming, osmo (manitol), halo (KNO_3) priming treatments, the moisture contents of the seeds have been determined using oven dry method [18] and brought to the same constant moisture. Seeds were fully immersed in the priming media on Petri Dishes for 6, 12 and 18hours. All seeds were removed from the priming media at the same time. Primed seeds were washed out and dried under shade back to the original moisture content prior to sowing, and sown in germination pots each of which contained 30 seeds. The Pots were lined for placing the seeds in a uniform distribution for germination and all seedlings per pot were used for analysis. Quantitative and qualitative data that included seedling emergence date, flowering date, vigour test, plant height, seed per pod, pod per plant, ground cover, grain yield and thousand seed weights were measured.

2.6. Data Analysis

The data were statistically analyzed using SAS software 9.3 version by using ANOVA procedure. Mean separation was done using Duncan test at 0.05 level of probability.

3. Result and Discussion

ANOVA analysis showed that all experimental traits showed there was significant difference between all traits of study. General ANOVA of all traits of experiment has been illustrated in Table 1 below. The results of the analysis of variance show that the priming time and priming materials significantly affect all attributes. At both the 0.05 and 0.01 levels of significance, parameters like emergence date, flowering date (FD), pod per plant (PPP), seed per pod (SPP), thousand seed weight (TSW), field establishment (STAB), and grain yield (GY) revealed significant differences. The outcome is consistent with study [25] on soybean for different traits.

Table 1. *Analysis of Variance (ANOVA) for Mean Square of Traits of Experiment.*

SV	DF	Emergence date	Stand count	Flowering date	Pod Per Plant	Seed Per Plant	Plant Height	Thousand Seed Weight	Grain Yield
REP	2	0.4	64.3	113.68	204.5	5.24	286.1	0.2	8.28
PM	2	1.68^{**}	184.6^{**}	3.18^{**}	211.7^{**}	4.79^{*}	129.1	1.68^{**}	1.3^{**}
PD	2	0.35^{**}	10.9^{**}	9.1^{**}	160^{**}	2.79^{*}	180.1	1.18^{**}	13.2^{**}
PM*PD	4	0.2	26.4	10.8	117.3	1.4	228.5	0.05	4.45
Error	34	1.2	24.3	16.5	68.9	3.24	127.3	0.8	18.26
CV		15.3	8.8	5.2	19.1	18.0	12.2	5.9	17.9

*, ** Significant level at 0.01 and 0.05% of significance, ns, non-significant REP, replication, PM, priming materials, PD, priming duration, CV, coefficient of variation, SV, source of variation, DF, degree of freedom

Table 2. *Yield and Yield Components Affected by Priming Materials.*

Priming materials	MS							
	Emergence date	Stand count	Flowering date	Pod Per Plant	Seed Per pod	Plant Height	Thousand Seed Weight	Grain Yield
Manitol	8.55^{a}	58.22^{a}	77.77^{a}	41.2^{a}	5.72^{a}	93.1^{a}	15.8^{a}	4.64^{a}
H_2O	7.22^{b}	52.22^{b}	82.44^{b}	48.5^{b}	6.77^{b}	95.5^{a}	16.3^{a}	7.93^{b}
KNO_3	6.94^{b}	57.17^{a}	77.66^{a}	41.89^{a}	5.66^{b}	89.4^{a}	15.9^{a}	4.4^{a}
Error	1.24	24.35	16.52	68.91	0.42	127.3	0.8	18.2
CV	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03
LSD	0.75	3.34	2.75	5.62	0.44	7.6	0.64	2.89
P value				0.05				

CV, critical value, LSD, least significant difference, MS, mean square, probability level=0.05.

