International Journal of Agricultural Sciences
Volume 17 | AAEBSSD | 2021 | 68-73
DOI:10.15740/HAS/IJAS/17-AAEBSSD/68-73
ISSN : 0973-130X
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RESEARCH PAPER

Studies on germination and seedling development of winter maize (*Zea mays* L.) as influenced by various seed priming methods

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Abstract : A field experiment was conducted for boosting the productivity of *kharif* sweet corn (*Zea mays* Saccharata) at Agronomy Farm,RCSM College of Agriculture, Kolhapur (M.S.), India during *kharif*, 2020 in black Vertisolsoil using split plot design with four replications and two factors, where main plot factors consist of time of application *viz* T_1:15 days after sowing (DAS), T_2: 30 DAS and T_3: 45 DAS and sub plot factors consist of levels of nano nitrogen (N) fertilizers *viz*N_1: 1.00 L ha^{-1}, N_2: 1.25 L ha^{-1} and N_3:1.50 L ha^{-1}. The results showed that at harvest, maximum plant height (183.41 cm), number of leaves (8.86 $plant^{-1}$), leaf area (58.40 dm^2plant^{-1}), dry matter accumulation (117.18 $gplant^{-1}$), length of cob (18.55 cm), diameter of cob (16.83 cm), weight of cob per plant (208.65 g), number of grains (371.25 cob^{-1}), green cob yield (125.96 q ha^{-1}), green fodder yield (344.39 q ha^{-1}), total uptake plant in total ((264, 98 and 230 kg ha^{-1}),yield of protein by grain (92.89 g kg^{-1}) and stover (50.96 g kg^{-1}) were obtained from treatment N_3 (1.5 L ha^{-1}) which was on par with treatment N_2 (1.25 L ha^{-1}) and significantly superior over N_1 (1 L ha^{-1}). While main plot showed that at harvest plant height (191.90 cm), number of leaves(10.09$plant^{-1}$), leaf area (62.63 dm^2plant^{-1}), dry matter accumulation (123.51 $gplant^{-1}$), length of cob (20.56 cm), diameter of cob (19.71 cm), weight of cob (222.29 g $plant^{-1}$), number of grains (402.07 cob^{-1}), green cob yield (138.32q ha^{-1}),stover yield (359.75q ha^{-1}), total uptake(287, 113 and 262 kg ha^{-1}), yield of protein by grain (97.36 g kg^{-1}) and stover (51.77 g kg^{-1})were significantly maximum when foliar spray of NN was done at 15 (DAS). The foliar application at 15 DAS had taken minimum number of days to reach 50 per cent of tasselling (51.62 days) and silking (55.97 days).

Key Words : Methods of seed priming, Winter maize, Germination, Root, Shoot length-vigor index

View Point Article : Bholane, J.P., Rajput, Kavita D. and Tomar, G.S. (2021). Studies on germination and seedling development of winter maize (*Zea mays* L.) as influenced by various seed priming methods. *Internat. J. agric. Sci.*, **17** (AAEBSSD) : 68-73, **DOI:10.15740/HAS/IJAS/17-AAEBSSD/68-73.** Copyright@2021: Hind Agri-Horticultural Society.

Article History : **Received :** 10.07.2021; **Revised :** 12.07.2021; **Accepted :** 15.07.2021

INTRODUCTION

Maize (*Zea mays* L.) is considered as the third most important food crop among the cereals in India and contributes to nearly 9 % of the national food basket. It is the most versatile crop with wider adaptability in varied-agro-ecologies and has highest genetic yield potential among the food grain crops. As the demand for

