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Full Length Research Paper

Low temperature stress effect on wheat cultivars germination

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In order to study low temperature stress effect on wheat cultivars germination, an experiment was carried out in the seed technology laboratory of Mohaghegh Ardabili University in Ardabil, Iran. It was conducted by factorial design based on complete randomized deign (CRD) with two factor and three replications; content 30 grain per replication. Factor A include three temperature levels (2, 3 and 5°C) and factor B, include five wheat cultivars (Gaspard, MV17, Sardary, Cascogen and Bezostaya) were used in this experiment. Result showed that velocity of seed was lowest in 2°C and Gaspard, Sardary, Cascogen and Bezostaya have highest velocity of seed, respectively. Therefore, greatest seed velocities belong to Bezostaya cultivar in 5°C temperature. Lowest seed velocity is related to MV17 in 2°C temperature. For the number of roots, Cascogen cultivar with greatest and Gaspard cultivar with lowest number roots were determined. Sardary cultivar has highest coleoptiles length. In the final result, Bezostaya cultivar was arranged in the first and highest level, between five cultivar for low temperature stress characteristics and Sardary cultivar showed second level, significantly in comparison of the another cultivars.

Key word: Low temperature stress, seedling, wheat, germination.

INTRODUCTION

Wheat at different stages of growth temperature ranges and generally requires heat and low temperature on the relative strength of their shows. Usually at about 4°C to start germination of wheat resistance against low temperature but relatively high and autumn races that are planted in low temperature areas, can be so low temperature -35°C and must tolerate moderate frost tolerance in wheat (10 to -17°C). Wheat resistance against low temperature ancestry to different stages of its growth and to changes in the early stages of growth has higher sensitivity (Khodabandeh, 2003). Wheat is one of the most important cereal crops of the world. In most areas of the world, wheat is a principal food. In Pakistan, wheat is a stable food and thus occupies central position in farming and agriculture policies. It contributes 13.8% value added to agriculture and 3.4% to GDP. During 2003 to 2004 wheat was cultivated on an area of 8176 thousand hectares, showing 1.8% increase over the previous year with the production of 19767 thousand tones which was 3.0% higher than the previous year (GOP, 2004). A stress affects practically every aspect of plant growth and metabolism. Plant responses to stress depend upon various factors such as duration and degree of stress, growth stage and time of stress exposure (Gupta and Sheoran, 1983). Due to their sedentary mode of life, plants resort to many adaptive strategies in response to different stresses such as high salt, dehydration, low temperature and heat, which ultimately affect the plant growth and productivity (Gill et al., 2003). Against these stresses, plants adapt themselves by different mechanisms including change in morphological and developmental pattern as well as physiological and biochemical responses (Bohnert et al.,

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1995).

Large areas of land under tomato production are established by sowing seed directly into the field instead of transplanting (Liptay and Schopfer, 1983). A primary task in breeding for stress tolerance is the identification and genetic characterization of useful germplasm. Appropriate time for sowing wheat, depending on the area conditions will change and more to soil temperature is about (Rashed and Koochaki, 2000). Wheat seeds germinated well in the state produces temperatures of more than 4°C; with the temperature of more than 4°C, the budding is done sooner. But when the temperature has very high level, seed germination will be lost. Minimum temperatures for bud production, and near zero in mid winter wheat was about 2°C and the best and most suitable is 8 to 10°C and maximum of 20 to 22°C (Khodabandeh, 2003). Germination stage is sensitive to soil temperature because the absorption seed needs water by enzymatic activity or is breathing (Voorhees et al., 1981). Germination and growth before emergence normally is controlled by soil temperature (Hegarty, 1973). According to Macduff and Wild (1986) root temperature on root growth, root number and length of barley and turnip effective range from 3 to 9°C turnip root length with increasing temperature increase. Barley root length with increasing temperature in the thermal range of 3 to 25°C after 20 days is increased 27 times. Abbasal-Ani and Hay (1983) reported that seedling root systems of barley, oats, rye and wheat at low temperature (5°C) shorter at high temperatures (15 and 25°C) is also fast. Davidson (1969) has reported that the temperature on the growth allocation between shoots and roots affects. Seed germination and vigor are prerequisites for the success of stand establishment of crop plants. Under stress conditions of different regions, low moisture and low temperature stress are limiting factor during germination. The rate and degree of seedling establishment are extremely important factors in determining both yield and time of maturity (Brigg and Aytenfisu, 1979). Seed germination is a major problem of wheat (*Triticum aestivum* L.) production. It is influenced by many environmental factors, but the availability of soil moisture has a major effect on germination and subsequent emergence. Besides the reduction in total germination, comparatively low soil moisture availability results in delayed emergence, a criterion of particular importance in the vigor and subsequent yielding ability of many crops (Azam and Allen, 1976). The rate of decline was found to be obvious, varying with crop species and cultivars (Ashraf and Abu-Shakra, 1978). Rate and seasonal distribution of precipitation, temperature and soil conditions are the main factors affecting yield and yield components of sesame in arid, semi–arid and low temperature areas (Nath and Chakrabotry, 2001).

