Dormancy-breaking treatment on spices of fennel

Effect of moist chilling and application of dormancy-breaking treatment on two spices of Foeniculum vulgare Mill

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Abstract

One of the problems of planting of fennel (Foeniculum vulgare Mill) is seeds dormancy of this plant’s seed. We designed an experiment and investigated effect of wet chilling levels including 0, 15, 30 and 45 days of chilling and different breaking dormancy treatments on breaking dormancy of seeds of two fennel species which are named Nahavand and Malayer. Dormancy-breaking treatments were including gibberellic acid (100 mg L-1), benzyl adenine (10-5 M), chitin (10-5 M), mixture of gibberellic acid + benzyl adenine, mixture of gibberellic acid + chitin, mixture of benzyl adenine + chitin, mixture of gibberellic acid + benzyl adenine + chitin (with the mentioned concentrations(, concentrated sulfuric acid (90%) for 15 second, potassium nitrate 0. 4%, distilled water, aminol forte 0. 4%, kadostim 0. 4%, fosnutren 0. 4% and humiforte 0. 4%. The results were indicated that chilling have significant effect on increasing of the germination percentage, coleoptile length, radical length, seedling length, rate of germination and vigor index. The treatments of benzyl adenine + chitin, gibberellic acid + chitin, aminol forte and distilled water caused a significant increase in characteristics of fennel germination in compare to other treatments. Varieties of Malayer has significant percentage of germination, coleoptile length, radical length, seedling length and vigor index in compared to varieties of Nahavand. The results indicated that in the condition of this

study moist chilling treatment (stratification) for 15 days convey with application of treatments of benzyl adenine + chitin and aminol forte is suitable to breaking dormancy of fennel seeds.

Keywords: Chilling, dormancy of seed, dormancy-breaking treatments, fennel

Introduction

Fennel (Foeniculum vulgare Mill.) is an aromatic, Herbaceous and biennial plant which grows to a height of 2 m. Fennel fruit is small with the length of about 8 mm and width of 3 mm, aromatic and sweet (Rchinger1987). One of the main characteristics of seed is the power of germination and vigor that is important for farmers (CopelandL. O. and M. B. McDonald, 1375). Studies have shown that many of the family Apiaceae plants are produced seeds with lots of endosperm and small embryos (Baskin, 1992). Percentage of seed germination in many plants of this family are low and their germination standards is lower than other plants. Lack of embryo, incompletely and dormant embryo in seed are the most important factors of seed dormancy and reducing of germination in this plants category (Robinson, 1954). The results of the studies of (Hedayati, 2000 and Nichols; , 1934Baskin, 1984, 1991 and , 1999 Troy, 1993; Widrlechner, 2000) indicate that a variety types of the Saubacus genus, Umbelliferus seeds and Dioscora and Cuphea species also show different degrees of physiological dormancy patterns and chilling can greatly help to resolve this type of dormancy. (Slater, 1982). Soltani Pour (1388) showed that the maximum and minimum rate of germination of fennel were 34. 1 and zero per day related to cold treatment and hot water treatment.

The maximum index of vigor seed was 365. 75 related to cold treatment and the minimum index of vigor seed was zero related to hot water treatment. Moist cold causes permeability of seed, materials washing and prevents germination, also cold resolves physiological dormancy and overcomes internal abscisic acid. Plant hormones or growth regulators are involved in many aspects of plant growth. Investigations showed that most of the plant hormones such as auxins, gibberellin, cytokinin, ethylene and abscisic acid affect on the stimulating germination or dormancy of seed via specific ways that cause controlling functions of nucleic acids (Cournf et al., 2002). The results of the interaction of different concentrations of gibberellin hormone (0, 100, 250, 500 and 1000 ppm) and the time of dipping in this hormone (24 and 48 hours) of the rhubarb indicated significant differences between treatments in terms of the evaluated characteristics (percentage and rate of Fecula gummosa). The maximum amount (65%) was obtained by increasing concentrations of this hormone from 100 to 500 ppm. However it was reduced by increasing concentrations of hormone to 1000 ppm. Bannayan and Najafi (1383) stated that germination of Fercula gummosa was increased at concentrations above 50 ppm of gibberellic acid. They observed that low concentration of gibberellic acid had no effect on breaking dormancy of Fecula gummosa, but the concentration of 50 ppm and increasing the soaking time from 48 to 72 hours improved percentage of germination. As the maximum percentage of Fercula gummosa seed germination was obtained at concentrations of 1000 and 2500 ppm.

