

## EFFECT OF PRIMING ON SEED VIGOR OF WHEAT (*Triticum aestivum* L.)

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### ABSTRACT

Priming is a process that controls the process of hydration of seeds for the ongoing metabolic processes before germination. Research on priming was conducted at ICERI seed laboratory from May to September 2009 to evaluate the effect of different priming methods on wheat seed vigor. Physical properties and chemical composition of seed were evaluated before seeds were treated. The priming treatment were conducted by soaking 250 g of seed in 500 mL of solution for hydropriming and halopriming. Two seed lots of Nias and Dewata variety were subjected to heated and unheated distilled water for 12 hours and subjected to KCl and CaCl<sub>2</sub> at 10, 20, and 30 ppm and unprimed seed. The experiment were arranged in completely randomized design, replicated thrice. Vigor evaluation by observed seed germination, simultaneity growth, germination rate, seedling dry weight, electric conductivity of seed leakage and length of primary root. The results showed that highest germination, simultaneity growth, seedling dry weight, and length of primary root, were priming treatment with KCl 30 ppm and CaCl<sub>2</sub> 20 and 30 ppm. Priming with distilled water for 12 hours gave higher germination percentage and simultaneity growth.

Keywords : priming, wheat, seed, vigor

### INTRODUCTION

Planting seeds of wheat on dry land depends on water availability. Appearance of delayed germination can occur due to land preparation and growing conditions environment

which are less optimal, caused an increase of abnormal seedling and seedling vigor is weak.

The growth of seedling can be slow or very diverse, depending on the vigor of seeds that are sowed, and environmental conditions. One of the methods to enhance and improve the growth of seeds that germinate is to provide treatment or priming invigoration (Heydecker and Coolbear, 1977).

Seed enhancements are 'value-added' techniques that improve germination or seedling growth or facilitate the delivery of seeds and other materials required at the time of sowing. Various seed invigoration treatments have been used to improve seed germination and seedling establishment. These include alternate hydration-dehydration (Nath *et al.*, 1991), water soaking (Rudrapal and Nakamura, 1988) and seed priming (Khan *et al.*, 1992).

Seed priming is a pre-germination seed treatment in which seeds are held at water potential that allows imbibition, but prevents radicle extension (Bradford, 1986). Seed priming has been used to improve germination, reduce seedling germination time, improve stand establishment and yield (Khan *et al.*, 1992). Soon *et al.* (2000) reported that hydropriming was best in promoting germination. The best priming treatment was found to be hydropriming for 24 h by Basra *et al.* (2003) followed by matricconditioning with gunny bags for 24 h.

Priming is the enhancement of physiological and biochemical events in seeds during suspension of germination by low osmotic potential and negligible matric potential of the imbibing medium.

Such treatments include water soaking (Bradford, 1986), priming in which hydration is controlled in an osmoticum such as polyethylene glycol (PEG) or a salt solution (Heydecker and Coolbear, 1977).

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Salts or non-penetrating organic solutes in liquid medium (osmoconditioning) or matrix solutions (matricconditioning) are used to establish equilibrium water potential between seed and the osmotic medium needed for conditioning (Khan, 1993). In osmoconditioning seeds are held at low water potential solutions while during matricconditioning seed hydration is controlled by the physical and osmotic characteristic of a solid matrix carrier (Kubik *et al.*, 1989).

Priming treatments could increase plant vigor, seed yield and harvest index (Farooq *et al.* 2007). Furthermore Farooq *et al.* (2007) also stated that priming treatment with  $\text{CaCl}_2$  increase wheat grain yield compare to control treatment, but did not affect plant height, spikelet number, seed number and 1000 grain weight. Priming treatment on the seed is one alternative to increase seedling resistance against environmental conditions that are less optimum growth (Ashraf and Foolad, 2005).

This research was conducted to study the effect of different priming treatments against some characters of wheat seed vigor.

## MATERIALS AND METHODS

The experiment was conducted from May to September 2009, in the Seed Laboratory and greenhouse of Indonesian Cereal Research Institute (ICERI), Maros, South Sulawesi, Indonesia. Two seed lot of cv. Nias and Dewata were collected from seed produced in Tinggimoncong, Gowa district of South Sulawesi, Indonesia (altitude around 1300 m asl). Two others seed lot of cv. Nias and Dewata were obtained from 18 months storage in the cold storage of ICERI.