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maize is growing globally due to its multiple uses for food, feed and industrial sectors, we need to produce more from same or even less resources. With the current and projected challenges for natural resources such as water scarcity, temperature stress etc, maize has emerged as a potential alternative for diversification of rice-rice system with rice-maize and maize-rice systems; and rice-wheat system with rice-maize cropping systems in many ecologies of the country (Jat *et al.*, 2013). The productivity of maize in India (2.47 t ha^{-1}) especially in Chhattisgarh (1.65 t ha^{-1}) is very low as compared to the world average of 4.3 t ha^{-1}. One of the major contributing factors to low crop yield in India especially in Chhattisgarh is poor establishment as a result of water shortage at critical time during initial crop growth. Therefore, good seedling establishment is an important prerequisite for successful crop production and this is particularly true for crops, such as maize which do not have the capacity to adjust to sub-optimal stand by tillering (Harris *et al.*, 2007). Seed priming is one of the most pragmatic and short-term approaches to combat the effects of drought and other environmental stresses on seedling emergence and stand establishment. Primed seeds usually have higher and synchronized germination owing to simply a reduction in the lag time of imbibitions, build-up of germination enhancing metabolites, metabolic repair during imbibition and osmotic adjustment (Fatemi,2014). Hydro-priming of maize seeds showed rapid seedling emergence and improved seedling vigor index (Hanegave *et al.,* 2011). Before maize sowing, six hours seed priming with 0.1 per cent thiourea improves seedling vigour, mitigates early moisture stress and enhances productivity of rainfed maize (Singh *et al*., 2008). Cow urine could also be considered as potential seed-priming agents, as they are rich in many plant nutrients including N, P and micronutrients (Winker *et al.,* 2009). Despite being long known as a rich source of plant nutrients, potential utility of cow urine as seed priming agent remains untried. Since, the information on seed priming effects on maize is lacking, the present study was therefore conducted with the possibility to improve productivity of winter maize through stimulation of early seedling growth vigour under the agro-climatic conditions of Chhattisgarh plains.

MATERIAL AND METHODS

To assess the effects of seed priming treatments on germination, seedling development and other related parameters of winter maize, the experiment was conducted during 2013-14 in Laboratory of Department of Agronomy, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh, India. The experiment comprised of seven treatments *viz.,* T_1- control, T_2- seed priming with a mixture of cow urine+vermicompost+ jaggery+warm water for 12 h, T_3- seed priming with a mixture of cow urine+ vermicompost + jaggery+warm water for 24 h, T_4- chemical seed priming with thiourea 0.1% for 12 h, T_5-chemical seed priming with thiourea 0.1% for 24 h, T_6-hydro-priming with water for 12 h and T_7- hydro-priming with water for 24 h. Hydro-priming involves allowing seeds to absorb sufficient water to initiate metabolic process but insufficient water to allow completion of germination. The seeds of hybrid maize var. Ravi 81 were placed between double layered germination paper wetted with the priming agents for 12 and 24 hours. The study was performed using Petri dishes (11 cm) containing two layered filter paper (90 mm). The seeds of cv. Ravi-81 were first sterilized in sodium hypochlorite (1%) solution and then washed twice in deionized distilled water. Then, Petri dishes containing double layer filter paper were moistened with respective priming solutions. Thereafter, selected number of seeds were soaked in these Petri dishes and then kept in an incubator (40% relative humidity) at 25^0C. Daily germination rate was measured and filter papers were replaced when needed. Similarly priming solution were added when required. Seeds were considered to have germinated when the emergent radicle reached 2 mm in length. After 7 days, germination percentage was measured by International Seed Testing Association (ISTA,1996) standard method. By the end of the 7^{th} day, the germination percentage, mean germination time, T50, the length of root and shoot, length of seedling and seed vigor were measured. The data on different parameters were recorded following the procedure as below:

Germination percentage:

The seedlings were counted daily until complete emergence. Germination was calculated according to the International Seed Testing Association (ISTA) method.

$$\text{Germination percentage} = \frac{\text{Number of germinated seeds}}{\text{Total number of experimental seed}} \times 100$$

The data of germination percentage was transformed to arcsine.

Germination index:

The germination index (GI) was calculated as described in the Association of Official Seed Analysts (AOSA, 1983) by following formula:

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

Mean germination time:

The mean germination time (days) was calculated according to the following formula (Ellis and Roberts, 1981).

$$\text{Mean germination time (MGT)} = \frac{\sum D_n}{\sum n}$$

where,

n = the number of seed which were germinated on day D, and

D = Number of days counted from the beginning of germination

The time to 50% germination (T_{50}) was calculated according to the following formula of Farooq *et al.* (2005).

$$T_{50} = \frac{t + \{(N/2) - n_i\}(t_i - t_j)}{n_i - n_j}$$

where,

N is the final number of germination and n_i, n_j cumulative number of seeds germinated by adjacent counts at times t_i and t_j when $n_i < N/2 < n_j$.

