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EFFECTS OF CHILLING ON GERMINATION IN FLAX (*L. usitatissimum* L.)

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ABSTRACT

This study was carried out in the biotechnology laboratory of Agricultural Faculty of Ondokuz Mayıs University. The objective of this study was to establish the effects of chilling period and chilling temperature on germination in linseed (*Linum usitatissimum* L.). Seeds were subjected to six different heat temperatures (0, 2, 4, 6, 8 and 10 ^{o}C) for 24, 48, 72, 96, and 120 hours. Germination tests were carried out in a clammed chamber at 25 ^{o}C with 70% humidity, 8 hours dark and 16 hours light condition. In all varieties, germination was significantly affected by temperature chilling level. Average mean germination percentage was 88.50% and 93.77% for Antares and 83.24% for Bionda. Germination capacity of seeds was affected either by chilling period or chilling temperature. The highest germination percentage were 0 ^{o}C chilling temperature and 96 hours chilling period for Antares with 97.20% and 72 hours chilling period for Bionda with 90.80% germination percentage.

Key words: Linseed, Germination, Chilling temperature, Chilling period.

INTRODUCTION

One of the first scientific experiments that children often do is to plant a seed and watch it germinate. The reanimation of the seemingly dead seed is fascinating to see, and has probably set more than a few plant scientists on the path to their future careers. Of course, this apparently simple phenomenon is no such thing and results from highly complex and regulated sets of developmental processes designed to maximize the chances for survival for the seedling (Holdsworth et al. 1999).

The life of every organism begins with a reproduction phase; developmental processes such as growth and organ formation are following. Further, these are followed by reproductive phases, which lead to the next generation. The cycle ends with this phase (Larcher, 1994). The main interested objects here are also seeds.

Seeds are the primary and essential starting point for a wide range of agronomic important plants. Because of the interest and demand to improve crops, there is considerable interest in increasing their germination ability. However, the success in germination seems to be highly dependent on genotype, environment, cultivated treatments and their interactions (Kurt, 2010). The relatively minor chemical changes to germination capacity have been readily manipulated in several oilseed crops.

Germination capability and seed vigor are two important characteristics of seed that may be affected by seed color and fatty acid composition (Culbertson and Kommendahl, 1956; Dogras et al. 1977). Seed color affects germination in various crop species including flax. Yellow seed in flax had a lower germination frequency than brown seeds in both blotter and soil germination tests (Culbertson and Kommedahl, 1956; Culbertson et al. 1960; Comstock et al. 1963).

In some studies, environmental factors such as temperature (Specht and Keller, 1997; Herranz et. al., 1998; Ianucci et. al. 2000; Eileen et. al. 2001; Wuebker et. al. 2001; Nyachiro et. al. 2002; Carter et. al. 2003), light intensity (Milberg and Andersson, 1998; Benvenuti et. al. 2001), photoperiod (Anon, 2004;), etc. effected germination ability of plant genotypes.

Temperature is one of the major environmental factors affecting germination (Nykiforuk and Johnson-Flanagan, 1994). O' Connor and Gusta (1994) reported that, temperature (over a range of 5-15º C) had no significant effect on germination frequency of flax, but seedling emergence was dramatically reduced by temperatures of less than 10 º C.

Many experiments were made to investigate germination of flax cultivars. For example Saeidi and Rowland (1999a,b) reported lower germination, less vigor and lower field emergence of flax cultivars with light seed color compared with dark seed colored genotypes.

The objective of this study was to investigate the effects of chilling temperature and chilling period on the germination capacity of linseed.

MATERIALS AND METHODS

This study was carried out in the biotechnology laboratory of Agricultural Faculty of Ondokuz Mayıs University. The experiment was arranged in a randomized split plot design with ten replicates. Seeds of the linseed cultivars Antares (brown seed) and Bionda (yellow seed) were subjected to 6 different chilling temperature (0, 2, 4, 6,

8, 10 °C) for 24, 48, 72, 96 and 120 hours chilling period in a water bath. After the chilling period, seeds were placed on Petri dish (100x15mm) with a filter paper (Watman No. 1) as a rate of 100 seeds on the paper in each dish. The seeds and filter paper were wetted with distilled water (5 ml water per Petri). The Petri dishes were wrapped with a strip of Para film around the edge to prevent evaporation. On the top of each Petri dish date and treatment type were recorded (Dahlquist, 2004).

