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Does priming improve dill *(Anethum graveolens)* seed germination and yield?

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Abstract

This study examines the effects of seed priming on germination and yield on dill, in the laboratory experiment and pot study. The method used in the laboratory and pot is CRD (Completely Randomized Design) with three replications. The treatments are GA3[1] with dosage of 500p.p.m, hydro-priming (HP) with 24 hours duration in room temperature, KNO3[2] and control. Then in laboratory with use of special paper and pure water the seeds were cultured in petri-dishes and were putt in germinator with 19^{0c} temperature for 8 days and were counted daily. Some parts of primed seeds were stored in normal condition for 6 months and were cultured in laboratory condition. All the primed seeds were farmed in pots. Three months later the plants were harvested in first blooming level and dry weight and essential oil percentage were measured. The results of laboratory study showed that the influence of various treatments on germination percentage (GP) and germination rate (GR) were significant. KNO3 showed the highest positive effect on germination percentage (84.33%). Plant height (PH) and main branch (MB) number in KNO3 treatment in comparision with others were the highest. The effect of different treatments on essential oil percentage (EOP) was significant. KNO3 with (3.06%) and GA3 with (2.93%) had the most positive effect on essential oil percentage. The effect of different treatments on seedling weight (SW), seedling length (SL), dry weight (DW) and storage seed germination percentage (SGP) were not significant.

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Introduction

Dill (*Anethum graveolens* L.) is an annual herb of the family Apiaceae. It is native to southwestern Asia and southeastern Europe. It has been cultivated since ancient times as a vegetable, a carminative, an aromatic, and an antispasmodic plant. It is considered to be one of the most important medicinal plants in Iran, after saffron (*Crocus sativus* L.), cumin (*Cuminum cyminum* L.), and fennel (*Foeniculum vulgare Mill.)* (Mirshekari, 2012).

Seed priming is done with various chemical and physical methods, these are like gibberellic acid, cytokinin, chloridric acid, sodium chloride, potassium nitrate, thiore, solphoric acid, laser, seed scraping and generator (Hoseini *et al.*, 2013). Priming is a pre-emergence treatment which seeds absorb water and then will be dried so that the germination process is started but the radical emergence is not happened (Feghenabi, 2007). In other words, in the priming process, the seed is incited to start cell division and then will be dried. If again the seeds absorb water; it will start emergence from the dried situation (Neamatollahi *et al.*, 2009).Using biochemical methods would increase the plant growth, yield and quality. This technique protects plant against diseases and pests and decreases the use of fertilizers and pesticides. So that the farmer can reach a crop with more quality and quantity with expensing less time; cost and effort (Feghenabi, 2007). Priming increases antioxidant enzymes like cation eskorbate in the seed. These enzymes reduce lipid per oxidation in germination time. So the germination percentage increases (Hoseini *et al.*, 2013). From the present and accessible literature sources, it is possible to select various research results of the application of different priming methods on plant production. Amooaghaie (2007); Baskin (1991); Schmitz *et al.* (2001); Thomas and Sambrooks (1985) used GA3 as a biostimulator, during their investigations they showed effects on the growth and development of plants (Amooaghaie and Valivand, 2011). Harris *et al.* (1999) demonstrated that on-farm seed priming (soaking seeds overnight in water) markedly improved establishment and early vigor of upland rice, maize and chickpea, resulting in faster development, earlier flowering and maturity and higher yields. This simple, low-cost, low-risk intervention also had positive impacts on the wider farming system and livelihoods and the technology has proved highly popular with farmers (Eskandari, 2011). HP value has already been shown for many crops, for example wheat, chickpea, maize, mungbean, sunflower and Barley (Eskandari, 2011). For the first time, Strogonov (1964) proposed that salt tolerance of plants could be enhanced by treatment of seed with salt solution prior to sowing. Successful results of KNO3 priming have been obtained for wheat, tomato, rice, melon and cucumber (Ghassemi Golezani *et al.*, 2011).The aim of this work was to study the effects of seed priming techniques on germination and yield of dill (Anethum graveolens L.) concurrent in laboratory experiments and pot studies in greenhouse condition.

Materials and methods

The experimental design

This study examines the effects of seed priming on germination and yield on dill, in the laboratory experiment and pot study. The method used in the laboratory and pot is CRD (Completely Randomized Design) with three replications.

Place and Duration of Study

Experiments were carried out at the Research Station of the Islamic Azad University, Tabriz Branch, northwestern Iran at June 2012. The climate of the research site is semiarid and cold with an average annual precipitation of 270 mm. The soil was sandy-loam with an electrical conductivity of 0.72 dS m^{-1}, pH of 7.74.

