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THE ROLE OF PRETREATMENT PARAMETERS ON SEED GERMINATION AND SEEDLING GROWTH OF TWO FENNEL CULTIVARS

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ABSTRACT. Fennel is one of the most important medicinal and spice plants and has become one of the most important economical medicinal plants in Mediterranean, and the Middle East. The germination ability and percentage are fundamental characteristics which influence the viability of the plants. Prechilling has meaningful influence on coleoptile length, radicle length, seedling length, germination percentage, mean time for germination and germination rate, but uniformity of seed germination did not significantly influenced by it. The cultivar effect was significant on coleoptile length, radicle length, seedling length, germination percentage and germination rate. However, mean time for germination and uniformity of seed germination did not significantly affected by cultivar. All experimental characteristics, except uniformity of seed germination, significantly influenced by hormone. The maximum coleoptile length, radicle length, seedling length,

germination percentage and germination ratio was related to 45 days moist prechilling treatment. Isfahan cultivar also had obtained the highest coleoptile and radicle length, seedling length, germination percentage and germination ratio compare to Shiraz cultivar. It seems that application of endogenous GA₃+KI and BA+KI concentration, which is provided mostly by chilling treatment, is the most effective factor for breaking the seed dormancy. On the basis of the results, usage of 45 days moist prechilling accompanied with application of GA₃+KI and BA+KI in Isfahan cultivar was appropriate.

Keywords: kinetin; gibberellic acid; benzyladenine; germination percentage; germination rate.

INTRODUCTION

Herbs due to having natural antioxidant compounds are widely

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used by food, pharmaceutical and cosmetics industries (Soleymani and Shahrajabian, 2012a,b; Ogbaji *et al.*, 2013; Soleymani *et al.*, 2013; Shahrajabian *et al.*, 2019a,b,c; Sun *et al.*, 2019a; Sun *et al.*, 2020a,b). Traditional herbs and plant have several therapeutic and pharmaceutical effects and also valuable natural food resources (Soleymani *et al.*, 2012; Ge *et al.*, 2018; Shahrajabian *et al.*, 2019d,e,f,g; Ogbaji *et al.*, 2018; Sun *et al.*, 2019b,c; Shahrajabian *et al.*, 2020a,b).

Fennel (*Foeniculum vulgare* L.) is a herb with galactogogues property, which belongs to the *Umbelliferae* and its root, leaf, fruit and seed are used (Soleymani and Shahrajabian, 2012a; Ghasemiet *al.*, 2014; Maghsoudi Kelardashti *et al.*, 2015). It is a popular medicinal plant with various pharmacological activities in both traditional Iranian and Chinese medicine (Rahimi and Shams Ardekani, 2012; Bokaie *et al.*, 2013; Maghsoudi Kelardashti *et al.*, 2015).

The germination ability and percentage are fundamental characteristics, which influence the viability of the plants developing from the grains (Soleymani and Shahrajabian, 2018). Sharifi and Pouresmael (2006) concluded that only cold treatments and gibberellic acid, cytokinin, potassium nitrate, washing and light treatments are not useful. Nkomo and Kambizi (2010) noted that prechilling, followed by exposure to a temperature higher than 30°C encourages germination of *Corchorus olitorius* seeds.

Rouhi *et al.* (2010) concluded that applying 500 ppm concentration of GA₃ and 0.1 of KNO₃ resulted in higher germination in waterlily dormant seeds. Plant hormones are used in breaking seed dormancy (Gupta *et al.*, 2008). Growth regulator, GA is effective in breaking seed dormancy in snowberry (*Symphoricarpos albus*) (Rosner, 2002). Although black cumin (*Nigella sativa*) is an important and expensive medicinal and spice plant, no information is available on the effects of moist prechilling and application of hormones on different cultivars of it. So, the aim of this study is survey the certain effects of different treatments to stimulate seed germination and seedling growth of two masses of black cumin. The aim of this research is to evaluate the certain effects of different treatments to stimulate seed germination and seedling growth of two cultivars of fennel.

