Bread Wheat Varieties Germination Under Influence of temperature Regimes under lab conditions

Sayran Sardar Hassan[1], Shaee Adeeb Gharib[2], Suaad Muhamad Sheikh Abdulla[3] and Kazhal Rashid Ahmad[4]

[(1,2,3,4)]College of Agricultural Engineering Sciences, Biotechnology and Crop Science Department, University of Sulaimani, Kurdistan-Iraq

Corresponding author Email: sayran.hasan@univsul.edu.iq

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Abstract:

To study the temperature effect on germination of common bread wheat varieties, an experiment has been carried out at the college of agricultural engineering sciences, the department of biotechnology and crop science, during the seasons 2018-2019. A factorial experiment was conducted based on a Complete Randomized Design (CRD) with two factors and three replications, and each replication contented 10 seeds. Factor A included four temperature levels (5, 15, 25°C, and room temperature (20-23°C)), and factor B, included five bread wheat varieties including (Adana, Maaroof, Alla, Shaho-2, Azmar-2). The results found out that the effect of bread wheat varieties highly significant effect on the root length, shoot length, germination percentage, seedling vigor index, and vigor index. The highest value for shoot length and seedling vigor index was recorded by Maroof variety. Effect of low temperature was highly significant different for roots and shoot characters, also for vigor index and seedling vigor index, the best temperature for most of these traits was 25 °C. The effect of the interaction between temperature regimes and varieties was highly significant difference for the root and shoot length characters which were Azmar-2 at 15 °C and Adana at 25°C, while germination percentage and seedling vigor index showed high significance difference in this interaction and the highest rate for seedling vigor index was recorded by Maroof variety at 15 °C, germination percentage recorded %100 for most interactions characters.

Keywords: Wheat varieties, Temperature, Germination, Seedling, and vigor index.

Introduction:

Wheat (*Triticum aestivum* L.) is second ranked most important cereal crop, and staple food for the population around the world, especially in Iraq. It provides more than 30% of the food calories and protein [12 and 2]. Bread wheat varieties are grown in a wide range of arid and semi-arid conditions where earlier and late cultivation occurs frequently due to fluctuation in a rain-fed region [22]. The global production of bread wheat is substantially affected by climate change and water scarcity in the grown environment [5 and 6]. Seed quality is one of the most influential characteristics to achieve optimal growth and yield production on farms, which is affected by many important factors such as genotypes characteristics, vitality, germination rate, moisture content, storage conditions, survival ability, and seed health, but the most important of which are germination percent and vigor index [4]. Seed germination is one of the major factors contributing to crop yield. Among the abiotic factors, the temperature is an important issue for wheat germination, because it persuades the rate of water absorption and additional substrates necessary for growth and development [5]. The optimum temperature for wheat germination is (15 - 18°C) while moderate-high temperature (25 - 32°C) [23]. It is a modifying agent in germination because it can affect the rate of water uptake and the supply of other substrates necessary for growth and development [6]. Water deficiency at the germination percentage and seedling stage is among the important factors to influence the yield of the wheat crop production [17]. The fast and uniform field emergence is essential for better growth and high yield. [20]. The most serious problem in wheat production is a lack of water in the growth phase of the seedling stage, water stress in the vegetative growth phase, final stress, or a combination of any two or three stages. Seed germination characteristics and seedling growth are very important factors in determining the quality and quantity of the crop [4]. The seed germination index and plant length are among the most sensitive indicators of drought stress, followed by the characteristics of root and seedling length indicating [9]. There is an inverse relationship between seed germination rate and final germination percentage as well as the amount of water absorbed by seeds dramatically with a high level of osmotic stress. [13]. Therefore, this study was set to determine how different temperature regimes affect wheat seed germinating traits and to explore optimum temperature for germ inability of different bread wheat varieties.

