



Seed Size Variation and Its Effect on Seed Germination and Growth Rate in Poaceae

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ABSTRACT

The Poaceae is one of the important families consisting of 10,000 species. The species belonging to the family found everywhere in the world. Most of the cereal grains belonging to the Poaceae include *Triticum aestivum* L. (Wheat), *Zea mays* L. (Maize), *Hordeum vulgare* L. (Barley), *Secale cereals* L.(Rye), *Pennisetum glaucum* L. and *Setaria italica* L.etc .The seeds of the family have great variation in their seed mass and size, considered one of the important factor affecting germination percentage and production rate. In most of the seeds the germination percentage is higher in larger seeds than that of smaller seeds. Environmental factor also influence the germination of seeds that are light, temperature and moisture. The larger seeds are resistant to harsh environmental condition and survive their best. The seeds of *Zea mays* L. germinated when imbibed at constant temperature of 15°C with 21% germination but maximum germination at 20°C and 25°C are 24%.The seeds of *Triticum aestivum* L. germinated with maximum germination of 25% at three different temperatures with highest germination rate but seeds of *Hordeum vulgare* L. at 15°C and 25°C results 25% but 24% germination at 20°C.The seeds of *Setaria italica* L. with minimum germination rate of 6% at 15°C and 20°C where as 10% germination at 25°C.The seeds of *Pennisetum glaucum* L. at 15°C and 25°C with 25% germination but lowest germination of 24% at 20°C.The seeds of *Secale cereals* L. germinated with 22% germination at 15°C but 21% germination at 20°C where as maximum germination at 25°C is 25%. It was finalized that high temperature affects the germination % age as well as germination rate in several large seeds of cereal crops.

Keywords: Seed Size Variation, Seed Germination, *Triticum aestivum*, *Zea mays*, *Hordeum vulgare*, *Secale cereals*, *Pennisetum glaucum*, *Setaria italica*.

INTRODUCTION

Seed size is an essential part of plant life¹⁻⁴, and its significance to plant growth and fitness strategy are extensively appreciated.⁵⁻⁹ Selection of the seeds on the basis of the number of important characters that it possesses greatly increases the yield of crops such as 50% in wheat.¹⁰

Cereal grains are significant source of nitrogen as well as proteins, it confines the needs of fertilizer or not required for some soil particularly, the Mash bean possess these qualities.¹¹ Most of the cereal cash crops belong to the family Poaceae economically beneficial for the country. Some of the dominant crops are wheat, maize, barley, sorghum, sugarcane, rye and grains. These found everywhere in the world.

The family has 10,000 different species differ in their shape and size.¹² It consists of 650 to 765 genera.^{13,14}

The various breeds belonging to the family are significant source of food for human and fauna of the world. The unipalynous grains are character of Poaceae family. There different grain morphology help in identification from other cereal grains.¹⁵ Researchers claim that certain biotic and abiotic factors are responsible for the development of plant species. The proliferation rate

maturation and viability greatly affected due to kernel mass where as in three categories of seeds liberal, intermediate and little.¹⁶ It has been reported that a study was conducted on the current knowledge of cactus grain formation .The general characters of plant such as phenotype (general Appearance), morphology (shape, size form, color) seed function, formation, sleeping period as well as, grain dispersal and storage of seed are included.¹⁷ As it has been observed much of research work applied to the food purposes as well as medicinal values and other significant features like morphology and ecological factors are unknown as for the family.

Different species of the family found in Balochistan, Pakistan which are cultivated due to food purposes. Certain abiotic factors influence germination but very little knowledge on these aspects.

MATERIALS AND METHODS

The seeds of different cereal crops like *Triticum aestivum* L. (Wheat), *Zea mays* L. (Maize), *Hordeum vulgare* L. (Barley), *Secale cereals* L.(Rye), *Pennisetum glaucum* L. and *Setaria italica* L. The seeds were obtained from seed certification Department Quetta, Pakistan. Their average germination rate at three different temperatures i.e. 15°C, 20°C and 25°C, were determined by using Germinator chamber.



