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Influence of Zn seed priming and coating on germination and seedling growth in wheat

Mohaned Mohammed Ali Mohammed*, Erkut Pekşen

Department of Field Crops, Faculty of Agriculture, University of Ondokuz Mayıs, 55270, Samsun, Turkey

*Sorumlu yazar/corresponding author: mohanedali6224@gmail

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ABSTRACT

In this study, the effect of seeds priming (2.5 and 5 mM) and coating (1.5, 2.5 and 5 g Zn/kg seeds) on early growth stages of two wheat varieties showing difference for their seed Zn contents (Imam with average 29 mg/kg Zn and Altındane 25.5 mg/kg Zn) on germination and seedling growth parameters were determined under controlled-growth chamber conditions 20-25°C and 70% RH. In each treatment, 25 seeds were placed into Petri dishes to determine seed germination and sown into pots containing 700 g alluvial soil with low Zn content to monitor seedling growth for 21 days using three replications. The results revealed that seed priming with Zn, particularly high dose (5 mM) had relatively positive impact on seed germination, mean germination time and seedling growth parameters when compared with low Zn dose (2.5 mM) and hydropriming in both two wheat varieties. Seed coating with Zn, particularly with low Zn concentration (1.5 g Zn/kg seeds) and in Altındane with less Zn content, has shown good respond and improved seed germination parameters in comparison with untreated seeds for both wheat varieties. In conclusion, Zn seed priming and coating had more evident effects on germination and seedling growth parameters in variety with low Zn content compared with high one. The lowest concentration of seed coated with Zn of 1.5 g Zn/kg seeds had positive impact on wheat seedlings growth as well as it has low cost and safe to prevent of environment pollution.

Keywords:
Wheat
Germination
Zn seed priming
Zn seed coating
Seedling growth

Ekim öncesi tohumlara Zn ile ön uygulama ve tohum kaplamanın buğdayda çimlenme ve fide gelişimine etkileri

ÖZET

Bu çalışmada, Zn ile tohum ön uygulamaları (2.5 ve 5 mM) ve tohum kaplamanın (1.5, 2.5 ve 5 g Zn/kg tohum), çinko içerikleri bakımından farklılıklar gösteren Imam (29 mg/kg Zn) ve Altındane (25.5 mg/kg Zn) buğday çeşitlerinde erken büyüme dönemlerinde, tohumların çimlenmesi ve fide büyüme parametreleri üzerine etkileri 20-25°C sıcaklık ve %70 oransal neme sahip kontrollü büyüme odası koşullarında belirlenmiştir. Her uygulamada, tohum çimlenmesini belirlemek için petri kaplarına ve 21 gün boyunca fide büyümesini izlemek için düşük Zn içeriğine sahip 700 g alüvyonlu toprak içeren saksılara üç tekrarlamalı olarak 25'er tohum ekilmiştir. Sonuçlar, düşük dozda (2.5 mM) Zn ile tohum ön uygulama ve destile su ile tohum ön uygulama işlemleriyle karşılaştırıldığında, Zn ile özellikle yüksek dozda (5 mM) tohum ön uygulama işleminin tohumların çimlenme oranı, ortalama çimlenme süresi ve fide büyümesi parametreleri üzerinde her iki buğday çeşidinde de olumlu bir etkiye sahip olduğunu göstermiştir. Zn ile tohum kaplaması, özellikle düşük Zn konsantrasyonlu tohum kaplaması (1.5 g Zn/kg tohumlar) ve daha az Zn içeriğine sahip Altındane çeşidinde olmak üzere, her iki buğday çeşidinde de muamele edilmemiş tohumlara oranla daha iyi tepki vermiş ve çimlenme parametrelerinde artış göstermiştir. Sonuç olarak, tohumların ekim öncesi Zn ile ön uygulamaya ve kaplamaya tabi tutulması, düşük Zn içeriğine sahip çeşitte yüksek olana kıyasla çimlenme ve fide büyüme parametreleri üzerinde daha belirgin etkiye sahip olmuştur. En düşük oranda çinko ile tohum kaplama (1.5 g Zn/kg tohum) buğday fidelerinin gelişimi üzerine olumlu etkileri yanı sıra düşük maliyetli ve çevre kirliliğini önleme bakımından güvenli olmuştur.

