Scientific Electronic Archives
Issue ID: Sci. Elec. Arch. Vol. 16 (8)
August 2023
DOI: http://dx.doi.org/10.36560/16820231758
Article link: https://sea.ufr.edu.br/SEA/article/view/1758

ISSN 2316-9281

Phosphorus priming influence on different quality of wheat cv. "Pardela" and "Gralha Azul" seeds

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Abstract. The seed priming allows the beginning of the metabolic processes necessary for the germination. Phosphorus is a macronutrient necessary for the growth and development of seedlings, since it participates in the structural components cell like the nucleic acid molecules. The objective was to evaluate the effect of priming and priming with phosphorus (P) on the physiological quality of wheat seeds with different levels of vigor. For the experiment, three lots of wheat seeds of Pardela cultivar, with different levels of vigor i.e. high, medium and low were used. The effect of priming with water and priming with different potential levels of phosphorus was evaluated: 0 (control), 0.10 %, 0.20 %, 0.30 %, 0.40 % and 0.50 % P. The first germination count, percentage of germination, abnormal seedlings, root and shoot length, and dry mass of the seedlings were determined. For the priming with water, the data were submitted to analysis of variance and the means compared by the Tukey test. In the study of the effect of the different concentrations of phosphorus, a variance and regression analysis was carried out, following the completely randomized design, in a factorial scheme 3x6. The Priming in water had significantly influenced all treatments, independently of the seeds vigor levels, increases in the percentage of normal seedlings obtained in the first count and also in the percentage of germination of the low and medium vigor lots, and the seedlings primed in water had significantly larger shoot length in the three different lots. Regarding the different concentrations of phosphorus, significant differences were observed only in the first count of the germination, which decreased with the increase of the phosphorus concentration and the length of the aerial part, which presented an inverse behavior, increasing with the highest levels of phosphorus. Significant interaction between the different vigor levels and phosphorus concentrations was observed only for the root length variable, where concave, linear and convex trends were observed for the high, low and medium vigor lots, respectively. Phosphorus solutions had the optimum role as priming source in promoting seed emergence and root development irrespective of quality seeds.
Key words: Triticum aestivum, Germination, Priming, Vigor.

Introduction

Seed priming is soaking of seed and drying back for moisture storage (ARIF et al., 2010). Normally the Water is used for the soaking of the seed to split or soften the hard seed coat for speeding up and synchronizing the germination process (AJOURI et al., 2004). Priming allows some of the metabolic processes to occur necessarily before germination (YARI et al., 2010) priming cause the production of antioxidants like catalase, peroxidase, superoxide dismutase which in turn protect the membrane from lipid peroxidation and adenosine triphosphate (ATP) production also amplifies in primed seed (GALLARDO et al., 2001; VARIER et al., 2010). Priming may increase resistance to abiotic stresses, and increases the performance of late sown wheat by improving chilling tolerance (FAROOQ et al., 2008), therefore the primed seed can rapidly imbibe and revive the seed metabolism, resulting in a higher germination rate and a reduction in the inherent physiological heterogeneity in germination (KHALIL, et al., 2010). Priming increase the drought tolerance, reduce pest damage and increase crop yield in cereals and legumes (HARRIS et al., 2001).

Phosphorus (P) is macronutrient necessary for plants growth and development (HARTMANN & GENEVE, 2000). It assists in transformation of solar energy into functional plant compounds, which illustrates that phosphorus nutrition is the fundamental element for development and production of normal plant (ALI et al., 2013). Phosphorus is structural component of macromolecules, such as the nucleic acid (DNA and RNA) and ATP.

Priming of cereals seeds with small amounts of nutrients before sowing has been shown to partially overcome nutrient immobilization problem in soils and enhance nutrient use efficiency (MIRAJ et al., 2013). Nutrient priming in P supports early phase of crop development, synchronizes the germination process and leading to enhance the final yield, especially in P deficient soil (TAYLOR & HERMAN, 1998; KHAN et al., 2001).

Wheat crop productivity in Brazil is 4.1 tons ha^{-1} (CONAB, 2019), which is comparatively low as compared to the major wheat producing countries like Europe and China producing 5.3 and 4.8tons ha^{-1}. The present study was conducted in a view to study the effect of priming, and priming with phosphorus (P) on the physiologically different quality wheat seeds.

