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Effect of Hydropriming on Germination and Some Related Characters of Seedling on Lentil, Soja Bean, Green Bean and Broad Bean

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ABSTRACT

Seed pretreatment is a more general term than seed priming and it includes all types of treatments given to seeds before seeding in order to gain any benefit during the plant life cycle. Often these terms overlap in the literature, but, in general, priming is a treatment for germination enhancement whereas seed pre-treatments are geared toward improvements beyond the germination process. In order to investigation effect of hydropriming treatment on germination and some related characters of seedling on lentil, soja bean, green bean and broad bean, experimental was conducted at physiology laboratory of Islamic Azad University of Ghaemshahr using a factorial based an completely randomized design with three replications. Seeds of four legumes (lentil, soja bean, green bean and broad bean) in the laboratory conditions were subjected to hydropriming for 0, 4, 8 and 16 h, then germination performance were considered. Results of laboratory experiment showed that treatment of hydropriming was significant on complete characters of seedling. Comparison of means showed that length time of priming, were different effect in seedling. Treatment of 16 h hydropriming increased rate germination, seedling dry mater and seed vigor. In lentil, percentage and rate germination was not different effect with hydropriming treatments. But, in soja bean and green bean, complete of the hydropriming treatments significantly effect on characters of seedling. Treatment of 8 and 16 h hydropriming, in broad bean was effective.

***Key words**:* Hydropriming, lentil, Soja Bean, Green Bean, Broad Bean, Seed Vigor

Introduction

Good crop stand establishment is considered to be essential for the efficient use of resources like water and light (Basra *et al*, 2005; Farooq *et al*, 2006). Uniform stand establishment is still a pre-requisite for cropping success because, under adverse conditions, crowding should be avoided in order to allow each plant maximum access to limited soil water (Kaur *et al*, 2005; Ghiyasi *et al*, 2008; Shad *et al*, 2010). Observations of crops in farmers' fields in Botswana between 1987 and 1991 suggested that crop establishment is often poor and Harris (1999) showed that a major reason for this is the poor access to timely draught by resource-poor farmers. Crops must be sown when "windows of opportunity" present themselves after a rainstorm. Seeds which germinate quickly produce viable seedlings with functional root systems which are not dependent on the rapidly-declining moisture in the soil surface layers (Farooq *et al*, 2007). Similarly, fast emergence reduces the risk of seedlings being affected by soil capping or crusting, or soil-borne pests and diseases (Harris *et al*, 2001; Shad *et al*, 2010; Adebisi *et al*, 2011).

Seed priming has been used to improve germination, reduce seedling emergence time and improve stand establishment and yield (Shivankar *et al*, 2003; Judi and Sharifzadeh, 2006). Primed seeds usually exhibit an increased germination rate, greater germination uniformity, and, at times, greater total germination percentage (Basra *et al*, 2005). Seed priming enhances speed and uniformity of germination (Mussa *et al*, 1999; Khalil *et al*, 2010; Khan *et al*, 2008), and induces several biochemical changes in the seed that are required to start the germination process such as breaking of dormancy, hydrolysis or mobilization of inhibitors, imbibitions and enzyme activation (Paul and Chodhury, 1991). The resulting improved stand established can reportedly increase the drought tolerance, reduce pest damage and increase crop yield in cereals and legumes (Harris *et al*, 1999; Harris *et al*, 2001; Khan *et al*, 2005; Judi and Sharifzadeh, 2006; Adebisi *et al*, 2011).