MATERIALS AND METHODS

In order to determine the effects of some pretreatment factors on primary growth and germination characteristics of two cultivars of fennel, an experiment was conducted as Split-factorial layout within completely randomized design at Seed Research laboratory, Islamic Azad University, Khorasgan (Isfahan) branch in 2015. Most pre-chilling treatments were 0, 15, 30 and 45 days treatments and cultivars were consisted of Isfahan and Shiraz. Hormone treatments were GA₃, BA, KI, GA₃+BA, GA₃+KI, BA+KI, GA₃+BA+KI, KNO₃, H₂SO₄ and distilled water as a control treatment. Firstly, seeds were surface sterilized in 1.5% (w/v)

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sodium hypochlorite solution for 15 min and rinsed three times sterile distilled water. For each treatment, four Petri dishes were used and 25 seeds were put into each of them, then, each Petri dish were covered with 10 mm of each specific treatment. In the first experiment, seeds were chilled for 15, 30 and 45 days, and after this period, seeds were soaked and treated with 10 hormone treatments. In the second experiment, seeds were treated

without pre-chilling treatments. In the third experiment, seeds treatments were done with polyethylene glycol. Germination percentage and germination rate was calculated with equation number 1 and 2, respectively. The mean separation was made using Duncan's multiple range test at 0.05 probability. Mean of replications was used for statistical analysis.

$$\text{Germination percentage} = \text{Number of germinated seed}/100 \quad (1)$$

$$Vg = \sum(Ni/Di), \quad (2)$$

where, Vg: germination rate on the basis of number of seeds per day; Ni: germinated seed per day; Di: day number after the beginning of experiment.

Uniformity of seed germination and mean time for seed germination (MTG) was evaluated by equations 3 and 4.

$$\text{Uniformity of seed germination} = \frac{1}{\frac{\sum(D-\bar{D})^2 \times N}{\sum N}} \quad (3)$$

$$\text{MTG} = \frac{\sum(nd)}{\sum n}, \quad (4)$$

where, n = number of germinated seed in the specific day; d = number of days from the beginning of germination; $\sum n$ = total number of germinated seed.

RESULTS AND DISCUSSION

Prechilling has meaningful influence on coleoptile length, radicle length, seedling length, germination percentage, mean time for germination and germination rate, but uniformity of seed germination did not significantly influenced by it.

The cultivar effect was significant on coleoptile length, radicle length, seedling length, germination percentage and germination rate. However, mean time for germination and uniformity of seed germination did not significantly affected by cultivar. All experimental characteristics, except

uniformity of seed germination, significantly influenced by hormone. The highest coleoptile length was related to 45 days chilling treatments, which had significant differences with all other treatments. This treatment also obtained the maximum radicle length, but just had significant differences with 0 and 15 days chilling treatments. Germination percentage was significantly increased from 0 to 45 days chilling treatments. The maximum and the minimum mean time for germination was related to 30 and 0 days chilling treatments. Germination rate also increased significantly from 0 to 45 days of chilling treatments. All differences among treatments about germination rate were significant. Germination is the most sensitive stage in the life cycles of a plant and

perfect and uniform germination is essential to have an appropriate green area and crop growth rate that will get better radiation and increase the yield (Ashraf and Mehmood, 1990). There were no significant differences between moist chilling treatments about uniformity of seed germination. Gupta *et al.* (2008) reported that prechilling treatment also improved seed germination in isabgol (*Psyllium husk*).

