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Effect of Hydro-Priming on Early Vigour, Yield, and Yield Components of Maize (*Zea mays* L.) at Mechara, Eastern Ethiopia

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Abstract: Seed hydro-priming is a quick and inexpensive method for increasing plant vigor in moisture-stressed locations. The goal of the current study is to determine the ideal hydropriming time for maize by examining the impact of hydropriming on the early vigor, yield, and yield component of maize. The Melkasa-2 maize variety was examined for early vigor, yield, and yield components at the Mechara Agricultural Research Center using RCBD design with three replications. Before sowing, the seeds were soaked in water for 12, 24, 36, 48, and 60 hours with unprimed seed as control and dried before sowing on the surface for 3 hours. The results showed that seed hydropriming had a highly significant impact on the number of days to emergence, the days to flowering, the height of the plant, the number of days to tasselling, and the number of days to silking, while the stand count at emergence, the number of leaves per plant, and the number of days to maturity also had a significant effect. The number of ears per plant, ear length, stand count at harvest, seed weight per hundred seeds, and yield were not statistically significant. With respect to early days to emergence, stand count at emergence, early days to silking, stand count at harvest, 100 seed weight, and grain yield, the favorable effects of hydro-priming were strongest at a 36-hours soaking time. In general, the length of hydro-priming time markedly enhanced the performance of maize growth under moisture stress, particularly during the early growth stages.

Keywords: Early Vigor, Hydro-Priming, Moisture Stress, Seed, Zea Mays

1. Introduction

Maize (*Zea mays* L., 2n = 2x = 20) is one of the most important crops in the world, particularly in Africa, where it is a common staple crop. However, the productivity of maize and agriculture worldwide are under threat from climate change and worsened irregular and repeated droughts. Drought puts food security at risk, especially in sub-Saharan Africa, where maize is mostly grown by poorly resourced subsistence farmers under dry land conditions [1].

Environmental stress is one of the most important factors in reducing the yield and production of crops. To increase the yield of these products, dealing with the effects of stress is considered one of the most useful methods [3]. Among abiotic stresses, drought stress is one of the biggest environmental constraints that reduces and limits crop production [12]. It is one of the most important constraints on agricultural production in most developing countries located in arid and semi-arid regions of the world [9].

Seed priming is one of the most effective, feasible, and quick strategies to enhance seed vigor and timing of germination, which results in a uniform stand and improved yield [15]. Seed priming is influenced by many factors, such as the water potentiality of the priming agent, priming agent duration, temperature, seed vigor, and seed storage conditions [7].

Successful crop establishment and high seedling vigor are considered decisive factors for the success of most field crops, as these parameters contribute to uniform plant growth and maturity, better competition with weeds, and high productivity [6]. An important goal of seed production is to increase seed vigor in order to improve the crucial and yield-determining stage of crop establishment. Nevertheless, low vigor of the seeds or adverse environmental conditions after sowing may cause slow seed germination and unreliable seedling emergence under field conditions [8].

Priming can be done in different ways: hydro-priming, Osmo-priming, halo-priming, and hormones [22]. Seed priming is a technology that has been shown to positively influence the germination and establishment of crops [10]. It is an efficient method for increasing seed vigor and synchronization of germination, as well as the growth of seedlings of many crops under stressful conditions [2].

Hydro priming is a special type of seed priming in which seeds are soaked in water and dried before sowing to accomplish seed hydration [21]. Soaking by submerging seeds in water can be performed with or without aeration [24].

It is a very simple, economical, and environmentally friendly technique. The direct benefits of seed priming were reported to be faster emergence, better and more uniform stands, less need to re-sow, more vigorous plants, better drought tolerance, earlier flowering, earlier harvest, and higher grain yield [11]. And the indirect benefits reported were earlier sowing of crops, earlier harvesting of crops, and increased willingness to use inputs [20].

