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DAMP WATER STREAM IMPACT FOR THE GERMINATION OF NORWAY SPRUCE (*PICEA ABIES* (L.) H. KARST.) SEEDS

Gerda Šilingienė, Jonas Račinskas, Regina Vasinauskienė

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Growing of economics and new technologies caused the environment pollution and more intensive using of natural resources. The principles of stable and balanced forestry became more and more important. Ecologization forests economy directly and indirectly impact environment, water, air, landscape. One of the most widely applied measures to protect seeds from the damage caused by fungi is spreading diseases are treaters. It is not allowed to use chemicals in ecological farms. In Lithuania the number of ecological farms is growing that is why the new effective ecological methods are needed to protect seeds from diseases. Alternative is to use high temperature. All live organisms are destroyed in a high temperature environment. It is very important to find optimal treatment time of high temperature so that pathogenic organisms would be destroyed but germination characteristics of the seeds would remain unaffected. Investigation performed made on 2009-2010 in Forest's Seeds and Plantings Quality Department laboratory and Siauliai Forest Enterprise nursery. It was investigated how a damp water steam effects germination of Norway Spruce (*Picea abies* (L.) H. Karst.) seeds.

Control sample was not affected by damp water steam and it's germination was 95.8%. Thermally treated seeds germination varied between 95.9% and 82.4% depending on treatment time in high temperature environment.

Here wise the research of fungicide MaximStar 025 FS (2 g/kg) was used for the seeds chemical treatment. Germination of these seeds was about 44.86 %. Whereas germination of seeds treated by damp water steam varied between 61.1% and 78.6%.

Key words: Norway Spruce Seeds, thermal treatment, germination.

Gerda Šilingienė (corresponding author), Lithuanian University of Agriculture, LT-4324, Kaunas distr., Lithuania, e-mail: g.silingiene@gmail.com

Jonas Račinskas, Lithuanian University of Agriculture, LT-4324, Kaunas distr., Lithuania, e-mail: mi@lzuu.lt

Regina Vasinauskienė, Lithuanian University of Agriculture, LT-4324, Kaunas distr., Lithuania, e-mail: regina.vasinauskiene@lzuu.lt

INTRODUCTION

In Lithuania as well as in all European Union general politics of agriculture and forests sectors is oriented to ecological farming. The main object of ecological farming is to improve soil texture, reduce pollution of heavy metals, and increase stocks of humus and nutrients in the soil. Numbers of ecological farms are growing. On 2009 in Lithuania there were 2679 certificated farms, about 134955 ha certificated and declared ecological land area (Ekoagros 2009). As states Z. Bitvinskaite, there are big efforts for the nursery ecologization in Poland (Bitvinskaitė 1996). New nurseries are set up where good quality seedlings are growing without chemicals. Instead of that, organic fertilizers are used, crop rotation is applied. According to the European Commission decisions it is compulsory to protect value of the soil, reduce environment pollution. This urges scientists perform research of agro ecosystem's elements intercommunion, improve existing technologies and develop new.

There were 153 forest‘s genetic conservation areas (3627 ha), 220 seeds stands (1710 ha) and 2201 selected tree in Lithuania. First selection group stands grow in 48.9 thousand ha. In 2009 there were collects 17.3 tones trees seeds. In 2009-2008 the yield of Norway Spruce seeds was pour and it was not collected. Thus in 2007 there were collected 2.6 tones of spruce seeds. One fifth (18%) of seeds were collected in genetic conservation areas and seeds stands. Most of seeds are collected in the first selection group stands. In 2009 forest enterprises nurseries were in 1367 ha area. There grow 160 million units' seedlings and saplings. The main part of them was spruce saplings (102.3 million units) (Lietuvos miškų ūkio statistika 2010).

The development of diseases depends on temperature, humidity and nutrients. On the surface of seed there are lots of fungi diseases agents which use seed's nutrients, emit micotoxins, quality and evolution of the seeds. The benefit of seeds dipping is proved but this method is not ecological. New ecological methods from pathogenic micro flora are investigated. They improve seeds quality, increase resistance for diseases and productivity (Dabkevicius & Kreimeris 1995, Vasiliauskiene 2002, Döll 2002). The aim of all seeds treatment methods is to control pathogens (Clear 2002).