Plumule length:

Shoot length was recorded by measuring the height of the seedling from the point of first cotyledonary node to the tip of the top most leaf. This was recorded on 7th day after treatment and expressed in cm plant^{-1}.

Radicle length:

The radicle (root) length was measured from the point of first cotyledonary node to the tip of longest root and expressed in cm plant^{-1}.

Dry weight of seedling:

The seedling were dried in hot air oven at 80^{0}C for 24 hours. Then, the dry weight was taken by sing an electronic balance.

Vigor index (VI):

The seedling vigor index was calculated following modified formula of Abdul-Baki and Anderson (1973)

VI= [seedling length (cm) × germination percentage]

Data were subjected to statistical analysis using ANOVA technique and treatment effects were compared using LSD test at 0.05 level of probability, when the F-values were significant (Steel and Torrie,1984).

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Germination % and GI :

Among the stages of the plant life cycle, seed germination and seedling emergence and establishment are key processes in the survival and growth of plants. Germination becomes visible by emergence of the structures surrounding the embryo by the radicle. The data on germination percentage as influenced by seed priming has been presented in Table 1. Results revealed that all the methods of seed priming improved the germination percentage as well as germination index in

Table 1: Effect of seed priming on germination percentage and its associated parameters of hybrid maize

Treatments	T50 (days)	Mean germination time (MGT)	Germination %	Germination index
T_1-Unprimed seed (control)	2.51	3.78	79.11	13.64
T_2-Biopriming 12 h	2.13	2.87	86.22	17.94
T_3-Biopriming 24 h	1.51	2.14	93.11	29.84
T_4-Chemical priming 12 h	2.31	3.32	83.44	16.83
T_5-Chemical priming 24 h	1.98	3.14	85.78	20.28
T_6-Hydropriming 12 h	2.28	3.08	84.84	17.08
T_7-Hydropriming 24 h	1.75	2.77	87.67	23.17
SE(m)±	0.13	0.22	2.08	1.08
CD at 5%	0.41	0.69	6.30	3.26

comparison to unprimed treatment. The maximum level of germination percentage (93.11) and germination index (29.84) was observed at bio-priming of 24 h (T_3) which was significantly higher as compared to other two methods of seed priming. While, unprimed seeds (control) showed significantly lowest germination (79.11) percent as well as germination index (13.64) and both of these parameters stand significantly lesser than primed seeds. Next to bio-priming, hydro-priming had pronounced effect on germination and germination index followed by priming with thiourea for 24 hours in comparison to unprimed treatments. When seeds are imbibed, the lag period before radicle emergence is considerably reduced and improved the rate and uniformity of germination. Similarly, Ambika and Balakrishnan (2015) also observed an increased germination in cluster bean due to seed priming with cow urine (2%). Rapid seedling emergence and improved field stand due to hydro-priming was also reported by Nagar *et al.* (1998). In all the primed treatments seed primed for 24 hours enhanced germination percentage and its index markedly compared to seed priming for 12 hours.

T_{50} and MGT:

The data shown in Table 1 further indicated that time taken to 50% emergence (T50) of maize and mean germination time (MGT) was significantly affected by different seed priming treatments. All methods of seed priming for 24 hours caused significant reduction in the time to 50 % emergence which took mean minimum germination time. Unprimed seed (control) took maximum time to reach at 50 % emergence (2.51 days) and recorded highest MGT (3.78 days) and both of these parameters remained significantly greater than those observed under all other priming treatments. Maize seed subjected to bio-priming with a mixture of cow urine+vermicompost+jaggary in hot water for 24 hours (T_3) took minimum time (1.51 days) to complete 50 % emergence (T_{50}) and reduced mean germination time by 1.64 days compared to control (unprimed) treatments. The probable reason for early emergence of the primed seeds may be due to the completion of pre-germination metabolic activities that making the seed ready for radicle protrusion and the primed seed germinated soon after planting compared with non-treated dry seed. These results are in line with the findings of Rahman *et al.*(2014) who had also recorded lowest mean germination time from primed seeds of maize.

