Journal of Agriculture, Food, Environment and Animal Sciences
Tarım, Gıda, Çevre ve Hayvancılık Bilimleri Dergisi
http://www.jafeas.com, ISSN: 2757-5659

J. Agric. Food, Environ. Anim. Sci.
2(1): 34-43, 2021

Assessment of Silicon Priming Under Different Water Levels (Irrigation Regimes) in Hybrid Maize

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Research Article

History:
Received: 19 September 2020
Accepted: 11 January 2021
Available online: 1 June 2021

Keywords:
Silicate priming
Hydropriming
Maize
Germination parameters

ABSTRACT

The Silicon nutrient has a best ability to increase the biotic and abiotic sufferance in many crops. In deficient condition of water, the effect of Sodium Silicate (SS) in the seed growth and in seedling were investigated. Two type of priming were performed in this experiment, hydro priming and silicate priming. Hydro priming is a priming in which seed were soaked in distilled water for 8 hours and in silicate priming the seed were soaked in (60 μM) silicate solution for same time. Seeds were sown under water deficient condition in the pots under different field capacity 100%, 80%, 60% and 40% respectively. The final germination percentage (FGP) of the seed treated with silicate priming was less than hydro priming. The results of mean germination time (MGT) and the germination index (GI) of the seed treated with hydro priming was less than silicate priming. The germination rate of the hydro priming was more than the seed with no priming. All these parameters were more efficient and higher in silicate priming than non-priming and hydropriming. There for all the development in the Maize plant was due to silicate priming rather than hydro-priming and non-priming. By interpretation, silicate seed priming increased the Maize seed germination and general growth under water stress that non-primed and hydro primed seeds. It indicates that in the seed of the priming had a tolerance potential against water deficient stress.

To Cite: Nazeer S, Sadia A, Raz MN., 2021. Assessment of Silicon Priming Under Different Water Levels (Irrigation Regimes) in Hybrid Maize. Journal of Agriculture, Food, Environment and Animal Sciences, 2(1): 34-43.

INTRODUCTION

Pakistan is agriculturist country having major focus on rice, wheat, maize, cotton, sugarcane. In the agriculture the contribution of the Maize about 2.2 percent in GDP is about 0.4 percent. The cultivated area of the Maize is about 1144 thousand (Pakistan Bureou of Statistic 2015-16). After wheat and Rice, the Maize is the 3rd most cereal in Pakistan. Maize is an important fount of the food, industrial products and

feed also. There are 7 different types of corn include waxy corn, flient corn, dent corn, sweet corn, popcorn, pod corn and flour corn.

Seed priming is a technique of soaking seeds in a solution containing organic compounds, ions, antioxidant, hormones, nutrients or simple water (Hameed et al., 2010). This technique is very effective approach, low cost and simple that is used for the increasement of yield and seed germination under any stress like water deficient condition.

Ahmad et al., (2012) showed that hydro priming increased the germination of seed and seedling growth. Similarly, in the Maize the priming with any chemicals, ions, any organic compounds and any antioxidant has also maximized the drought tolerance (Hameed et al., 2010) Sodium silicate priming in form of meta silicate also influences the germination of seed and seedling growth as earlier in maize (Pei et al., 2010).

Earlier work expressed the improvement of seed priming that influenced by many complicated interaction of many components including plant type, potential of water of priming agent, temperature, duration of priming, storage capacity of primed seeds and seed vigor and its dehydration (Parera and Cantliffe, 1994).

In short, the research shows that under drought stress condition the silicate application has a potential to enhance the leaf area, plant height, yield and dry mass of the crop (Gong et al., 2003; Singh et al., 2006). Under abiotic stress the treatment with the (SS) improved the stability of the cell membrane by decreasing the lipid peroxidation in the Maize plant (Liang et al., 2007; Pei et al., 2010; Wang et al., 2011).

In this study, the following experiment was design to check the possible use of sodium silicate as seed priming agent for improvement of water deficient tolerance in the maize crop.