Germination of Seeds

The germination tests were performed with 5 replicates of 20 seeds per Petri dish of 9 cm diameter. Each Petri dish was lined with two layers of filter paper and moistened with 8 ml of distilled water. The criterion of seed germination was visible radical protrusion.¹⁸ T50 was used to determine the speed of germination, T50 is the number of days to germination of 50% of all germinated seeds and its value is calculated by linear interpolation from the two germination values closest to median germination.¹⁹ Standard error (SE \pm) was calculated by using SPSS ver. 11.5 (SPSS Inc., USA).

Effect of Temperature on Germination of Seeds

The temperature one of the important ecological factor greatly affects the germination of seeds. The seeds placed in Petri dishes were placed at different temperature in a growth chamber model R1-201 H germinator for viability. The temperature of germinator set at 15°C for one week for all six seed samples then set at 20°C for one week for all seed samples and finally at 25°C for one week for all seeds to observe influence of germination of seed with temperature factors.

Statically analysis was performed by ANOVA. (One of the ways for variance analysis)

RESULTS AND DISCUSSION

Seed Germination of *Triticum aestivum* L. (Wheat) at 15°C, 20°C and 25°C

The seeds of Wheat were imbibed at 15°C, 20°C and 25°C, under white light conditions. The germination started on second day under 15°C, while under 20°C delayed on one day and where the germination was observed under 25°C at second day Fig(1).The rate of Germination was faster under 25°C, while moderate at 20°C, However the rate of germination was slower under 15°C Fig(1).The final germination was (25 % \pm 14.43376) under 25°C and (25 % \pm 14.43376) under 20°C, while under 15°C final germination was observed (25 % \pm 14.43376), Table (2).

The time course of seed germination of Wheat shows that optimum temperature of 25°C plays important role in the enhancement of germination as well as rate of germination. The germination is not suppressed under low temperature while temperature of 15°C was proved to limit the germination as well as rate of germination.

Seed germination of *Hordeum vulgare* L. (Barley) at 15°C, 20°C and 25°C

The seeds of Barley were imbibed at 15°C, 20°C and 25°C, under white light conditions. The germination started on second day under 15°C, while under 20°C delayed on one day and where the germination was observed under 25°C at first day Fig (72). The rate of germination was faster under 25°C,while moderate at 20°C,However the rate of germination was slower under 15°C Fig (2). The final germination was (25% \pm 14.43376) under 25°C and (24 %

\pm 13.85641) under 20°C, while under 15°C final germination was observed (25 % \pm 14.43376). Table (2)

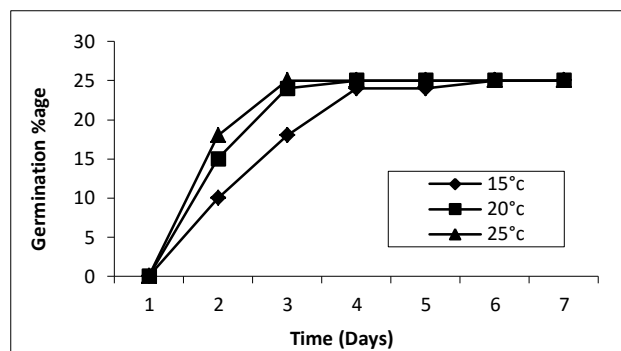


Figure 1: Time course of seed germination of *Triticum aestivum* L. at 15°C, 20°C and 25°C temperatures.

The time course of seed germination of Barley showed that optimum temperature of 25°C plays important role in the enhancement of germination as well as rate of germination. The germination is not suppressed under low temperature while temperature of 15°C was proved to limit the germination as well as rate of germination.