Method

The treatments are gibberellic acid (GA3) with dosage of 500p.p.m, hydro-priming (HP) with 24 hours duration in room temperature, potassium-nitrate (KNO3) and control. Before the experiment the seeds were disinfected in hypochlorite-Na 5% solution for 3 minutes. Then seeds were transferred to aseptic dishes. GA3 and KNO3 solutions were added to dishes and remained for two hours. Seeds for HP were wetted for 24 hours in pure water. After the seeds extracting from solutions and were dried in room temperature. Then in laboratory with use of special paper and pure water the seeds were cultured in petri-dishes and were putt in germinator with 19^{0c} temperature for 8 days and were counted daily. Finally, germination percentage (GP) was computed as the cumulative number of germinated seeds with normal radicles. The germination rate (GR) was calculated by using the equation below (Maguirw, 1962).

$GR = \Sigma n / N \times 100$ Eq. (1)

Where: Σn-total number of germinated seeds at each counting, N-number of total seeds.

Some parts of primed seeds were stored in normal condition for 6 months and then storage seeds germination percentage (SGP) were cultured in laboratory condition. All the primed seeds were farmed in pots and while growth plant height (PH) and main branch (MB) were counted. Three months later the plants were harvested in first blooming level and dry weight (DW) and essential oil percentage (EOP) were measured. Essential oil was extracted by Clevenger device.

Statistical analysis

All data were analyzed using the MSTAT-C software. Treatment means were separated using Fischer's Protected LSD at P= 0.05 level.

Results and discussion

As the table1 indicates, there are significance differences between treatments in germination percentage (GP), germination rate (GR), plant height (PH), main branch number (MB) and essential oil percentage (EOP). But the effect of different treatments on seedling weight (SW), seedling length (SL), dry weight (DW) and storage seed germination percentage (SGP) were not significant. The survey results showed priming increased oxidative enzyme activity of the components leading to improve germination and seedling growth. In other words, the treated seeds germinated faster and sprouted sooner than soil and less time exposed to soil pests and pathogens (Afghani-Asl and Taheri, 2012). Table1 shows that effect of priming on seedling length, seedling weight and storage seeds germination percentage was not significant.

Table 1. Mean Squares of Dill by LSD method.

s.o.v	df	SGP	EOP	DW	PH	MB	GR	GP	SW	SL
Treatment	3	324.5^{ns}	0.33*	149.18^{ns}	155.19**	2.22**	241.95**	571.63*	1.28^{ns}	98.59^{ns}
Error	8	32.25	0.82	25.92	52.66	0.66	9.29	14.50	0.17	16.1
CV (%)	-	25.5	20.7	16.8	12.1	20.1	8.56	14.97	19.4	12.4

*, **, ^{ns}: Indicate significant difference at 5%, 1% and

Table 2. Influence of seed priming on the yield and quality of Dill.

	Plant Height (cm)	Main Branch	Germination Rate (%)
KNO3	101.99	7	31.24
GA3	95.66	6.33	29.81
HP	90	5.66	24.03
Control	85	5	11.54

