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Effect of seed priming on growth and yield parameters of maize

Efecto del remojado de semillas sobre los parámetros de crecimiento y rendimiento del maíz

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Abstract

Maize is the principal food crop of people living in inner Terai region of Nepal. This region receives comparatively less rainfall that results in insufficient seedling emergence and inappropriate stand establishment. So seed priming is simple cost-effective and easily implementable technique that ensures better germination and crop establishment as well as enhancing production. The study was conducted from February 2021 to May 2021 in farmer's field, Hadiya-9, Udaipur to examine how the growth and yield parameters were affected by seed priming. The experiment was laid out in single factor randomized complete block design with 3 replications and 7 treatments namely T1: control, T2: hydro priming for 6 h, T3: hydro priming for 12 h, T4: zinc sulphate priming (0.5 % for 12h), T5: zinc sulphate priming (1 % for 12 h) and T6= zinc sulphate priming (2 % for 12 h), T7= cow urine priming (2 times dilution). Results showed that there was a significant effect on the germination percentage, germination index, days to 100 % germination, leaf number, days to tasseling and silking, cob length, kernel per cob, cob girth, total plant population per hectare, 1000 grain weight, grain yield, biological yield and harvest index of corn. Hydro priming for 18 h (T3) and Cow urine priming 2.5 times dilution for 12 h (T7) were found to be most effective priming solution showing higher influence in germination percentage, germination index, days to 100 % germination, leaf number, days to tasseling and silking, plant height, cob length, kernel per cob, total plant population per hectare and harvest index. To sum up, the result indicate that the findings suggest that using hydro priming for 18 h and cow urine priming 2.5 times dilution for 12 h as seed priming agents can significantly improve the growth and yield parameters of corn. This study clarifies the potential of several compounds used during seed priming to improve corn development and production.

Key Words: *Zea Mayz, corn, Seed priming, germination percentage, crop establishment, yield*

Resumen

El maíz es el principal cultivo alimentario de las personas que viven en la región interior de Terai de Nepal. Esta región recibe comparativamente menos lluvia, lo que resulta en una emergencia insuficiente de plántulas y un establecimiento inadecuado de rodales. Por lo tanto, la preparación de semillas es una técnica sencilla, rentable y de fácil ejecución que garantiza una mejor germinación, establecimiento del cultivo y también mejora la producción. El estudio se llevó a cabo entre febrero de 2021 y mayo de 2021 en el campo del agricultor, Hadiya-9, Udyapur, para examinar cómo los parámetros de crecimiento y rendimiento se vieron afectados por la preparación de semillas. El experimento se distribuyó en un diseño de bloques completos al azar de un factor con tres repeticiones por tratamiento, detallados a continuación, T1: control, T2: hidrocebado durante 6 h, T3: hidrocebado durante 12 h, T4: remojado con sulfato de zinc al 0.5 % durante 12 h, T5: remojado con sulfato de zinc al 1 % durante 12 h, T6 = remojado con sulfato de zinc al 2 % durante 12 h y T7 = remojado

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con orina de vaca (dilución 2 veces). Los resultados mostraron que hubo un efecto significativo en el porcentaje de germinación, índice de germinación, días hasta el 100 % de germinación, número de hojas, días hasta la formación de borlas y estrías, longitud de la mazorca, grano por mazorca, circunferencia de la mazorca, población total de plantas por hectárea, peso de 1000 granos, rendimiento de grano, rendimiento biológico e índice de cosecha de maíz. Se descubrió que la imprimación hídrica durante 18 h (T3) y la imprimación con orina de vaca durante 12 h diluido 2.5 veces (T7) fueron las soluciones de imprimación más efectivas y mostraron una mayor influencia en el porcentaje de germinación, el índice de germinación, los días hasta el 100 % de germinación, el número de hojas y los días hasta formación de panojas y estrías, altura de la planta, longitud de la mazorca, grano por mazorca, población total de plantas por hectárea e índice de cosecha. En resumen, el resultado indica que los hallazgos sugieren que el uso de hidrocebado durante 18 h y remojado con orina de vaca durante 12 h diluido 2.5 veces como agentes de cebado de semillas puede mejorar significativamente los parámetros de crecimiento y rendimiento del maíz. Este estudio aclara el potencial de varios compuestos utilizados durante la preparación de semillas para mejorar el desarrollo y la producción del maíz.

