Effect of Different Photoperiods on Cold Hardiness in Cherry (*Prunus avium* cv. Ulster)

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In this research we have investigated the effects of different photoperiods on cold hardiness of cherry trees (*Prunus avium* cv. Ulster). One year old, cherry trees were exposed 8 hours of day length and 16 hours of dark period for short day conditions and 16 hours of light and 8 hours of dark period for long day conditions. We also compared the acclimatization pattern of cherry trees with hybrid aspen (*Populus tremula* ×*Populus tremuloides*) trees. LT_{50} values indicated that short day and long day conditions did not alter the cold hardiness of cherry trees. Under the same experimental conditions hybrid aspen trees were affected from different photoperiods. Aspen trees exposed to short day conditions were hardier than the trees exposed to long day conditions. We also investigated the acclimatization the patterns of basal and apical parts of the branches both in cherry and aspen trees. There were no significant differences in cold hardiness of the basal and apical parts of the branches in aspen and cherry trees.

Key words: photoperiod, cherry, Prunus avium, acclimatization, cold hardiness, aspen

Farklı Gün Uzunluklarının Kirazda (*Prunus avium* cv. Ulster) Soğuğa Dayanıklılık Üzerine Etkisi

Bu araştırmada farklı fotoperiyodların bir yaşlı kiraz ağaçlarında (*Prunus avium* cv. Ulster) soğuğa dayanıklılık kazanılması üzerine olan etkisi incelenmiştir. Bir yaşlı kiraz ağaçları, kısa gün koşulları olarak 8 saat aydınlık ve 16 saat karanlık, uzun gün koşulları olarak da 16 saat aydınlık ve 8 saat karanlık periyodda tutulmuşlardır. Bu çalışmada ayrıca melez apsen ağacı (*Populus tremula* ×*Populus tremuloides*) ile kiraz ağacının soğuğa dayanıklılık yönüyle benzerlik veya farklılıkları araştırılmıştır. Kiraz ağaçları için LT_{50} değerlerinin farklı gün uzunluklarında değişmediği saptanmıştır. Aynı deneysel koşullara maruz bırakılan melez aspen ağaçlarında ise kısa gün koşullarına maruz kalan ağaçların uzun gün koşullarına maruz kalan ağaçlara göre soğuğa daha dayanıklı olduğu saptanmıştır. Bu araştırmada aynı zamanda kiraz ve melez aspen ağaçlarının dallarının apikal ve basal kısımlarının soğuğa dayanıklılığında, fotoperiyodun her hangi bir farklılık yaratmadığı saptanmıştır.

Anahtar Kelimeler: Fotoperiyod, gün uzunluğu, kiraz, Prunus avium, aspen, aklimatizasyon, dona dayanım

Introduction

Temperate zone woody plants have capacity to resist to cold temperatures. So, they can survive under cold temperatures. Survival strategy under cold temperature is based on cold acclimatization. Research on cold acclimation of trees suggests that cold acclimation occurs in different stages (Weiser, 1975). The first stage of cold acclimation is initiated by short daylength. The second and third stages are initiated by low temperatures and freezing temperatures. The third stage may not be observed where plants are not exposed lower than 0°C.

Phytochromes are the photoreceptors that are responsible measuring daylength in plants. They active signaling pathways leading to changes in gene expression. The changes in gene expression cause physiological and developmental responses (Welling et al., 2002).

Lots of research has been conducted about the effect photoperiodism on cold acclimation in woody plants. Especially, aspen trees are

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used to investigate the effect of photoperiod on cold acclimation experiments. Since hybrid aspen trees (*Populus tremula* ×*Populus tremuloides*) can be used to obtain transgenic plants and those plants are used to study on the effects of expression and over expression of phyotochrome genes such as phyA (Olsen et al., 1997).

Scots pine (*Pinus sylvestris)* is also used a model plant to investigate effect of photoperiodism on cold acclimation (Beck et al., 2004). However, limited research had been conducted in horticultural plants, especially in fruit trees. Apple trees are known to response different photoperiods on cold acclimation. Under short daylenght conditions apple trees were hardier than long day conditions (Howell and Weiser, 1970)

In this research, we investigated the effect of photoperiod on cold acclimation in cherry trees (*Prunus avium* cv. Ulster). We compared the acclimation trends of cherry trees with aspen trees which their acclimation trends are already known.

Materials and Methods

In order to investigate the effect of different photoperiods on cold acclimation we used one year old potted cherry trees (*Prunus avium* cv. Ulster) grafted on Mazzard rootstock. One year old branches of young cherry trees were used for cold hardiness tests after the growing period. We also used hybrid aspen trees (*Populus tremula* ×*Populus tremuloides*) to compare the acclimation patterns.