Anahtar kelimeler:
Buğday
Çimlenme
Zn ön uygulama
Zn tohum kaplama
Fide gelişimi

1. Introduction

Zn deficiency is common micronutrient deficiency occurrence both in crops and human being. Zn reserved in seed must be in adequate rate to sustain crop growth. Furthermore, high Zn content in grain has also positive effects on seed germination and seedling vigor (Welch, 1999; Cakmak, 2008). During the growth phase of crop, supply of Zn during the seed germination either comes from seed reserves or from soil. Therefore, sufficient grain reserves of Zn are essential for seed germination particularly in soils that are deficient in Zn (Rengel and Graham, 1995). Thus, this limitation of grain Zn content can be overcoming through variety of interventions and strategies (Stein, 2010), these include both agronomic and genetic biofortification of cereal crops.

Agronomic biofortification can be achieved by increasing soil Phyto availability or by application of Zn fertilizers (White and Broadley, 2011). Among Zn fertilization methods which deliver Zn to plant are seed priming and coating which are an economical and effective alternative to foliar and soil application (Farooq et al., 2012). Moreover, seed priming and coating are cost-effective as very small amount of Zn are sufficient to induce improvement in germination seeds (Singh and Usha, 2003). Seed priming known as soaking seeds in water or nutrient solution under determined time and conditions and drying back to their original weight have been shown to mitigate crop establishment and increase plant yield. Zn seed priming have proven obviously their effectiveness for improving seed germination and seedling growth in wheat (Harris et al., 2008; Rehman et al., 2015; Reis et al., 2018), rice (Prom-u-thai et al., 2012), maize (Ajouri et al., 2004; Muhammad et al., 2015) and soybean (Goiba et al., 2018). Furthermore, grain yield and stress tolerance have been significantly improved via Zn primed seeds in various crops under different growth conditions (Yilmaz et al., 1997; Slaton et al., 2001; Ajouri et al., 2004; Harris et al., 2007; Imran et al., 2013; Bradáčová et al., 2016).

Seed coating is another cost-effective and efficient of seed treatment method for delivery mineral nutrients by adhering them to the seed surfaces using a sticky substance to increase seed performance (Freeborn et al., 2001). The term of seed coating is used to denote the application of a useful material(s) to the seed without changing its general size and shape (Taylor and Harman, 1990). Macro- and micronutrients have been applied to seed in seed coating and revealed positive effects to improve early plant growth (Scott and Archie, 1978; Scott et al., 1987). However, seed coating has effectively improved production of many crops like barley (Zeļonka et al., 2005) and rice (Tavares et al., 2012). In wheat seed coating with Zn, seed germination, seedling growth and tissue Zn content increases in comparison with uncoated seeds (Rehman and Farooq, 2016). There is limited information to the quantity of Zn fertilizers that can be applied effectively to seeds without injury to the germination seeds. Therefore, the main aim of this work was to study the effect of different Zn concentrations applied through seed priming and coating on seed germination and seedling growth of two wheat varieties different in their Zn content under controlled growth condition.

2. Materials and Methods

2.1 Source of Wheat Varieties

Two wheat varieties, Imam and Altındane, were used in the experiments. Imam variety, which has average grain Zn concentration of 29 mg/kg and where commonly cultivated in deficit-stressed water areas in the north part of Sudan, was obtained from Agricultural Research Corporation (ARC), Wad Madani, Sudan. Turkish variety Altındane, which has average grain Zn concentration of 25.5 mg/kg and commonly grown in Samsun province, was supplied from Black Sea Agricultural Research Institute.

2.2 Strategies of Zn Application

The treatments of this experiment are shown in Table 1.