### Seed priming

Before the start of experiment, seeds were surface sterilized in 10% sodium hypo-chlorite solution for 10 minutes, then rinsed with sterilized water and air-dried. Priming treatments were arranged in a completely randomized design with 2 factors, replicated thrice. Following priming treatments were included :

#### A. Priming:

- T<sub>1</sub> = control (without priming)
- T<sub>2</sub> = hydropriming with heated distilled water (40°C), 12 hours
- T<sub>3</sub> = hydropriming with distilled water, 12 hours

- T<sub>4</sub> = halopriming with 10 ppm KCl
- T<sub>5</sub> = halopriming with 20 ppm KCl
- T<sub>6</sub> = halopriming with 30 ppm KCl
- T<sub>7</sub> = halopriming with 10 ppm  $\text{CaCl}_2$
- T<sub>8</sub> = halopriming with 20 ppm  $\text{CaCl}_2$
- T<sub>9</sub> = halopriming with 30 ppm  $\text{CaCl}_2$

#### B. Seed lot:

- L<sub>1</sub> = Nias (18 months stored)
- L<sub>2</sub> = Nias ( fresh harvest)
- L<sub>3</sub> = Dewata(18 months stored)
- L<sub>4</sub> = Dewata(fresh harvest)

A weighed quantity (250 g) of wheat seeds was used in each treatment in plastic beakers containing 500 mL of respective solution for 12 hours for hydropriming and halopriming (Bennet and Waters, 1987). After soaking, seeds were redried to original weight with forced air under shade.

### Vigor Evaluation

#### Emergence Test

The experiment was carried out in pots filled with sand. Fifty seeds were sown per pot at the depth of 3 cm and the experiment was replicated thrice. The pots were placed in the green house. The data regarding the 4<sup>th</sup>, 5<sup>th</sup>, and 6<sup>th</sup> day or final emergence percentage, germination rate and simultaneity growth were recorded after the start of experiment. The data for the shoot length and dry weight of seedling was recorded after 6 days of sowing (AOSA, 1991).

#### Electric Conductivity of Seed Leakage

Four-grams seeds of each treatment were soaked on plastic beaker having distilled water at 25 °C. Electrical conductivity of seed leachates was measured after 24 hours of soaking (Ashraf *et al.*, 1999) using the conductivity meter and expressed as  $\mu\text{mhos}/\text{cm}^2/\text{g}$ . The experiment was replicated thrice.

#### Physical Properties and Chemical Composition of Wheat Seed

Physical properties and chemical composition of wheat seeds were evaluated before seeds were treated includes : seed weight, seed density, moisture content, protein, fat, carbohydrates, fiber and ash. Data were analyzed with general linear model using SPSS Statistic version.17.

## RESULTS AND DISCUSSION

### Physical Properties and Chemical Composition of Wheat Seed

The observation on the physical properties and chemical composition of seed lots of Nias and Dewata were presented in Table 1. Old seeds and fresh harvested seeds showed no differences in some physical properties. Seed weight in the range of 41.1 to 42.7 g. while the seed density between 0.033 to 0.036.

Carbohydrate decreased by 2.14% in Nias and 0.16% in Dewata after being stored for 18 months. Fat and fiber showed a slight decrease, while the protein is relatively stable (Table 1).

### Vigor Evaluation

The old seeds (18 months storage) showed lower germination, spontaneous growth, seedling dry weight, and root length than the fresh harvest seed (Table 2). Electric conductivity of seed soaking water and reducing sugar content tend to increase with length of storage. Nias only showed an increase of electrical conductivity of 2.96%, while in Dewata, the increase of electrical conductivity was only 2.94%. It indicates that the shelf life of wheat seed is high (Table 3).

Table 1. The physical properties and chemical composition of wheat seed lot of Nias and Dewata (Seed Laboratory, ICERI, 2009)

Seed lot	1000 seed weight (g)	Seed Density (g/cc)	Moisture Content (%)	Carbohydrate (%)	Protein (%)	Fat (%)	Fiber (%)	Ash (%)
Nias (18 months)	41.1 ns*)	0.035 ns*)	8.19 ns*	80.63 ns*)	15.70 ns*)	2.13 ns*	3.13 ns*)	1.54 ns*)
Nias (fresh harvest)	41.3	0.036	10.36	82.40	15.05	2.14	3.15	1.41
Dewata (18 months)	42.7	0.033	10.98	78.95	17.07	2.14	2.86	1.54
Dewata (fresh harvest)	41.9	0.034	10.55	79.08	17.05	2.28	3.08	1.59

Remarks: \*) ns = numbers in the same column were not significantly different. Observation were conducted before seeds were treated

Table 2. Seed vigor from different seed lot. (Seed Laboratory, ICERI, 2009\*\*)

Seed lot	Germination (%)	Simultaneity Growth (%)	Germination Rate (%)	Seedling Dry weight (mg)	Primary root length (cm)
Nias (18 months)	97.70 ab *)	89.41 d *)	24.34 ab*)	28.47 a*	18.50 b*)
Nias (fresh harvest)	98.82 cd	93.29 a	23.86 a	30.49 c	18.07 a
Dewata(18 months)	97.48 a	90.11 b	25.37 cd	28.40 a	18.66 b
Dewata(fresh harvest)	98.29 bc	91.96 c	24.79 bc	29.47 b	19.18 c