Trees were grown in two identical walk in growth chambers (Model PGV36, Conviron, Canada). Fifteen aspen and twenty cherry trees were placed in each growth chamber. Daylenght in growth chamber 1 were adjusted to short day conditions (8 hours day and 16 hours of dark). Daylenght in growth chamber 2 was adjusted to long day conditions. Before the experiments, light response curves were formed by CIRAS 1 photosynthesis measurement equipment (PP Systems, Hertfordshire, UK) and saturation points for photosynthesis were determined. 700 $\mu mol.m^{-2}.sec^{-1}$ light intensity was applied which was above saturation point for photosynthesis both for cherry and aspen trees. This light intensity was applied for 8 hours with the combination of fluorescent and incandescent lights. Compensation point was 70 $\mu mol.m^{-2}.sec^{-1}$ for photosynthesis both for cherry and aspen trees.70 $\mu mol.m^{-2}.sec^{-1}$ light intensity was applied with only incandescent lights for 8 hours additional light. By doing so, we have supplied total 16 hours daylength to growth chamber 2. We have applied high intensity light only for 8 hours in growth chamber 1, in order to keep the time equal for photosynthesis in both short day and long day conditions. By this way we avoided any interaction of the carbohydrate mechanism which could affect of the cold hardiness of the tress.

Temperature of growth chambers were set to 21°C for day period and 18°C for dark period. Relative humidity was set to 75% in both growth chambers.

Potted aspen and cherry trees were placed in growth chambers on 12th of May. They were grown until 7th of September. Cold hardiness test were initiated 10 day intervals between 7th of September and 27th of November. Visual examination cold hardiness test method (Howell and Weiser,1970) was used to determine the cold hardiness of the trees. Collected samples were subject to freezing tests in a electronic controlled freezer (So-Low Environmental Equipment, Cincinnati, OH, USA). Cooling step rate was 2°C/h. Three basal and apical twigs were sampled from trees for each cooling step with three replicates. Samples were wrapped in wet gauze to ensure ice nucleation. Wrapped wet gauze was placed in aluminum foil. Thermo couples were inserted inside the twig tissue to monitor temperature. After freezing, twigs were placed into humidity chambers to allow injury symptoms for ten days. After the incubation period cambium tissue was inspected. Brown tissues are considered dead and light green tissues are considered alive. LT_{50} values (Lethal temperature which 50% of the samples were death) were calculated according to the modified Spearman-Karber method (Bittenbender and Howell, 1974). The data was separated by standard deviation.

Basal and apical parts of the branches were investigated separately, to see if any difference occurs in cold acclimation on basal and apical parts of the branches.

Results and Discussion

There were significant differences in LT_{50} values between short day treatments and long day treatments in aspen trees (Figure 1). The difference was observed on all of the cold hardiness test dates. LT_{50} values for long day treatments ranged between -3.67°C and -8.33 in cold hardiness tests. We did not observed an increase in cold hardiness except on the last cold hardiness test (November 27) in long day apical sample. LT_{50} values were significantly different than short day treatment for aspen trees. LT_{50} values for short day treatments ranged between -17°C and -19.86°C in cold hardiness tests. The data was statistically different and indicated that aspen trees that were exposed short day conditions were hardier than the aspen trees exposed to long day conditions. The data was in the agreement with the report of Welling et al. (1997).

There were no significant differences between apical and basal parts of branches in aspen trees.

LT_{50} values for cherry did not affected from different photoperiod (Figure 2). We did not observe any increase in the cold hardiness of the cherry trees under short day conditions. There was no acclimation or de-acclimation pattern for both treatments. There were fluctuations in LT_{50} values which were insignificant statistically. LT_{50} values ranged between -13.67°C and -9°C for cherry trees for both long day and short day treatments.

In cherry trees, apical and basal parts of the branches did not show any difference in cold hardiness. This may indicate that there is no moving signal or significant acclimation pattern that moves from apical to basal or basal to apical in both aspen and cherry trees.

Our experiment indicated that different photoperiods did not affect cold acclimation of cherry trees. Under the same conditions, aspen trees responded the different photoperiods and cold hardiness of the aspen trees increased significantly under short day conditions.

Conclusion

Our research showed that in some woody plants like aspen cold acclimation may be triggered by photoperiod. However, this may not be the case for cherry trees. Cold acclimation of cherry trees may not be affected from photoperiod. Temperature interaction may also be considered for cold acclimation. Interaction of photoperiod and temperature may trigger the cold acclimation in cherry trees. It was found that growth and growth cessation in *Prunus* species were also regulated by the interaction of photoperiod and temperature (Heide, 2008).