Material and methods

The experiment was conducted in the Laboratory of Seed Analysis at the Department of Agronomy, State University of Londrina (UEL), Londrina-PR. For the experiment, three different seed lots were used, with different levels of vigor (high 85%, medium 73% and low 68%). To get different quality of vigor two different wheat varieties (Pardela and Gralha Azul) were collected from IAPAR (Instiuto agronomico do Parana, PR, Brazil) and were first evaluated for germination test. Pardela perform best by having more than 90% germination was selected while gralha Azul showed only 75% germination. Pardela were than exposed to 0 hour (Without treatment), 12hours and 24hours of heat treatment at 40 ºC, for reducing vigor of the wheat seeds for getting three different levels for vigor. The seeds obtained had 85%, 73% and 68% of germination respectively for Zero, 12hours and 24hours of heat treatment (SBRUSSI & ZUCARELI, 2014).

After that, the seed lots were initially homogenized by means of the soil divider, as recommended by the Rules for Seed Analysis (BRASIL, 2009). For the evaluation of the isolated effect of priming with water and non primed seeds and priming levels with phosphorus, four replicates of 50 seeds per batch were submerged in 100 ml of distilled water at the following concentrations of phosphorus by using Diammonium Phosphate (DAP): 0 (control), 0.1%, 0.2%, 0.3%, 0.4%, and 0.5% weight/volume. The control was submerged just in 100 ml of distilled water, without received phosphorus concentrations.

After the priming of the seed lots, the following physiological evaluations were carried out: Germination and first counting: performed with four replicates of 50 seeds each, on towel paper moistened in the ratio 2.5 times the mass of the substrate. The rolls of paper, packed in plastic bags, were kept in germinators under a temperature of 20°C (AL-QASEM et al., 1999). The evaluation consisted of two counts, at four and seven days after the test, determining the percentage of normal, abnormal and dead seedlings (BRASIL, 2009).
Seedling length: Ten seeds were distributed in the upper third, in the longitudinal direction of the pre-moistened substrate paper. The seeds were positioned with the end of the radicle to the bottom of the paper and rolls similar to the germination test were made with four replicates per treatment (BRASIL, 2009) and placed to germinate for four days. After this period the length of the aerial part and of the primary root of the normal seedlings was measured in centimeters.

Dry mass of seedlings: seedlings obtained from the length test were separated into two parts, aerial part and root, and dried at 65 °C until constant mass and the results were expressed in grams by seedlings of the aerial and root portions (NAKAGAWA, 1999).

For the isolated effect of priming in water, the data were submitted to analysis of variance and the means compared by the Tukey test. In the study of the effect of the different concentrations of phosphorus, a variance and regression analysis was performed, following the completely randomized design, in a two factorial scheme 3x6 (ZONTA; MACHADO, 1992).

Results and discussion

The high percentage of germination is fundamental for the comparative study between seeds with different levels of vigor, therefore deterioration process were carried out for the reduction of several attributes of seed performance and vigor, resulting, finally, in the loss of germination capacity of the seeds (MARTINS et al., 2009).

The influence of priming on all variables studied on wheat seeds with varying vigor (Table 1). Priming with Water had significantly affected the first germination. It was noticed that water primed seed attained higher first germination test, final germination, root length, minimum dead seed percentage and lower abnormal seeds than unprimed seeds. Regarding the variation of different vigor of seeds, all the variables studied were non-significant. The interaction of different vigor of seeds and priming with and without water was non-significant. The early DNA replication and higher RNA and protein synthesis and ATP availability influence the lag phases are through priming (KHAN et al., 2008). Water Seed priming of wheat had improved seedling emergence time and promotes emergence percentage (PARERA & CANTLIFFE, 1994; KHAN et al., 2011).

Table 1. Priming influence on wheat seeds with different vigor on First germination, Final Germination, Root Length, Shoot Length, Dry Weight, Dead seeds, and Abnormal seeds.