Table 1. Treatments in the germination and seedling growth experiments conducted under controlled conditions
Çizelge 1. Kontrollü koşullar altında yürütülen çimlenme ve fide gelişimi denemelerindeki uygulamalar

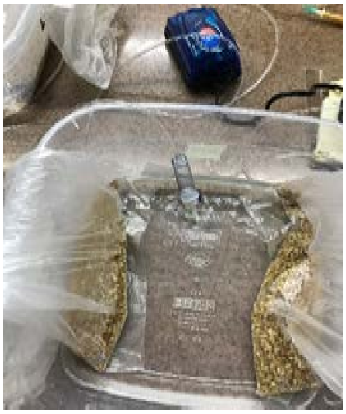
Treatments	Zn concentrations
Control (untreated seeds)	0
Hydropriming (HP)	0
Seed priming	2.5 mM
Seed priming	5 mM
Seed coated with Arabic Gam (5%)	0
Seed coating	1.5 g/kg seed
Seed coating	2.5 g/kg seed
Seed coating	5 g/kg seed

2.2.1 Seed priming

Seeds were soaked in distilled water for hydropriming and in 2.5 and 5 mM aerated solution of Zn for 12 h at 25°C, in the dark for Zn priming. Aeration of the solutions was provided with a simple aquarium pump (Figure 1a). After priming duration ended, the primed seeds were washed thoroughly with distilled water and allowed to dry back to their original moisture content of 12% at room temperature.

2.2.2 Seed coating

Initially, seeds of wheat varieties were weighted before coated with zinc sulphate ($ZnSO_4.7H_2O$). Then, $ZnSO_4.7H_2O$ finely grinded (150 µm) and Zn solutions were prepared at rates of 1.5, 2.5 and 5 g Zn/kg seeds. Finely grounded of zinc sulphate mixed with Arabic Gam (AG) solution (5%, w.v) (Figure 1b) for 5 min to improve retention of Zn applied to seeds. Subsequently, seeds were soaked in resulted slurry (solution Arabic Gam + Zn) and incorporated sufficiently for 5 min and kept drying for the constant weight. The weight of applied coating material was determined by difference between the weight of dry coated seeds (Figure 1c) and weight of the raw seeds. Due to the adhesive substance incorporated with the coating was generally less than 5% of the weight micronutrient (Zn), therefore, weight of AG was negligible and it was discharged.


a)

b)


c)

Figure 1. Priming process (a), Arabic Gam (adhesive substance) (b) and coated seeds (c)
Şekil 1. Priming işlemi (a), Arap zamkı (yapışkan madde) (b) ve kaplanmış tohumlar (c)

2.3 Germination and Seedling Emergence Conditions

This experiment was established to study the effect of Zn seed coating and priming on seed germination parameters at early growth stage under growth controlled-condition temperature at 20-25°C and 70% RH. The treatments of this experiment have been showed in Table 1. 25 seeds of each treatment were sown in pot containing 700 g alluvial soil with low Zn content for 21 days using three replications. Before sowing and depending to soil analysis, basal fertilizer was applied; phosphorus 75 mg/kg soil, nitrogen 100 mg/kg soil and potassium 25 mg/kg soil as P_2O_5, urea and K_2SO_4, respectively. After sowing, the pots were irrigated by 70% of water holding capacity until 7th day of seedling growth. The germination was monitored and the number of seedlings was determined daily based on standard germination test (ISTA, 2015). The seeds were considered as normal seedling when the radicle presented about 2 mm.

2.4 Seed Germination Test

In each treatment, 25 seeds were placed into Petri Dishes to determine seed germination rate (GP) and mean germination time (MGT) using three replications. The germinated seeds for each Petri dish were counted daily for 7 days. Then, the germination percentage was calculated at the 7th day. The germination percentage (GP) and mean germination time (MGT) were calculated according to the following equation (Zhang et al., 2007).

Germination percentage (GP) = 100 x (No. of germinated seeds/ No. of total seeds)

Mean germination time (MGT) = Σ (Gt × Tt)/Σ Gt

Where Gt is the number of germinated seeds on day t, Tt is time corresponding to Gt in days. Seedling vigor index after 7 days was calculated according to formula (Salah et al., 2015).

2.5 Measurement of Seedling Growth Parameters

As in the germination test, 25 seeds were sown into pots containing 700 g alluvial soil with low Zn content to monitor seedling growth for 21 days using three replications. At the end of the 21st days, five seedlings from each pot were selected, rooted and washed with distilled water and their roots and shoots fresh weight and dry mater were determined after oven-drying for 48 hours at 70°C.