Palabras clave: *Maíz, remojado de semillas, porcentaje de germinación, establecimiento del cultivo, rendimiento.*

Introduction

Maize (*Zea mays* L.), is a significant grain crop that is grown all over the world. It is significant staple food crop that supplies the majority of the raw ingredients needed by livestock and several agro-allied businesses worldwide (Dowswell, 1996). It is the third important crop worldwide after wheat and rice in terms of production and productivity. Since maize has a higher productive potential than other members of the poaceae family, it is known as the “Miracle crop” or the “Queen of the Cereals” throughout the world (Malhotra, 2017).

In Nepal, corn is the second most important staple food crops both in term of area and production after rice. In 2021/2022 maze was cultivated in an area of 979 776 hectares and the production of 2 997 733 metric ton. Out of total corn cropping area, about 80 % of the land is in mid hills of the country while rest 20 % of the land is in Terai and inner Terai region.

Despite the great marketing potential, the rising output of corn cannot keep up with the quicker pace of rise in demand. The amount produced and the demand for maize are very different (Shrestha, 2019). So, seed priming can be a better solution to that problem. Seeds are hydrated sufficiently to allow them to grow, while preventing the emergence of radicles (Nawaz et al., 2013). Among the many methods of seed priming, hydro-priming, bio-priming, solid matrix priming, osmo-priming, and chemical priming are some of the most popular (Waqas et al., 2019). Based on the species, seed morphology, and physiology of the plant, various priming treatments can be applied (Paparella et al., 2015). Each of these methods facilitates the pre-germination process. Seed priming improves germination rate, crop establishment, growth and yield of corn (Bakht et al., 2011). During priming, dormant seeds are given conditions that are similar to abiotic stress. The process involves partially hydrating the seeds, which weakens the endosperm, channels energy stores, causes radicle protrusion (germination), and replenishes the antioxidant system (Banerjee & Roychoudhury, 2018).

Materials and methiod

Experiment Site

The experiment was carried out at Hadiya, Triyuga Municipality-11, Udayapur. The research site was located at coordinates of 26º 46’ 26” N and 86º 49’ 36” E and an altitude of 123 m from the sea level. The texture of soil was sandy loam to sandy clay with pH of 6.5. The climate of the research site was characterized by three distinct seasons namely rainy monsoon (June-October), cool winter (November-February), and hot spring(March-May).

Plant Material

Registered variety of corn namely PL3300 was used for this research. PL 3300: It is highly popular variety. Its coverage is larger in terai, inner terai, tars and foot hills. It has deep orange, bold and shiny kernel, sturdy and hardy stem, pink tassel and silk.

Experimental design

The experiment was conducted using a single-factor Completely Randomized Block Design (RCBD) which was designed according to our land topography and three replications of each treatment was be done. Maize (var PL3300) seed were placed in plastic bowls and were submersed in water, zinc sulphate solution and cow urine respectively (Table 1). Then the primed seed were surface dried under the shade for 2 h. Seeds were sown at a depth of 3 cm to 5 cm in a well-prepared plot. Each plot contained single bed of 12 m^2 area and each bed contained 28 plants. Five plants were taken from these as sample plant leaving the plant at the boundary. The space between each plot was kept 50 cm. Two weeks prior to sowing, FYM was integrated at a rate of 15 $t.ha^{-1}$. Analogously, chemical NPK was administered at the recommended rate of 120:60:40 kg. ha^{-1}. During field preparation, half of the urea and the entire dosage of other chemical fertilizers were applied. Half of the leftover nitrogen dosage was divided into two halves, which were top-dressed during the knee-high stage and earthing up. Irrigation and weeding were carried out during critical stages, specifically at the knee-height and tasseling stages. Additionally, chemical pesticides such as Emmamectin benzoate were applied at recommended doses to manage Cutworm (*Agrotis ipsilon*) and Fall Armyworm (*Spodoptera frugiperda*).