Materials and Methods

Seed Characterization

Seed samples of two species namely Malayer and Nahavan were collected from Sarsir area of Hamadan in 1390. In order to preparation seeds, at first the same size and apparently healthy seeds were separated by a loop. Average weight of 1000 seeds was 3 g. After stratification period, the seeds were sterilized and breaking dormancy treatments were applied on them and they were placed in germinator machine with photoperiod of 8 hours of light at 30 ° C and 16 hours of darkness at 20 ° C (ISTA, 1985).

Characteristics of Experiment Location

To evaluate the effects of moist chilling and application of hormonal, chemical treatments and biological stimuli to break dormancy and induce germination of two varieties of fennel, an experiment was performed in laboratory of seed technology of the Agriculture faculty of Islamic Azad University khorasgan brunch Isfahan in 91-92 years. The research was performed based on a split factorial experiment in a completely randomized design (CRD) with four replications. Levels of stratification set in the main plot and variety factorial and break dormancy treatment set in sub-plots.

Effect of moist chilling on breaking dormancy of seed

Moist chilling levels include 0, 15, 30 and 45 days. This means that the seed is placed in distilled water for 24 hours. Then the moist seeds were placed inside sterilized and humid cotton bags separately. These bags were kept in isolated and dark environment at 4 ° C in the refrigerator.

Effect of treatments on breaking dormancy of seed

After the chilling period, 14 pregermination treatments were applied on the seeds.

14 braking dormancy treatments were as follow:

1-Gibberellic acid (100 mg L-1). 2- Benzyl adenine (10-5 M). 3- Chitin (10-5 M). 4- Mixture of gibberellic acid + benzyl adenine. 5- Mixture of gibberellic acid + chitin. 6- Mixture of benzyl adenine + chitin. 7- Mixture of gibberellic acid + benzyl adenine + chitin. 8- Concentrated sulfuric acid (90%) for 15 second. 9- Potassium nitrate 0. 4%. 10- Distilled water. 11- Aminol forte 0. 4% (Growth Stimulus). 12- Kadostim 0. 4% (Growth Stimulus). Fosnutren 0. 4% and Humiforte 0. 4% (Growth Stimulus). Concentrations used for treatments 4, 5, 6 and 7 were same as the concentrations of treatments 1, 2 and 3. Used hormones in these experiments were manufactured by Sigma Company and biological stimuli, including 19 kinds of amino acids, low molecular weight polypeptides and also nutrients were manufactured by Inagrosa Company.

Statistical population and sampling

In order to determine the percentage and rate of germination germinated seeds were counted once per 24 hours according to the ISTA instruction. Root were considered germinated when they exhibited a radical extension of 2 to 3 mm (Bahadori et al., 1386). Evaluation of germination will be end when amount of germinated seeds in consecutive counts are same and this time was considered as the end of the germination period.

After this period, the following parameters were measured:

1-Germination percentage 2- Coleoptile length 3-Radicle length 4-Germination rate 5- Uniformity of germination 6- Seed vigor index

1. Percentage of germination according to equation of (Jefferson and Pennacchio, 2003) G=(n/N)×100

G = germination percentage n = amount of germinated seeds N = amount of the seeds in each petri dish container

Germination rate according to equation of (Bahadori and Javanbakht, 1385)

RG = 1/MTG

RG = rate of germination MTG = Mean Time of Germination

Uniformity of germination was calculated according follow equation (Karam and Al-Salem, 2001)

Uniformity of germination = (4)

D = number of days from the beginning of germination

∑n = total number of germinated seeds N = number of germinated seeds at day = average number of days from the beginning of germination

Data Analysis:

Analyses of variance was performed on the data by MSTATC software. The means of parameters levels was compared using Duncan’s multiple range tests at %5 level of probability. Excel software was used to plot diagrams.