MATERIAL and METHODS

Maize varieity Pearl that is semi dent white and a full season crop was purchased from Maize and Millet Research Centre Yousaf wala, Sahiwal. Experiment was conducted in glasshouse during spring season 2016-17. Before sowing, maize seeds were primed with fresh water and in silicate solution for 24 hours. Primed seeds: fresh water, silicate solution (60 μM) along with unprimed seeds were grown in soil filled pots. After germination, field capacity (40%, 60%, 80% and 100%) was maintained by weight bases. Daily temperature, humidity was noted for whole crop duration. Complete Randomized Design (CRD) was used for experimental layout with three replications.

Parameters

Germination test

The potential of germination was estimated of both primed and non-primed Maize seed by Association of Official Seed Analyst (Anonymous 1990). Counts of germinated seeds that started from the first day of germination and the terminated seed that started when maximum seed germination was obtained.

Mean germination test

It was calculated by using equation of Ellis and Robert (1981)

$$MGT=\sum D_n / \sum n$$

Where "n" represents the number of seeds germinated on day and ''D'' represents the number of days that counted from the start of germination.

Final germination percentage

It was measured by using the following formula

$$FGP= \frac{\text{Number of seed germinated on final day}}{\text{Total no. of seeds sown}} \times 100$$

Germination index

It was measured by using rules of ASS0CIATION OF OFFICIAL SEED ANALYSIS (AOSA) (Anonymous, 1983) and by using the following formula.

Germination index= number of germination seeds/Days of first count+number of germination seeds /Days of final count)

Energy of germination

It was measured at 4^{th} day of planting it is a percentage of germination from 4^{th} day of planting to total tested seeds (Ruan et al., 2002).