Treatment Details

The total of 7 treatments will be done on each replication (Table 1):

Table 1: Treatment Details

Treatments	Treatment details
T1	Control (no priming)
T2	Hydro priming for 6 h
T3	Hydro priming for 18 h
T4	Zinc sulphate priming 0.5 % for 12 h
T5	Zinc sulphate priming 1 % for 12 h
T6	Zinc sulphate priming 2 % for 12 h
T7	Priming with cow urine 2.5 times dilution for 12 h

Parameter recorded

Data the different parameters were recorded following the procedures as below:

Germination percentage

Germination percentage was calculated by dividing the number of healthy seedlings by the total number of seeds in the test and multoplying by 100 (Carpýcý et al., 2009).

$$\text{Germination percentage} = \frac{\text{Number of seed germinated}}{\text{Number of seed sown}} \times 100$$

Germination index

The germination index (GI) was calculated by following formula (Alvarado et al., 1987; Ruan et al., 2002; Atik et al., 2007).

$$GI = \frac{\text{Number of germinated seed}}{\text{Days of first count}} + \cdots + \frac{\text{Number of germinated seeds}}{\text{Days of final count}}$$

Days to full germination

Days to full germination was calculated when nearly 100 % of the seeds had germinated.

Tasseling Days

The date of panicle emergence was recorded for each plot from the time of panicle emergence until all plants had flowered. For every phenological observation, the mid three rows will be taken for data collection.

Silking Days

The date was noted from the start of silk production until almost 100 % silking of each plot. A silk that was visible one centimeter from a closed ear was said to have emerged. The same rows as that of tasseling records was taken for days of silking.

Leaf Number

Five sample plant were taken from each plot then, the number of leaves on each plant will be counted. They will be counted at an interval of 15, 30, 45, 60, 75 and 90 days after sowing (DAS). Finally, average data will be taken from it.

Plant Height

Five plants were randomly selected and tagged in sampling rows of each plot. The plant height was recorded at 15, 30, 45, 60 and 75 days after sowing (DAS). It was measured from ground surface to the ligules of the uppermost leaves.

Number of harvested ears

Total number of ears harvested from the net harvestable area was recorded.

Kernel per cob

kernel per column of the sample plant cob was calculated and was multiplied for number of kernel rows per cob

Kernel per cob = number of Kernels per row number of Kernels per column

Ear length

Length of the ear was measured from base to the tip of the ear and was recorded in centimeter at the time of harvest.

Ear girth

To calculate the ear girt middle diameter of ear without husk was measure using Vernier caliper and was recorded on millimeter.

Thousand Grain Weight or Test Weight

One thousand shelled maize grains from each plot was randomly taken, weighed and recorded as test weight and expressed in gram (g).

Fresh Stover yield

Stover was cut down from the net harvested area and was weighted using weighing machine.

Biological yield

Biological yield was calculated using following formula:

Biological yield = Grain yield + Stover yield

Harvest index

Harvest index was calculated using formula:

$$\mathrm{HI} = \frac{\text{Economic yield(Grain yield)}}{\text{Biological yield(Grain yield+stover yield)}}$$

Using the Agricolae software, the data were analyzed using Duncan's Multiple Range Test (DMRT) at the 5 % level of significance for the separation of means. The gathered data were analyzed using R studio version 3.5.3 after being imported into MS Excel version 2016 in compatibility mode.

Table 2: Effect of maize seed priming on the germination percentages (%), Germination index, Days to 100 % germination

Treatment	Germination percentage (%)	Germination Index	Days to 100 % germination
T1	72.61^{d}	7.88^{c}	13.00^{a}
T2	85.71^{c}	12.10^{b}	12.33^{ab}
T3	100.00^{a}	16.68^{a}	10.66^{c}
T4	94.42^{ab}	12.87^{b}	12.33^{ab}
T5	88.09^{bc}	12.78^{b}	12.66^{a}
T6	90.47^{bc}	11.84^{b}	12.33^{ab}
T7	95.23^{ab}	16.42^{a}	11.33^{bc}
LSD(0.05)	8.732 121	2.228 859	1.306 9
SEM (±)	2.833 902	0.676 630 7	0.396 745 1
F-probability	<0.001	<0.001	<0.05
CV %	5.466 242	9.680 38	6.073 706
Grand Mean	89.7	12.942 43	12.095 24

Note: The common letter(s) within the column indicate non-significant difference based on Duncan Multiple Range Test (DMRT) at 0.05 level of significance, ** significant at 1 % level of significance, *** significant at 0.1 % level if significance. (SEM-Standard Error of mean, CV- Coefficient of Variation, LSD-Least Significance Difference).