Seedling emergence date: The impact of the priming materials on the emergence date was favorable. There were considerable differences in the priming materials. Manitol distinguished itself significantly from other priming materials. The manitol priming produced the highest emergence date (8.55), while potassium nitrate priming produced the lowest date (6.94) (Figure 1). According to this study, potassium nitrate accelerates the emergence date more quickly than other priming materials because short emergence dates are needed in drought-prone environments. Numerous writers have demonstrated that priming a seed causes it to sprout sooner than an unprimed seed. (the research [20] investigated how hydro priming affected pinto bean emergence and found that the field's significant seedling emergence percentage, mean emergence time, grains/m^2, and grain yield/m^2 values. The shortest amount of time for an emergency was 18 hours (7.11), followed by 6 hours (7.22), and the longest amount of time was 12 hours (8.4). Based on this accomplishment, 18 hours of priming time may be considered for early seedling emergencies (Figure 2). Authors [20] claim that hydro-priming seeds for 7 or 14 hours greatly increased the percentage of seedlings that emerged.

Seedling field establishment/stand count: Common bean seedling field establishment was affected by the priming substance. Manitol priming resulted in good field establishment while water priming had poor field establishment. Mannitol produced the highest field stand count (58.22), whereas water priming produced the lowest (52.22). The longest priming period, 6 hours (55.8), was followed by 18 hours (56.6) and 12 hours (55.8). different scientific authors, investigated the impact of various priming durations and water potential on the emergence of common seedlings and found that a 12 hour priming period promotes early field emergence [23]. Better seedling emergence from hydro-primed seeds after 7 and 14 hours implies that the right priming duration can enable optimum plant establishment of pinto bean cultivars in the field, according to the research [20].

Flowering date: The osmo priming manitol chemical recorded the shortest flowering date (77.77). By priming with water, the longest date (82.44) of blossoming was recorded. The earliest blossoming date is absolutely necessary to avoid the difficult conditions of a region that is prone to drought. Thus, priming with manitol may be advised to advance the common bean's flowering date. The shortest date of flowering was measured at 12 hours (77.4), and the longest at 6 hours (80.7). Because common beans must reach an early maturity stage to avoid being irritated by rainfall, priming after 12 hours helps to hasten the flowering period.

Pod per plant: While priming with manitol produced the fewest pods per plant (41.2), priming with water produced the most pods per plant (48.5). Since that yield is a trait that is correlated with pod number per plant, as pod number climbed, so did yield. According to this theory, priming with water may increase common bean output in areas that are prone to drought. The highest pod per plant registering time for priming was 18 hours, while the minimum registering length for priming was 6 hours. The yield and number of pods per plant were positively correlated, meaning that as the number of pods increased, so did the yield. Hence, priming with common bean seed could inadvertently increase the yield. The authors [8, 24] reported that, the increase in number of pods per plant and number of seeds per pod may be attributed to priming treatment.

Seed per pod: Minimum seed per plant (5.72) was obtained from priming by manitol followed by priming with potassium nitrate (5.66) while the maximum (6.77) was from hydro primed common bean seed. Minimum and maximum of seed per pod was registered from priming with duration of 18hr (6.8) and 6hr (5.7) respectively. Study [25] on soybean agrees with this study so that priming with water enhances seed per pod and pod per plant.

Grain yield: Seed priming positively enhanced the yield of common bean. Hydro Priming of the seed recorded the highest yield (7.94) followed by priming with manitol (4.64). To promote the yield of common bean at rainfall scarcity area hydro priming of common bean is may be recommended. For yield trait, 18hr (10.6) duration showed the maximum by following with 6hr (7.4). Some authors [14] showed that hydro-priming of chickpea seeds for 8, 16 and 24 hours enhanced seedling emergence, biological yield, grains/m^2 and grain yield per unit area. Beneficial effects of hydro-priming on grain yield were also reported in wheat [19], safflower [3], sunflower [17] and rice [13].