Remarks: \*) number followed by the same letter in the same column, not significantly different by Duncan test at level 0.05 \*\*) the average value of priming treatment

Table 3. Electric conductivity of seed soaked water (24 hours) from 4 seed lot Nias and Dewata varieties. (Seed Laboratory, ICERI, 2009)

Seed lot	Electric conductivity ( $\mu\text{mhos}/\text{cm}^2/\text{g}$ )	Reducing sugar (%)
Nias (18 months)	7.44	2.13
Nias (fresh harvest)	7.22	1.94
Dewata (18 months)	7.15	2.15
Dewata (fresh harvest)	6.94	1.83

Seedling dry weight of four seed lot tend to increase with priming. Priming treatment with KCl-20 and 30 ppm and  $\text{CaCl}_2$ -20 and 30 ppm showed higher increased of seedling dry weight compare to control and others priming treatment (Table 4). Halopriming with 20 and 30 ppm  $\text{CaCl}_2$  and 30 ppm KCl showed the highest seedling dry weight, while the highest primary root length with 30ppm  $\text{CaCl}_2$ . Control treatment and the hydropriming with heated distilled water  $40^\circ\text{C}$  have the lower seedling dry weight than other treatments (Table 4).

These findings were similar to Farooq *et al.* (2007), which stated that priming wheat seed with  $\text{CaCl}_2$  improved seed vigor and grain yield of wheat. In priming, enhancement of physiological and biochemical events in seeds takes place during suspension of germination by low osmotic potential and negligible matric potential of the imbibing medium.

In this research, KCl and  $\text{CaCl}_2$  solution medium are used to establish an equilibrium of water potential between seed and osmotic medium needed for conditioning. These two priming treatment (KCl and  $\text{CaCl}_2$ ) at concentration of 20 and 30 ppm could enhance seed vigor parameter includes seedling dry weight, germination rate and spontaneous growth. Maximum invigoration was achieved in hydro-priming for 24 h supporting earlier work done by Fujikura *et al.* (1993) who reported that hydro-priming cause greater increase in germination rate in cauliflower than other priming treatment.

The increased plant biomass might be due to synchronized germination and early stand establishment in treated seeds. These findings are similar with earlier research on asparagus (Evan and Pill, 1989), pepper (Smith and Cobb, 1991), Canola (Zhang *et al.*, 1994) and wheat (Nath *et al.*, 1991). An increase in root length was recorded in priming treatment with 20 and 30 ppm KCl and  $\text{CaCl}_2$  solution, which might be the result of higher embryo-cell wall extensibility. These higher root length may be due to the fact that, priming induced nuclear replication in root tips of fresh seeds (Sharifzadeh *et al.*, 2006). These observations are in conformity with earlier work on wheat and pepper seeds (Stofella *et al.*, 1992).

Table 4. Effect of priming treatment on seed vigor. (Seed Laboratory, ICERI, 2009)

Priming Treatment	Germination (%)	Simultaneity Growth (%)	Germination Rate (%)	Seedling Dry weight (mg)	Primary root length (cm)
Control	94.08 a	88.00 a	19,95 a	22.19 a	15.43 a
DW-40	96.08 b	87.42 b	20,69 a	22.99 b	15.53 a
DW	98.42 c	90.17 c	23,84 b	26.79 c	17.48 b
KCl-10 ppm	98.67 c	91.75 d	25,42 c	29.05 d	19.18 c
KCl-20 ppm	99.08 c	92.25 de	26,54 d	31.62 f	19.58 d
KCl-30 ppm	99.33 c	93.08 ef	27,83 e	32.87 g	20.33 e
$\text{CaCl}_2$ -10 ppm	98.42 c	93.17 ef	24,32 b	31.16 e	19.25 c
$\text{CaCl}_2$ -20 ppm	98.59 c	93.42 f	25,47 c	32.95 g	19.83 d
$\text{CaCl}_2$ -30 ppm	99.25 c	93.50 f	27,27 de	33.26 g	20.83 f

Remarks: <sup>a)</sup> Number followed by the same letter in the same column, not significantly different by Duncan test at level 0.05  
<sup>\*)</sup> Data were the average value of the test genotype DW = distilled water, DW-40 = distilled water at  $40^\circ\text{C}$

## CONCLUSIONS

The results of this study showed that invigoration of wheat seed through a process of priming effect on germination percentage, simultaneity growth, germination rate, seedling dry weight, and root length of Nias and Dewata. Seed vigor of old seed lot was lower than fresh seed lot. Halopriming with 20 and 30 ppm of KCl and CaCl<sub>2</sub> increased seed germination, spontaneous growth, seedling dry weight, and primary root length. Hydropriming with distilled for 12 hours increased seed emergence in terms of germination percentage and simultaneity growth.

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