Materials and Methods:

Laboratory experiments were conducted to evaluate the germination traits of various wheat varieties below various temperature regimes at the Biotechnology and Crop Science department College of Agriculture engineering Science, University of Sulaimani. Seeds of five bread wheat varieties Adana, Maaroof, Alla, Shaho-2, and Azmar-2, all the varieties were grown at the experimental field station of the College of Agricultural Engineering Sciences, the University of Sulaimani in Bakrajo (Latitude N 35° 32 036; Longitude E 45° 21 865 and Elevation 726m) 10km southwest of Sulaimani center during the crop seasons of 2018-2019. Obtained seeds parameters were tested under three

different temperatures (5, 15, and 25 °C), where the incubator temperature was adjusted to the test degree for each experiment for a duration of 15 days, and the germinated seeds were counted 4 Times starting from 48 hours after sowing. The same parameters were recorded for the five study wheat seeds when they were placed in the same condition without temperature monitoring or by placing them all in normal position. The temperature in the laboratory room is between (20-23 ° C). The treatments were placed in complete randomized design within factorial (CRD) having three replications. Ten seeds were randomly selected from each variety with three replicates, and the seeds were sterilized by using Ethanol (96%) for 2-3 minutes washed from Ethanol 2 times by distilled water, the seeds were placed in Petri dishes (90 mm in diameter) for all treatments, two layers of Whatman filter paper were used, and kept in the incubator (M 7040 R Electro. Mag) at various temperatures as mentioned above, and the seeds were watered with distilled water wherever needed during the germination period. Daily germinated seeds were recorded for the treatment from the second day after planting. All the data were statistically analyzed according to the methods of the one-way analysis of variance (ANOVA), the comparisons of traits' means were carried out by using Least Significant Difference (L.S.D) test at the probability level of 1%, using the statistical program JMP, version 7 [15]. The following characteristics were measured:

Germination percentage (%), Shoot length (cm), Root length (cm), Seed vigor index (%), Number of roots, Fresh shoot weight (mg), Fresh root weight (mg), Shoot dry weight (mg) and Root dry weight (mg), and Seedling vigor Index %.

The germination percentage % (GP) counted after 48 hours passed according to [14].

$$GP\ \% = \frac{\text{Number of germinated seeds until i day}}{\text{The total number of seeds tested}} \times 100$$

Vigor Index percentage counted as the following equation [11]:

$$Vigor\ index = \frac{\text{A1}}{T1} + \frac{A2}{T2} + \frac{\text{A3}}{T3} \ldots\ldots\ldots \frac{An}{Tn}$$

Where:

A = Number of seeds germinated,

T = Time (days) Corresponding to A

n = No. of days to final counting of germination.

And Seedling vigor Index % (S.V.I) was calculated by the following formula [15].

S.V.I % = (Root length + shoot length) x Germination%

Result and Discussions:

The germination rate of bread wheat, like many other crops, has decreased significantly with global climate changes such as high and low temperatures, changing planting and sowing dates, and also less rain and drought stress are among the main factors causing the decrease in germination rate. Finding bread wheat varieties that can sprout on limited water resources is critical to boosting wheat production under rainfed conditions [1]. It can be concluded from this research that reducing the percentage of germination is

associated with either reducing the water absorption rate in the seeds or delaying the germination process [16]. The results of the analysis indicated significant variation between the five bread wheat cultivars in germination percentage (%), strength index, and seedling strength index (%) as shown in Table 1. The differences among studied cultivars were highly significant for all the study traits, the highest germination value was recorded 98.33% of the cultivar Shaho-2 and 97.5% in Maaroof and Alla varieties, the lowest value for germination percentage was recorded 82.5% in Adana, while the maximum value of the vigor index showed 3.329 in Shaho-2, while the Maaroof cultivar gave the maximum value for seedling vigor index percentage reached 1294.29%, the lowest value was 902.45% shown by Adana. In this study, no specific trend of increasing or decreasing was observed in wheat seed germination percentage in table 1.

Table 1: Means of five varieties for germination percentage, vigor index and seedling vigor index characters.

Varieties	Germination%	Vigor index	Seedling vigor index %
Adana	82.50	2.1743	902.454
Maaroof	97.50	2.6845	1294.297
Alla	97.50	2.8936	1037.611
Shaho-2	98.33	3.3299	1209.961
Azmar-2	96.66	2.6379	1217.421
$LSD_{.01}$	6.5318	0.5600	4.1481

Table 2. Illustrated that effect of the temperature (°C) was highly significant difference on vigor index and seedling vigor index percentage, but it was not significant difference on germination percent. in this experiment exposing seeds to the treatment 15°C gave the highest value for seedling vigor index percentage reached to 1768.15% and the lowest value 22.367 %, while on the temperature 25°C produced the highest value for vigor index reached 4.6132. The lowest values for all characters showed by 5°C treatment. This could be predicted due to genetic potentiality of the wheat varieties to withstand the temperature fluctuation. These results suggest that increased in temperatures on seed water absorptions effects on germination percentage and seedling vigor index [19].