Root and shoot growth:

The root and shoot length are the most important parameters because roots are in direct contact with soil and absorb water from soil and shoot supply it to the rest of the plant. Comparing the results provided on the effect of seed priming on growth and seedling vigor of maize in Table 2 revealed that root and shoot length of maize was significantly influenced by the seed priming treatments. Significantly maximum root length (22.73 cm) and shoot length (19.67 cm) was recorded in seeds bio-primed for 24 hours as compared to other methods and time of seed priming. While, unprimed seeds (control) resulted in minimum root (16.18 cm) and shoot (14.92 cm) length which was significantly lower than those observed due to all methods of seed priming. An increase of root length in primed seeds as compared to the unprimed could be a result of embryo cell wall extensibility. Seed priming increase the free radical scavenging enzymes to improve plant viability and

Table 2: Effect of seed priming treatments on growth and vigor index of maize seedling

Treatments	Seedling dry weight (g)	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Vigor Index
T_1-Unprimed seed (control)	0.48	16.18	14.92	31.10	2460.32
T_2-Biopriming 12 hrs	0.85	20.06	16.70	36.76	3169.51
T_3-Biopriming 24 hrs	1.56	22.73	19.67	42.40	3947.49
T_4-Chemical priming 12 hrs	0.54	17.96	15.24	33.19	2770.21
T_5-Chemical priming 24 hrs	0.77	19.10	16.21	35.31	3028.91
T_6-Hydropriming 12 hrs	0.67	19.50	16.11	35.62	3021.16
T_7-Hydropriming 24 hrs	0.93	20.92	17.52	38.45	3370.04
Mean					
SE(m)±	0.02	0.36	0.31	1.20	38.93
CD at 5%	0.06	1.01	0.94	3.39	117.43

strength. Priming decreased the resistance of the endosperm envelope to expansive growth allowing the turgor threshold for germination to be reached faster than in non-primed seeds thereby greater root and shoot length. Increased root and shoot length of cluster bean due to seed priming with cow urine (2%) were also reported by Ambika and Balkrishnan (2015).

Seedling growth :

The length of seedling and their dry weight was significantly influenced by the seed priming treatments. The maximum seedling length (42.40 cm) and dry weight (1.56 g) was recorded in seeds bio-primed for 24 hours, being significantly superior over rest of the treatments. While, unprimed seeds (control) showed significantly less seedling dry weight (0.48). Next to bio-priming hydro-priming also had a significant effect on seedling growth in comparison to unprimed as well as priming with thiourea. Rapid germination of seeds due to priming ultimately could lead to the production of larger seedlings. The results presented confirm that primed seed exhibit early vigour and produce significantly taller root and shoot and thereby heavier seedlings due to enhanced activity of α-amalyse as reported by Harris *et al.* (1999). Moreover, significant improvement in the growth and development of maize seedlings due to bio-priming can be ascribed to the presence of a range of plant nutrients therein, including N, P, K and micronutrients which might had accelerated the germination and growth of maize seedlings. Also the results of this experiment are same with the results Kumar (2011).

Seedling vigor index:

A positive reaction of seedling growth and vigor index to different priming was observed compared to that of control (unprimed seed). Seedling vigour index was significantly influenced by the seed priming treatments. Among the priming treatments, the maximum seedling vigor index (3947.49) was noticed under bio-priming at 24 h which remained significantly superior over other methods and time of seed priming. While, unprimed seeds gave minimum seedling vigor of 2460.32 being significantly inferior to those recorded under different methods of seed priming. The reason of poor seed vigour of unprimed seed may be due to slower rate of imbibition (Fatemi, 2014). Hydro-priming of maize seeds stand next to bio-priming in respect to seedling vigor index. The better seedling vigor is due to significant improvement in germination and length of seedlings due to bio-priming. The reasons for increased seed physiological parameters observed in the present study may be due to the fact that bovine urine and vermicomposed used as bio-prime agents, contains physiologically active substances *viz.,* growth ragulators, nutrients as reported by Ambika and Balakrishnan (2015) in their experimental findings. They also observed increased vigour index of cluster bean due to seed priming with cow urine (2%). On the other hand Hanegave *et al.* (2011) reported that hydro-priming of maize seed resulted in maximum seedling dry weight as well as seedling vigor index. Seed priming with thiourea (0.1%) enhanced the seedling vigour as compared to unprimed seed but proved significantly inferior over other methods of priming. Improvement in different growth parameters and seedling vigour index of maize due to priming with thiourea has also been reported by Singh *et al*. (2008). Seed treatment with thiourea improves sucrose loading to phloem, thereby translocation of photosynthates and thus improved dry weight and length of plumule and radical.

