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WHEAT SEED GERMINATION UNDER THE INFLUENCE OF TEMPERATURE REGIMES

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ABSTRACT

Temperature greatly influences germination of the seeds. Most of the varieties lack the ability to sustain temperature stress with significant differences for germination and related traits. Laboratory investigations were conducted to determine the effect of different temperature regimes on germination traits of various wheat (Triticum aestivum) varieties at Department of Agronomy, Sindh Agriculture University, Tandojam, Pakistan during 2008. Seeds of five wheat varieties (Moomal 2000, T J-83, Imdad-2005, Abadgar-93 and Mehran-89) were tested for germination and related traits under three temperature regimes (10, 20 and 30^{o}C) in germinator. The increase in temperature significantly enhanced germination and related traits. All the wheat varieties germinated well (80-97%) sown at 10-30^{o}C, whereas, shoot length was maximum in Moomal-2000 and Mehran-89 sown at 20 and 30^{o}C, respectively. Root length, fresh shoot and root weight, root dry weight including seed vigor index were maximum with increasing temperature particularly in case of variety Mehran-89. The maximum seed germination, vigor index occurred at 20-30^{o}C and these temperature regimes were identified as optimum for wheat seed germination.

Key Words: **Wheat, Temperature, Germination, Varieties**

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INTRODUCTION

Seed germination is a factor which contribute yield of the crop. Among the abiotic factors, temperature is considered an important issue for wheat germination, because it persuades the rate of water and additional substrates necessary for growth and development. In Pakistan, it is believed that wheat could be sown during October to December where temperature range between 20-30^{0}C, however, fluctuation in temperature may influence germination of wheat which could be predicted due to genotypic variation. Germination may be dependent on the ability of seed to utilize reserves more efficiently (Rao and Sinha, 1993), by mobilization of seed reserves for germination traits (Penning de Vries *et al.*, 1979). Temperature is a modifying factor in germination since it can influence the rate of water absorption and other substrates supply are necessary for growth and development (Wanjura and Buxtor, 1972; Essemine *et al*., 2002). The rapid and uniform field emergence is essential to achieve better growth and high yield (Parera and Cantliffe, 1994). The optimal temperature favors a good aptitude to germinate, whereas low and high temperature extends delay in germination.

The influence of high temperatures on growth and development of wheat and other crops is well documented (Porter and Gawith, 1999; Wheeler *et al*., 2000). High temperatures damage photosynthetic membranes (thylakoids) and cause chlorophyll loss (Al-Khatib and Paulsen, 1984), decrease leaf photosynthetic rate, increase embryo abortion (Saini *et al*., 1983), lower grain number, and decrease grain filling duration and rates (Wardlaw and Moncur, 1995; Wheeler *et al*. 1996; Ferris *et al*., 1998; Prasad *et al*., 2006) thus resulting in lower grain yield (Wardlaw *et al*., 1989; Stone and Nicolas, 1994; Wheeler *et al*., 1996; Ferris *et al*., 1998; Gibson and Paulsen, 1999). At the molecular level, high temperatures adversely affect cell metabolism (Berry and Björkman, 1980; Levitt, 1980) and cause changes in the pattern of protein synthesis (Lindquist, 1986; Vierling, 1991; Larkindale *et al*., 2005). Supra-optimal temperatures suppress the synthesis of the normal complement of cellular proteins and at the same time induce the synthesis and accumulation of many new proteins including heat shock proteins (Vierling, 1991; Feder and Hofmann, 1999; Law and Brandner, 2001). The minimum and maximum temperatures can effect from seed germination to seed maturation (Lobell and Ortiz-Monasterio, 2007). Khan *et al*., (2007) suggested that in case of wheat varieties genetic variances are of greater magnitude than environmental variances for most of

the traits. This study therefore was set to determine how different temperature regimes affect wheat seed germinating traits and to explore optimum temperature for germinability of different wheat varieties.