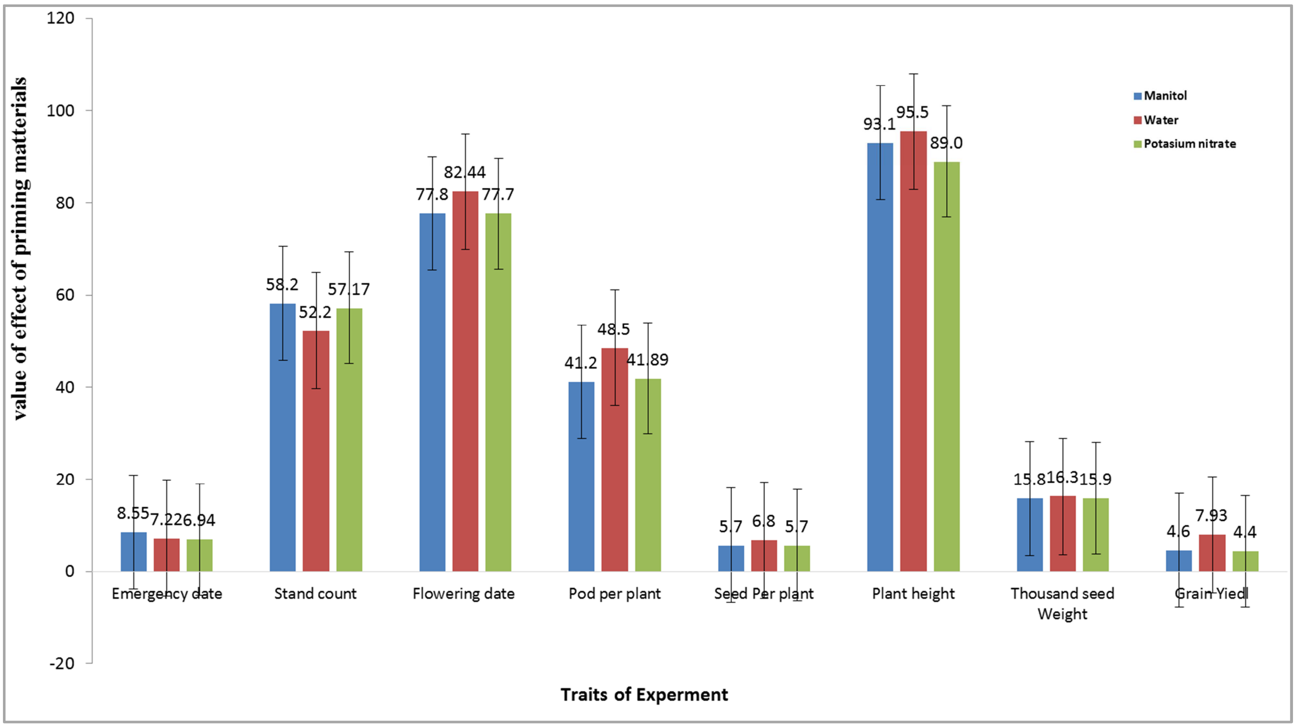

Figure 1. Graphical Representation of Mean of the Experimental Traits Priming with Manitol, Water and Potassium Nitrate on Common Bean.