The aim of this study was study of low temperature stress effect on germination of wheat cultivars for selection of best cultivar for planting in low temperature conditions.

MATERIALS AND METHODS

Experiment in 2011 was performed in Ardabil whit, two factors factorial with three replications and 100 seeds in each replication. The first factor was the levels of temperature (2, 3 and 5°C) and the second factor was cultivars (Gaspard, MV17, Sardary, Cascogen and Bezostaya). Germination test and seedling growth in Petri dishes of 9 cm long with a filter paper and the following one in the seeds were conducted. In order to disinfect seeds of two fungicides, Benomyl was used in thousands. For applying different temperature of germination chamber model Axyos were used. After 24 h, germinated seeds were counted and this practice continued for 20 days period (seed germination). Last day of root length, shoot length and coleoptiles length with ruler was measured. Number of roots were counted and the germination rate of the given ratio of the total number of seeds germinated to the total obtained by multiplying the number of seeds germinated on day (I) was estimated. For data analysis, SAS software was used. Comparison of means with LSD test at the 5%level of probability was performed.

RESULTS

Root length and germination rate

ANOVA results showed that root length under the influence of thermal treatments is applied. Thus the temperatures of 3 and 5°C maximum and temperature of 2°C lowest root length were observed. Between cultivars significant differences were not observed for root lengths. Comparison of means (Figure 1) and variance analysis showed germination wheat cultivar under the influence of treatment temperature was applied, so that the lowest rate of germination in the treatments at 2°C was achieved. Between cultivars of germination rate, significant difference was observed in 5% level probability. Differences was observed between cultivars in terms of germination rate, thus cultivars Gaspard, Sardary, Cascogen and Bezostaya had the highest germination rate and MV17 cultivar obtained in the category (Figure 2).

Number of root, stem length and coleoptiles length

Results of variance analysis and comparison between the cultivars showed the number of roots is significantly different so that the Cascogen and Gaspard cultivars obtained the highest and lowest number of roots, respectively. Also it was observed that with decreasing temperature, root number was significantly reduced. So that in the thermal treatment of 2 and 5°C respectively, lowest and highest number of roots were observed (Figure 3). Results showed that among the studied cultivars of stem length, there is no significant difference. ANOVA results and comparison of means (Figure 4) showed stem length was affected by treatment

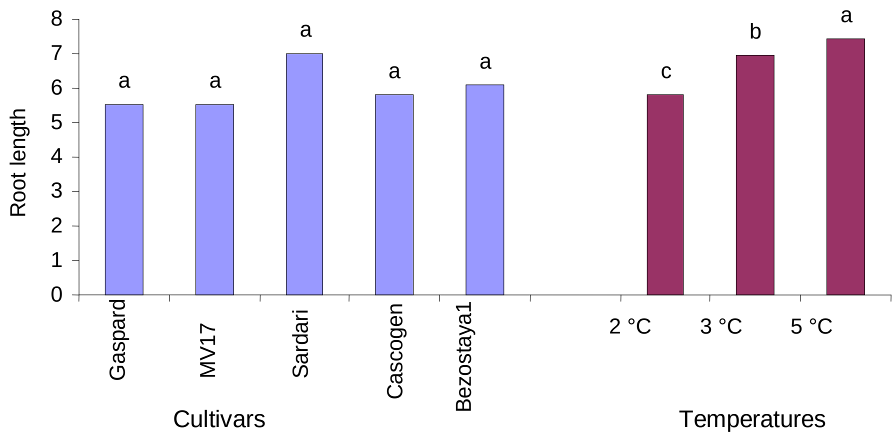

Figure 1. Effect of low temperatures on root length of wheat cultivars.