When priming occurs at sub-optimal temps, thermal time can also be added to the equation. Three basic systems used to deliver/restrict H2O, supply air to seeds: 1. Osmo priming 2. Matrix-priming 3. Hydro priming all can be conducted as batch processes. Commercial systems can handle quantities from tens of grams to several tons at a time Hydropriming methods have practical advantages of minimal waste material produced (vs. osmo-, matri priming). Slow imbibitions is the basis of the patented 'drum priming' and related techniques

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(Wang *et al*, 2003). Hydropriming refers to alternate wetting and drying of seeds under laboratory conditions to withstand and continue productive plant growth even under adverse field condition of drought, cold and salt. Pre-sowing hydropriming brings about physiological reorganizations, metabolic, anatomical and morphological changes (Li *et al*, 2011). Physiological reorganization that takes place are increase in hydrophilic property of the protoplasmic colloids namely the viscosity and elasticity, increase in osmotic pressure, changes in the quality of proteins and overall increase in the water holding capacity of seed. In primed seeds, Phase II is extended and maintained until interrupted by dehydration, storage Phase III water uptake is achieved upon subsequent sowing and rehydration (Chivasa *et al*, 2001. Ashraf and Foolad, 2005; Iqbal *et al*, 2006).

Priming protocols, materials can be tailored to given species, seed lots for optimal results. The beneficial effects of priming have been demonstrated for many field crops such as wheat, rice, sugar beet, maize, soybean and sunflower (Ruan *et al*, 2002; Khajeh- Hosseini *et al*, 2003; Sadeghian and Yavari, 2004). Basra *et al* (2003) reported that priming treatment significantly affected growth parameters and recorded an increase in LAI and dry matter accumulation due to priming in canola. However, the simplest technique, that of soaking seed in water for a short period of time prior to sowing seems not to have been tested systematically for legumes, although the practice is often used with maize (eg. in Malawi and Zimbabwe, although usually only when farmers have delayed sowing and are trying to “catch up”). Various seed treatments are well established, particularly in the horticultural industry and some techniques are quite complicated (Paul and Chodhury, 1991; Farooq *et al*, 2006). In general, priming offers the opportunity to almost always germinate seeds at much higher speeds without detrimental effects in germination percentages. The objective of this study was to effect of hydropriming treatment on germination and some related characters of seedling on lentil, soja bean, green bean and broad bean.

Material and Methods

In order to investigation effect of hydropriming treatment on germination and some related characters of seedling on lentil, soja bean, green bean and broad bean, experimental was conducted at physiology laboratory of Islamic Azad University of Ghaemshahr using a factorial based an completely randomized design with three replications. Seeds of four legumes (lentil, soja bean, green bean and broad bean) were sterilized in 2% sodium hypochlorite for 30 min and finally washed several times with distilled water. Seeds of legumes in the laboratory conditions were subjected to hydropriming for 0, 4, 8 and 16 h, then germination performance were considered. Percentage germination and rate germination was recorded on the 10th day after sowing, shoot length and total weight and seed vigor were recorded. In addition, Seedling vigor index was recorded after 10 days. Seeds were considered germinated when the radical extended through the seed coat. Vigor index for each treatment was determined using the following formula developed by Abdul-Baki and Anderson (1973).

Seedling Vigor = [root length + shoot length] × percentages of germination

The plants were removed 10 day after sowing, and roots were washed using slow running water to remove soil particles and organic debris. The dry mass of shoot and root samples, root length and shoot length was determined after drying in an oven at 60 °C with forced air. Ten normal seedlings were selected at random from each treatment of the germination test on ten day (final count day) and used for measuring root length. The root length was measured from the tip of primary root to the base of the hypocotyl and the mean root length was expressed in centimeters. The shoot length was measured from the base of the primary leaf to the base of the hypocotyl and the mean shoot length was expressed in centimeters. Data were subjected to ANOVA using the SAS statistical software package using GLM (SAS Institute., 2000) and Duncan's multiple range tests was performed to compare the treatment means. The level of statistical significant was accepted as $P<0.05$ (Steel and Tore 1960).