Result y discussion

Germination Percentage

Analysis of variance revealed that the seed priming has significant ($p < 0.05$) influence on the germination percentage of PL-3300 maize variety (Table 2). The highest germination percentage was recorded on T3, hydro priming for 18 h (100.00 %) which was significantly higher (with $p < 0.05$) other treatment and statistically similar (at par) with treatment T7, cow urine priming 2.5 times dilution for 12 h (95.23 %) and T4, Zinc sulphate priming 0.5 % for 12 h (94.4 %). The lowest germination percentage was recorded for T1, no priming i.e. control (76.61 %) respectively.

This outcome supports (Harris, 2006) findings that the ideal priming time for maize seeds is 18 h. According to the results of the current study, priming maize seeds requires an 18 h soaking in water for enhancing better emergence. During initial stage, seed are inactive and has low moisture. During seed priming, water imbibition occurs, resulting in enzyme activation, translocation, utilization of reserved food materials, and a change in seed biochemistry (Alam, Amin, Ara, & Ali, 2013). Activity of hydrolytic enzyme (α-amylase, endoxylanase, and phytase) was found maximum in hydro primed seed (Fincher, 1989). Hydro priming should be done up to safe limit otherwise it may damage the seed and affects the germination process (Prasad et al., 2012). This research shows that hydro primed for 18 h maize germinates better than hydro primed for 6 h maize. Higher the hydro priming duration, higher is the water imbibition process. This result is supported by (Adhikari et al., 2021).

Germination Index

Analysis of variance revealed that the germination index of PL-3300 maize variety is significantly ($p < 0.05$) influenced by seed priming (Table 2). The highest germination index was recorded on T3, hydro priming for 18 h (10.66) which was significantly higher than other treatment and statistically similar (at par) with treatment T7, cow urine priming 2.5 times dilution for 12 h (11.33). The lowest germination index was recorded for T1, no priming i.e. control (7.88).

The study of Prasad et al. (2012) showed that the highest germination index was recorded on hydro priming for 48 h rice. Hydro priming of seed enhances the germination speed and uniformity of seed that results in higher germination index (Moreno et al., 2017). It appears that primed seeds reduced emergence time by around 50 %. When seeds are primed with water, their metabolism, and germination are revived and they quickly absorb water. Consequently, there is higher germination velocity that affects germination index (Meena et al., 2013). Grains needs to absorb water in order to break seed dormancy and to activate metabolism (Fincher, 1989). During the germination period or sprouting period there is rapid absorption of water that initiate metabolism, where protein is synthesized using existing mRNA and then the lag phase starts (Bewley & Black, 1994).

Days to 100 % germination

The analysis of variance demonstrated a significant ($p < 0.05$) influence of seed priming on the number of days required for 100 % germination of the PL-3300 corn variety (Table 2). The earliest days to 100 % germination was recorded on T3, hydro priming for 18 h (10.66) which was significantly higher than other treatment and statistically similar (at par) with treatment T7, cow urine priming 2.5 times dilution for 12 h (11.33). The lowest germination index was recorded for T1, no priming i.e. control (13.00) which was statistically similar to T2, T4, T5, T6 respectively.

Plant Height

The analyzed data (Table 3) revealed that seed priming does not have significant($p>0.05$) influence on plant height of maize at 15 DAS, 45 DAS, 60 DAS and 75 DAS. But at 30 DAS there was significant influence of seed priming. Highest plant height was recorded in the treatment T7, cow urine priming 2.5 times dilution for 12 h (13.28 cm) which was statistically similar to treatment T3, T4, T5 and T7. The lowest plant height was recorded in the treatment T2 (9.56 cm)

The study of (Kumar, 2014) shows that seed primed with cow urine has the potential

Table 3: Effect of maize seed priming on plat height at 15, 30, 45, 60 and 75 DAS.

