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STANDARDIZATION OF CHEMICAL SEED PRIMING TREATMENT TO IMPROVE SEED QUALITY IN MAIZE cv CO 1

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Abstract

Maize (*Zea mays* L.) 2n=20 is cultivated globally being one of the most important cereal crops and most widely distributed crops of the world. It is cultivated in tropics, sub-tropics and temperate regions. It is the world's leading crop and is widely cultivated as cereal grain that was domesticated in Central America. It is one of the most versatile emerging crops having wider adaptability. Globally, maize is known as queen of cereals because of its highest genetic yield potential. The major constraints to maize production in the country include both abiotic and biotic factors, such as drought, nutrient deficiencies, weeds, diseases and insect pests. The occurrence of abiotic stresses such as drought is often difficult to predict in spite of their periodic nature in some of the environments. One potential way of improving establishment is to develop seed treatments that can increase seed vigor or germination rates. A common method employed is seed priming. Seed priming is an effective technology to enhance rapid and uniform emergence and to achieve high vigour, leading to better stand establishment and yield. It is a controlled hydration process followed by re-drying that allows seed to imbibe water and begin internal biological processes necessary for germination, but which does not allow the seed to actually germinate. *In vitro* evaluation was carried out to study the optimize the priming agent and priming duration of maize. The maize cv Co 1 seeds were soaked at 6, 12 and 18 hours of duration at 1, 2 and 3% concentrations of $ZnSO_4$, KCl, KNO_3, KH_2PO_4, $CaCl_2$. The study revealed that, the seeds primed with KH_2 PO_4 1% for 6h were recorded the higher speed of germination (15.6), higher germination percentage (92 per cent), longer root length (31.4 cm), longer shoot length (16.4 cm), higher dry matter production (2.146), and higher vigour index (4398). But the unprimed control seeds recorded the lower speed of germination (10.6), lower germination percentage (81 per cent), shorter root length (12.6 cm), shorter shoot length (24.2 cm), lower dry matter production (1.631 g), and lower vigour index (2980.8).Hence, the suitable halo priming technique for maize seeds could be fixed as KH_2 PO_4 1% for 6h.

***Key words*:** Maize, Seed priming, Speed of germination.

Introduction

Maize (*Zea mays* L.) is the third important cereal crop of the world next to wheat and rice. It is one of the economically important cereal crops grown almost in all the continents of tropics, sub-tropics and temperate regions. It ranks second in production and first in productivity among the cereals and millets at global level. Good quality seeds imply vigour, uniformity and structural soundness besides its genetic and physical purity. In ancient days, various seed treatments were practiced as initial production techniques for improved productivity. Seed is a living entity and is subjected to various environmental stresses which affect the quality. Despite the high yielding potential and various advantages of maize, the yield per unit area of the crop is low in India. Delay in germination and low seed viability are the serious problems limiting the production of maize. Highly vigorous seeds germinate rapidly, uniformly and are able to withstand environmental adversity after sowing. However, the use of maize seeds of low physiological quality is a common practice under tropical and subtropical production conditions, leading to inadequate plant population in the field. Seed priming is a controlled hydration process that involves exposing seeds to low water potentials that restrict germination, but permits pregerminative physiological and biochemical changes to occur. Upon rehydration, primed seeds may exhibit faster rates of germination, more uniform emergence, greater tolerance to environmental stress, and reduced dormancy in many species (Khan, 1992). In the last two decades, seed priming, an effective seed invigouration method, has become a common seed treatment to increase the rate and uniformity of emergence and crop establishments in most vegetable and flower crops especially in advanced countries. It is reported that seed priming is one of the most important developments to help rapid and uniform germination and emergence of seeds and to increase seed tolerance to adverse environmental conditions (Heydecker *et al.*, 1975;

Harris *et al*., 1999). Seed priming has presented promising, and even surprising results, for many seeds including the cereal seeds. The few studies on maize are not overemphasized and are encouraging, but more information is required before its use as a routine practice in seed technology. Harris *et al*. (2001) reported that maize genotypes responded positively to priming, where priming was effective and represented increases ranging from 17 to 76 per cent. Primed and dried seeds normally have a more rapid and uniform germination when subsequently re-hydrated, especially under adverse environmental conditions (Bradford, 1986). Hence with the above background the present study were carried out in maize cv Co 1 to standardize and optimize the priming agent and priming duration.