Results and Discussion

Results of laboratory experiment showed that treatment of hydropriming was significant on complete characters of seedling. This may due to more water absorption, better root development, increased size of cell walls with profound effect on transpiration and stomatal behavior (Andoh and Kobata, 2002). Comparison of means showed that length time of priming, were different effect in seedling. Treatment of 16 h hydropriming increased rate germination, seedling dry mater and seed vigor (Table 1). Among the different soaking hours the seeds soaked for 16 hours recorded significantly the highest (92. 5%) germination percentage as compared to unsoaked seeds (79.4%). Li *et al* (2011) reported that, Hydropriming shortened the delay of MGT (means of germination time) at all osmotic potentials, and improved the germination percentage in distilled water (from 52% to 59%) and resistance to salt stress with nearly double germination (from 16% to 29%) at the highest salt concentration. Amylases are key enzymes that play a vital role in hydrolyzing the seeds starch reserve, thereby

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supplying sugars to the developing embryo. Effects of hydropriming on water potential, the driving force for water up-take during imbibition and the activity of α-amylase were examined in wheat and rice kernels (Andoh and Kobata, 2002).

In the present study as in germination, similar trend was also noticed in Seedling vigor, Root and Shoot length and seedling dry weight. Significant difference in shoot length due to different soaking hours was observed. Among the different soaking hours, 16 hours soaking period recorded significantly the highest shoot length than the control. Due to the seeds soaking in water significantly the highest seedling vigor index was observed in seeds soaked for 8 and 16 hours as compared to unsoaked seeds (Table 1). In soja bean and green bean, complete of the hydropriming treatments significantly effect on characters of seedling. Treatment of 8 and 16 h hydropriming, in broad bean was more effective (Table 1). Recent research on a range of crop species showed faster germination, early emergence, and vigorous seedlings achieved by soaking seeds in water for some time, followed by surface drying before sowing, which may result in higher crop yield. For example, Abebe and Modi (2009) investigated Hydro-Priming in Dry Bean (*Phaseolus vulgaris* L.). They reported that, there was significant difference between cultivars for germination percent at the 2nd day, while only the media of hydration was significant at the 8th day count. None of the factors were significant at the 4th day. In that experimental (Abebe and Modi, 2009), There was significant difference among hydration media and cultivars for normal seedlings at the 8th day, while the interaction was non-significant. Completely immersing the seed in water-filled flask did not cause the failure of germination in the first experiment; rather hydration followed by dehydration treatment was the possible cause. The similar observations were also made by Ghassemi-Golezani *et al* (2010) that, experimental of influence of hydro-priming duration on field performance of pinto bean (*Phaseolus vulgaris* L.) cultivars show that, the effects of hydro-priming on percentage of seedling establishment, ground cover and plant biomass were significant, but hydro-priming had no significant effect on chlorophyll content index.

Table 1: Effect of hydropriming treatment on germination and some related characters of seedling on lentil, soja bean, green bean and broad bean.

Source variation	Rate germination	Percentage germination	Root length	Shoot length	Dry Weight	Seedling vigor
crop						
lentil	3.02 b	100.0 a	4.42 b	6.72 a	0.02 d	0.03 c
soja bean	5.17 a	95.2 a	5.74 a	3.06 b	0.36 a	0.08 b
green bean	3.40 b	59.2 b	5.53 a	3.01 b	0.07 c	0.01 d
broad bean	2.23 c	95.6 a	4.21 b	3.54 b	.012 b	0.11 a
priming						
control	2.52 b	79.4 b	4.31 b	3.11 c	0.15 c	0.50 c
4 hour	3.64 a	86.9 ab	4.82 b	3.73 bc	0.20 b	0.82 b
8 hour	3.82 a	89.7 a	5.04 ab	4.12 b	0.21 b	0.94 ab
16 hour	3.86 a	92.5 a	5.82 a	4.80 a	0.25 a	1.08 a

In each treatment, means followed by the same letter are not significantly different at $P \leq 0.05$.

Table 2: Effect of hydropriming treatment on germination and some related characters of seedling on lentil, soja bean, green bean and broad bean.