Priming (Pri)	Variables						
	First Germination	Final Germination	Root Length	Shoot Length	Dry weight	Dead Seeds	Abnormal seeds
Wthout Water	42.75b	79.66b	12.01b	9.67a	0.025	11.66a	8.67
Water Priming	77.50a	89.66a	13.43a	8.17b	0.024	5.33b	6.00
F	1.02*	0.11*	2.40*	1.80*	0.39 ns	0.23*	0.01ns
Vigor (Vig)							
High	58.75	84.00	11.75	8.64	0.024	9.50	7.25
Medium	63.50	85.75	12.91	9.24	0.025	7.75	7.25
Low	58.12	84.25	13.49	8.88	0.025	8.25	7.50
F	106.69 ns	9.57 ns	4.60 ns	32.38ns	0.23 ns	8.43 ns	2.23ns
F (Pri x Vig)	0.73 ns	0.63 ns	0.55 ns	0.25 ns	0.48 ns	1.02 ns	0.95 ns
CV	13.71	9.35	12.72	7.22	11.58	62.84	59.68

Means followed by different letter are significantly different from each other at 5 % Level of significance by Tukeys, test ($p<0.05$); ns: non significant; * Significant ($p<0.05$).

The seeds germination varies according to its vigor and genetic characteristics (FREITAS et al., 2002; MATTIONI et al., 2009). Priming may result in the early activation of the metabolic machinery of the seed making it ready for the germination. The pattern was observed that seed soaking enhanced emergence in mungbean as compared to unprimed seed (ARIF et al. 2003). Likewise, FAROOQ et al. (2008) reported that seed soaking decreased the germination time that may allow the seedling to escape the deteriorating soil physical condition.

The effect of priming on all variables studied on wheat seeds with varying vigor was non significant for most of the variables studied. Phosphorus except first germination and shoot length was significantly influence by Phosphorus priming. Higher first germination attained by seeds treated with 0.2% P priming. It was noticed that water primed seed attained higher first germination test, and lower dead seed percentage than Phosphorus primed seeds. Regarding the variation of different vigor of seeds, all the variables studied were non significant except shoot length and Abnormal seeds. The interaction of different vigor of seeds and priming with and without water was non-significant.

Vigorous seeds show higher capacity to resist various environmental stresses during the germination process, and give better development conditions to the plant. In this aspect, MELO et al. (2006) observed that rice plants originated from high vigor seeds were of good vegetative growth. On the other hand, less vigorous seed lots present lower emergence percentage and growth (KOLCHINSKI et al., 2005).

Phosphorus absorption may have triggered the processes of germination can be correlated with priming that switched on many biochemical and physiological processes necessary for seed germination. Priming affected the seed germination an earlier replication of DNA and its repair, increasing RNA and protein synthesis and higher amount of ATP availability (GALLARDO et al., 2001; VARIER et al., 2010; YARI et al., 2010).

The experiment followed after studying influence of priming with water, it was further studied to find the influence of priming with Phosphorus. It was verified that no significant variation was recorded for all variables studied except abnormal seeds, which were higher for high vigor seeds and lower for Low vigor seed (Table 2). The priming solution of water and Phosphorus, had signicantly influence on first germination count, which was higher for water (77.50%) followed by 0.2% P priming. Shoot Length was higher at higher P priming level, 0.5 % P primed seeds attained higher (10.88 cm) length in comparison to water primed seeds.

The study to find the influence of priming with Phosphorus on rooting of different Lots of wheat seeds, a significant variation was recorded for Phosphorus levels on root length, also the interaction of wheat seeds and P priming was significant (Table 3). The P priming solution of 0.3 % and 0.4 %, had higher root length 14.41 cm and 14.26 cm respectively, which were higher for water (77.50 %) followed by 0.2 % P priming. Shoot Length was higher at higher P priming level, 0.5 % P primed seeds attained higher (10.88 cm) length in comparison to water primed seeds. A significant interaction between the different vigor levels and phosphorus concentrations was observed for the root length, where concave, linear and convex trends were observed for the high, low and medium vigor lots, respectively (Figure 1).

Table 2. Phosphorus priming influence on wheat seeds with different vigor on First germination, Final Germination, Root Length, Shoot Length, Dry Weight, Dead seeds, and Abnormal seeds.