2.6 Experimental Design and Data Analysis

The experimental design used in this study was a completely randomized design with 48 treatments including 8 levels of Zn and two wheat varieties with three replications. Data analysis was performed with JMP software program and significant differences among mean values were assessed using Fisher's least significant differences (LSD) test at 0.01 probability level.

3. Results

The germination percentage (GP) and mean germination time (MGT) were significantly influenced by Zn treatments of seed priming and coating. Among Zn application methods, seed coating with 1.5 g Zn recorded the highest GP and lowest MGT among other Zn treatments in Imam variety (Table 2). Generally, seed coating and priming with Zn revealed remarkable increase in germination percentage and improved seedling growth in all Zn concentrations in comparison with untreated seed and hydropriming respectively and for both varieties (Figure 2).

a) b) c) d)

Figure 2. Effects of priming and coating of wheat seeds with Zn on seedling growth. Seedlings from untreated seeds (a) and coating with 1.5 g Zn (b), hydropriming (c) and priming with 5 mM Zn (d)

Şekil 2. Buğday tohumlarının Zn ile priming uygulaması ve kaplanmasının fide büyümesi üzerine etkileri. Uygulama yapılmayan tohumlardan (a), 1.5 g Zn ile kaplanan tohumlardan (b), hidropriming işleminden (c) ve 5 mM Zn ile kaplanan tohumlardan (d) elde edilen fideler

Table 2. Effects of Zn treatments on germination percentage (GP) and mean germination time (MGT) in wheat

Çizelge 2. Buğdayda çimlenme yüzdesi (GP) ve ortalama çimlenme süresi (MGT) üzerine Zn uygulamalarının etkileri

Zn treatments	GP (%)		Mean	MGT (days)		Mean
	Imam	Altındane		Imam	Altındane	
Control	77.7 e	78.6 e	78.1 e	5.5 a	6.2 a	5.7 a
Hydropriming	78.0 e	92.0 a	85.0 d	4.4 c	4.3 e	4.4 d
Seed priming (2.5 mM)	78.0 e	93.0 a	85.5 cd	4.4 c	4.8 cd	4.6 c
Seed priming (5 mM)	85.4 cd	90.7 ab	88.0 bc	4.5 bc	4.3 e	4.5 cd
Seed coating with Arabic Gam	80.4 e	79.7 e	80.0 e	4.7 b	5.0 bc	4.9 d
Seed coating (1.5 g Zn/kg seed)	92.0 a	91.4 ab	91.5 a	3.6 e	4.6 de	4.1 e
Seed coating (2.5 g Zn/kg seed)	88.0 bc	89.7 ab	88.8 b	3.9 d	5.0 bc	4.5 cd
Seed coating (5 g Zn/kg seed)	89.0 ab	84.4 d	87.0 bcd	3.8 de	5.2 b	4.5 cd
Mean	83.5 b	87.4 a		4.4 b	4.9 a	
CV%	2.5			3.2		
LSD	3.6			0.25		
P value	Zn	**			**	
	V	**			**	
	ZnxV	**			**	

Means followed by different letters are statistically different. **: significant at P<0.01

Seed coated with 1.5, 2.5 and 5 g Zn/kg seed in comparison with untreated seeds (control) enhanced seed germination with 18, 13 and 14% in Imam variety and with 16, 14 and 7% in the Altındane variety, respectively. While in comparison with hydropriming, seed priming particularly with 5 mM had better germination for both varieties, especially for Imam variety which improved germination percentage with 10%. Moreover, Altındane variety hasn't show any significant difference between seed priming with Zn and hydropriming. In both varieties seeds which treated with Zn priming and coating, lower mean MGT were determined in comparison with untreated seed and hydropriming. Furthermore, seed coating in all Zn concentration with 1.5, 2.5 and 5 g achieved important differences and less MGT by 3.6, 3.9 and 3.8 days were noted, respectively when compared with untreated seeds 5.5 days in Imam variety. The lowest dose of seed coating (1.5 g) took less time (4.6 days) to complete its MGT and the higher doses than 1.5 g Zn/kg caused more MGT in comparison with seed coating with Arabic Gam (5 days) in Altındane variety. However, in case of seed priming, hydroprimed seeds (HP) have showed relatively decreasing in MGT and were less than those primed with Zn in both wheat varieties (Table 2). Moreover, fresh roots and shoots were significantly affected by Zn application, variety and their interaction (Table 3). Compared with HP and untreated seeds, seed priming and coating significantly improved seedling root shoot length, fresh and dry weight for both wheat varieties (Figure 3).