The highest coleoptile length (1.656 mm), radicle length (0.9288 mm), seedling length (2.484 mm), germination percentage (55.46%) and germination rate (3.541) was related to Isfahan, which had meaningful difference with Shiraz cultivar. Although, the maximum mean time for germination and uniformity of seed germination was obtained for Isfahan, there were no significant differences between Isfahan and Shiraz. The highest coleoptile length and radicle length was related to GA₃+KI and BA, respectively. The highest and the lowest seedling length also were obtained by KI. BA+Ki treatment had obtained the highest germination percentage, which had significant differences with all other treatments except of BA. The highest mean time for germination and germination rate was related to GA₃+BA and BA+KI, respectively. There were no significant differences in uniformity of seed germination among hormone treatments (*Table 1*). Gupta *et al.* (2008) concluded that GA has shown promising effect in breaking seed dormancy, with

accelerated seed germination (speed of germination, vigor index) and seedling growth (seedling dry weight). On the basis of the results, usage of 45 days moist prechilling, accompanied with application of GA₃+KI and BA+KI in Isfahan cultivar was appropriate.

CONCLUSION

Prechilling had significant effect on coleoptile length, radicle length, seedling length, germination percentage, mean time for germination and germination rate. Cultivar also had significant influence on coleoptile length, radicle length, seedling length, germination percentage and germination rate of fennel seeds. All experimental characteristics, except uniformity of seed germination, significantly influenced by hormone. The maximum coleoptile length, radicle length, seedling length, germination percentage and germination ratio was related to 45 days moist prechilling treatment. Isfahan cultivar had obtained the highest coleoptile and radicle length, seedling length, germination percentage and germination ratio, compare to Shiraz cultivar. Application of endogenous GA₃+KI and BA+KI concentration, which is provided mostly by chilling treatment, is the most effective factor for breaking the seed dormancy. On the basis of the results, usage of 45 days moist prechilling, accompanied with application of GA₃+KI and BA+KI in Isfahan cultivar, was appropriate.

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Table 1 - Mean comparison for coleoptile length (mm), radicle length (mm), seedling length (mm), seedling length (mm), germination percentage (%), mean time for germination, germination rate, and uniformity of seed germination

Treatment	Coleoptile length	Radicle length	Seedling length	Germination percentage	Mean time for germination	Germination rate	Uniformity of seed germination
Prechilling (day)							
0	0.8536d	0.7809bc	1.534c	14.23d	11.29a	0.4727d	0.3174a
15	1.100c	0.6635c	1.664c	36.29c	11.10a	1.578c	0.2184a
30	1.450b	0.8725ab	2.222b	54.94b	7.908b	3.467b	0.2446a
45	2.236a	0.9595a	2.998a	71.10a	5.728c	5.99a	0.2370a
Cultivar							
Isfahan	1.656a	0.9288a	2.484a	55.46a	8.902a	3.541a	0.2366a
Shiraz	1.164b	0.7094b	1.773b	32.82b	9.109a	2.246b	0.2721a
Hormone							
GA ₃	1.463bc	0.9222abc	2.284b	39.01d	10.55a	2.533d	0.2481b
BA	1.530abc	1.8122bcd	2.242bc	64.32a	9.971a	3.937a	0.2056b
KI	1.627ab	0.9678ab	2.494ab	46.43c	9.686a	3.359b	0.2513b
GA ₃ +BA	1.452bc	0.7925cd	2.145bc	53.46b	10.80a	3.107bc	0.2484b
GA ₃ +KI	1.771a	1.0114a	2.685a	41.43cd	10.16a	2.774cd	0.2122b
BA+KI	1.530abc	0.8359be	2.265bc	67.52a	9.944a	4.207a	0.2025b
GA ₃ +BA+KI	1.643abc	0.9041abc	2.447ab	55.10b	10.47a	3.282b	0.2103b
KNO ₃	0.8247d	0.6197e	1.343d	24.55e	6.503b	1.944e	0.2159b
H ₂ SO ₄	1.347c	0.6584de	1.905c	24.79e	6.376b	1.713e	0.2253b
Distilled water	0.9113d	0.6638de	1.475d	24.79e	5.594b	1.998e	0.2238b

Common letters within each column do not differ significantly; GA₃ = Gibberellic acid; KI = Kinetin; BA = Benzyladenine.

Germination and seedling establishment from laboratory experiments does not necessarily mean that germination and seedling emergence from the field soils, so more field experiments are needed and seed dormancy is one of the major problems in studies

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