Hot water, sun energy, damp water seam, fire, ect. are effective ways of pathogens destruction (Agarwal & Sinclair 1989). Using of infrareds rays can diminished some of together with seeds spreading viruses (Soenartiningsih 1996), bacterium (Grondeau & Samson 1994), nematodes (Tenente 1999) and fungies (Takano 1985). Seeds were studied after treatment by microwaves in 68 - 75°C temperature (VonHoersten & Luecke 2001), low temperature plasma and magnetic field (Lynikiene 2006).

Higher and higher attention is given to the thermal methods. Process of thermal methods could be different various temperature environments. Damp water steam is ecological high temperature environment that can fully replace pesticides. Special conditions are created to prepare seeds. In the working environment temperature is 100^{o}C (Gimbutis 1993). Process of heat transmission is very intensive, steam condensation takes place on the seeds surface and the heat is given. Devices of damp water steam are very effective (Gimbutis 1993). The environments of high temperature water steam do not allow resisting for the live organisms. Thus there are no data about 100°C damp water steam impact to the spruce seeds viability.

The main processes of seeds maturity are germ formation and accumulation of nutrients. At the beginning of seeds maturity physiological processes are very intensive and there is lots of water in the tissues. Simple and soluble organic compounds such as amino acids, soluble carbohydrates, vitamins are dominating. Temperature is important factor from the beginning of seed's growth. The critical temperature which determines gametogenesis is measured.

Viability of seeds is the main characteristic of seeds germination. Seeds of deferent plants groups germinate very differently. Optimal germination temperature for the most of the plants is more than 20°C and maximum – not higher than 30 °C (Šlapakauskas 2006).

Genetic nature of the seeds determines their optimal germination temperature. For example, the best germination of Beech's, Oak's, Fir's seeds is on the temperature is +20 °C and for the Larch seeds - +25 °C. Maple seeds viability was increased when temperature deceased from 20-30 °C till 10-15 °C. The Norway Spruce seeds start to germinate when temperature is 7°C, but optimal temperature is 15-25 °C (Karazija 2008).

According to scientific studies dry seeds still remain after viable treaties by 120-130°C heat (Šlapakauskas 2006). Researchers showed that Norway Spruce and Scots Pine seeds stay viable in 70 °C an higher temperature (Skov 1996).

Viability of stored seeds also depends on the temperature. Seeds are fertile in quite wide range of temperature. Conditions are more favorable when seeds are kept in hermetic environment, relative humidity is not high and temperature is rather low.

The aim of the study is to investigate damp water steam impact on the seeds of Norway Spruce germination in different high temperature environments.

MATERIAL AND METHODS

During the outdoor and laboratory researches it was measured damp water steam thermal impulses impact for the germination of Norway Spruce seeds.

Damp water steam gained at 15kW power steam boiler. Steam boiler connected with steam scatter by high temperature hose. Steam scatter placed on the shaft that has 2.5 millimeters thread. The shaft connected with synchronous electric engine by muff. Regulator of rev "Altivar 28" is connected with electric engine. The needed period of treatment is got when scatter's rev are changed by regulator. A special easel is used for thermal seeds treatment investigated.

Thermal seeds treatment is based on high temperature area creation around the seed. During thermal treatment the area of high temperature around the seed is created by damp water steam. Damp water of 100^{o}C temperature steam condensates and gives the heat. The surface of the seed heated intensively. During experiment the seeds placed on a special net so seeds would be treated from all sides. Damp water steam scatter is 3 centimeters under the seeds.