Vigor (Vig)	Variables					
	First germination	Final Germination	Shoot Length	Dry weight	Dead Seeds	Abnormal seeds
High	71.75	86.58	10.24	0.02	8.00	5.75a
Medium	74.83	89.75	10.13	0.06	6.75	5.42ab
Low	73.25	88.58	10.09	0.02	7.16	3.75b
F	1.45 ns	2.57 ns	0.20 ns	0.99 ns	0.85 ns	4.02*
Priming (Pri)						
Control(water)	77.50	89.66	9.67	0.024	6.00	5.33
0.1%P	70.50	88.16	9.85	0.023	8.16	4.33
0.2%P	77.00	90.33	10.17	0.024	6.50	5.00
0.3%P	72.16	87.16	10.23	0.098	7.83	5.16
0.4%P	71.16	87.66	10.09	0.024	7.33	5.00
0.5%P	71.33	86.83	10.88	0.024	8.00	5.00
F	2.99*	0.99 ns	2.91*	1.00 ns	0.81 ns	0.20ns
F (Pri x Vig)	1.75 ns	0.58 ns	1.13 ns	0.99 ns	0.72 ns	1.35 ns
CV	8.55	5.54	8.38	285.81	46.28	52.67

Means followed by different letter are significantly different from each other at 5 % Level of significance by Tukeys, test (p<0.05); ns: non significant; * Significant (p<0.05).

Table 3. Phosphorus priming influence on wheat seeds with different vigor on Root Length.

		Vigor			
	Priming	High	Medium	Low	Mean
Root Length	Water	12.560 ab	13.160 ab	14.565 ab	13.43ab
	0.1%P	12.049 b	12.225 ab	13.790 ab	12.68b
	0.2%P	13.465 ab	15.450 a	12.135 b	13.68ab
	0.3%P	15.020 ab	13.670 ab	14.095 ab	14.26a
	0.4%P	14.450 ab	14.330 ab	14.455 ab	14.41a
	0.5%P	12.440 ab	14.185 ab	14.635 ab	13.75ab
	Mean	13.33	13.83	13.94	
F Vigor	1.62 ns				
F Priming	2.90*				
F (Pri x Vig)	2.98*				
CV (%)	9.21				

Means followed by different letter in columns are significantly different from each other at 5 % do not differ by Tukey's test (P<0.05); ns: non significant; * Significant (p<0.05).

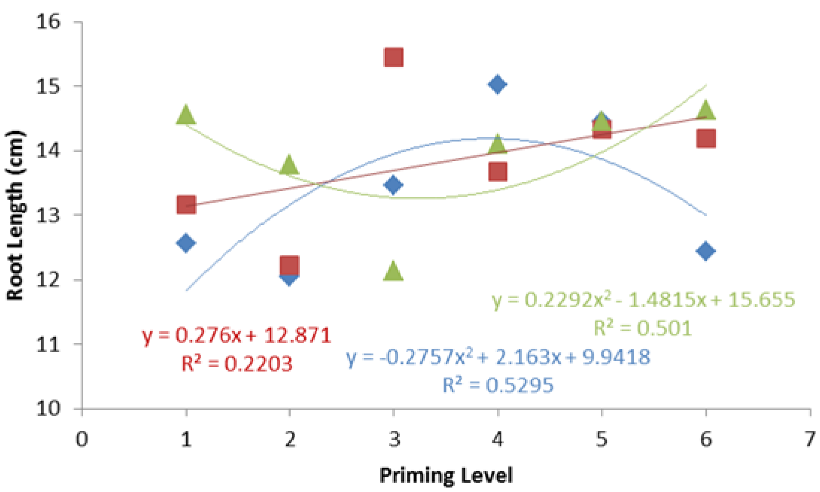

Figure 1. Regression; High (Polynomial), medium (Linear) and low (Polynomial) in Blue, Red and Green color respectively of different vigor seeds for root length of different priming treatments.

Seed emergence plays crucial role in overcoming the future fate of the plant. Faster emergence may be due to priming as it synchronizes the metabolism of all seeds in the seed lot, thus ensuring uniform emergence and growth in the field. In fact, it synchronizes all the cells of germinating embryo in G2 phase of the cell cycle for uniform development of the seedling (AJOURI et al., 2004; BIELESKI, 1973; MAZOR, et al., 1984).

It has been concluded that priming with water is superior to non primed seeds. Optimum results were also obtained with in phosphorus priming, endorsed its role as priming source in promoting seed emergence and rooting variables irrespective of quality seeds. The use of Phosphorus as priming is useful to get early germination and good rooting for establishment of good crop.

Acknowledgements

The authors thank Brazilian National Council for Scientific and Technological Development (CNPq) and The World Academy of Sciences (TWAS) for financial support.

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