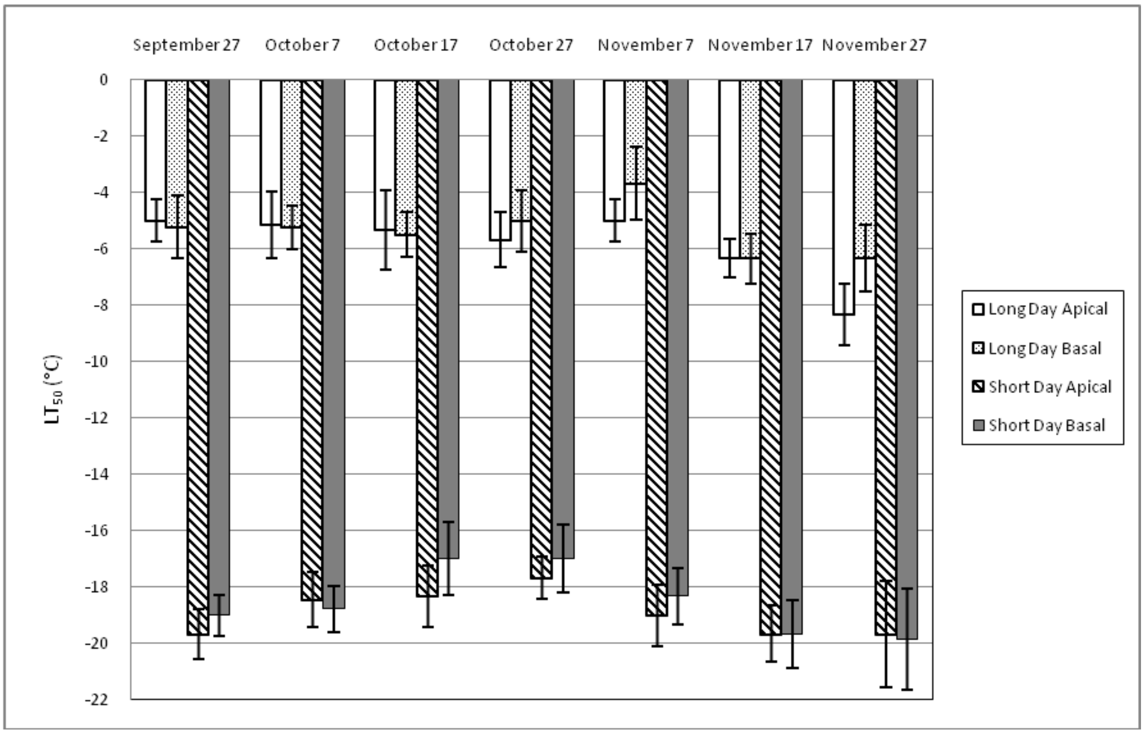

Figure 1. LT_{50} values of aspen trees which were exposed to short day and long day conditions.

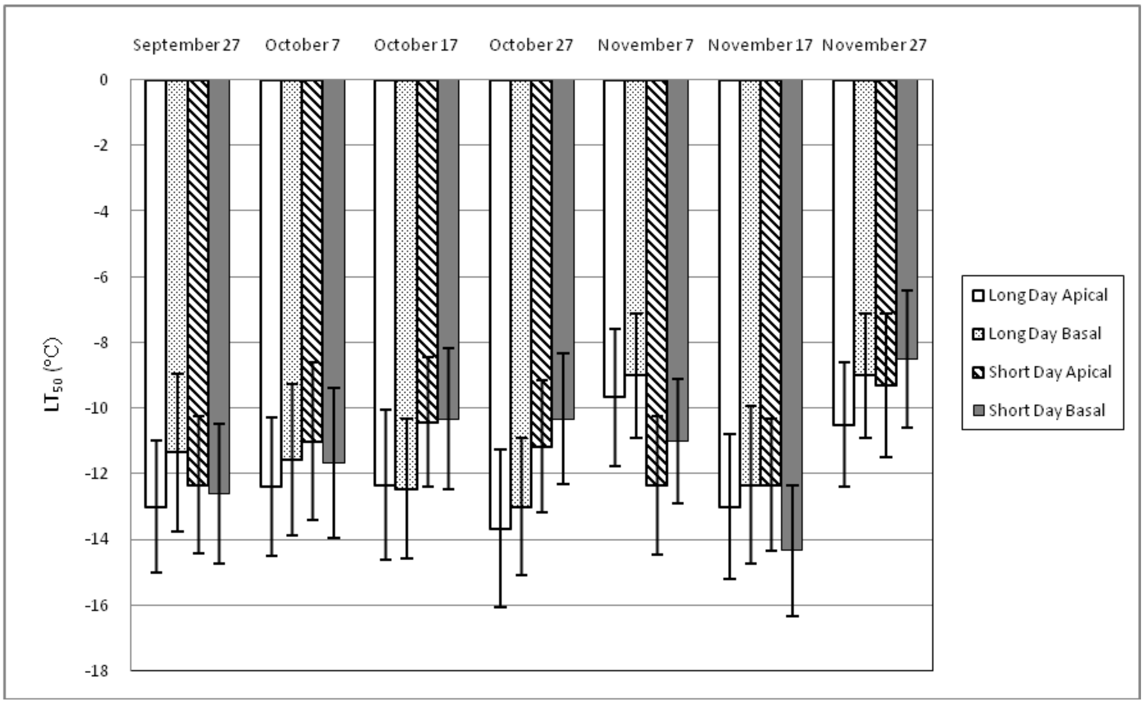

Figure 2. LT_{50} values of cherry trees which were exposed to short day and long day conditions.

It should be considered that we were able to test only one cherry cultivar. Different cultivars may respond differently. It is also possible that in cherry trees, phyotochrome gene expression may be different than aspen trees. We can make this conclusion for *Prunus avium* cv. Ulster. For further research, transgenic cherry trees with phyA gene would be useful to study on the affect of photoperiod in cherry trees.

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