MATERIALS AND METHODS

Laboratory experiments were conducted to evaluate the germination traits of various wheat varieties under various temperature regimes at Department of Agronomy, Sindh Agriculture University, Tandojam, Pakistan during 2008. Seeds of five wheat varieties viz. Moomal-2000, T.J-83, Imdad-2005, Abadgar-93 and Mehran-89 were tested under three temperature regimes (10, 20 and 30^{o}C). The treatments were set in randomized complete block design (RCBD) having four replications. A set of fifty randomly selected seeds of each variety were placed in petri dishes having 13.5 cm diameter (25 seeds in each Petri dish) on double layer of Whatman filter paper No.1 and kept in the germinator (Model-PL3) at various temperatures as mentioned above. The seeds were moistened when ever necessary. The germination was recorded after 48 hours. The shoot, root length, including fresh and dry weights were recorded after 7 days. Seed vigor index from same lot was calculated by multiplying germination percentage and seedling length.

Statistical Analysis

The data were statistically analyzed through MSTATC computer software. The LSD values for mean comparison were calculated only if the general treatment *F* test was significant at a probability of 0.05 (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Seed germination and vigorous seedlings are important characteristics for wheat which could provide advantages for crop establishment. In this study, temperature significantly influenced germination and related traits of various wheat varieties. The highest germination (97%) was recorded in Abadgar-93 treated with 30^{o}C, TJ-83 and Imdad-2005 (96%) treated with 10 and 20^{o}C respectively. Values of these treatment combinations were non-significant with each other. The results further revealed lower germination (82 and 80%) in Mehran-89 and TJ-83 treated with 20 and 30^{o}C respectively. In this study, no specific trend of increasing or decreasing was observed in wheat seed germination Table I. This could be predicted due to genetic potentiality of the wheat varieties to withstand the temperature fluctuation. The findings of this study are in agreement with the reports of Khodabandeh (2003) that best and most suitable temperature for wheat seed germination is 20 to 22°C. Al-Qasem *et al*. (1999) reported that no germination occurred at 5^{o}C. Total germination percentage for large seeds was significantly higher than that for small seeds. At 10^{o}C, the cumulative germination percentage was significantly higher in F8 than Hourani-27. At 15^{o}C, no significant differences were found between these two genotypes, but at 20 and 30^{o}C, the cumulative germination percentage tended to be higher for Hourani-27.

Table I ***Germination and seed vigor index of different wheat varieties under the influence of different temperature regimes***

Source of variation		Germination (%)	Shoot length (cm)	Root length (cm)	Seed vigor index
Temperature x varieties					
10^{o}C	Moomal-2000	88.0 cd	6.5 i	5.8 k	571.6 h
	TJ-83	96.0 a	8.4 f	6.3 i	810.2 e
	Imdad-2005	96.0 a	10.5 d	7.3 g	1008.0 c
	Abadgar-93	90.3 bc	7.7 g	6.0 j	701.3 f
	Mehran-89	88.6 cd	10.0 e	7.7 f	923.0 d
20^{o}C	Moomal-2000	92.0 b	14.0 a	9.1 b	1291.3 a
	TJ-83	85.0 e	7.0 h	5.7 k	594.6 gh
	Imdad-2005	96.0 a	8.5 f	6.8 h	816.0 e
	Abadgar-93	86.0 de	11.6 c	8.2 e	1003.3 c
	Mehran-89	80.0 f	7.8 g	6.7 h	624.0 g
30^{o}C	Moomal-2000	90.0 bc	10.5 d	8.1 e	945.3 d
	TJ-83	82.0 f	13.5 b	8.9 c	1107.0 b
	Imdad-2005	87.0 de	7.0 h	6.6 h	609.0 g
	Abadgar-93	97.0 a	11.5 c	8.7 d	1118.3 b
	Mehran-89	92.0 b	14.0 a	9.6 a	1291.3 a
LSD (%)		2.78 4	0.3129	0.175	34.96

In each column, means followed by common letter are not significantly different at 5% probability level.

The increase in temperature, significantly increased the shoot and root length of the seedlings. Maximum shoot length (14 cm) was found in Moomal-2000 and Mehran-89 treated with 20 and 30^{o}C

respectively. With regard to root length, application of 30°C to Mehran-89 significantly increased root length (9.6 cm), followed by, 9.1 cm root length in Moomal-2000 treated with 20°C. Further decrease in temperature regime below 20°C drastically reduced the root length of all the wheat varieties Table I.