Germination was carried out in a clamber at 25 °C with % 70% of humidity, 8 hours dark and 16 hours light condition. The seeds were observed every day for germination. Germination was recorded when white radical (root) emerges from the seed 1 cm long. The number of germinated seeds in each dish were counted every day and recorded daily on a prepared data sheet. All viable seeds should have germinated within 10 days. At the end of the test, total numbers of seeds that have germinated were recorded (Samimy et al. 1987).
Statistical analysis of data was performed by analysis of variance and significance was assessed by calculation of least significant difference at $P<0.05$ or lower.

RESULTS AND DISCUSSION

Effects of Genotype on Germination

Effect of genotype on germination was statistically significant. An average germination percentage was 88.5%, whereas germination percentage was 93.77% for Antares and 83.24% for Bionda. The germination percentage of Antares was 10.51% higher than Bionda (Figure 1). Genotypic effects on germination were mentioned in some plants. For example Christiansen and Lewis (1973) indicated that effect of seed chilling on germination depends on the parent. Hereby it must be regarded that the used linseed genotypes have different seed color. Antares is brown seeded, Bionda yellow seeded. Seed color affects germination in various crop species, including flax. Yellow seed in flax had a lower germination frequency than brown seeds (Culbertson and Kommedahl, 1956; Culbertson et al. 1960; Comstock et al. 1963; Saeidi and Rowland, 1999a,b). This can explain the lower germination performance of Bionda.

Effects of Chilling Temperature on Germination

Effect of chilling temperature on germination was not statistically significant. However there were relatively low germination differences within the chilling temperatures. Germination percentage was changed between 86.70% and 89.76%. The highest germination percentage (89.76%) was recorded at chilling temperature of 8 °C and the lowest germination percentage (86.70%) was recorded at chilling temperature of 6 °C (Figure 2). References regarding pre-chilling of flax seeds are rarely. In the Handbook of Seed Technology for Genebanks (Ellis et al. 1985), pre-chilling (Higgins, 1951) plus co-applied potassium nitrate (Doyle et al. 1952) is mentioned as a very effective dormancy-breaking treatment. The handbook of "Canadian Methods and Procedures for Testing Seed" prechilling is the exposure of imbibed seeds to low temperatures before being given the prescribed germination temperatures (Anon. 1997). Because we have obtained no differences regarding germination between used genotypes it can be said, that these genotypes may not contain seed dormancy or not differ in their sensitivity to chilling temperatures.

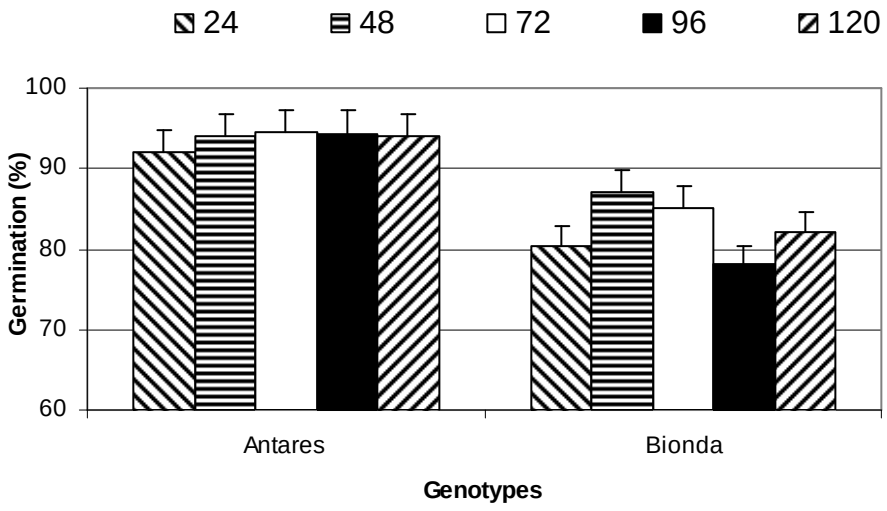

Figure 1. Effect of genotype and chilling period combination on germination in flax.