Materials and Methods

The present study was carried using genetically pure seeds of maize (*Zea mays* L.) cv. Co 1 obtained from the Tamilnadu Agricultural University Coimbatore, Tamilnadu. The experiments were conducted at the Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalai Nagar (11°24'N latitude and 79°44'E longitude with an altitude of +5.79 mts above mean sea level). The bulk seeds were first dried to below 12% moisture content, cleaned, then graded with suitable sieves and imposed for following priming treatments *viz.,* $ZnSO_4$, KCl, KNO_3, KH_2PO_4, $CaCl_2$ and water. The maize cv Co 1 seeds were soaked at 6,12 and 18 hours of duration at 1, 2 and 3% concentrations of $ZnSO_4$, KCl, KNO_3, KH_2PO_4, $CaCl_2$. After priming, the seeds were removed from the solutions, rinsed in water, shade dried at room temperature and assessed for the following seed quality parameters along with unprimed control. The experiment was carried out with four replications in factorial completely randomized block design. The above treatments were evaluated for their seed quality parameters i.e., germination percentage (ISTA, 1999), speed of germination (Maguire, 1962), shoot length (ISTA, 1999), root length (ISTA, 1999), drymatter production (ISTA, 1999) and vigour index under laboratory condition. The data were statistically analyzed as per the method of Panse and Sukhatme (1985).

Results and Discussion

Establishment of a good seedling stand in the field is an important and foremost need for higher crop yield. This depends largely on the field germination and vigour potential of the seeds used for sowing. Seed priming or osmo conditioning is one of the physiological methods that improves seed performance and provides faster and synchronized germination. It is an easy, low cost and low risk technique and being used to overcome the salinity problem in agricultural lands. It entails the partial germination of seed by soaking in either water or in a solution of salts for a specified period of time and then re-drying them just before the radicle emerges. This condition stimulates many of the metabolic processes involved with the early phases of germination and it has been noted that seedlings from primed seeds emerge faster, grow more vigorously and perform better in adverse conditions. Some of the factors that affect seed priming response are solution composition and osmotic potential

In the present study, standardization of optimize the priming agent and priming duration for maize cv. CO 1 revealed that the seeds soaked in KH_2PO_4 1% for 6 h was able to germinate earlier. The seeds primed with KH_2PO_4 1% for 6 h produced higher speed of germination (15.6), germination percentage (92), shoot length (16.4 cm), root length (31.4 cm), dry matter production (2.146 g) and vigour index (4398) when compared to unprimed seed and other treatments (Fig. 1 and Fig. 2). The promotory effect observed in the KH_2PO_4 primed seed for Speed of germination and germination parameters has been referred to the invigorating effect of presoaking. According to Austin *et al.* (1969), the KH_2PO_4 seed priming treatment had improved the velocity of germination and seedling emergence.

Afzal *et al*. (2008) reported that enhancement in α-amylase activity in primed seeds may be attributed to proper hydration during imbibition that increased the starch hydrolysis and suggested that starch was converted into reducing sugars. The effect of the increased starch hydrolysis due to hydration treatments was not lost during the redrying process, as seen in the faster germination and increased uniformity of germination, higher seedling dry weight. They have also observed that partial soaking and subsequent drying back had shown the invigorating effect upon the seeds of a number of species. Studies have indicated that relatively short pre-hydration treatments, either brief imbibition in water or exposure to high relative humidity can improve the vigour of the seeds Powell, A.A. and S. Matthews, 1984). Many studies have related the KH_2PO_4 priming induced germination enhancement to the improvement in membrane integrity as well as the increases in protein and nucleic acid syntheses (Smith and Cobb, 1991). It was also plausible to presume that the enhanced germination due to potassium dihydrogen phosphate might be due to ions absorption during priming as reported by Frett *et al.* (1991).

Moreover, the potassium salts had been reported to raise the ambient oxygen level by making less oxygen available for the citric acid cycle (Bewley and Black, 1982). In the present study, increase in shoot length, root length and dry matter production due to priming might be due to earlier start of emergence. This paved way to conclude that the potassium ions were absorbed during seed priming with KH_2PO_4 solution and it was utilised rapidly during the course of germination. This might be one of the reason for germination enhancement and production of longer root, shoot and heaviest seedlings by seeds primed with KH_2PO_4 1% for 6h. Similar results obtained and recommended by Mura *et al.* (2015) in sesame, Prakash *et al.* (2013) in rice and Sathish *et al.* (2011) in maize hybrid. Hence, the present study revealed that the seeds primed with KH_2PO_4 1% for 6 h was able to germinate earlier with higher germination percentage, shoot length, root length, dry matter production and vigour index than the other treatments and control in maize cv. CO 1. seeds when compared to other treatments.