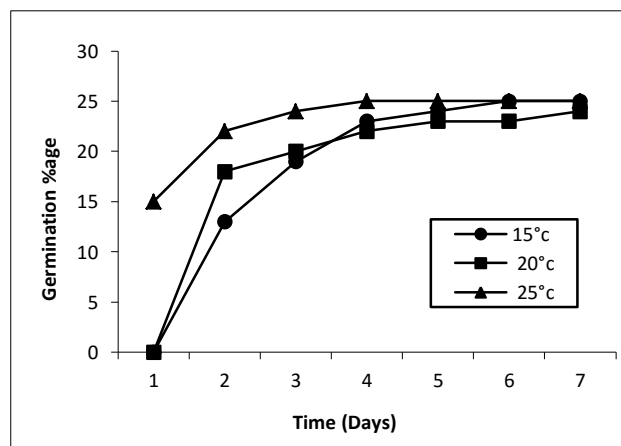


Figure 2: Time course of seed germination of *Hordeum vulgare* L. at 15°C, 20°C and 25°C temperatures.

Seed germination of *Zea mays* L. (Maize) at 15°C, 20°C and 25°C

The seeds of *Zea mays* were imbibed at 15°C, 20°C and 25°C, under white light conditions. The germination started on fourth day under 15°C, while under 20°C delayed on three day and where the germination was observed under 25°C at second day Fig (3). The rate of germination was faster under 25°C, while moderate at 20°C, However the rate of germination was slower under 15°C Fig (3). The final germination was (24% \pm 13.85641) under 25°C and (24% \pm 13.85641) under 20°C, while under 15°C final germination was observed (21% \pm 12.12436) Table (2).

The time course of seed germination of *Zea mays* showed that optimum temperature of 25°C plays important role in the enhancement of germination as well as rate of germination. The germination is not suppressed under low temperature while temperature of 15°C was proved to limit the germination as well as rate of germination.

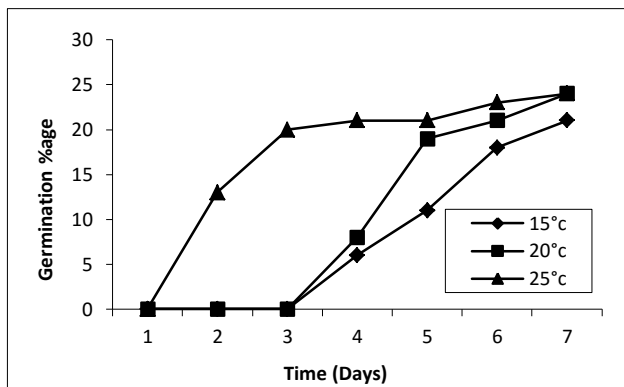


Figure 3: Time course of seed germination of *Zea mays* L. at 15°C, 20°C and 25°C temperatures

Seed germination of *Setaria italic* L. (*Setaria*) at 15°C, 20°C and 25°C

The seeds of *Setaria* were imbibed at 15°C, 20°C and 25°C, under white light conditions. The germination started on Fourth day under 15°C, while under 20°C delayed on one day and where the germination was observed under 25°C at second day Fig (4). The rate of germination was faster under 25°C, while moderate at 20°C, However the rate of germination was slower under 15°C Fig (4). The final germination was (10% ± 5.773503) under 25°C and (6 % ± 3.464102) under 20°C, while under 15°C final germination was observed (6 % ± 3.464102) (Table 2).

The time course of seed germination of *Setaria* showed that optimum temperature of 25°C plays important role in the enhancement of germination as well as rate of germination. The germination is not suppressed under low temperature while temperature of 15°C was proved to limit the germination as well as rate of germination.