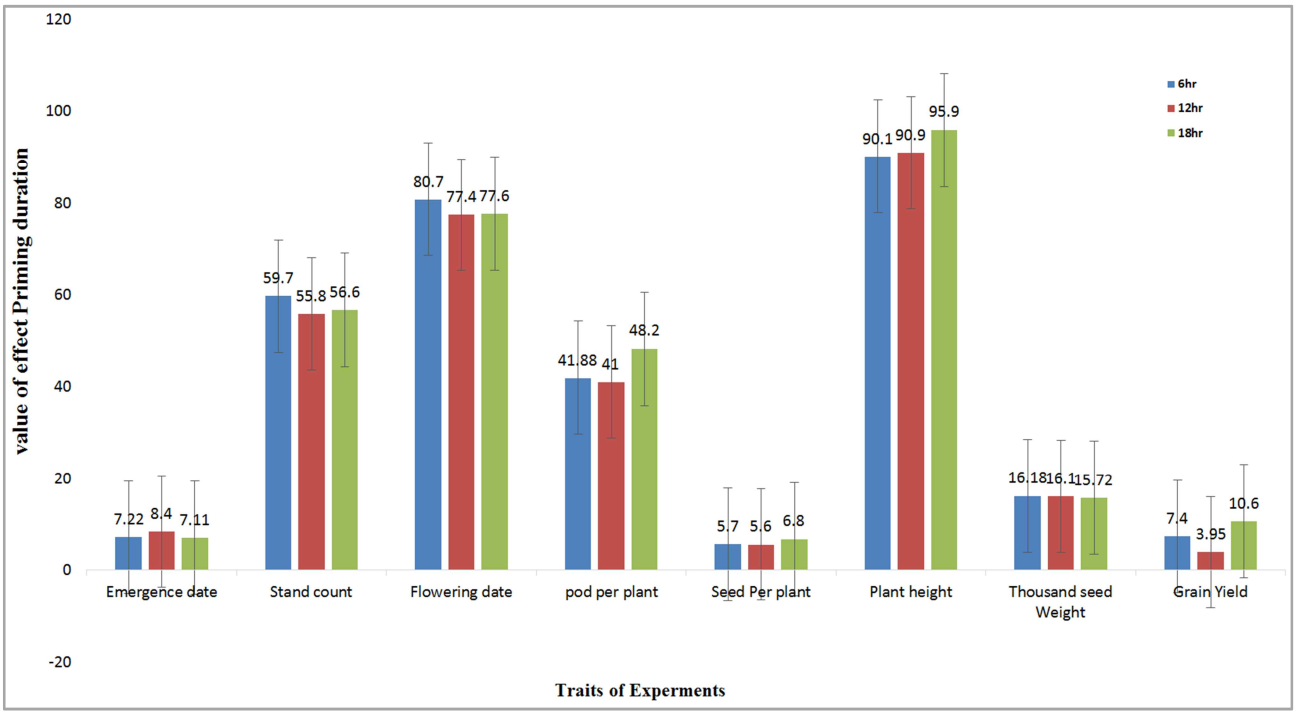

Figure 2. Graphical Representation of Mean of Experimental Traits Because of Priming Duration (6hr, 12hr and 18hr) on Common Bean.

Table 3. *Yield and Yield Component Affected by Priming Durations.*

Priming durati (hr)	MS							
	Emergence date	Stand count	Flowering date	Pod Per Plant	Seed Per Plant	Plant Height	Thousand Seed Weight	Grain Yield
6hr	7.22[a]	59.7[a]	80.7[a]	41.88[a]	5.7[a]	90.1[a]	16.18[a]	7.4[a]
12hr	8.4[b]	55.8[b]	77.4[b]	41.7[a]	5.6[a]	90.9[a]	16.1[a]	3.95[b]
18hr	7.11[a]	56.6[b]	77.6[b]	48.2[b]	6.8[b]	95.9[a]	15.72[a]	10.6[c]
Error	1.2	24.3	16.5	68.9	0.42	127.3	0.8	18.26
CV	2.03	2.03	2.03	2.03	2.03	2.03	2.03	2.03
LSD	0.75	3.34	2.75	5.6	0.44	7.6	0.64	2.89
P value				0.05				

CV, critical value, hr, hour, LSD, least significant difference, probability level=0.05.

Both graph displays that all priming materials and duration have no significant effect on thousand seed weight and plant height traits of common bean seedling.

Ground cover and vigority: 1-9 Categorical data has been recorded to estimate these traits. Recorded data has three categories. 1-3 range which is good ground cover and vigority, 4-6 which is medium and 7-9 which poor in ground cover and vigority. The data revealed that both priming material and duration enhanced the good ground cover and vigority. This result corporate with study [6, 15] so that priming seed enhanced vigority index of seedling.

4. Summery and Conclusion

On the basis of this observation, it may be concluded that common bean seed positively responded to treatment of priming duration and materials. In drought prone area early seedling germination absolutely required to escape the rainfall scarcity of an environment. Seed priming that enhance early seedling emergency may enhance yield and yield attributed traits of common bean. Based on this, priming with potassium nitrate (6.94) and 18hr (7.11) priming duration were the earlier seedling emergence promoters. Hydro priming and 6hr priming duration enhanced Pod per plant, seed per plant and seed yield parameter.

Conflict of Interest Statement

The author declares that I have no competing interests.

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