Treatment	Plant height at 15DAS	Plant height at 30DAS	Plant height at 45DAS	Plant height at 60DAS	Plant height at 75DAS
T1	1.32[b]	9.86[bc]	59.06[ab]	134.40[b]	182.86[a]
T2	1.30[b]	9.56[c]	57.33[b]	141.33[ab]	181.86[a]
T3	1.55[ab]	12.13[ab]	60.93[ab]	153.00[ab]	185.20[a]
T4	1.34[b]	11.81[abc]	61.26[ab]	154.93[a]	191.20[a]
T5	1.25[b]	11.03[abc]	52.86[b]	145.60[ab]	195.33[a]
T6	1.44[ab]	9.86[bc]	56.20[b]	148.60[ab]	188.06[a]
T7	1.82[a]	13.28[a]	70.60[a]	160.06[a]	191.00[a]
LSD (0.05)	0.439 940 4	2.393 655	11.987 04	19.061 98	23.090 76
SEM (±)	0.133 555 9	0.726 659	3.890 244	5.786 781	7.009 826
F-probability	ns	< 0.05	ns	ns	ns
CV %	17.230 41	12.142 56	11.276 71	7.226 404	6.906 532
Grand Mean	1.435 238	11.080 95	59.752 38	148.276 2	187.933 3

Note: DAS-Days after sowing, the common letter(s) within the column indicate non-significant difference based on Duncan Multiple Range Test (DMRT) at 0.05 level of significance, ** significant at 1 % level of significance, *** significant at 0.1 % level if significance. (SEM-Standard Error of mean, CV- Coefficient of Variation, LSD-Least Significance Difference)

Table 4: Effect of maize seed priming on Leaf number at 15, 30, 45, 60 and 75 DAS

Treatment	Leaf number at 15DAS	Leaf number at 30DAS	Leaf number at 45DAS	Leaf number at 60DAS	Leaf number at 75DAS
T1	1.86[b]	4.03[a]	8.33[a]	12.26[c]	14.13[a]
T2	2.00[b]	5.06[a]	8.12[a]	12.93[bc]	14.33[a]
T3	3.20[a]	5.13[a]	8.46[a]	13.86[ab]	14.66[a]
T4	1.93[b]	5.13[a]	7.93[a]	14.06[ab]	14.66[a]
T5	2.00[b]	4.93[a]	8.33[a]	13.33[abc]	14.13[a]
T6	2.66[ab]	4.86[a]	7.60[a]	13.60[abc]	14.26[a]
T7	2.73[ab]	4.86[a]	8.60[a]	14.46[a]	14.86[a]
LSD (0.05)	0.945 079 2	0.690 102 6	1.011 823	1.246 705	0.892 036 9
SEM (±)	0.286 904 5	0.209 499 4	0.307 166 5	0.378 471 2	0.289 499 6
F-probability	< 0.1	ns	ns	< 0.05	ns
CV %	22.675 04	7.773 156	6.936 12	5.189 224	3.472 951
Grand Mean	2.342 857	4.990 476	8.2	13.504 76	14.438 1

Note: DAS-Days after sowing, the common letter(s) within the column indicate non-significant difference based on Duncan Multiple Range Test (DMRT) at 0.05 level of significance, ** significant at 1 % level of significance, *** significant at 0.1 % level if significance. (SEM-Standard Error of mean, CV-Coefficient of Variation, LSD-Least Significance Difference).

to enhance crop growth and development. This potential of urine is due to presence of nutrient like nitrogen, phosphorous, manganese, iron and other micronutrient Schouw et al. (2002). Likewise, the research conducted by Tian et al. (2014) in maize revealed that there is no any influence of priming treatment on plant height, which was found symmetrical to this research.

Leaf number

Leaf number of corn was significantly ($p < 0.05$) influenced by seed priming at 15 DAS and 60 DAS (Table 4). But at 30, 45 and 75 DAS there was no significant influence of seed priming. At 15 DAS highest leaf number was recorded in the treatment T3, hydro priming for 18 h (3.20) which was statistically similar to treatment T6 and T7. The lowest leaf number was recorded in the treatment T2 (1.86). Whereas at 60 DAS highest leaf number was recorded in the treatment T7, cow urine priming 2.5 times dilution for 12 h (14.46) which was statistically similar to treatment T3, T4, T5, T6. Lowest leaf number was recorded in treatment 1, control (12.26).

Tasseling Days

The days to tasseling of PL-3300 corn variety was significantly ($p < 0.05$) influenced by seed priming (Table 5). Earliest days to tasseling was recorded in the treatment T3, hydro priming for 18 h (64.66), which is statistically similar to treatment T3. The lowest plant height was recorded in the treatment T1, no priming (70).