Source variation	Rate germination	Percentage germination	Root length	Shoot length	Dry Weight	Seedling vigor
Lentil						
control	2.33 b	100 a	3.63 c	4.73 c	0.04 b	0.19 b
4 hour	3.62 ab	100 a	4.10 b	6.33 ab	0.06 ab	0.21 b
8 hour	2.86 b	100 a	4.30 b	5.93 b	0.05 b	0.15 bc
16 hour	3.29 ab	100 a	5.63 ab	7.70 a	0.07 a	0.24 a
soja bean						
control	4.38 b	86 c	4.33 b	1.83 d	0.35 c	1.54 c
4 hour	5.52 a	93 b	4.43 b	2.17 c	0.43 b	2.34 b
8 hour	5.33 a	100 a	6.97 ab	4.70 a	0.49 ab	2.59 b
16 hour	5.45 a	100 a	7.37 a	3.97 ab	0.50 a	2.73 ab
green bean						
control	1.81 c	36 c	4.57 b	2.50 c	0.06 c	0.10 c
4 hour	3.67 ab	60 b	6.07 a	3.27 b	0.09 b	0.32 b
8 hour	4.47 a	70 a	5.73 a	2.77 bc	0.09 b	0.41 a
16 hour	3.67 ab	70 a	6.00 a	3.70 ab	0.11 a	0.40 a
broad bean						
control	1.47 b	94 b	4.27 ab	3.40 b	0.19 c	0.28 d
4 hour	1.79 ab	94 b	4.10 b	3.17 bc	0.23 b	0.41 c
8 hour	2.72 a	88 c	3.23 bc	3.20 b	0.24 b	0.64 b
16 hour	2.94 a	100 a	4.30 ab	4.43 a	0.32 a	0.96 a

In each treatment, means followed by the same letter are not significantly different at $P \leq 0.05$.

Our results showed that in soja bean and broad bean, percentage and rate germination was different effect with hydropriming treatments. This was due to hydration of the seeds; hydrolytic enzymes were activated in the endosperm converting complex stored food materials into metabolically useful chemicals that resulted in to growth of the embryo (Andoh and Kobata, 2002). While hydropriming could not improve this character under all condition as compared to lentil (figure 1). Metabolic changes that result due to hydropriming are increased respiration, high level of synthetic reactions even during drought; leaves of hardened plants have more starch, increased phosphorylation activity of their mitochondria, higher rate of photosynthesis because of increase in the bound water and higher organic phosphorus and nucleuo-proteins (Khan *et al*, 2008). A significant effect of soja bean seed treatment was found for rate germination, percentage germination, root and shoot length, dry weight and seedling vigor (Table 2). Maximum seedling dry weight in soja bean was attained from hydroprimed seeds in 16 h treatment. Priming could be defined as controlling the hydration level within seeds so that the metabolic activity necessary for germination can occur but radicle emergence is prevented.

In the modern agriculture with its bias for technology and precision, demands that each and every seed should readily germinate and produce a vigorous seedling ensuring high yield. optimal yield need fast germination and uniform emergence on the field, this implies that hydropriming is the key to enhanced fast germination, uniform emergence plants and resistance to inadequate environmental factor that control seed germination. Daniel *et al*. (2009) reported that respiration, radicle protrusion and cell division consistently occurred sooner in primed (radicle) seeds compared to non primed seed when they were imbibed at 250C.

Conclusions:

Our results showed significant improvement in germination and early growth on lentil, soja bean, green bean and broad bean due to hydropriming treatment. The data on germination percentage revealed significant difference due to seed soaking for different periods. Treatment of 16 h hydropriming increased rate germination, seedling dry mater and seed vigor. Due to the seeds soaking in water significantly the highest seedling vigor index was observed in seeds soaked for 8 and 16 hours as compared to unsoaked seeds. In soja bean and broad bean, percentage and rate germination was different effect with hydropriming treatments. It can be concluded from the results of the present investigations that, hydropriming were effective on lentil, soja bean, green bean and broad bean.

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