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**EFFECTS OF VERNALIZATION COLD ON SOME  
PHYSIOLOGICAL FEATURES OF TWO SUSCEPTIBLE  
AND RESISTANT WHEAT CULTIVARS**

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*Cold acclimation process is an essential mechanism in wheat cultivars' tolerance to cold stress. Results of FLN measurements indicated no vernalization requirement for Kavir spring wheat and vernalization fulfillment after 42 days of vernalization cold for Marthon winter wheat.*

**Key words:** wheat, Accustomed to cold, final leaf number (FLN)

Cold, salinity and draught are some unfavorable environmental factors that inflict irreparable damages on plant growth. Exposure to lower temperature affects geographical distribution of plants and leads to significant decrease in their metabolism [5]. Vernalization is a mechanism of enabling winter cereals to adopt with environmental conditions, and helps the plants to control their growth according to changes of seasons and, thus, being imposed to vegetative growth during the winter, preserve themselves against cold stress through vernalization requirement [4]. Vernalization depends on two factors of light and cold. The optimal temperature for vernalization is generally estimated to be 4° C, but it differs for various cultivars [7]. When exposed to cold temperatures, the plants with vernalization requirement are prone to losing leaf number before their vernalization fulfillment, and then the number reaches a fixed amount [3]. During cold compatibility, many different biochemical and physiological changes occur, including increasing sugar level, solvent proteins, antioxidant enzymes, Proline, expression of new protein isophrome and changes in membrane lipid composition. Due to exposure to chloroplast, the photosynthesis device is affected by vernalization cold [2]. This is because of sensitive systems of internal membrane of thylakoid (including lipid composition with fatty acids) [6]. The present study was done to investigate the rela-

tionship between vernalization requirement and the expression of cold tolerance in the winter wheat (Marthon) and the spring wheat (Kavir).

### **Materials and methods**

The present study utilizes two cultivars, Marthon winter wheat as resistant and Kavir spring wheat as susceptible against cold. The study is conducted under completely controlled conditions in a completely randomized blocks design with 4 replications. The seeds were sterilized with 3% hypochlorite sodium for 15 minutes before they were soaked at 20° for 24 hours and then, 15 seeds were planted in 2cm deep pots. The pots were kept in the lab at 20± with 300 mol/m<sup>2</sup>/s constant light. Half the pots of each cultivar were used as control temperature treatment up to the end of the experiment (56 days for Kavir and 77 days for Marthon) and the remaining half were kept after day 14 at 4±1°C as cold treatments (42 days for Kavir and 63 days for Marthon). The first samples were taken at day 14 (the transition day to 4°C treatments) and it was set as the zero day cold. Then, samples were taken from the youngest leaves at days 21 and 42 for Kavir spring wheat and days 21, 42 and 63 for Marthon winter wheat. At this time, plantlets of both cultivars were sampled simultaneously. On the whole, the samples were taken at 4 different times for the winter wheat resistant against cold and 3 times for the spring wheat.

**Measuring Final leaf number:** seeds of the cultivars were planted at 20° C for 14 days. Some of the seeds were kept at this temperature without being induced by vernalization cold (4°C) until the emergence of flag leaf (zero day cold). The other group was induced by vernalization cold differently at 21 and 42 days for kavir and 21, 42, and 63 days for Marthon and then it was returned to 20° C temperature for the emergence of flag leaf. Here, the number of leaves on the stem was recorded. [7]. The differences in vernalization periods arise from the difference in vegetation growth of the two cultivars. To examine FLN, a factorial experiment in a completely randomized design with two factors: two levels of cultivars (spring and winter) and three levels of vernalization days (0, 21, and 42) with 3 replications was utilized.

### **Results and discussion**

Results of variance analysis (Table 1) showed that simple and interactive effects of the cultivar during vernalization days were significant at 1% probability, but the simple effect of vernalization days indicated no significant difference. Results of comparing means are presented in Table 2 and changes in final leaf number in Fig 1.

Table 1.

**Mean squares of variance analysis final leaf number  
in the two studied cultivars**

Sources of variations (S.O.V)	Degrees of freedom (D.F)	final leaf number (FLN)
Genotype	1	*16.281*
Vernalization days (d)	2	0.038 <sup>ns</sup>
CV×d	2	*2.549*
Error	18	0.081
Total	23	-
CV% (Coefficient of variation)	-	13.49

<sup>ns</sup> and \*\*: insignificant difference at probability 5% and significant difference at probability 1%