Treated seeds sacked into the hermetic plastic bags. The characteristic of seeds evaluated in the Forest‘s Seeds and Plantings Quality Department. The seeds of Norway Spruce collected on 2007 were used to indicate germination on 2010.There were five samples of the seeds (five grams each). Samples were analyzed according to the schemes:

Control sample – 4x100 seeds = 20 iterations
1 s – 4x100 seeds = 20 iterations
2 s - 4x100 seeds = 20 iterations
3 s - 4x100 seeds = 20 iterations
4 s - 4x100 seeds = 20 iterations

Seeds were picked randomly and treated 100^{o}C damp water steam in the intervals of 1, 2, 3, and 4 second in. Control sample was not treated by damp water steam. For the every interval of treatment were five iterations (25 samples). After treatment the seeds of Norway Spruce sawed in a special pots and germination of them was studied. Observations were performed at 7'th, 11'th, 15'th, 21'st and 26'th day according to International Seeds Research Department (ISRD) rules (Valstybės žinios 2003).

In order to evaluate ground germination, outside research were made. Technology of soil preparation, sowing and planting observation was the same as commonly used for the one year spruce plantings in the nurseries. Siauliai forest enterprise's nursery was selected as one of the most modernized.

Treater MaximStar 025 FS (2 g/kg) applied for the control sample seeds and other samples were treated by damp water steam 1, 2, 3, and 4 seconds. On 2010 May seeds were sowed by

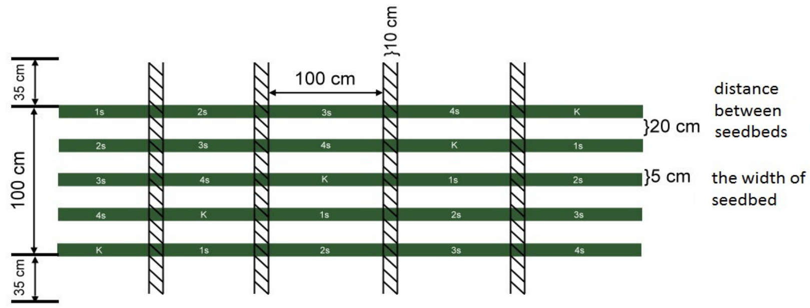

Fig. 1. Sowing scheme of Norway Spruce seeds (K – control sample – chemical treater was used for the seeds; 1s, 2s, 3s, 4s – damp water steam was used for the seeds).

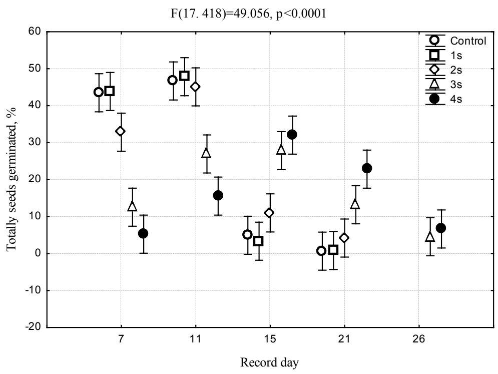

Fig. 2. Germination of Norway Spruce seeds treated by damp water steam.

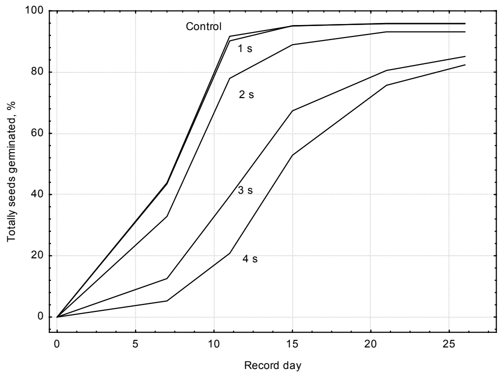

Fig. 3. Total germination dynamics of Norway Spruce seeds in laboratory treated by damp water steam in different periods.

sowing-machine (Egedal 83). The scheme of five row (25-25-25-70) (Fig. 1). The norm of sowing was 280 seeds per meter; 1400 seeds for every sample. Ground germination was indicated with 5 iterations. Fields of records were set randomly (Raudonis 2009). On 2010 May – October seedlings evaluated every 10 day. The germinated seeds were counted. ANOVA was used for evaluation of data.