Table 2: Effect of temperature on the germination percentage, vigor index and seedling vigor index characters.

Temperature °C	Germination%	Vigor index	Seedling vigor index %
5	92.000	0.887	022.367
15	97.333	3.013	1768.157
25	96.667	4.613	1745.973
Room temp. (20-23)°C	92	2.462	992.899
$LSD_{.01}$	N.S	0.5009	4.1021

N.S = non-significant

From table 3 it was indicated that the effect of interaction was highly significant on germination rate and seedling vigor index rate for all the traits. The highest value for interaction between germination percentage and different temperature 100% was recorded at 15°C, 25°C, and room temperatures (20-23°C) in Maaroof, Alla, Shaho-2, and Azmar-2 respectively, except Adana recorded the lowest value 60% at room temperature (20-23°C). but the highest vigor index recorded at 25°C temperature 4.944, 4.888, 4.788, and 4.666 respectively in Alla, Azmar-2, Maaroof, and Shaho-2. Seed vigor index is an indicator of rapid germination and speed of growth [24] The seedling vigor index percentage, the highest value was 2113.70% recorded by the interaction between the second variety Maaroof with temperature (15 °C). However, decrease in seed vigor index was noted in the lower temperature of (5 °C) 16.645% in Shaho-2. [24] reported that no germination occurred at 5°C temperature. [18] registered that variation in wheat genotypes recorded higher germination rates as temperature increased from 10°C to 30°C. The results are in agreement with the above statement, whereas the differences in seed germination percentage and seedling at 5°C, and 25°C may be due to genetic variation or environmental factors [21].

Table 3: Effect of interaction varieties and different temperature on germination percentage, vigor index and seedling vigor index characters.

Interactions		**Germination%**	**Vigor index**	**Seedling vigor index %**
Varieties	**Temp.** ^{o}C			
	5	93.333	1.041	21.733
	15	90.000	2.510	1165.260
Adana	25	86.667	3.777	2066.120
	Room temp. (20-23)	60.000	1.367	356.690
	5	93.333	0.821	21.778
	15	100.000	2.822	2113.700
Maaroof	25	96.667	4.788	2030.570
	Room temp. (20-23)	100.000	2.305	1011.130
	5	90.000	1.113	26.778
	15	100.000	3.155	1573.700
Alla	25	100.000	4.944	1327.760
	Room temp. (20-23)	100.000	2.361	1222.200
	5	93.333	0.368	16.546
	15	100.000	3.155	1910.000
Shaho-2	25	100.000	4.666	2027.730
	Room temp. (20-23)	100000	2.361	885.560
	5	90.000	1.093	25.002
	15	96.667	3.422	2078.110
Azmar-2	25	100.000	4.888	1277.660
	Room temp. (20-23)	100.000	3.915	1488.900
$LSD_{.01}$		13.0637	N.S	4.4458

N.S = non-significant

From table 4 it was illustrated that the differences among varieties were highly significant difference for root length, shoot length, and the number of roots, while for the other characters the differences among varieties were non-significant. The root length in Azmar-2, Shaho-2, and Maaroof varieties recorded the highest value 6.6553, 6.1538, 6.1198 respectively but Adana give the lowest value 5.2644. Variety Maaroof gave maximum value for shoot length reached 7.007 cm, but Alla gave minimum value reached 4.9144 cm. While variety Alla showed the highest value for the character number of roots reached 3.5118, but Shaho-2 recorded lowest value 2,4048. Moreover, roots are an important sink for assimilates in wheat. Since remobilization of assimilates occurs after anthesis, assimilates from roots may supplement primary sources from the leaf and stem [25]. The highest root fresh weight, shoot fresh weight, and root dry weight was 0.002, 0.0356, and 0.0041 mg respectively observed in Alla.

Table 4: Means of varieties for root length, shoot length, number of roots, root fresh weight, shoot fresh weight, root dry weight, and shoot dry weight characters.