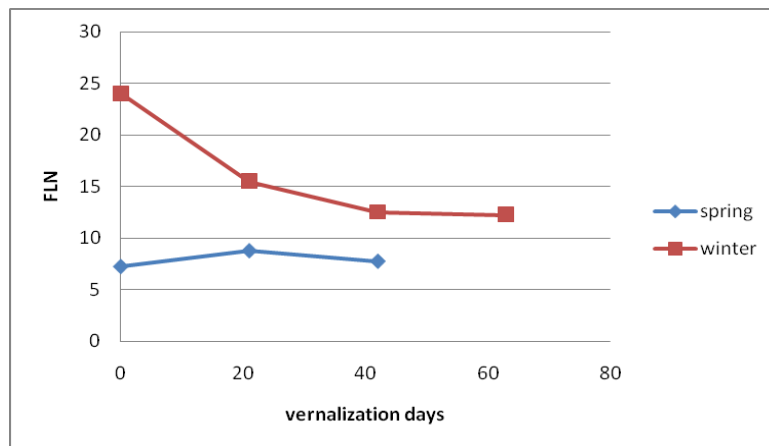
Table 2.

**Comparison of means final leaf number in the two studied cultivars**

Vernalization days	FLN	
	Spring	Winter
Zero (control)	7.2±50.36	24.00±0.41
21	8.75±0.43	15.5±0.29
42	7.75±0.38	12.5±0.27
63	-	12.25±0.00
CV% (Coefficient of variation)	4.5	1.6
MS (Mean-square)	0.687 <sup>ns</sup>	1.134**

<sup>ns</sup> and \*\*: insignificant difference at probability 5% and significant difference at probability 1%

The number of vernalization days had no effect on final leaf number in Kavir spring wheat (Table 2, Fig. 1). Thus, findings of the study demonstrated that vegetation growth in this cultivar is fulfilled without vernalization cold treatment. Many studies have shown that phenologic stages in wheat cultivars with no vernalization requirement occur early, leading to early entry to reproductive stage, which makes them vulnerable to long exposure to cold [8]. In Marthon winter wheat, the number of vernalization days significantly affects final leaf number at 1% probability (Table 2, Fig. 1). The study indicated that final leaf number in winter cultivars is influenced by vernalization period, so much so that, exposure to vernalization temperature (4° C) in these cultivars leads to significant decrease in FLN and the vernalization saturation fulfills at 42 days.



**Fig 1.** Changes of final leaf number during vernalization period in spring Kavir wheat (Blue line) and Marthon winter cultivar (Red line)

Studies indicate that exposure of winter cereals in vernalization cold leads to decrease in final leaf number which stops at a fixed number after a certain range, called the vernalization fulfillment range[1]. If it is not exposed to low temperature, Marthon wheat produces a great deal of leaves (24 ones) to reach the reproductive stage and it needs a longer time to reach this stage. But when it is exposed to low temperature, its final leaf number is reduced to half (12.5 leaves) and after 42 days of vernalization enters the reproductive stage. This response from Marthon cultivar shows its high vernalization requirement and later transmission to reproduction stage, indicating later expression of resistance genes to cold in the vegetation period which leads to higher resistibility against cold in this wheat.

Therefore, it can be said that vernalization fulfillment is a turning point in expressing cold tolerance. Our results are consistent with findings of other studies [6].which show that maximum level of cold tolerance in cereals with vernalization requirement occurs at vernalization period and decrease later on.

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## **BUĞDANIN SOYUĞADAVAMLI VƏ HƏSSAS SORTLARININ BƏZİ FİZİOLOJİ XÜSUSİYYƏTLƏRİNƏ SOYUQLA YAROVİZASİYANIN TƏSİRİ**

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### **XÜLASƏ**

Soyuğa uyğunlaşma prosesi buğda sortlarının soyuq stressə qarşı davamlığının mühüm mexanizmidir. Təcrübələrin nəticələri yazlıq buğdada (Kavir) yarovizasiyaya tələbatının olmasını, payızlıq buğdada (Marton) isə soyuqla yarovizasiyanın 42 gündən sonra başa çatmasını göstərir.

**Açar sözlər:** buğda, soyuğa uyğunlaşma, yarpaqların son sayı

## **ВЛИЯНИЕ ЯРОВИЗАЦИИ ХОЛОДОМ НА НЕКОТОРЫЕ ФИЗИОЛОГИЧЕСКИЕ ОСОБЕННОСТИ УСТОЙЧИВЫХ И ЧУВСТВИТЕЛЬНЫХ СОРТОВ ПШЕНИЦЫ**

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### **РЕЗЮМЕ**

Процесс адаптации сортов пшеницы к холоду является важным механизмом их устойчивости к холодному стрессу. Полученные результаты показали, что у яровой пшеницы сорта Кавир отсутствуют требования к яровизации, а у озимой пшеницы сорта Мартон яровизация заканчивалась через 42 дня.

**Ключевые слова:** пшеница, адаптация к холоду, конечное число листьев

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