Table 1 : Effect of different priming agents and duration of priming on speed of germination and germination percent of maize cv. CO 1

Priming agent (A)	**Speed of germination**				**Germination %**			
	Soaking duration in h (D)				**Soaking duration in h (D)**			
	6	**12**	**18**	**Mean**	**6**	**12**	**18**	**Mean**
T_1 – Water	12.77	11.94	11.5	12.07	87 (68.91)	86 (68.07)	83 (65.67)	85 (67.55)
T_2 - KH_2PO_4 1%	15.6	15.14	14.84	15.19	92 (73.68)	89 (70.69)	86 (68.07)	90 (70.81)
T_3 - KH_2PO_4 2%	14.83	14.58	14.5	14.64	87 (68.89)	86 (68.07)	84 (66.45)	86 (67.80)
T_4 - KH_2PO_4 3%	14.7	14.53	14.3	14.51	87 (68.89)	85 (67.25)	84 (66.45)	85 (67.53)
T_5 - KNO_3 1%	14.77	14.38	13.94	14.36	86 (68.05)	84 (66.45)	80 (63.45)	83 (65.98)
T_6 - KNO_3 2%	14.97	14.48	14.08	14.51	86 (68.07)	83 (65.67)	81 (64.18)	83 (65.97)
T_7 - KNO_3 3%	15.33	14.7	14.4	14.81	89 (70.69)	87 (68.91)	84 (66.45)	87 (68.68)
T_8 - $CaCl_2$ 1%	14.88	14.44	14.02	14.45	86 (68.07)	85 (67.25)	84 (66.45)	85 (67.25)
T_9 - $CaCl_2$ 2%	15.21	14.62	14.4	14.74	88 (69.78)	87 (68.91)	85 (67.25)	87 (68.65)
T_{10} - $CaCl_2$ 3%	14.77	14.32	13.54	14.21	87 (68.91)	85 (67.25)	80 (63.45)	87 (66.54)
T_{11} - $ZnSO_4$ 1%	12.1	12.07	12.05	12.07	86 (68.07)	82 (64.92)	79 (62.74)	82 (65.24)
T_{12} - $ZnSO_4$ 2%	12.02	12	11.97	12.00	83 (65.67)	80 (63.45)	75 (60.01)	79 (63.04)
T_{13} - $ZnSO_4$ 3%	11.95	11.81	11.51	11.76	78 (62.04)	76 (60.67)	74 (59.35)	76 (60.69)
T_{14} - KCl 1%	12.03	12.06	12.01	12.03	82 (64.92)	78 (62.03)	77 (61.35)	79 (62.77)
T_{15} - KCl 2%	11.98	11.96	11.93	11.96	80 (63.45)	77 (61.35)	78 (62.04)	78 (62.28)
T_{16} - KCl 3%	11.91	11.77	11.47	11.72	78 (62.04)	74 (59.35)	72 (58.06)	75 (59.82)
Mean	13.74	13.43	13.15	13.43	85.1 (67.37)	82.7 (65.56)	80.4 (63.86)	83 (65.58)
T_0 - Unprimed seeds (C)	10.6				81 (64.18)			
	T		D	TXD	T	D	TXD	
SEd	0.06		0.16	0.28	0.32	0.78	1.35	
CD (P=0.05)	0.13		0.32	0.55	0.65	1.55	2.68	

(Figures in the parenthesis are Arcsine transformed value)

Table 2: Effect of different priming agents and duration of priming on shoot length and root length of maize cv. CO 1