Results of laboratory experiment

Analysis of variance of the laboratory data indicated that, the germination percentage was significantly affected by priming methods. The highest germination percentage was recorded for seeds primed with KNO3 (84.33%). After that GA3 has the most GP with 71%. However, germination percentage of unprimed and primed seeds with HP was almost similar (Figure 1). Table 1 exhibits the data pertaining to germination rate of dill seed. The difference between primed and non-primed seed for GR was statistically significant. The seed treatments in KNO3 and GA3 increased the GR more than other treatments. The positive effects of osmo-priming on seed germination and seedling growth were also reported for barley, cucumber, fennel and winter rapeseed (Ghassemi-Golezani *et al.*, 2010). Analysis of variance of the laboratory data indicated that, the highest germination rate and seedling dry weight were recorded for seeds primed with KNO3 (Ghassemi-Golezani *et al.*, 2011). It might be due to early synthesis of nucleic acids, DNA, RNA and proteins during salt hydration process, which ultimately resulted in improved energy of germination of seeds. Rapid germination of seeds ultimately could lead to the production of larger seedlings (Ghassemi-Golezani *et al.*, 2011). GA3 treatment increased ion content in chloroplast and vacuole while there was no change in cytoplasm ion content (Yuan and Xu, 2001). *Kelussia odoratissima Mozaff*. is one of the endogenous plant species of Iran which is exposed to extinction during the recent decades. Results showed that seed priming with GA3 significantly improved seedling growth as compared to the control (Amooaghaie and Valivand, 2011). Seed priming with GA3 in Milk-Thistle might cause the acceleration in metabolic reactions before germination and make germination of cultivated seeds possible under salinity stress (Sedghi *et al.*, 2010). Also, GA3 may activate the synthesis of proteins and other metabolites required by the embryo for germination. GA3 might have enhanced growth promoter levels that helped overcome the effect of the inhibitors (such as ABA), leading to seed dormancy release (Amooaghaie and Valivand, 2011). Hydro-priming generally improves grain yield of sesame cultivars through enhancing seed germination rate, seedling emergence rate and percentage, and grains per plant. The highest yield increase was obtained with 16 h hydro-priming (Eskandari, 2011). Hydro-priming clearly improved both rate of germinaion and mean germination time both under salt stress conditions. Furthermore, hydro-priming resulted in increase of normal germination (Neamatollahi *et al.*, 2009). Results showed that the effect of hydro and osmo-priming on germination percentage of fennel were significant (Neamatollahi *et al.*, 2009). The efficiency of seed hydro-priming for better seedling establishment, also reported in barley, lentil and chickpea (Ghassemi-Golezani *et al.*, 2011). Hydro-priming clearly improved rate of germinaion and mean germination time under salt stress conditions. Furthermore, hydropriming resulted in increase of normal germination percentage (Neamatollahi *et al.*, 2009).The results showed that the effect of HP was significant on germination percentage, seedling vigor, seedling length and seedling dry weight in dill (Karimian, 2011). Researchers found safe maximum lengths of time for which seed should be primed, beyond which it could be damaging to the seed or seedling. Recommended safe limits were 24 h for maize and rice, 10 h for chickpeas and 8 h for pearl millet (Ghassemi-Golezani *et al.,* 2010).

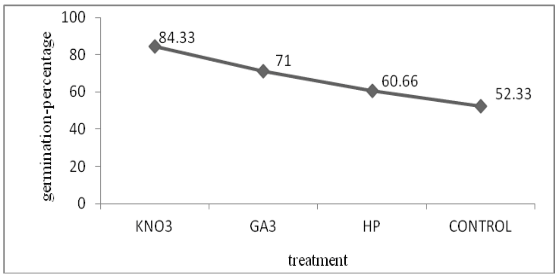

Fig. 1. Germination percentage (GP).

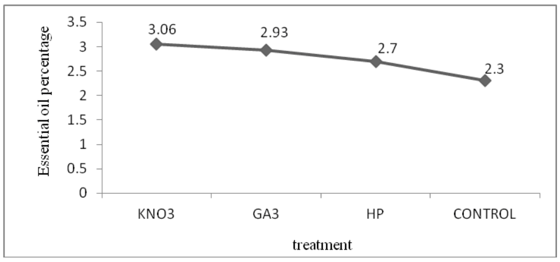

Fig. 2. Essential oil percentage (EOP).

Results of pot study

The results of pot study have shown in table2. Analysis of variance revealed that there was significant difference between primed and non-primed seed on plant height and mean branch (Table 2). Maximum plant height was depicted in KNO3 treatment (101.99 cm) and minimum plant height was noted in control and HP treatments. Also, Maximum - means branch number was noted in KNO3 treatment with 7 branches (Table 2). Ghassemi-Golezani *et al.* (2011) said that, the positive effects on yield and plant height also reported for barley, cucumber, fennel and winter rapeseed. Ramazan *et al.* (2010) said that priming with KNO3 greatly influenced the plant height as nitrogen supplied by KNO3 is an indispensable elementary constituent of numerous organic compounds such as amino acids, proteins and nucleic acids. Moreover, it plays role in formation of protoplasm and new cells, as well as encourages plant elongation. The essential oil percentage (EOP) responded positively and significantly to seed priming methods. Priming the seeds in KNO3 had greatest effect on essential oil percentage (3.06). After that other treatments like GA3 and HP effected positively on EOP (Figure2). A significant increase in essential oil yield due to seed priming, in comparison to those seeds not primed, was expected because the germination rate, uniformity in seed, seed yield, and oil content in primed seeds were high. Thus, all of these factors contribute to a higher essential oil yield. However, priming may increase yield in directly through its effect on even stand establishment, because uniformity in the stand results in higher yield (Mirshekari, 2012). Feghenabi (2007) understood that, the GA3 increased oil percentage in safflower. Scientists found that micro-nutrient treatments increased the essence yield in Cumin from 1.72 kg/ha to 2.56 kg/ha. Also, seed germination with iron and boron enhances germination and yield of Dill (Mirshekari, 2012).

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