RESULTS AND DISCUSSION

Laboratory germination experiment. The nested ANOVA results shows that the there are significant differences among different treatment times and recording days on laboratory germinated seeds (F=17.418, p<0.0001). After days 7 of sowing the best results was observed on control and 1 second treated seeds as well as worthiest – 3 and 4 seconds treated samples. On 11 day of experiment in the laboratory the mostly germinated seeds were from control, 1 and 2 seconds treated. The sample of 3 and 4 seconds treated seed was again poorest. Later on 15 and 21 day of experiment the germination of seeds completely changed, and on 15th days the samples of 3 and 4 seconds treatment showed highest rates of germination well as control, 1 and 2 seconds – lowest (Fig. 2).

The analysis of totally germinated seeds in laboratory conditions shows that on the end of experiment 95.8% of all seeds from control sample were germinated, very similar results was from the samples treated by 1 second by damp water stream (Fig. 3).Total germination of seeds treated by 2 seconds damp water stream was 2.6 % as well as 3 and 4 seconds – more than 10% less than control. All germination process was more delayed in the samples that were treated in longer intervals of damp water stream.

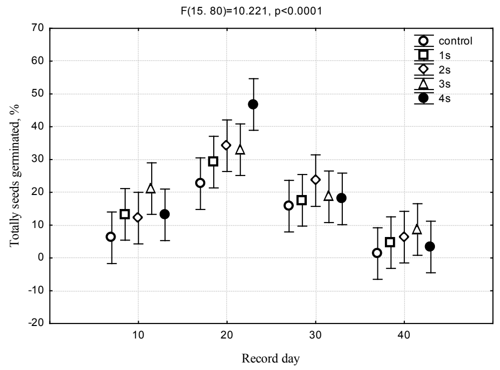

Fig. 4. Ground germination of seeds treated by damp water steam.

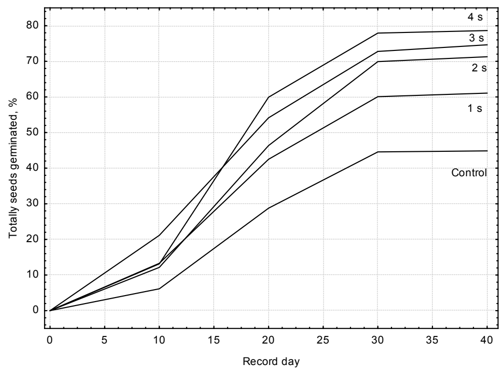

Fig. 5. Total germination dynamics of Norway Spruce seeds in ground treated by damp water steam in different periods.

Ground germination experiment. The nested ANOVA results shows that the there are significant differences among different treatment times and recording days on ground germinating seeds ($F=10.221$, $p<0.0001$). The highest amount of germinated seed in all samples was on 20 day treatment and there was significantly higher 4 second sample comparing control and other treatment by damp water stream period samples. The lowest proportion of seeds germinated in all samples was on the last 40 days record date (Fig. 4).

The analysis of totally germinated seeds in ground conditions shows that on the last day of experiment (40^{th}) 44.86% of all seeds from control sample were germinated, however it was worthiest result comparing it with all samples treated by damp water stream (Fig. 5). The best results were of sample that was treated by 4 second period of damp water stream. It was 1.75 times higher than traditional chemical treatment.

The damp water steam has a positive impact for the ground germination of seeds. Ground germination depends on treatment time. For the ecologization of the environment and diminishing usage of the chemicals in the nurseries it is purposeful to continue studies how to use thermal seeds treatment instead of chemical treatment.

CONCLUSIONS

Control sample was not affected by damp water steam and it‘s germination in laboratory was 95.8%. Thermally treated seeds germination varied between 95.9% and 82.4% depending on treatment time (1 s and 4 s respectively) in high temperature environment.

The highest germination of the Norway Spruce seeds treated by damp waters steam was 1s at 7’th day as well at 26’th day germinated only those seeds which were treated by damp water steam 3-4 seconds.

The best ground germination was of the seeds treated by damp water steam 3-4 seconds at 20’th day. Germination of seeds for which chemical theaters were used was 44.9 %, and germination of seeds treated by damp water steam was 61.1 – 78.6 %.

It is purposeful to use thermal seeds treatment in order to reduce chemical using in forest nurseries.

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