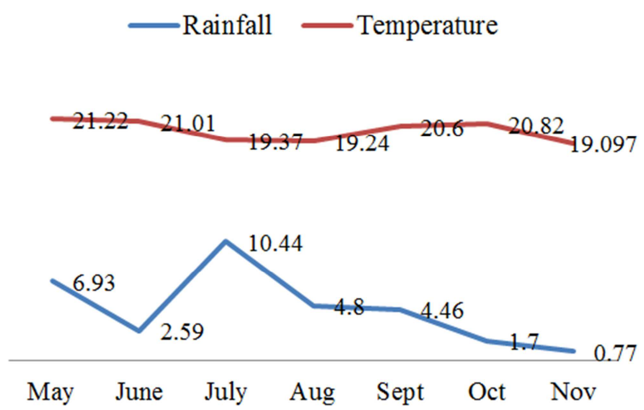
In hydropriming, the priming agent is water, and the priming duration is determined by controlling the seed imbibition [14]. It is not allow radicle protrusion and permits seeds to dry back to their initial water content. However, it is difficult to avoid the radicle growth since hydropriming is a non-controlled water uptake [23].

In Hararghe, maize is one of the major crops widely cultivated in the area. However, during the onset of cropping season, it is challenged by inconsistencies in rainfall, especially at sowing and the physiological maturity stage of many crops. Sowing maize is frequently affected by moisture stress during the cropping season, resulting in poor emergence, poor uniformity, re-sowing of seed, less vigorous plants, or even complete failure of the crop in the area. Alternatively, seed priming is an efficient, practical, and simple technique to increase rapid and uniform emergence, high seedling vigor, and yield in many field crops under unfavorable environmental conditions [17]. Therefore, this study was aimed at the following objectives: (i) to study the effect of hydro priming on early vigor of maize; (ii) to know the effect of hydro priming on yield and yield components; and (iii) to identify the optimum duration of hydro priming suitable in the area for maize.

2. Materials and Methods

2.1. Description of the Study Area

The experiment was conducted at the Mechara Agricultural Research Center of the West Hararghe Zone, Eastern Ethiopia, during the 2021 cropping season. The site is located 434 km to the east of Addis Ababa in the Daro Lebu district and 115 km from Chiro (the zone capital town) to the south, which connects to the Arsi and Bale zones. It is located at latitude of 40°19'.114"N, a longitude of 08°35'.589"E, and an altitude of 1760 m. a. s. l. The research center receives a rainfall of about 900 mm per year. The mean minimum and maximum temperatures of the area are 14 and 26°C, respectively, with an average of 20°C. The soil type is sandy clay loam, with low available phosphorous and a pH ranging from 5.3 to 6. The most commonly grown crops include maize, sorghum, groundnuts, coffee, *khat*, haricot bean, and finger millet (Mechara Agricultural Research Center, 2023).



Note: Aug = August, Sept =September, Oct = October and Nov = November

Figure 1. *The chart shows the monthly average of rainfall and temperature distribution during the cropping period.*

2.2. Experimental Design and Treatments

The experiment was carried out on clean and healthy Melkasa-2 maize variety seeds that were selected based on their yield potential and adaptation in growing areas. One-liter water-holding containers were used to soak 400 seeds of each treatment for 12, 24, 36, 48, and 60 hours, respectively, with unprimed seeds serving as the control treatment. The containers were kept on a mechanical shaker to prime the seeds uniformly. After treatment, seeds were allowed to air-dry on a paper towel for an hour (surface drying) to avoid clumping. The soaked treatments were removed simultaneously in water, dried for 3 hours, and then sown.

Seeds were then sown in a randomized complete block design with six treatments (T1 = unpriming (Control), T2 = 12 hours, T3 = 24 hours, T4 = 36 hours, T5 = 48 hours, and T6 = 60 hours of soaking) and three replications with 50 seeds per treatment per replication and ten seeds per row in each plot. The treatments were randomly assigned to the experimental units. The plot size was 9 m^2 (3m length × 3m width), with five rows of 75cm inter-row and 30cm intra-row spacing. The distance between plots, intra-blocks, and replications was 0.5m, 1m, and 1.5m, respectively. All recommended agronomic practices were followed as suggested for maize production.

2.3. Data Recorded

The data were recorded for the following parameters: days to 50% emergence; stand count at emergence; number of leaves per plant; days to 50% flowering; plant height (cm); number of ears per plant; ear length (cm); 50% days to tasselling; 50% days to silking; stand count at harvest; 75% days to maturity; hundred seed weight (g); yield (Qt/ha).

2.4. Data Analysis

All data were analyzed using analysis of variance (ANOVA), and the mean was separated by the least significant difference (LSD) at the 5% level of significance using Genstat software Version 18.