REFERENCES

Abdul-Baki, A. S. and Anderson, J. D. (1973). Relationship between decarboxilation of glutamic acid and vigour in soybean seed, *Crop Sci.,* **13**: 222-226.

Ambika, S. and Balakrishnan,K. (2015). Enhancing germination and seedling vigour in cluster bean by organic priming. *Scientific Research and Essays (academicJournls),* **10**(8):298-301.

AOSA (Association of Official Seed Analysts) (1983). *Seed Vigour Testing Handbook*. Contribution No. 32 to the handbook on Seed Testing, Pp.30-32.

Ellis, R.A. and Roberts, E.H. (1981). The quantification of ageing and survival in orthodox seeds. *Seed Sci. Tech.,* **9**:373-409.

Farooq, M., Basra, S. M. A., Hafeez, K. and Ahmad, N. (2005). Thermal hardening: a new seed vigor enhancement tool in rice. *Journal of Integrative Plant Biology,* **47** : 187-193.

Fatemi, S.N. (2014). Germination and Seedling Growth in Primed Seeds of Sunflower under Water Stress. *Annual Research & Review in Biology,* **4**(23):3459-3469.

Hanegave,A.S.,Hunje,R.,Nadaf,H.L.,Biradarpatil,N.K. and Uppar, D.S. (2011). Effect of seed priming on seed quality of maize (*Zea mays* L.) *Karnataka J.Agric.Sci.,* **24** (2):237-238.

Harris, D., Joshi, A. , Khan, P.A., Gothakar, P. and Sodhi, P.S.

(1999). On-farm seed priming in semi-arid agriculture: Development and evaluation in corn, rice and chickpea in India using participatory methods. *Exp. Agric*., **35**:15–29.

Harris, D., Rashid, A., Miraj, G., Arif, M. and Shah, H. (2007). On-farm seed priming with zinc sulphate solution-A cost effective way to increase the maize yields of resource poor farmers. *Field Crop Res.,* **102**: 119-127.

International Rules for Seed Testing (ISTA) (2008). *International Seed Testing Association* Chapter 5: Germination test. pp. 1-57.

Jat, M.L., Satyanarayana, T., Kaushik, M., Parihar, C.M., Jat, S.L., Tetarwal, J.P., Jat, R.K. and Saharawat,Y.S. (2013). Fertiliser best management practices for maize systems.*Indian J.Fert.,* **9** (4):80-94.

Kumar, Manoj (2014). Influence of Seed Priming with Urine, Phosphorus and Zinc on Maize (*Zea mays* L.) Yield in an Acid Soil of Northeast India. *Indian Journal of Hill Farming,* **27** (1) : 78-80.

Nagar, R.P, Dadlani, M. and Sharma, S.P. (1998). Effect of hydro-priming on field emergence and crop growth of maize genotypes. *Seed Res*., **26**(1): 1-5.

Rahman, M.M., Ahammad, K.U. and Ahmed, M. (2014). Effect of seed priming on maize (*Zea mays* L.) seedling emergence under different sowing dates. *Bangladesh J.Agril.Res.,* **39** (4) : 693-707.

Singh, D., Mehta, S. and Nepalia,V. (2008). Effect of seed priming and i s duration on seedling vigour and productivity of rainfed maize (*Zea mays* L.).: In : *Maize Agronomy-Section V of Proceedings of the 10th Asian Regional Maize workshop held at Makassar,* Indonesia Oct 20-23,2008. pp:531-534.

Steel, R. G. D. and Torrie, J. H. (1984). *Principles and procedures of statistics,* 2nd Ed. p. 172-177. McGraw Hill Book Co.,Singapore.

Winker, M., Vinnerås, B., Muskolus, A., Arnold, U. and Clemens, J. (2009). Fertiliser products from new sanitation systems: Their potential values and risks. *Bioresource Technol.,* **100** : 4090-4096.