Variety	Root length (cm)	Shoot length (cm)	No. of roots	Root fresh weight (mg)	Shoot fresh weight (mg)	Root dry weight (mg)	Shoot dry weight (mg)
Adana	5.2644	5.4759	2.7857	0.0101	0.0301	0.0032	0.0049
Maaroof	6.1198	7.0077	3.1071	0.0145	0.0283	0.0038	0.0053
Alla	5.4693	4.9149	3.5818	0.0200	0.0356	0.0041	0.0049
Shaho-2	6.1538	5.9488	2.4048	0.0098	0.0283	0.0030	0.0043
Azmar-2	6.6553	5.6985	3.5275	0.0136	0.0353	0.0051	0.0062
$LSD_{.01}$	0.7649	1.4632	0.6253	N.S	N.S	N.S	N.S

N.S = non-significant

The effect of temperature on the elongation of shoot and root of the wheat seedling is shown in Table 5 confirmed that the effect of different temperatures was highly significant on all studied characters. The exposing seeds to treatment 15^{o}C showed the highest value for root length and root dry weight reached 10.3151 cm and 0.0057 mg respectively. Using temperature 25^{o}C produced the highest value for most characters including shoot length, the number of roots, shoot dry weight, root fresh weight, and shoot fresh weight reached 8.8942 cm, 4.3999, 0.0075 mg, 0.0209 mg, and 0.0501 mg respectively. Exposing the seeds to 5^{o}C temperature showed the zero value for all the studied characters. The collected data of the present study are supported by [7] and [3] which indicated that shoot dry weight and seedling stage increased with increasing temperature from (15-35^{o}C) in bread wheat. While it was reported [8] that the additional decrease in the temperature regimes led to a significant decrease in the shoot fresh weight, dry weight and root length, root dry weight of the wheat varieties, but the increase in temperature at 30°C led to an increase in the fresh shoot weight, shoot length and fresh root weight as wheat genotypes.

Table 5: Effect of temperature on five bread wheat varieties for root, shoot length (cm), root, shoot fresh weight (gm), root, shoot dry weight (gm) number of root characters.

Temperature (°C)	Root length(cm)	Shoot length(cm)	No. of roots	Root fresh weight (mg)	Shoot fresh weight(mg)	Root dry weight (mg)	Shoot dry weight (mg)
5	0.2438	0	0	0	0	0	0
15	10.3151	7.7535	3.9479	0.0170	0.0433	0.0057	0.0064
25	9.3555	8.8942	4.3999	0.0209	0.0501	0.0053	0.0075
Room temp. (20-23)	3.8156	6.5889	3.9776	0.0163	0.0326	0.0043	0.0065
$LSD_{.01}$	0.6841	1.3088	0.5593	0.0087	0.0078	0.0019	0.0014

The data in table 6 confirmed that the interaction between varieties and temperature was highly significant difference only on the characteristics root length, shoot length, while it was not significant for the rest characters. The highest value for root elongation was 13.343 cm produced by the interaction between Azmar-2 and exposing seeds to temperature 15°C, and 12.00 cm in Adana at temperature 25°C was recorded. while the maximum shoot length was 11.889 cm produced by the interaction between Adana variety with using temperature 25°C. The interaction between the five studied variety and temperature at 5°C was not significant. Decrease in temperature regimes significantly reduced root fresh weight, shoot fresh weight, root dry weight, and shoot dry weight of the five wheat varieties. However, [26] that shoot dry weight of wheat seedling increased with increasing temperature (15-35°C).

Table 6: Effect of interaction between five varieties and different temperatures on some root and shoot characters.

Interaction V.	Temp.	Root length (cm)	Shoot length (cm)	No. of roots	Root fresh weight (cm)	Shoot fresh weight (cm)	Root dry weight (cm)	Shoot dry weight (cm)
Adana	5	0.2300	0	0	0	0	0	0
	15	7.1610	5.7367	3.5870	0.0085	0.0283	0.0048	0.0062
	25	12.0000	11.8890	4.6667	0.0203	0.0693	0.0050	0.0086
	Room temp. (20-23)	1.6670	4.2780	2.8890	0.0114	0.0227	0.0029	0.0049
Maaroof	5	0.2330	0	0	0	0	0	0
	15	9.5230	11.6140	3.7620	0.0146	0.0461	0.0052	0.0067
	25	11.3890	9.6390	4.4443	0.0289	0.0383	0.0068	0.0080
	Room temp. (20-23)	3.3340	6.7777	4.2220	0.0143	0.0287	0.0031	0.0063
Alla	5	0.3000	0	0	0	0	0	0
	15	10.5770	5.1597	4.4380	0.0241	0.0438	0.0057	0.0046

