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Determination of Cardinal Temperatures and Germination Respond to Different Temperature for Five Lawns Cultivars

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Introduction: Germination of every plant species respond to temperature variation in particular way. Germination is critical stage in plant life cycle. Seed germination is a complex biological process that is influenced by various environmental and genetic factors. The effects of temperature on plant development are the basis for models used to predict the timing of germination. Estimation of the cardinal temperatures, including base, optimum, and maximum, is essential because rate of development increases between base and optimum, decreases between optimum and maximum, and ceases above the maximum and below the base temperatures. Usually, a linear increase in germination rate is associated with an increase in temperature from base temperature (*Tb*) to an optimum. An increase of temperature from the optimum will reduce the germination rate to zero. To determine the best planting date for plants, it is necessary to find the base (*T*b), optimum (*T*o) and maximum temperatures (*T*c) for seed germination. These are known as cardinal temperatures. Modelling of seed germination is considered an effective approach to determining cardinal temperatures for most plant species, although these methods have some limitations due to unpredictable biological changes. The results of fitting mechanical models are useful for evaluating seed quality, germination rate, germination percentage, germination uniformity and seed performance under different environmental stresses such as salinity, drought, and freezing. Regression models incorporating more parameters can produce more precise estimates. Cardinal temperature was determined using segmented and logistic models in millet varieties and seedling emergence of wheat. In the dent-like model at lower-than-optimum temperature, a linear relationship holds between temperature and germination rate. This relationship remains linear at higher-than-optimum temperatures, but with a reducing trend. With increasing temperature, germination rate increases linearly up to an optimum temperature.

There are many cultivars of turfgrasses available each year and this large number can make your choice difficult. This guide is designed to help you decide which cultivars to use from those that have performed well in tests in Mashhad and are commercially available. When choosing a turf grass, consider the environmental aspects of where you plan to establish the turf and the cultural techniques that you will use to manage the grass and then choose the appropriate grass for your situation.

Materials and Methods: In order to determine cardinal temperatures in five cultivars of turfgrass (*Festuca arundinacea asterix*, *Festuca arundinacea eldorado*, *Festuca arundinacea starlet*, *Lolium perenne* and *Bermuda grass*) in eight temperature levels (5, 10, 15, 20, 25, 30, 35, 40^{0}C), factorial experiment was conducted in completely randomized design with four replications in research laboratory of Faculty of Agriculture, Ferdowsi University of Mashhad.

In the end of experiment measuring the following indices:

Final Germination Percentage (FGP) and Germination Rate (GR) were calculated based on below equation:

$FGP = (n / N) \times 100$

In this equation, n is the number seed germination at the end of the trial and N is the total of seeds.

$GR = {}_{=1}\left(\frac{gi}{di}\right)$

gi: the number of seed germination in every count and di:the number of days to counting until n-th day.

The base (*T*b), optimum (*T*o) and maximum temperatures (*T*c) for seed germination were calculated based on below equation.

$= \frac{b}{2a}$ و $x \le T_0$ $y = ax^2 + bx + c$

$$Tb, Tc = \left|\frac{b \pm \sqrt{b^2 - 4ac}}{2a}\right|$$

Data was analysis with MSTAT-C, Minitab ver, 13 and Excel software and means were comparative with

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Dunkan multiple range test in 5 percent probability.

Results and Discussion: Results showed that the germination percent, germination rate, radical length, plumule length, root to shoot and seedling vigor index are affected by temperature, variety and them interaction ($P<0.05$). Most characteristics were observed at 25^0C. For example maximum germination percent and rate were obtained in *Festuca arundinacea asteri*, most radical length and plumule length were noted in *Lolium perenne* and maximum seedling vigor index was noted in *Festuca arundinacea Eldorado*. Higher and lower temperatures than the optimum temperature decreased significantly on the values found. There was variation in response to cardinal temperatures between varieties of grass.

Conclusion: Rate of germination at each temperature for each genotype was computed as the inverse of time taken for 50% of the seeds to germinate. Rate of germination for each genotype at different temperatures was modelled with temperature to determine the base (t_b), and optimum (t_{opt}) temperatures. Response of germination to temperature for each genotype was calculated as the slope of a linear regression of the rate of germination on temperature below t_{opt}. Range in base temperature among the genotypes was between 4°C and 8.7°C differences, the optimum temperature among the genotypes was between 23°C and 30.5°C differences and the maximum temperature among the genotypes was between 41°C and 49.1°C differences but was statistically significant though they might be biologically significant. It seems, because of the diversity of tropical and cold temperatures to be different ecotypes.

Keywords: Cardinal temperatures (max, opt and min), Lawns cultivars, Seedling vigor