Layout

Layout desin has been shown in table 1**.**

Factor A

- P_0= No priming

- P_1= Hydro priming
- P_2= Silicate priming

Factor B

- F_1= 100%
- F_2= 80%
- F_3= 60%
- F_4= 40%

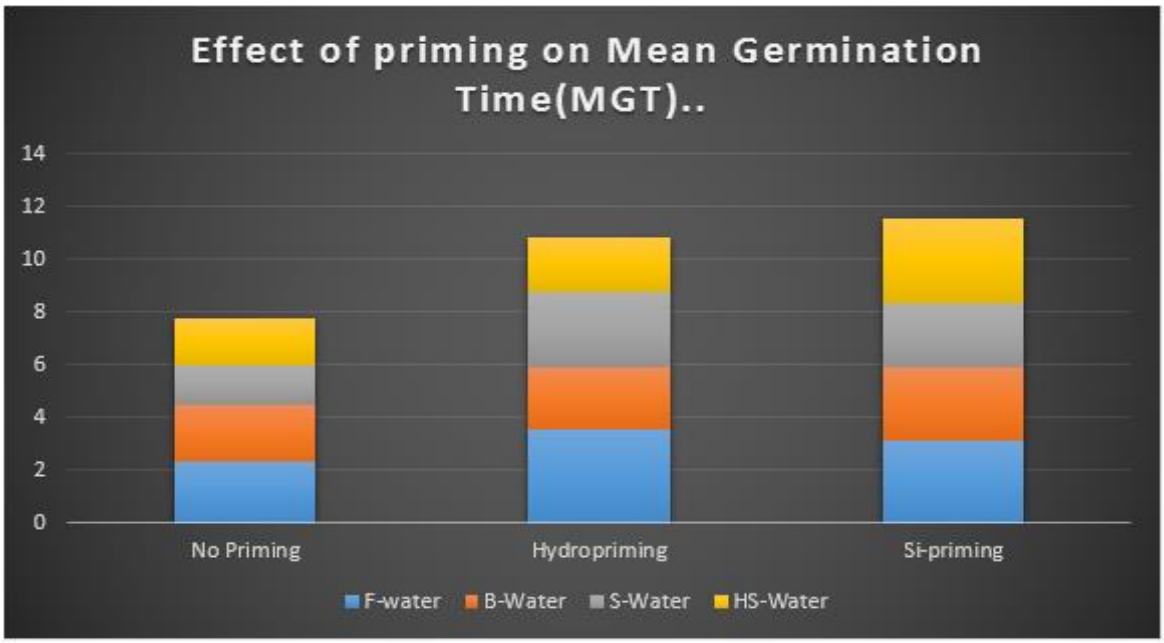
Table 1. Layout design

R1	$P_0F_1R_1$	$P_1F_1R_1$	$P_2F_1R_1$
	$P_0F_2R_1$	$P_1F_2R_1$	$P_2F_2R_1$
	$P_0F_3R_1$	$P_1F_3R_1$	$P_2F_3R_1$
	$P_0F_4R_1$	$P_1F_4R_1$	$P_2F_4R_1$
R2	$P_0F_1R_2$	$P_1F_1R_2$	$P_2F_1R_2$
	$P_0F_2R_2$	$P_1F_2R_2$	$P_2F_2R_2$
	$P_0F_3R_2$	$P_1F_3R_2$	$P_2F_3R_2$
	$P_0F_4R_2$	$P_1F_4R_2$	$P_2F_4R_2$
R3	$P_0F_1R_3$	$P_1F_1R_3$	$P_2F_1R_3$
	$P_0F_2R_3$	$P_1F_2R_3$	$P_2F_2R_3$
	$P_0F_3R_3$	$P_1F_3R_3$	$P_2F_3R_3$
	$P_0F_4R_3$	$P_1F_4R_3$	$P_2F_4R_3$

RESULTS

The effect of priming was observed on the maize seeds with the non-primed seeds. Seeds were primed with silicates and some were hydro primed. In results it was observed that seeds which was primed with silicates, germination was 97% increased. The final germination percentage is less in the silicate priming as compared to hydro and non-priming (Figure 1). Hydro priming was also effective and increased the final germination Percentage of seeds as compared to non-primed ones. However, in comparison between hydro priming and priming with sodium silicates, seeds primed with sodium silicates shown better results than hydro primed seeds. The mean germination time of the silicate priming is higher than hydro priming and mean germination time of hydro priming is higher than non-priming

(Figure 2). The results shown that soaking of seeds was less effective as compared to priming with sodium silicates. Simple seed soaking is also beneficial in terms of enhancing germination but there is an extra edge with sodium silicate priming. The germination index is higher in the silicate priming as compared to non and hydro-priming (Figure 3).



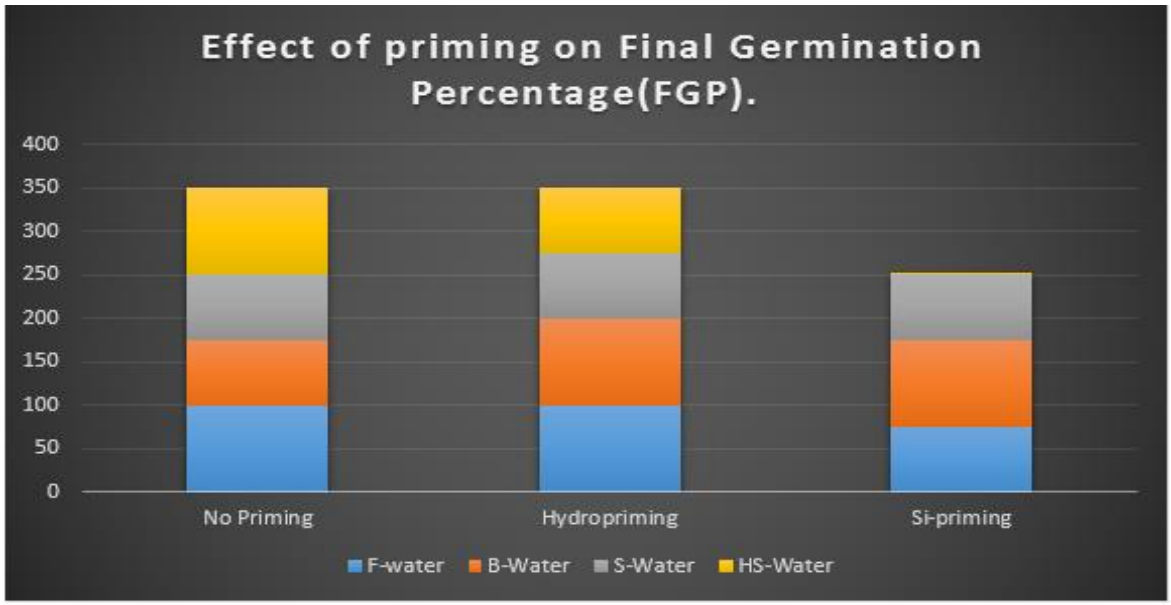


Figure 1. Effect of Priming on mean germination.