	25	6.2780	7	5	0.0293	0.0459	0.0051	0.0069
	Room temp. (20-23)	4.7220	7.5000	4.8890	0.0264	0.0528	0.0057	0.0083
	5	0.1780	0	0	0	0	0	0
	15	10.9710	8.1287	3.2860	0.0143	0.0375	0.0052	0.0052
	25	11.0550	9.2220	3.1110	0.0118	0.0499	0.0041	0.0068
Shaho-2	Room temp. (20-23)	2.4110	6.4447	3.2223	0.0130	0.0259	0.0026	0.0051
	5	0.2780	0	0	0	0	0	0
	15	13.3430	8.1287	4.6667	0.0235	0.0610	0.0077	0.0095
	25	6.0560	6.7210	4.7777	0.0143	0.0472	0.0057	0.0072
Azmar-2	Room temp. (20-23)	6.9450	7.9443	4.6657	0.0165	0.0330	0.0070	0.0079
LSD.01		1.5298	2.9265	N.S	N.S	N.S	N.S	N.S

N.S = non-significant

Correlation analysis is one the most important statistical parameters for selection and crop improvement [10]. The simple correlation coefficient between each pair of characters represents in Table 7. Correlation analysis revealed that the association between each pair was highly significant and positive except of the correlation between the germination percentage with the other characters which were not significant difference. Correlation analysis revealed that root length exhibited significant and positive correlation with number of roots 0.731, root fresh weight 0.721 mg, root dry weight 0.851 mg, shoot length 0.838 cm, shoot fresh weight 0.858 mg, shoot dry weight mg 0.781 mg, vigor index 0.775, and seedling vigor index percentage 0.963. Table 7 which indicated that by increasing these attributes, root length will increase. Correlation coefficients illustrated that number of roots showed highly positive and significant association with root fresh weight 0.908 mg, root dry weight 0.929 mg, shoot length 0.861 cm, shoot fresh weight 0.899 mg, shoot dry weight mg 0.955 mg, vigor index 0.811, and seedling vigor index percentage 0.821. Root fresh weight showed significant correlation with, root dry weight 0.875 mg, shoot length 0.771 cm, shoot fresh weight 0.838 mg, shoot dry weight mg 0.854 mg, vigor index 0.772, and seedling vigor index percentage 0.778, and non-significant correlation with Germination percentage. Root dry weight showed significant correlation with shoot length 0.837 cm, shoot fresh weight 0.873 mg, shoot dry weight mg 0.930 mg, vigor index 0.819, and seedling vigor index percentage 0.885. Shoot length showed significant correlation with shoot fresh weight 0.905 cm, shoot dry weight mg 0.916 mg, vigor index 0.784, and seedling vigor index percentage 0.942.

Table 7: The simple correlation coefficient among the study characters.

Varieties	Root length (cm)	No. of roots	Root fresh weight (mg)	Root dry weight (mg)	Shoot length (cm)	Shoot fresh weight (mg)	Shoot dry eight (mg)	Germination%	Vigor index	Seedling vigor ndex %
Root length (cm)	1									
No. of roots	0.731 **	1								
Root fresh weight (mg)	0.721 **	0.908 **	1							
Root dry weight (mg)	0.851 **	0.929 **	0.875 **	1						
Shoot length (cm)	0.838 **	0.861 **	0.771 **	0.837 **	1					
Shoot fresh weight (mg)	0.858 **	0.899 **	0.838 **	0.873 **	0.905 **	1				
Shoot dry weight (mg)	0.781 **	0.955 **	0.854 **	0.930 **	0.916 **	0.925 **	1			
Germination%	0.320	0.280	0.298	0.309	0.280	0.265	0.227	1		
Vigor index	0.775 **	0.811 **	0.772 **	0.819 **	0.784 **	0.797 **	0.802 **	0.417	1	
Seedling vigor index %	0.963 **	0.821 **	0.778 **	0.885 **	0.942 **	0.905 **	0.868 **	0.401	0.826 **	1

**: Significant at 1% probability level, N.S = non-significant.

Conclusions:

The different temperatures had significant effects on germination percentage and seedling vigor index for the five studied varieties. The high temperature increased the rate of germination and seedling vigor index, which increases the average of root elongation, plant length and the number of roots. Maaroof variety had the best performance for most traits under temperature conditions. The temperature between (15-25 ° C) showed a clear difference between varieties and it is a direct factor affecting the germination percentage.

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