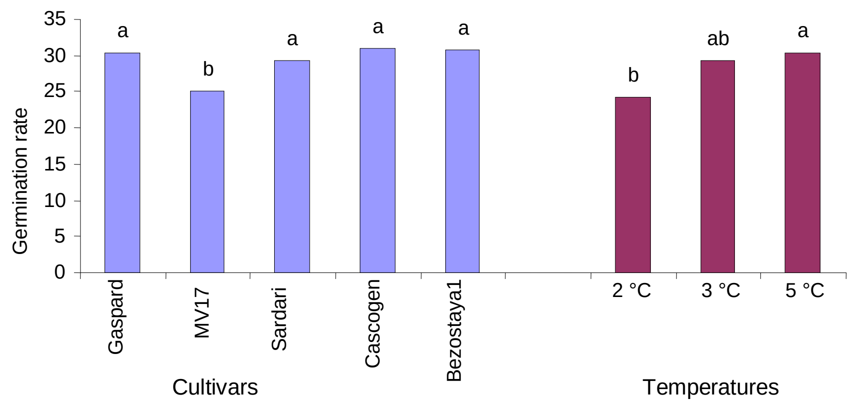

Figure 2. Effect of low temperatures on germination rate of wheat cultivars.

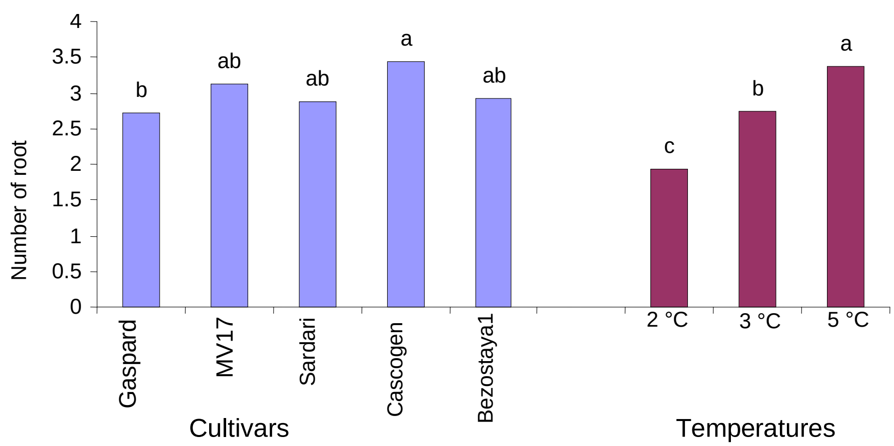

Figure 3. Effect of low temperatures on number of root of wheat cultivars.

temperature studied. Thus the treatment of temperature 5°C has the highest and treatment of the temperature 2°C has the lowest stem length. The results showed a difference in length of coleoptiles with significant in 5% probability level. Comparison of means (Figure 5) showed that Sardari cultivar having the highest level