Table 3. Effects of Zn treatments on fresh weight of roots and shoots in wheat
Çizelge 3. Buğdayda kök ve sürgün taze ağırlığı üzerine Zn uygulamalarının etkileri

Zn treatments	Fresh roots weight (mg)		Mean	Fresh shoots weight (mg)		Mean
	Imam	Altındane		Imam	Altındane	
Control	80.0 g	110.0 f	95.3 e	120.0 f	156.6 c	139.0 e
Hydropriming	90.0 g	121.0 cde	105.0 d	124.0.f	178.6 b	151.0 d
Seed priming (2.5 mM)	113.6 ef	128.0 bc	120.0 bc	146.0 d	177.0 b	161.8 c
Seed priming (5 mM)	116.0 cdef	133.0 b	125.0 ab	178.0 b	176.3 b	177.0 b
Seed coating with Arabic Gam	109.0 f	120.0 cdef	115.0 c	136.0 e	162.0 c	150.0 d
Seed coating (1.5 g Zn/kg seed)	114.6 def	146.0 a	130.6 a	180.0 ab	190.0 a	185.0 a
Seed coating (2.5 g Zn/kg seed)	121.0 cde	126.6 bc	124.0 ab	172.0 b	179.0 b	176.0 b
Seed coating (5 g Zn/kg seed)	112.4 ef	126.0 bcd	119.0 bc	172.0 b	172.0 b	172.6 b
Mean	107.3 b	126.5 a		154.0 b	174.0 a	
CV%	6			3.5		
LSD	11.8			9.7		
P value	Zn	**			**	
	V	**			**	
	ZnxV	**			**	

Means followed by different letters are statistically different. **: significant at P<0.01

a) b) c) d) e) f) g) h) i)

Figure 3. Effects of priming and coating of wheat seeds with Zn on shoots and roots length. Seedlings from seed coating with 5, 2.5 and 1.5 g Zn (a, b and c), hydropriming (d and h), untreated seeds (e and i), seed priming with 5 and 2.5 mM Zn (f and g)

Şekil 3. *Buğday tohumlarının Zn ile priming uygulaması ve kaplanmasının sürgün ve kök uzunluğu üzerine etkileri. 5, 2.5 and 1.5 g Zn ile kaplanan tohumlardan (a, b ve c), hidropriming işleminden (d ve h), uygulama yapılmayan tohumlardan (e ve i), 5 ve 2.5 mM Zn ile kaplanan tohumlardan (f ve g) elde edilen fideler*

In Imam variety, seed coating with 1.5, 2.5 and 5 g Zn had positive effect on all growth seedling parameters and enhanced root fresh 44, 51 and 40%, shoot fresh 50, 43 and 43% (Table 3), root length 23.34 and 28%, shoot length 26.5, 13 and 20% (Table 4), root dry weight 43, 40 and 54% and shoot dry weight 38, 26 and 23%, respectively when compared with untreated seeds (Table 2). On the other hand, Altındane variety had shown significant results in Zn seed coated in all concentration, particularly low dose of 1.5 g Zn where improved and increased roots and shoots fresh weight, root and shoot length and roots and shoots dry weight by 33 and 21, 31 and 26%, and 22 and 25%, respectively in compared with untreated seeds (Table 3, 4 and 5, respectively).