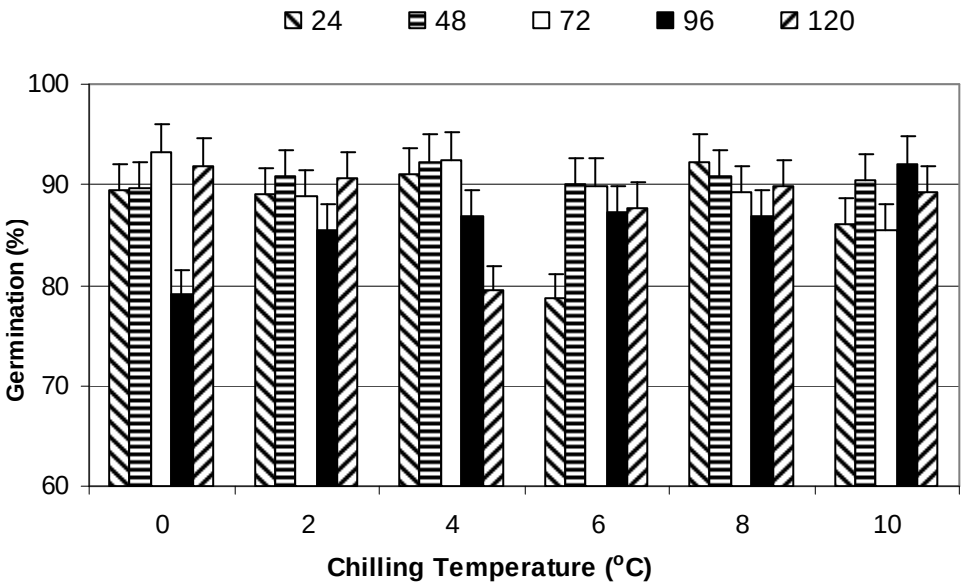

Figure 2. Effects of chilling period and chilling temperature combination on germination in flax.

Effects of Chilling Period on Germination

Besides the not significant effects of chilling temperature, chilling period effected seed germination in significantly. In terms of chilling period, the germination percentage changed between 86.23% and 90.63%. The highest percentage of germination (90.63%) was recorded at 48 hours chilling period and the lowest germination percentage (86.23) was found at 96 hours chilling period. However, mean germination first increased from 87.73% at 24 hours chilling up to 90.63% at 48 hours chilling, and then it decreased (89.82% for 72 hours and 86.23% for 96 hours) up to 96 hours and increased again at 120 (88.10%) hours chilling. This result indicates an interaction between genotypes and chilling period (Figure 3).

There was a statistically significant genotype x chilling period interaction on all germination counting dates. The highest germination percentage was 94.43% for Antares at 72 hours chilling period and 87.20% for Bionda at 48 hours chilling period. Also the lowest germination percentages of 92.00% for Antares and of 80.47% for Bionda were recorded for both genotypes at 24 hours chilling period (Figure 3).