Results

Stratification

It was observed that moist chilling is the most important treatment on seed germination of Fennel like many other members of Apiaceae family. However, Stratification have a significant effect on percentage of germination, coleoptile length, radical length, seedling length, average time of germination, germination rate and seed vigor index at %1 level of probability but the uniformity of germination was not significant (Table 1). The results indicated that increasing cold stratification duration for 15 days increased seed germination. Comparison of means using Duncan method indicated that the maximum percentage was obtained with 15 days cold stratification treatment resulting in 36. 86% and it was decreased by increasing moist cold stratification duration as 45 days cold stratification treatment resulting in 11. 18% stated that there was no significant difference in germination practically (Table 2). Results indicated that the maximum average time of germination was obtained by using no stratification treatment and cold stratification of 15 days but average time of germination was decreased significantly by increasing cold stratification duration from 15 to 30 and 45 days (Table 2). Stratification treatment have a significant effect on seed vigor index at %1 level of probability (Table 1). the maximum seed vigor index was obtained by using cold stratification treatment of 15 days and there was a significant difference between this treatment and other treatments. the minimum seed vigor index was obtained by using cold stratification treatment of 45 days and there was a significant difference between this treatment and other treatments (Table 2).

Breaking dormancy treatments

The results of variance analyses table of breaking dormancy treatments application indicated that applied of hormone- amino acid- chemical treatment caused a significant difference between germination parameters such as percentage of germination, coleoptile length, radical length, seedling length, average time of germination, germination uniformity, germination rate and seed vigor index (Table 1 and 2). Comparision of means indicated that the maximum affect on germination of fennel was obtained by using aminol forte, benzyl adenine + chitin treatments (Table 2).

Interactions of moist chilling and breaking dormancy treatments indicated that bio-stimulant treatments of kadostim and aminol forte and hormonal treatments of benzyl adenine + chitin had the highest percentage of germination in the absence of cold. An increased in germination percentage was observed by increasing cold stratification duration of mentioned treatments to 15 days but increasing cold stratification duration up to 15 days reduced germination percentage with the same ratio. However, increasing cold stratification duration from 0 to 15 days for nitrate potassium treatment increased germination percentage of 26% that is maximum percentage of germination but increasing stratification duration to 30 and 45 days reduce germination percentage to a lesser extent compared with that (Table 2). The results of applied treatments revealed that the concentrations of used materials and the duration of these treatments are effective in stimulating germination.

Varieties

The results of varieties reaction indicate that increasing percentage of germination, coleoptile length, radical length, seedling length and seed vigor index of Malayer variety is significantly higher than nahavand variety. The seeds of Malayer variety with 32. 29% of germination is ranked higher than the seeds of Nahavand variety with 13. 11% of germination (Table 2).

The interaction between the moist chilling with break dormancy treatments and varieties

Study of interactions of moist chilling, varieties and breaking dormancy treatments indicated that cytokinins convey with increasing cold stratification duration to 15 days increased some parameters such as percentage of germination, coleoptile length, radical length, seedling length and etc. in Malayer and Nahavand varieties (Table 3). The highest average time of germination was obtained by using 15 days cold stratification treatment covey with distilled water treatment in Nahavand variety while the lowest average time of germination was obtained using 30 days cold stratification treatment covey with sulfuric acid treatment in Nahavand and Malayer varieties and 30 days cold stratification convey with kadostim in Malayer variety. Interactions of variety, chilling and breaking dormancy treatments have a significant effect on seed vigor index at %1 level of probability (Table 3). The maximum seed vigor index was obtained by using humiforte treatments convey with cold stratification treatment of 15 days in Malayer variety and there was a significant difference between this treatment and other treatments. The minimum seed vigor index was obtained by using sulfuric acid treatment convey with cold stratification treatment of 30 days in Nahavand and Malayer varieties and there was a

significant difference between this treatment and other treatments except kadostim treatment convey with cold stratification treatment of 45 days in Nahavand variety and sulfuric acid treatment convey with cold stratification treatment of 15 days in Nahavand variety (Table 3).