Figure 2. Effect of priming on final germination.

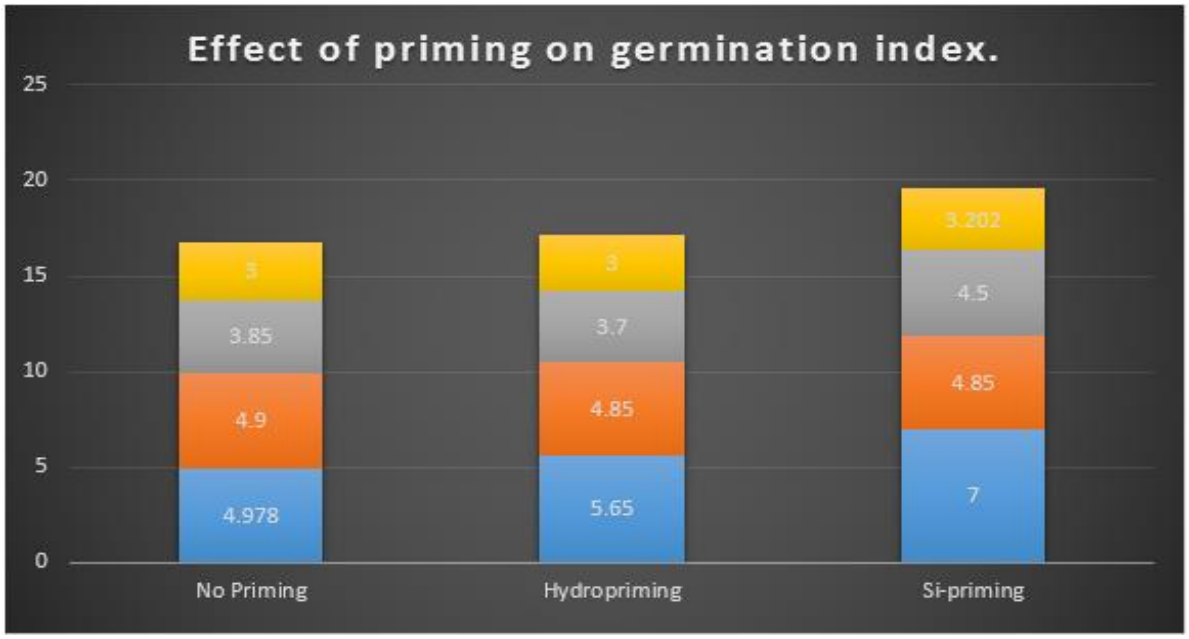


Figure 3. Effect of Priming on Germination Index.

Table 2. Different parameter related to germination at different field capacity.

REP	**FC**	**SP**	**H** (cm)	**GI**	**FGP** (%)	**MGT** (days)	**FW** (g)	**DW** (g)
1	F1	p_o	39.8	2.2	75	2.7	2.8	0.7
1	F2	p_o	67.8	4	100	2.5	5.61	0.83
1	F3	p_o	49.3	2.4	75	3	1.9	0.52
1	F4	p_o	77.75	2	100	2.88	5.67	0.71
1	F1	p1	41.3	2	75	3	3.72	0.61
1	F2	p1	69.75	0.8	100	3.4	5.42	1.09
1	F3	p1	51.6	1.6	100	3.3	4.93	0.91
1	F4	p1	47.1	1.2	75	3.4	2.41	0.62
1	F1	p2	59.25	4	100	2.5	2.8	0.68
1	F2	p2	32.5	2	75	2.7	2.83	0.59
1	F3	p2	0	0	0	0	0	0
1	F4	p2	41	3	100	2.5	3.93	0.38
2	F1	p_o	11.5	1	50	4.6	1.1	0.25
2	F2	p_o	15	1.6	75	3.25	1.32	0.48
2	F3	p_o	50.1	2	100	2.5	3.42	0.74
2	F4	p_o	35.2	1.4	75	3.4	3.31	0.75
2	F1	p1	14	1	50	2.8	1.11	0.25
2	F2	p1	0	0	0	0	0	0
2	F3	p1	0	1	25	4.66	1.63	0.76
2	F4	p1	34.7	1.4	100	3.4	3.98	0.69
2	F1	p2	25.7	1.8	75	2.88	1.77	0.36
2	F2	p2	6.5	3	50	2.6	3.93	0.29
2	F3	p2	72.7	4	100	2.5	3.98	0.91
2	F4	p2	35.5	4	50	2.5	2.51	0.74