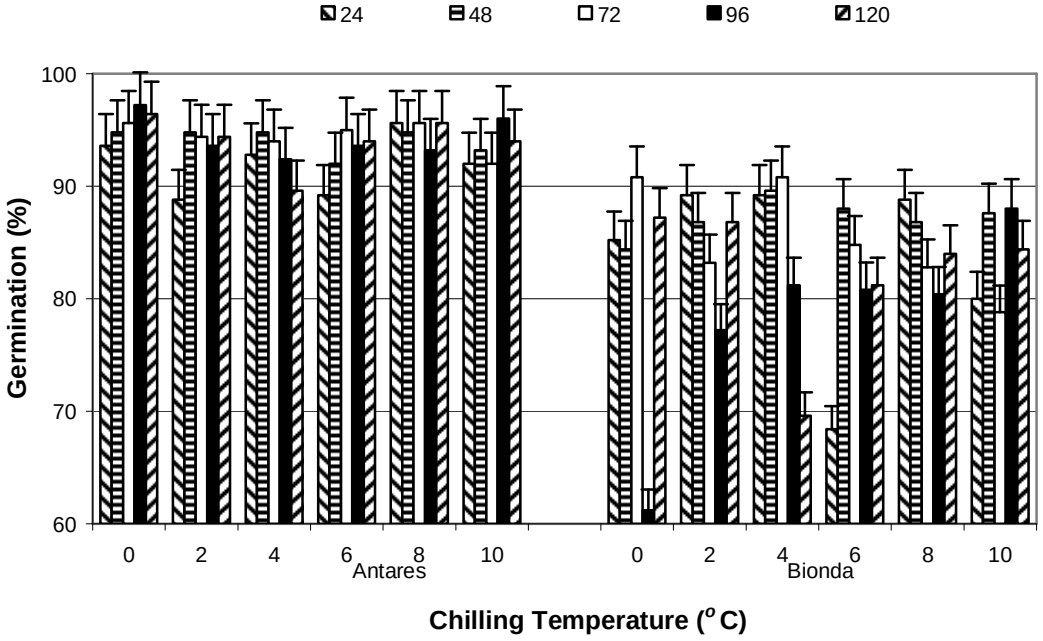

Figure 3. Effect of genotype, chilling period and chilling temperature combination on germination in flax cultivars.

Effects of chilling period and chilling temperature interaction were also statistically significant. The highest germination percentage (93.20%) was recorded at 0 ^{o}C for 72 hours chilling period and the lowest germination percentage (78.80%) was recorded at 6 ^{o}C for 24 hours chilling period. This means that low temperature and long period of chilling has more effects on seed germination than high temperature and short period of seed chilling. So, there is a difference of 14.00% between highest and lowest germination percentage values (Figure 3).

The genotype x chilling period x chilling temperature interaction was also statistical significant. The highest germination percentage was recorded at 0 ^{o}C for 96 hours chilling period for Antares (97.20%) and also at 0 ^{o}C for 72 hours chilling period for Bionda (90.80) whereas lowest germination was recorded at 2 ^{o}C for 24 hours chilling period for Antares (88.80%) and at 0 ^{o}C for 96 hours chilling period for Bionda (61.20%). There was important decrease for germination percentage between highest and lowest values about 8.40% for Antares and 32.60% for Bionda. It seems to be that the chilling period more increased germination percentage at low temperature than high temperature for Antares. The experiment results also showed that the chilling period more effected than chilling temperature on germination of the cultivar Bionda (Figure 3).

Several studies were made to study the effect of different factors on germination in crop plants. For example, the effects of soaking duration on germination (Sabongari and Aliero, 2003) and pre-sowing treatments on emergence and seedling growth (Arin and Kiyak, 2003) of tomato (*Lycopersicum esculentum* Mill), priming in annual ryegrass (*Lolium multiflorum* Lam.) (Tiryaki et al., 2004), the effect of chilling on germination of some *Gossypium* species (Anjum and Khatoon, 2003), the effect of pre-chilling on germination of *Sinapis arvensis* L. (Paolini et al., 2001), effect of low temperatures on germination in canola ((Nykiforuk and Johnson-Flanagan, 1994) and also pre-chilling on germination of *Panicum virgatum* L. (Grabowski et al., 1995). Regarding chilling period and chilling temperature in flax literature is failing. Some experiments were made in flax to study the effect of temperature, seed color and linolenic acid concentration on germination and seed vigor (Saedi and Rowland, 1999a,b), the effect of low temperature and seeding depth on the germination and emergence (O'Connor and Gusta, 1994). Obtained results showed that besides known agents effecting germination of flax, chilling of flax seeds can effect germination in flax.

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