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Evaluation of Invasive Plant *Centaurea balsamita* Cold Acclimated in the Spring to Chilling and Freezing Stress

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Introduction: Invasive plants threaten the ecosystems of agriculture, forests and rangelands. In this regard, Centaurea balsamita is an annual plant of asteraceae family that invades the fallow and slope lands. This plant is reproduced by seed and distributed in Syria, Turkey, Iran, Afghanistan and Central Asia (Turkmenistan to Tian Shan). Given that, according to studies accomplished in the world, threats of invasive plants are widely known, and since most studies related to freezing and cold stress tolerance are conducted on crop plants and there is little information about invasive plants, and considering that the precise identification of problematic invasive species. This study was performed to evaluate invasive plant Centaurea balsamita cold acclimated in spring to chill and freezing stress.

Materials and Methods: The experiments were conducted at Ferdowsi University of Mashhad, Faculty of Agriculture, in 2014 in a completely randomized design. In this experiment *Centaurea balsamita* in 2 to 4 and 4 to 6 leaf stage after the period of cold acclimation in the spring exposed to ten chilling and freezing temperatures (4, 2, 0, -2, -4,-6, -8, -10, -12 and -14 °C). In the experiment the pots were kept in the nursery from March 12, 2014 to April 19, 2014 and after cold acclimation period under these conditions, they were exposed to Chilling and freezing temperatures using thermogradient freezer. Freezer temperature was 8 °C at the beginning of the experiment and after placing the samples inside, the temperature decreased with the speed of 8 °C per hour. The cytoplasm membrane stability of *Centaurea balsamita* was evaluated using electrolyte leakage; then the lethal temperature of 50% of samples was determined based on leakage percentage (LT_{50el}). Survival percentage was evaluated by counting the number of live plants in each pot. Then, at the end of the recovery period, the lethal temperature for 50% of survival percentage (LT_{50su}) and reduction temperature for 50% of dry weight ($RDMT_{50}$) were determined (three weeks after the application of freezing treatment).

Results and Discussion: The lowest and highest percentage of electrolyte leakage in cold acclimated *Centaurea balsamita*, with spring conditions influenced by chilling and freezing temperatures were at 4 °C and -14 °C, respectively. Temperature reduction from -6 °C to -8 °C caused significant increase ($P \leq 0.05$) in electrolyte leakage in *Centaurea balsamita*. In addition, the lowest and highest percentage of survival in cold acclimated *Centaurea balsamita*, with spring conditions influenced by chilling and freezing temperatures were observed at 4 °C and -14 °C, respectively. Temperature reduction from -6 °C to -8 °C caused significant decrease ($P \leq 0.05$) in survival percentage in *Centaurea balsamita*. The highest and lowest dry weight in cold acclimated *Centaurea balsamita*, with spring conditions influenced by freezing temperatures, after the recovery period (21 days after application of freezing treatment) were observed at 4 °C and -14 °C, respectively. Temperature reduction to below -6 °C caused significant decrease ($P \leq 0.05$) in biomass of *Centaurea balsamita*. According to the results of the present experiment, LT_{50el}, LT_{50su} and $RDMT_{50}$ for acclimated *Centaurea balsamita* with spring conditions are -7.05 °C, -7.6 °C and -7.15 °C, respectively. Researchers reported that the plants with more tolerant to cold have less LT_{50el}, LT_{50su} and $RDMT_{50}$.

Conclusions: This study showed that in invasive plants such as *Centaurea balsamita*, using electrolyte leakage and survival tests can be relatively good methods in assessing and identifying invasive plants tolerant to cold, and help to identify invasive plant cold tolerance, predict their distribution and invasion. However, to ensure more about the cold tolerance of this invasive plant, it is recommended to cold acclimate this plant in areas with higher elevation and colder than Mashhad to achieve more accurate assessment of cold tolerance. Yet, due to low LT_{50su} of this plant when distributed, migration this invasive plant to wheat, barley and rangelands is highly plausible.

Keywords: LT_{50el}, LT_{50su}, $RDMT_{50}$, Recovery

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