FC= Field capacity, SP= Seed priming, H= Height, GI= Germination index, FGP= Final germination percentage, MGT= Mean germination time, FW= Fresh weight, DW= Dry weight, Po= No priming, P1= Hydro priming and P2= Silicate priming.

From results it was clear that non primed seeds germination requires more time to germinate with respect to primed seeds. Silicate primed seed shown more plant height, fresh weight, dry weight, germination index, final germination percentage and mean germination time as compared to hydro priming or non- priming (Table 2).

DISCUSSION

Seed priming treatments not only have potential to improve plant germination and stand establishment under non-stress condition (Khan, 1992; Afzal et al., 2005) but also have potential against environmental stress (Hameed et al., 2010). Quick and uniformity in the seed germination and better germination of the seedling is a main factor of the crop establishment. Seeds are more sensitive to abiotic stresses during growth and germination period (Carter and Chesson, 1996). Similarly, in all experimental study the seed priming with the sodium silicate enhance all germination and seedling growth under water deficit stress.

Evidences has been showed that application of sodium silicate give better germination index, growth, seedling and increase mean germination time of Maize seedling which ultimately increase yield (Abro et at., 2009). But final germination percentage was overcome under shortage of water that treated by sodium silicate priming.

Seed priming initiates the seed germination by stimulating the biochemical processes in seeds. These changes and processes include enzyme activation, dormancy breakdown, metabolic activity of germination inhibitors and imbibition (Asgedom and Becker, 2001; Ajouri et al., 2004) that's why primed seeds shown better and faster growth rate than non-primed seeds (Rowse 1995). All these positive effects were definitely due to stimulatory effect of primed seed on initial phase of germination by mediation of cell division in germination Maize seeds (Hassanpouraghdam et al; 2009). Seed priming can repair the damage membrane that was caused by deterioration during seed storage and abiotic stresses (Ruan et al., 2002). Silicon promotes the growth and development under water deficient stresses (Hattori et al., 2005; Gong et al., 2005, 2008; Miao et al., 2010). It has also reported that by silicon priming shows the better emergence and seedling of seeds (Basra et al.,2003).

CONCLUSION

In conclusion, tested seed priming treatment not only enhance seed germination but also improve Maize seedling growth under water deficient condition. Observed the beneficial effect on seed germination, germination index, final germination

percentage, mean germination time and overall growth from sowing to maturity indicated an improvement under water deficient stress tolerance was due to priming that is silicate priming.

ACKNOWLEDGEMENT

The authors wish to thank Maize and Millet Research Centre Yousaf wala, Sahiwal for providing seeds and Bahhauddin Zakariya University for providing research facilities.

Conflict of Interest Statement

The authors have declared that that there are no competing interests.

Authors' Contributions

Sareen Nazeer contributed to collection of the seeds conducting the experiment and preparation of first draft. Anila Sadia and Muhammad Naeem Raza is involved in collection of data and help Samreen in preparation of draft.

REFERENCES

Abro SA, Qureshi R, Soomro MF, Mirbahar AA, Jakhar GS., 2009. Effects of silicon levels on growth and yield of wheat in silty loam soil. Pakistan Journal of Botany, 41: 1385-1390.

Afzal I, Basra SMA, Iqbal A., 2005. The effects of seed soaking with plant growth regulators on seedling vigor of wheat under salinity stress. Journal of Stress Physiology and Biochemistry, 1: 6-14.

Ahmad I, Khaliq T, Ahmad A, Basra SMA, Hasnain Z, Ali A., 2012. Effect of seed priming with ascorbic acid, salicylic acid and hydrogen peroxide on emergence, vigor and antioxidant activities of maize. African Journal of Biotechnology, 11: 1127-1137.