Discussion

Our data indicated that improving moist chilling to 15 days can be caused breaking dormancy of seeds as the maximum amount was obtained with 15 days cold stratification treatment resulting in 36. 86% and it was decreased by increasing moist cold stratification duration as 45 days cold stratification treatment resulting in 11. 18% stated that there was no significant difference in germination practically. There is continuity between seed dormancy and germination (Choun, 1996). This reaction can be due to growth of stratified embryos. Similarly, number of cell, dry weight and final length were increased in the embryonic axis of cherries seed which had been stratified (Eleni and Pelak, 1960). Also absorption of oxygen and energy were provided at the surface of cellular that the enzymes catalase, phosphatase, alkaline lipase and peroxidase were increased (Zarska-Maciejewska and Lewak, 1976). Thus it becomes clear that many of fetal development and metabolism are affected by stratification. In addition amount of hormone changes in stratified seeds. For example, ABA level is reduced due to seeds stratification of apple, pine, walnut and hazelnut. Adding gibberellin can be substituted stratification in some seeds (Pinï¬ eld, 1968) due to the stimulatory role of this hormone. During the stratification procedure observed an increase in the amount of internal gibberellin which can be confirmed previous hypothesis)Frankland and Virnik, 1966). Therefore, in

addition of the increase in growth rate and metabolic activity of the stratified seeds, changing of the inhibitor and stimulator levels can also be effective in breaking of the seed dormancy. The stratification time varies depending on the species. Seeds of Wild Rose needs to have a two-month period of stratification (Crocker and Barton, 1931). The stratification time depends on the age of the seeds. The seeds of Malayer variety with 32. 29% of germination is ranked higher than the seeds of Nahavand variety with 13. 11% of germination. The difference between seeds collection areas or the condition of the seed on the mother plant and strength of seed dormancy could be the reasons of this observation. On the other hand, it seems that induction of secondary dormancy is provided by the development of chilling on the studied seeds of the 1390.

Study of breaking dormancy treatments effect indicated that the maximum affect on germination of fennel was obtained by using aminol forte, benzyl adenine + chitin treatments (Table 2-4). These reactions can probably be accrued due to the effect of cytokinins such as kinetin on increase activity of alpha-amylase that finally lead to the breakdown of starch molecules. In the other hand it seems that the resolve of seed dormancy by cytokinins may be related to increasing membrane permeability and exchanging storage materials. In addition cytokinins increase the process of cell division in the embryo by stimulating the synthesis of RNA and DNA and thereby facilitates seed germination. Thus the cytokinins are required to complete induction of germination by GA and reduce the effect of growth inhibitor (such as ABA) indirectly. Agrol and Dalani (2004) also proposed a model to study the effect of the germination stimulating and inhibitory hormones and they concluded

that 1ibberellins can not break seed dormancy when there are high levels of ABA in the seed and in this case, presence of 1ibberellins besides the cytokinin leads to overcome ABA and seed dormancy will be beaked. Totally, it is believed that seed dormancy in excellent plants will be occurred by the balance of growth internal inhibitory and stimulating. Therefore, dormancy may be occurred due to the presence of growth inhibiting substances or lack of growth stimulating substances or a combination of both them. The amount of these endogenous compounds are controlled by environmental factors such as light and temperature. Study of interactions of moist chilling, varieties and breaking dormancy treatments indicated that cytokinins convey with increasing cold stratification duration to 15 days increased some parameters such as percentage of germination, coleoptile length, radical length, seedling length and etc. in Malayer and Nahavand varieties. The increase of mentioned parameters by cytokinins probability related to increasing membrane permeability and exchanging storage materials. However, chilling is effective due to elimination of germination inhibitory factors. Moist chilling increases effects of breaking dormancy treatments and as a result resolve dormancy and Induces germination. In the other hand, bio-stimulant treatments of kadostim and aminol forte and chemical treatments of nitrate potassium convey with increasing chilling duration improved degree of their germination.

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