Seed vigor index is an indicator of rapid germination and speed of growth. It was superior in seed of Moomal-2000 and Mehran-89 treated with 20-30°C respectively, however decrease in seed vigor index was noted in the lower temperature of 10°C Table I. Sikder and Paul (2010) also reported higher seed vigor index at optimum temperature in wheat.

Raise in temperature increased fresh shoot and root weights of Mehran-89 seedlings (4238 and 362 mg respectively) at 30°C. Further decrease in temperature regimes significantly reduced weight of both the traits in rest of wheat varieties. The shoot dry weight also increased with change in temperature from 10°C to 20 and 30°C and was greater (255 mg) in Abadgar-93; however, Mehran-89 efficiently increased (131 mg) root dry weight at 30°C. Table II. The findings of the present study are supported by Hassan *et al.* (2004) that shoot dry weight of wheat seedling increased with increasing temperature (15-35°C).

Table II ***Fresh shoot, fresh root, shoot dry and root dry weight of different wheat varieties under the influence of different temperature regimes.***

Source of variation		Fresh shoot wt./50 seedlings (mg)	Fresh root wt./50 seedlings (mg)	Shoot dry wt./50 seedlings (mg)	Root dry wt./50 seedlings (mg)
Temperature x varieties					
10°C	Moomal-2000	3032.0 n	279.0 j	198.0 j	96.6 h
	TJ-83	3550.0 g	310.0 f	230.0 f	112.0 ef
	Imdad-2005	3750.0 c	330.0 c	225.0 g	115.0 cd
	Abadgar-93	3140.0 m	288.0 i	197.3 j	97.0 h
	Mehran-89	3580.3 f	305.0 g	248.6 b	107.0 g
20°C	Moomal-2000	3695.0 d	325.0 d	218.3 h	118.0 c
	TJ-83	3010.0 o	277.3 j	185.3 k	97.0 h
	Imdad-2005	3440.3 h	317.3 e	241.3 d	115.3 cd
	Abadgar-93	4186.0 b	340.0 b	255.0 a	124.0 b
	Mehran-89	3180.0 k	301.0 h	201.0 i	97.3 h
30°C	Moomal-2000	3301.0 j	311.6 f	238.0 e	110.3 f
	TJ-83	3415.0 i	315.3 e	197.6j	117.0 cd
	Imdad-2005	3166.0 l	289.6 i	199.0 ij	96.0 h
	Abadgar-93	3679.0 e	330.0 c	255.0 a	114.6 de
	Mehran-89	4238.0 a	362.0 a	245.3 c	131.0 a
LSD (%)		0.6968	0.764	0.7600	0.91716

In each column, means followed by common letter are not significantly different at 5% probability level.

In this study, wheat varieties differed significantly for germination and related traits. Robert *et al*. (2008) also reported varietal differences for vigor and germination traits. Mahan *et al.* (1995) observed that thermal stress influence morphology and physiology of the root system which may influence water movement through the plant. 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 (Hay and Walker, 1989). Nyachiro *et al*. (2002) reported that most genotypes recorded higher germination as temperature increased from 10 to 30°C. Our findings are in agreement with the above statement, whereas the differences in seed germination percentage at 10°C and 30°C may be due to genetic variation. Rawson (1986) demonstrated some of the genetic variation in heat tolerance that exists between wheat genotypes. Paulsen (1994) was also of the opinion that when assessing genotypic differences in tolerance to temperature stress, consideration must be given to the duration of the heat stress and the criteria used for evaluating tolerance.

In this study, correlation analysis showed positive relationship between germination and its related traits. The increase in seedling shoot length increased root length (r=0.95). The fresh root weight had positive relation with fresh shoot weight (r=0.94), root dry weight with root fresh weight (r=0.94), shoot length with seed vigor index (r=0.97) and germination with seed vigor index (r=0.34).

CONCLUSION AND RECOMMENDATIONS

Regarding temperature effects on seed germination and related traits, the seeds of Moomal-2000 and Mehran-89 supplied with 20 or 30^{o}C responded well for germination, seed vigor index, shoot and root length, fresh and dry weight.

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