Ajouri A, Haben A, Becker M., 2004. Seed priming enhances germination and seedling growth of barley under conditions of P and Zn deficiency. Journal of Plant Nutrition and Soil Science, 167: 630-636.

Anonymous, 1983. Association of Official Seed Analysis (AOSA). Seed vigor testing handbook. Contribution No. 32 to the handbook on seed testing. Association of Official Seed Analysis, Springfield, IL.

Asgedom H, Becker M., 2001. Effects of seed priming with nutrient solutions on germination, seedling growth and weed competitiveness of cereals in Eritrea. In: Proc. Deutscher Tropentag, University of Bonn and ATSAF, Magrraf Publishers Press, Weickersheim. P: 282.

Basra SMA, Zia MN, Mehmood T, Afzal I, Khaliq A., 2003. Comparison of different invigoration techniques in Wheat (Triticum aestivum L.) seeds. Pakistan Journal of Arid Agriculture, 5: 6-11.

Carter LM, Chesson JH., 1996. Two USDA researchers develop a moisture seeking attachment for crop seeders that is designed to help growers plant seed in soil sufficiently moist for germination. Seed World, 134: 14-15.

Gong H, Zhu X, Chen K, Wang S, Zhang C., 2005. Silicon alleviates oxidative damage of wheat plants in pots under drought. Journal of Plant Science, 169: 313-321.

Gong HJ, Chen KM, Chen GC, Wang SM, Zhang CL., 2003. Effects of silicon on growth of wheat under drought. Journal of Plant Nutrition, 26: 1055-1063.

Gong HJ, Chen KM, Zhao ZG, Chen GC, Zhou WJ., 2008. Effects of silicon on defense of wheat against oxidative stress under drought at different developmental stages. Journal of Plant Biology, 52: 592-596.

Hameed A, Afzal I, Iqbal N., 2010. Seed priming and salinity induced variations in wheat (Triticum aestivum L.) leaf protein profiles. Seed Science and Technology, 38: 236-241.

Hassanpouraghdam MB, Pardaz JE, Akhtar NF., 2009. The effect of osmo-priming on germination and seedling growth of Brassica napus L. under salinity conditions. Journal of Food, Agriculture and Environment, 7: 620-622.

Hattori T, Inanaga S, Hideki A, Ping A, Shigenori M, Miroslava L, Lux A., 2005. Application of silicon enhanced drought tolerance in sorghum bicolor. Plant Physiology, 123: 459-466.

Khan AA., 1992. Preplant physiological seed conditioning. Horticultural Reviews, 14: 131- 181.

Liang Y, Sun W, Zhu YG, Christie P., 2007. Mechanisms of silicon-mediated alleviation of abiotic stresses in higher plants: A review. Environmental Pollution, 147: 422-428.

Miao BH, Han XG, Zhang WH., 2010. The ameliorative effect of silicon on soybean seedlings grown in potassium-deficient medium. Annals of Botany, 105: 967-973.

Parera, CA, Cantliffe DJ., 1994. Presowing seed priming. Horticultural Reviews, 16(16): 109-141.

Pei ZF, Ming DF, D Liu, Wan GL, Geng XX, Gong HJ, Gong, Zhou WJ., 2010. Silicon improves the tolerance to water-deficit stress induced by polyethylene glycol in

Wheat (Triticum aestivum L.) seedlings. Journal of Plant Growth Regulation, 29(1): 106-115.

Rowse HR., 1995. Drum Priming- A non-osmotic method of priming seeds. Seed Science and Technology, 24: 281-294.

Ruan S, Xue Q, Tylkowska K., 2002. The influence of priming on germination of rice Oryza sativa L. seeds and seedling emergence and performance in flooded soil. Seed Science and Technology, 30: 61-67.

Singh K, Singh R, Singh JP, Singh Y, Singh KK., 2006. Effect of level and time of silicon application on growth, yield, and its uptake by rice (Oryza sativa). Indian Journal of Agricultural Sciences, 76: 410-413.

Wang X, Wei Z, Liu D, Zhao G., 2011. Effects of NaCl and silicon on activities of antioxidative enzymes in roots, shoots and leaves of alfalfa. African Journal of Biotechnology, 10: 545-549.