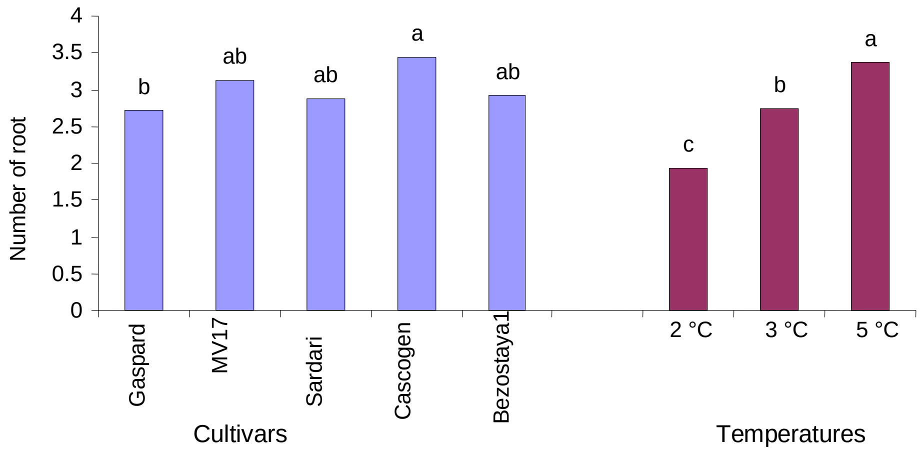

Figure 4. Effect of low temperatures on stem length of wheat cultivars.

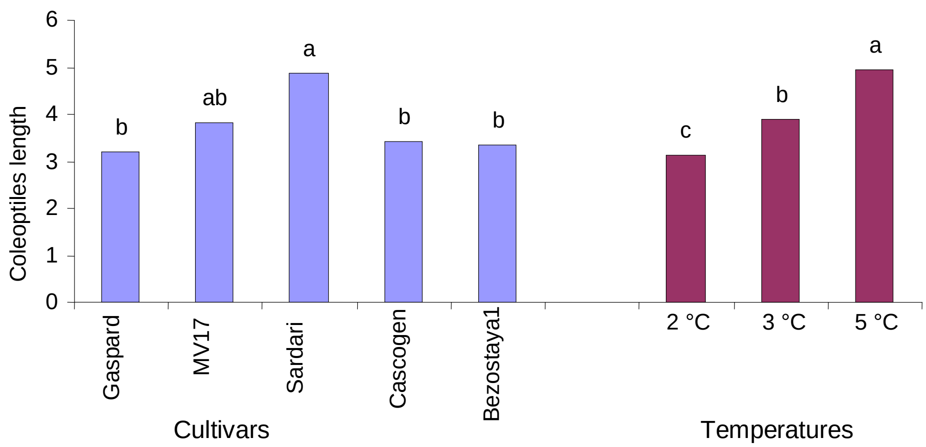

Figure 5. Effect of low temperatures on coleoptiles length of wheat cultivars.

during the first and cultivars coleoptiles Gaspard, Bezostaya and Cascogen jointly received the lowest level. MV17 cultivar after of Sardari cultivar was the second level.

DISCUSSION

In general it was found that the lowest emergence of traits is the lowest temperature (2°C) among the studied temperatures. And according to cultivars studied and results found, show that at low temperatures, Bezostaya cultivar in the first rank, and then Sardari cultivar, has had a more normal growth than other cultivars. Foolad and Lin (1999) showed that there were significant differences among cultivars respecting germination index. In many crop plants, seed germination and early seedling growth are the stages most sensitive to environmental stresses (Cook, 1997; Jones, 1986). In the cultivated plants, chilling temperatures in the range of 0 to 12°C (low temperature stress) in the germination, significantly delay the onset, reduce the rate and increase the dispersion of seed germination events (Jones, 1986; Foolad and Lin, 1997; 1998). The presence of environmental stress, such as low temperature restricts establishment of direct-seeded crops. Poor seed germi-nation may result in uneven stand establishment and poor crop performance (Jones, 1986). Most commercial cultivars of some plants are highly sensitive to low temperature stress during seed germination; however, genetic variation exists within the cultivated plant and related wild species (Jones, 1986; Foolad and Lin, 1997; Maas, 1986). Adaptation to all these stresses is associated with metabolic adjustments that lead to the modulation of different enzymes (Shinozaki and Shinozaki-Yamaguchi, 1996; Yan et al., 2001; Ehsanpour and Amini, 2003). Among these enzymes are phosphatases, which are believed to be important for many physiological processes, including regulation of soluble phosphorous (Pi) (Yan et al., 2001). Phosphateases are traditionally classified as being acid and alkaline depending on their optimum pH for enzyme activity, above and below pH 7.0 (Barret-Lennard et al., 1982). Free soluble phosphate reserves plays vital role in energy transfer, metabolic regulation, and important structural constituent of biomolecules like phytin bodies in the ungerminated seeds, protein and nucleotide phosphorylation (Ehsanpour and Amini, 2003; Fincher, 1989).

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