Table 5: Effect of maize seed priming on Tasseling days and silking days

Treatment	Days to 100 % tasseling	Days to 100 % silking
T1	70.00[a]	73.00[a]
T2	68.00[bc]	71.00[bc]
T3	64.66[d]	67.66[d]
T4	69.00[ab]	72.00[ab]
T5	67.33[c]	70.33[c]
T6	67.33[c]	70.33[c]
T7	65.66[d]	68.66[d]
LSD (0.05)	1.326 514	1.326 514
SEM (±)	0.402 554 3	0.402 699 2
F-probability	< 0.001	< 0.001
CV %	1.105 445	1.058738
Grand Mean	67.428 57	70.428 57

Note: The common letter(s) within the column indicate non-significant difference based on Duncan Multiple Range Test (DMRT) at 0.05 level of significance, ** significant at 1 % level of significance, *** significant at 0.1 % level if significance. (SEM-Standard Error of mean, CV-Coefficient of Variation, LSD-Least Significance Difference).

Silking days

Leaf number at 30 days of PL-3300 corn variety was not significantly ($p < 0.05$) influenced by seed priming (Table 5). Earliest days to silking was recorded in the treatment T3, hydro priming for 18 h (67.66) and cow urine priming (68.66). The lowest plant height was recorded in the treatment T1, no priming (73.00).

Table 5 shows that hydro priming for 18 h has a significant effect on days to tasseling and silking period. This finding is similar with the study of Koirala (2017) who concluded that priming treatment reduces the silking period i.e. primed treatment silked three days earlier than the non-primed one.

Harvested ear

Harvest index of PL-3300 corn variety was not significantly ($p < 0.05$) influenced by seed priming (Table 6). However, the highest harvest index was recorded in the treatment T7, cow urine priming for 12 h (1.13). The lowest plant height was recorded in the treatment T1, no priming (1).

Cob weight

The cob weight of PL-3300 corn variety was not significantly ($p > 0.05$) influenced by seed priming (Table 6). Highest cob weight was recorded in the treatment T7, cow urine priming (328.76). The lowest plant height was recorded in the treatment T1, no priming (249.26).

Cob length

The cob length of PL-3300 corn variety was significantly ($p < 0.05$) influenced by seed priming (Table 6). Highest cob length was recorded in the treatment T7, cow urine priming 2.5 times dilution for 12 h (21.99) which was

Table 6: Effect of maize seed priming on Harvested ear, cob weight (g), cob length(cm), kernel per cob and cob girth

Treatment	Harvested ear	Cob Weight	Cob Length	Kernel per cob	Cob girth
T1	1.00[a]	249.26[a]	15.55[C]	450.17[b]	46.39[c]
T2	1.O6[a]	298.90[a]	18.89[c]	505.31[ab]	46.51[c]
T3	1.06[a]	315.10[a]	20.11[abc]	600.00[a]	48.39[ab]
T4	1.06[a]	294.93[a]	19.44[abc]	549.33[ab]	46.87[bc]
T5	1.06[a]	296.76[a]	19.39[abc]	509.81[ab]	47.05[abc]
T6	1.00[a]	303.13[a]	21.50[ab]	585.52[a]	48.65[a]
T7	1.13[a]	328.76[a]	21.99[a]	603.33[a]	48.39[ab]
LSD (0.05)	0.567 013 5	98.078 85	2.517 57 4	109.375 5	1.562 813
SEM (±)	0.054 433 02	31.830 28	0.817 047 5	33.203 92	0.474 434 3
F-probability	ns	ns	< 0.1	< 0.1	< 0.05
CV %	9.534225	18.492 87	7.081 741	11.315 19	1.851 636
Grand Mean	1.057 143	298.123 8	19.983 33	543.355 2	47.443 55

Note: The common letter(s) within the column indicate non-significant difference based on Duncan Multiple Range Test (DMRT) at 0.05 level of significance, ** significant at 1 % level of significance, *** significant at 0.1 % level if significance. (SEM-Standard Error of mean, CV-Coefficient of Variation, LSD-Least Significance Difference).

statistically similar to treatment T3, T4, T5 and T6. The lowest plant height was recorded in the treatment T1, no priming (15.55).