Priming agent (A)	Shoot length (cm)				Root length (cm)			
	Soaking duration in h (D)				Soaking duration in h (D)			
	6	12	18	Mean	6	12	18	Mean
T_1 – Water	13.7	13.6	12.9	13.4	27.6	27	25.4	26.7
T_2 - KH_2PO_4 1%	16.4	15.3	14.6	15.4	31.4	28.7	27.4	29.2
T_3 - KH_2PO_4 2%	14.6	13.9	14.5	14.3	29.2	27.5	27	27.9
T_4 - KH_2PO_4 3%	14	13.5	13.6	13.7	28.9	27.4	25.8	27.4
T_5 - KNO_3 1%	14	13.8	13.4	13.7	29.7	27	24.7	27.1
T_6 - KNO_3 2%	14.7	14.4	13.8	14.3	29	28.8	27	28.3
T_7 - KNO_3 3%	15.5	14.5	14.1	14.7	30	28.4	28	28.8
T_8 - $CaCl_2$ 1%	14.4	13	12.6	13.3	28.5	27	26.2	27.2
T_9 - $CaCl_2$ 2%	15.1	13.6	13.2	14.0	29.9	28.4	26.9	28.4
T_{10} - $CaCl_2$ 3%	13	12.1	11.8	12.3	28.7	26.4	25.8	27.0
T_{11} - $ZnSO_4$ 1%	13.5	12.6	11.3	12.5	29	28	27.3	28.1
T_{12} - $ZnSO_4$ 2%	12.4	10.3	10.1	10.9	27.8	26.8	26.2	26.9
T_{13} - $ZnSO_4$ 3%	11.7	9.3	9	10.0	26.2	25.6	24.9	25.6
T_{14} - KCl 1%	13.1	12.6	10.9	12.2	28.6	27	23.3	26.3
T_{15} - KCl 2%	12.6	11.1	11.4	11.7	27	26.9	25.3	26.4
T_{16} - KCl 3%	11.7	10.9	10.7	11.1	25.7	25.7	24.8	25.4
Mean	13.74	13.43	13.15	13.43	28.6	27.3	26.0	27.3
T_0 - Unprimed seeds (C)	12.6				24.2			

	T	D	TXD	T	D	TXD
SEd	0.067	0.159	0.275	0.138	0.329	0.571
CD (P=0.05)	0.132	0.135	0.546	0.27	0.65	1.13

Table 3 : Effect of different priming agents and duration of priming on dry matter production and vigour index of maize cv. CO 1.

Priming agent (A)	Dry matter production (g 10 seedlings^{-1})				Vigour index			
	Soaking duration in h (D)				Soaking duration in h (D)			
	6	12	18	Mean	6	12	18	Mean
T_1 – Water	1.832	1.79	1.766	1.80	3,593	3492	3,179	3421
T_2 - KH_2PO_4 1%	2.146	1.951	1.774	1.96	4398	3,916	3,162	3825
T_3 - KH_2PO_4 2%	1.927	1.897	1.81	1.88	3,811	3,560	3,486	3619
T_4 - KH_2PO_4 3%	1.899	1.845	1.756	1.83	3,732	3,477	3,310	3506
T_5 - KNO_3 1%	1.901	1.783	1.716	1.80	3,758	3,427	3.048	2396
T_6 - KNO_3 2%	1.882	1.855	1.839	1.86	3,758	3,586	3,305	3550
T_7 - KNO_3 3%	2.001	1.927	1.798	1.91	4050	3,732	3,536	3773
T_8 - $CaCl_2$ 1%	1.892	1.847	1.794	1.84	3,689	3,400	3,259	3449
T_9 - $CaCl_2$ 2%	1.956	1.872	1.813	1.88	3,960	3,654	3,409	3674
T_{10} - $CaCl_2$ 3%	1.871	1.806	1.798	1.83	333.6	3,273	3,008	2205
T_{11} - $ZnSO_4$ 1%	1.789	1.774	1.707	1.76	3,655	3329	3,049	3344
T_{12} - $ZnSO_4$ 2%	1.761	1.74	1.885	1.80	3,337	2968	2,723	3009
T_{13} - $ZnSO_4$ 3%	1.797	1.787	1.761	1.78	2,956	2,652	2,509	2706
T_{14} - KCl 1%	1.829	1.782	1.771	1.79	3,419	3,089	2,633	3047
T_{15} - KCl 2%	1.801	1.764	1.72	1.76	3,168	2,988	2,863	3006
T_{16} - KCl 3%	1.796	1.741	1.643	1.73	2,917	2,708	2,556	2727
Mean	1.88	1.82	1.77	1.82	3408	3328	2874	3204
T_0 - Unprimed seeds (C)	1.631				2980.8			

	T	D	TXD	T	D	TXD
SEd	0.009	0.022	0.038	16.68	39.72	68.81
CD (P=0.05)	0.01	0.04	0.08	33.1	78.8	136.5

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