3. Results and Discussion

3.1. Analysis of Variance

The analysis of variance showed a highly significant ($P \leq 0.01$) effect on days to emergence, days to flowering, plant height, days to tasselling, and days to silking. It also significantly ($P < 0.05$) affects stand count at emergence, number of leaves per plant, and days to maturity. While it has a non-significant effect on the number of ears per plant, ear length, stand count at harvest, hundred seed weight, and yield (Table 1).

Table 1. *Effect of Hydro Priming on Early Vigour, Yield, and Yield Components of Maize.*

Trt (hours)	DE	Sce	NL	FD	Ph	NE	EL	DT	DS	Sch	DM	100SW	YLD
0	10.67a	45.67b	12.73ab	75.67a	177.53c	1.27a	27.73a	72.33a	76.33a	43.67b	142.67a	26.13a	47.9a
12	8b	47.67a	12.27b	71.67bc	180.17bc	1.27a	27.33a	69.66b	74.66ab	46.67ab	138ab	25.07a	56.4a
24	6c	47.67a	13.27a	72.33b	186.87abc	1.4a	27.07ab	69bc	72.66bc	45ab	138.67ab	24.3a	45.7a
36	4d	49.33a	12.8ab	69.67bcd	192.87ab	1.27a	26.47ab	69d	69d	49a	131.67b	28.1a	58.5a
48	5c	48a	12.93ab	67d	193.33ab	1.47a	25.67b	66d	71cd	45.67ab	135b	26.4a	52.3a
60	6c	48a	12.73ab	68.67cd	199.33a	1.4a	27.13ab	66.33d	69.66d	46.67ab	134.67b	27a	53.7a
Mean	7	47.72	12.78	70.83	188.35	1.34	26.9	68.38	72.22	46.1	136.78	26.17	52.46
CV	16.31	2.18	4.07	2.429	4.21	15.91	3.095	2.05	2.23	4.92	3.057	9.88	15.83
LSD	1.95**	1.87*	0.94*	3.09**	14.24**	0.38ns	1.49ns	2.52**	2.89**	4.08ns	7.51*	46.47ns	14.92ns

Note that: ns = non-significant, * = significant, ** = highly significant, Trt = treatment; DE = 50% days of emergence; Sce = stand count at emergence; NL = number of leaves per plant; FD = 50% flowering date. Ph = plant height (cm), NE = number of ears per plant, EL = ear length (cm), DT = 50% days to tasselling, DS = 50% days to silking, Sch = stand count at harvest, DM = 75% days to mature, 100 SW = hundred seed weight (g), and YLD = yield in quintal per hectare.

3.2. Effect of Hydro Priming on Early Vigor of Maize

Seedling vigor is the most important seed quality trait under a variety of environmental conditions because it is essential to the establishment of newly emerged seedlings in a hostile field environment. Seedling viability is significantly enhanced by priming. However, it is very dependent on the accuracy and focus of optimum priming methods [6].

The effect of hydropriming on the early vigor of maize is presented in Table 1. The days to the earliest mergence (4 days) for 36 hours of soaking and the latest days to emergence (10.67 days) were recorded for unpriming. The seed hydropriming suggested that soaking for 36 hours is the earliest day to emergence. The stand count at emergence was recorded at 49.33 plants for the 36-hour hydro priming treatment and 45.67 plants for the control (unprimed seeds), as described in Table 1.

Hydro-priming can encourage germination, especially in unfavorable growing conditions, improving the germination rate in numerous crop species [13]. According to the seedling vigor index, primed seeds resulted in more robust seedlings than non-primed seeds [5]. The potential for quick germination, uniform emergence, and proper seedling development is determined by seedling vigor [16].

3.3. Effect of Hydro Priming on Yield and Yield Components of Maize

The number of leaves was significantly influenced by seed hydropriming. The number of leaves that could be acquired after 12 hours of soaking was the lowest (12.27), and the number of leaves that could be obtained after 24 hours of soaking was the maximum (13.27) (Table 1). The study on sorghum indicated that hydroprimed seeds generated much more plants and leaves [4].

Hydropriming had a significant impact on plant height; the highest plant height (199.33 cm), which was obtained from 60 hours of seed soaking followed by 48 hours of seed hydropriming, and the shortest plant height (177.53 cm), which was obtained from unprimed seeds. This shows that hydropriming enhances plant height in a good way when compared to control. This is a result of the unprimed seed's extended emergence. The study in Bambara groundnut claims that hydroprimed seeds increased plant height, facilitating efficient field growth [5].