Kernel per cob

The kernel per cob of PL-3300 corn variety was significantly ($p < 0.05$) influenced by seed priming (Table 6). Highest kernel per cob was recorded in the treatment T7, cow urine priming 2.5 times dilution for 12 h (606.33) which was statistically similar to treatment T6. The lowest kernel per cob was recorded in the treatment T1, no priming (450.17).

During hydro priming, seeds imbibe water, which reduces the lag period of radicle emergence, improving germination rate and uniformity (Karmore & Tomar, 2015). Seed priming technology significantly influence the grain yield on maize (Koirala, 2017). Research conducted by Kumar (2014) shows that there is relative increase in yield of maize due to hydro priming followed by cow urine but in contrast, the result of this study shows that the yield or the kernel per cob is relatively higher in cow urine primed seed (603.33) as compared to hydro primed seed (600).

Cob girth

The cob girth of PL-3300 corn variety was significantly ($p < 0.05$) influenced by seed priming (Table 6). Highest cob girth was recorded in the treatment T6, zinc sulphate priming 2 % for 12 h (48.65) which was statistically similar to treatment T3, T5 and T7. The lowest plant height was recorded in the treatment T1, no priming (46.39).

Total Plant population per hectare

The plant population per hectare of PL-3300 corn variety was significantly ($p < 0.05$) influenced by seed priming (Table 7). Highest plant population per hector was recorded in the treatment T7, cow urine priming for 12 h (82 828.28) cow urine priming which is statistically similar to T2, T3, T4, T5 and T6. The lowest plant population per hector was recorded in the treatment T1, no priming (63 636.36).

1000 grain weight

The 1000 grain weight of PL-3300 corn variety was significantly ($p < 0.05$) influenced by seed priming (Table 7). Highest 1000 grain weight was recorded in the treatment T6, zinc sulphate priming 2 % for 12 h (48.65) which was statistically similar to treatment T2, T3, T4, T5 and T7. The lowest plant height was recorded in the treatment T1, no priming (46.39).

Grain yield (kg/ha)

The grain yield ($kg.ha^{-1}$) of PL-3300 corn variety was significantly ($p < 0.05$) influenced by seed primin (Table 7). Highest 1000 grain weight was recorded in the treatment T6, zinc sulphate priming 2 % for 12 h (48.65) which was

Table 8: Effect of seed priming on Stover weight, Biological yield and harvest index.

Treatment	Stover weight (kg/ha)	Biological yield (kg/ha)	Harvest index
Control	3 490.667[a]	6 363.095[a]	0.451 436 5[c]
Hydro priming for 6 h)	2 833.333[b]	5 911.523[ab]	0.520 050 1[b]
Hydro priming for 18 h	2 383.333[d]	5 601.440[b]	0.573 628 0[ab]
Zinc sulphate priming 0.5 % for 12 h	2 683.333[bc]	6 296.502[a]	0.572 364 2[ab]
Zinc sulphate priming 1 % for 12 h	2 600.000[c]	5 900.412[ab]	0.559 207 1[ab]
Zinc sulphate priming 2 % for 12 h	2 650.000[bc]	6 065.638[a]	0.562 391 1[ab]
Priming with cow urine 2.5 times dilution for 12 h	2 500.000[cd]	6 179.012[a]	0.594 716 5[a]
LSD (0.05)	176.936 1	420.087 3	0.049 572 98
SEM (±)	43.857 09	104.126 9	0.012 287 64
F-probability	< 0.001	< 0.05	< 0.001
CV %	3.637 333	3.906 088	5.087 917
Grand Mean	2 734.381	6 045.374	0.547 684 8

Note: The common letter(s) within the column indicate non-significant difference based on Duncan Multiple Range Test (DMRT) at 0.05 level of significance, ** significant at 1 % level of significance, *** significant at 0.1 % level if significance. (SEM-Standard Error of mean, CV- Coefficient of Variation, LSD-Least Significance Difference).

statistically similar to treatmentT2, T3, T4, T5 and T7. The lowest plant height was recorded in the treatment T1, no priming (46.39).