Table 4. Effects of Zn treatments on length of roots and shoots in wheat
Çizelge 4. *Buğdayda kök ve sürgün uzunluğu üzerine Zn uygulamalarının etkileri*

Zn treatments	Root length (cm)		Mean	Shoot length (cm)		Mean
	Imam	Altındane		Imam	Altındane	
Control	8.6 e	8.6 e	8.6 b	15.0 de	15.0 de	15.0 d
Hydropriming	11.0 abc	11.0 ab	11.0 a	14.0 e	17.7 ab	16.0 cd
Seed priming (2.5 mM)	11.0 abc	11.0 abc	11.0 a	18.0 ab	17.0 bc	17.5 b
Seed priming (5 mM)	9.6 de	12.3 a	11.0 a	17.0 bc	17.3 bc	17.1 b
Seed coating with Arabic Gam	10.0 cde	10.3 bcd	10.3 a	17.3 bc	16.0 cd	16.6 bc
Seed coating (1.5 g Zn/kg seed)	10.6 bcd	11.3 abc	11.0 a	19.0 a	19.0 a	19.0 a
Seed coating (2.5 g Zn/kg seed)	11.6 ab	10.0 bc	10.8 a	17.0 bc	16.0 cd	16.5 bc
Seed coating (5 g Zn/kg seed)	11.0 abc	10.3 bcd	10.6 a	18.0 ab	15.3 de	16.6 bc
Mean	10.5	10.6		16.9	16.5	
CV%	8.6			5.5		
LSD	1.5			1.5		
P value	Zn	ns			**	
	V	**			ns	
	ZnxV	*			**	

Means followed by different letters are statistically different. *: significant at P<0.05, **: significant at P<0.01, ns: non-significant

Table 5. Effects of Zn treatments on dry weight of roots and shoots in wheat
Çizelge 5. Buğdayda kök ve sürgün kuru ağırlığı üzerine Zn uygulamalarının etkileri

Zn treatments	Root dry weight (mg)		Mean	Shoot dry weight (mg)		Mean
	Imam	Altındane		Imam	Altındane	
Control	7.3 f	10.3 e	8.6 b	14.0 g	16.4 f	15.2 e
Hydropriming	10.3 e	11.0 cde	10.6 c	13.3 g	18.6 bcd	16.0 de
Seed priming (2.5 mM)	11 cde	120. abc	11.5 b	17.0 ef	17.0 ef	17.0 cd
Seed priming (5 mM)	13.2 a	11.6 bcd	12.3 a	19.0 bc	18.7 bcd	18.8 b
Seed coating with Arabic Gam	10.6 b	10.6 de	10.6 c	14.3 g	16.4 f	15.3 e
Seed coating (1.5 g Zn/kg seed)	10.4 e	12.6 ab	11.5 b	19.3 ab	20.6 a	20.0 a
Seed coating (2.5 g Zn/kg seed)	10.2 e	10.6 de	10.5 c	17.6 cdef	17.7 cdef	17.6 c
Seed coating (5 g Zn/kg seed)	11.3 cde	12.0 abc	11.6 b	17.3 def	18.0 bcde	17.6 c
Mean	16.5 b	18.0 a		16.9	16.5	
CV%	6.4			5.2		
LSD	1.1			1.5		
P value	Zn	**			**	
	V	**			**	
	ZnxV	**			**	

Means followed by different letters are statistically different. **: significant at P<0.01

Furthermore, in comparison with HP with 5 and 2.5 Mm had displayed significant influence through enhanced the weight of root fresh (29 and 23%), shoot fresh (19 and 14 %) shoot length (21 and 28 %) and shoot dry matter (42 and 27 %) in Imam variety. Among seed treatments, seed coating by 1.5 g Zn/kg seed using $ZnSO_4$. $7H_2O$ gave the highest seedling fresh root and shoot weight, root and soot length (Table 3, 4 and 5). Altındane was the superior than Imam variety for fresh root and shoot weight (Table 3), dry root and shoot weight (Table 5), while they weren't statistically different for root and shoot length (Table 4). Across varieties, Altındane have shown higher weight for root and shoot fresh by 126.5 and 174 mg than that of Imam variety (107.3 and 154 mg, respectively) (Table 3).

4. Discussion

Zn concentration of seed is essential and remarkable element for seed germination and during the early establishment phase, particularly when seeds sown in Zn deficient soil. Many previous studies had displayed the value of Zn sufficient seeds for seed vigor based on seed germination and seedling height (Welch, 1999; Cakmak, 2008).