The days to flowering were significantly influenced by hydro-priming. The seed soaking for 48 hr, 60 hr, and 36 hr significantly shortened the number of days to flowering (67 days, 68.67 days, and 69.67 days) as compared to the latest days to flowering (75.67 days, 72.33 days, and 71 days) from unprimed, 24 hr, and 12 hr seed soaking, respectively. The study on chickpeas illustrated that primed seeds required fewer days to reach 90% physiological maturity [18].

The effect of seed hydropriming on days to tasselling was found to be highly significant. Unpriming seed produced tassels in 72.33 days, which was the longest time ever recorded. The 48-hour seed soaking produced the shortest days to tassels (66 days). The 36-hour seed soaking method produced the earliest days to silking (69 days). The unprimed treatments produced the latest silking days (76.33 days).

Days to maturity were significantly impacted by seed hydropriming. Early maturity was achieved by soaking the seeds for 36 hours (131.67 days), whereas the unprimed treatment produced late maturity. The time it took for soaked seeds to emerge and mature was considerably shorter than that of unprimed seeds [19]. The results demonstrated that seed hydropriming shortened the time to maturity, which is helpful in areas with moisture stress environment.

Ear length, stand count at harvest, and number of ears were not significantly influenced by hydropriming, but there was a numerical difference between treatments.

Seed hydropriming had no significant effect on the weight of 100 seeds; however, there was a numerical difference between treatments: 281.33g at 36 hours and 243g at 24 hours of seed soaking. In contrast to this study, hydropriming study in pinto beans enhanced the weight of the hundred seeds [8].

The hydropriming treatments had differing grain yields, although this difference was not statistically significant. The 36-hour seed soaking produced the highest grain yield (58.5 qt/ha) while unprimed seed produced the lowest grain yield (47.9 qt/ha).

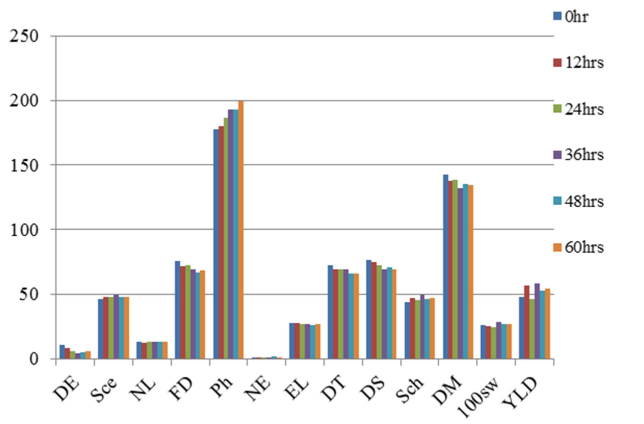


Figure 2. *The chart shows the effect of hydropriming on early vigor, yield, and yield components of maize.*

Note: DE = 50% days to emergence; Sce = stand count at emergence; NL = number of leaves per plant; FD = 50% flowering date. Ph = plant height (cm), NE = number of ears per plant, EL = ear length (cm), DT = 50% days to tasselling, DS = 50% days to silking, Sch = stand count at harvest, DM = 75% days to mature, 100sw = hundred seed weight (g), YLD = yield in quintal per hectare, hrs = hours.

4. Summary and Conclusion

Growing a profitable crop depends on seed emergence and the early stages of seedling growth since they have a substantial impact on crop stand count and yield. Hydro-priming is a simple, low-cost, easily adaptable, and environmentally friendly technique for improving maize production. This study showed that adopting a seed hydro-priming technique can reduce poor emergence, poor uniformity, re-sowing of seed, less vigorous plants, or even complete failure of the crop in areas of inconsistencies of rainfall. The results of the study indicated that maize early vigor, yield, and yield components were positively enhanced by seed hydro-priming technique under moisture stress environment. The results of this study showed that seed hydro-priming for 36 hours of soaking resulted in early emergence days, silking days, maturity days, and a greater stand count at emergence. The effect of hydropriming on the early vigor, yield, and yield components of maize was studied in the field. Therefore, it is essential to conduct the present outcomes under the greenhouse in order to validate the current findings.

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