Table 7: Effect of maize seed priming on Total plant population per hector, 1000 grain weight, and Grain yield

Treatment	Total Plant population per hector	1000 grain weight(gm)	Grain yield(kg/ha)
T1	63 636.36[b]	371.66[b]	2 872.428[c]
T2	77 777.78[a]	400.00[ab]	3 078.189[bc]
T3	75 757.58[a]	420.00[a]	3 218.107[abc]
T4	78 787.88[a]	396.66[ab]	3 613.169[ab]
T5	77 777.78[a]	391.00[ab]	3 300.412[abc]
T6	73 737.37[a]	430.00[a]	3 415.638[abc]
T7	82 828.28[a]	416.00[a]	3 679.012[a]
LSD(0.05)	9 924.052	35.814 36	513.898 2
SEM(±)	3 012.716	10.872 42	156.007 7
F-probability	<0.05	<0.1	<0.1
CV %	7.363 574	4.987 826	8.724 578
Grand Mean	75 757.58	403.619	3 310.994

Note: The common letter(s) within the column indicate non-significant difference based on Duncan Multiple Range Test (DMRT) at 0.05 level of significance, ** significant at 1 % level of significance, *** significant at 0.1 % level if significance. (SEM-Standard Error of mean, CV- Coefficient of Variation, LSD-Least Significance Difference).

Stover weight

The Stover weight of PL-3300 corn variety was significantly ($p < 0.05$) influenced by seed priming (Table 8). Highest Stover weight was recorded in the treatment T1, control 0.5 % for 12 h (3 490.667) which was statistically similar to treatmentT2, T3, T4, T5, and T7. The lowest Stover weight was recorded in the treatment T3, hydro priming for 18 h (2383.333).

Biological yield

The grain yield (kg.ha^{-1}) of PL-3300 corn variety was significantly ($p < 0.05$) influenced by seed priming (Table 8). Highest biological yield was recorded in the treatment T4, zinc sulphate priming 0.5 % for 12 h (6 296.502) which was statistically similar to treatment T1, T2, T4, T5 and T6. The lowest biological yield was recorded in the treatment T1, no priming (5 601.440).

Zn concentration in maize seed can be safely and successfully increased from 15 mg/kg to 560 mg/kg by priming it for 16 hours with 1 % Zn solutions, as reported by Harris et al. (2007). Priming with 1 % zinc is an appealing alternative for resource-poor maize farmers in zinc- deficient areas of Pakistan and other places, since priming maize seeds with water boosted output by 14 % at no additional expense and adding little amounts of $ZnSO_4$ to the priming water doubled that yield gain (Harris et al., 2007). Table 7 shows that highest 1000 grain yield of maize was recorded in Zinc sulphate priming 2 % for 12 h and this result is in accordance with Sharma & Parmar (2018) in maize.

Harvest index

The harvest index of PL-3300 corn variety was significantly ($p < 0.05$) influenced by seed priming (Table 8). Highest harvest index was recorded in the treatment T7, cow urine priming for 12 h (0.594 716 5) which was statistically similar to treatment T3, T4, T5, and T6 and the lowest harvest index was recorded in the treatment T1, no priming (0.451 436 5[c]).

Kumar (2014) mentioned that cow urine priming also enhanced yield in low fertility acidic soil of India. On the other hand, Rehman et al. (2015) mentioned that seed priming technology enhance grain rows and 1000-grain weight, grain and biological yield and harvest index; however, my finding was not in line with Rehman et al. (2015) because it was no significant effect of seed priming on the harvest index of corn.

Conclusion

To sum up, the purpose of this study was to assess how different priming solutions affected the growth and yield characteristics of maize. The findings from this study emphasize the positive impact of seed priming on maize/corn production. Priming treatments significantly enhanced key parameters such as germination, plant growth, and yield, with hydro priming for 18 hours showing the most promising results. Notably, cow urine priming and zinc sulfate priming also demonstrated beneficial effects on specific yield parameters. Overall, seed priming emerges as a cost-effective and easily adoptable strategy for improving maize/corn yield, offering potential benefits for farmers in regions with limited rainfall offering a promising avenue to boost corn yields and ensure food security in vulnerable regions This study highlights the knowledge gap and highlights the need for more research to fully comprehend the benefits and constraints of seed priming in the context of corn production.

Conflict of interest

The authors declare no irreconcilable circumstances.

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Authors contribution

Conceptualization - ED; methodology - ED; formal analysis - ED and SD; investigation- SD; literature and field experiment review - ED and SC; literature - ED; resources - ED and AK; data curation – ED and SC; writing—original draft preparation - ED; writing—review and editing – SC, AK and SD; visualization – ED. All authors have read and agreed to the published version of the manuscript.

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