The results of this study showed that seed priming with Zn high dose (5 mM) had relatively positive impact on seed germination and seedling growth parameters when compared with low Zn dose (2.5 mM) and hydropriming of two wheat varieties. Similarly, seed primed with 5 or 10 mM $ZnSO_4$ generally mitigate the germination of barley seeds (Ajouri et al., 2004). On the other hand, seed priming with Zn up to 5 mM significantly enhanced seed growth, germination rate and dry weight of rice (Todeschini et al., 2011; Cambrollé et al., 2012; Prom-u-thai et al., 2012). Furthermore, several authors have described positive response to seed priming with Zn in seed germinating (Johnson et al., 2005; Mohsin et al., 2014; Reis et al., 2018).

Seed priming with $ZnSO_4$ was very cost-effective in wheat and have widely applied and adopted by farmers for various crops like wheat. However, many results have shown that use seeds with adequate Zn concentration could increment grain Zn content, germination rate and increase yield in wheat (Yilmaz et al, 1997; Reis et al, 2018), maize (Ajouri et al., 2004; Harris et al., 2007) and chickpea (Johnson et al., 2005; Hidoto et al., 2017). And the data from this study confirmed that the seed priming with Zn is an effective way to increase germination rate particularly with high Zn concentration (5 mM) in variety with low Zn content. Seedling from seed primed with water are known as hydropriming and to take less time to emergence and grow vigorously than those from non-primed seeds (Ajouri et al, 2004; Arif, 2005; Rashid et al., 2002).

The data in Table 3 follow this pattern, but seed primed with 2.5 Mm in Imam variety and 5 Mm in Altındane variety have taken the same time to complete MGT in comparison with HP. In present research work, Zn seed priming advanced all seedling growth parameters and has shown significant results particularly in Imam variety. On the other hand, seeds of Altındane variety have observed less responds Zn priming that might be return to that enough grain Zn content of this variety in comparison with low or medium Zn seed content or due to genetic variation.

However, the results of this research also showed that seed coating with Zn has observed good respond and revealed important results for all seed germination parameters in comparison with untreated seeds for both wheat varieties particularly variety with less Zn content (Altındane variety). This result clearly indicates to that seed coating with Zn could have more effective influence when applied to variety with low Zn content rather than those have sufficient Zn content. As indicated above, coated seed with 1.5 g Zn/kg seed had shown a slightly improvement in seed germination when compared to other concentrations and untreated seeds. Rehman and Farooq (2016) pointed out seed coated with Zn improves the seedling weight due to better root and shoot growth. Similarly, Zn coated seed make the nutrient available during the early establishment phase of seed germination and that leaded to faster the seedling growth (Taylor and Harman, 1990). Moreover, seed coated with the highest dose of Zn 5 g/kg seed had a deleterious effect on seed emergence and seedling growth for both varieties, especially in Altındane variety. Nevertheless, previous studies have noticed the same results reported by Dirginčiutė-Volodkienė and Pečiulytė (2011) and Rehman and Farooq (2016), where that accumulation Zn at high concentration may induce Zn toxicity, which may affect plant growth.

5. Conclusions

Seed priming in Zn containing solution and seed coating with Zn are simple and practical way to enhance seed Zn prior to sowing and contribute to better seedling growth. Moreover, seed with high Zn content can ameliorate seed germination, seedling vigor, sustain crop growth and stress tolerance particularly in Zn deficient soil. There was large difference between wheat varieties in term of the response to Zn priming and coating, the effectiveness was more pronounced in variety accumulated low Zn content than that have high. Seed priming with Zn was an effective way to increase germination rate and improve seedling growth, particularly with high Zn concentration (5 mM) in comparison with low rate and hydropriming. Moreover, Zn coated seed with more than 1.5 g Zn/kg seed had negative affect on seedling growth as high doses had depressed the germination and seedling growth.

Therefore, the lowest dose of Zn coating at the rate of 1.5 g Zn/kg seed is considered as completely economic and safely the for ecosystem.

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