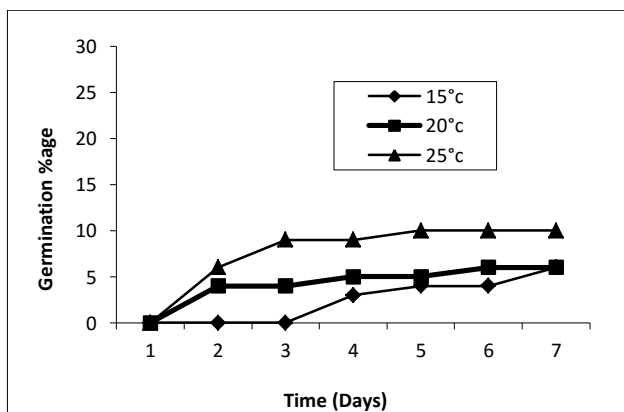


Figure 4: Time course of seed germination of *Setaria italic* L. at 15°C, 20°C and 25°C temperatures

Seed germination of *Secale cereals* L. (*Rye*) at 15°C, 20°C and 25°C

The seeds of Rye were imbibed at 15°C, 20°C and 25°C, under white light conditions. The germination started on third day under 15°C, while fewer than 20°C delayed on one day and where the germination was observed under 25°C at second day. Fig (5). The rate of germination was faster under 25°C, while moderate at 20°C, However the

rate of germination was slower under 15°C Fig (5). The final germination was (24 % ± 13.85641) under 25°C and (21 % ± 12.12436) under 20°C, while under 15°C final germination was observed (22% ± 12.70171) Table (2).

The time course of seed germination of Rye showed that optimum temperature of 25°C plays important role in the enhancement of germination as well as rate of germination. The germination is not suppressed under low temperature while temperature of 15°C was proved to limit the germination as well as rate of germination.

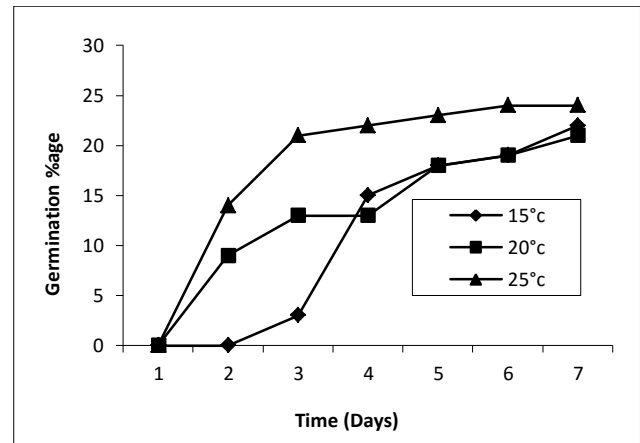


Figure 5: Time course of seed germination of *Secale cereals* L. at 15°C, 20°C and 25°C temperatures.

Seed germination of *Pennisetum glaucum* L. (*Pennisetum*) at 15°C, 20°C and 25°C

The seeds of *Pennisetum* were imbibed at 15°C, 20°C and 25°C, under white light conditions. The germination started on Fourth day under 15°C, while fewer than 20°C delayed on one day and where the germination was observed under 25°C at second day. Fig (6). The rate of germination was faster under 25°C, while moderate at 20°C, However the rate of germination was slower under 15°C (Fig 6). The final germination was (25 % ± 14.43376) under 25°C and (24 % ± 13.85641) under 20°C, while under 15°C final germination was observed (25 % ± 14.43376). Table (2).

The time course of seed germination of *Pennisetum* showed that optimum temperature of 25°C plays important role in the enhancement of germination as well as rate of germination. The germination is not suppressed under low temperature while temperature of 15°C was proved to limit the germination as well as rate of germination.

The most of the important cereal grains belongs to the family poaceae are important source of food for the human beings as well as animal. The production of the yield greatly depends on biotic and abiotic factors. Variation in seed size, weight clearly influences germination in poaceae. Large size seed and heavy seeds germinate early and achieve greater germination percentage than small seeds in laboratory trial. Greater stocks of food and energy in heavy than small or intermediate weight seeds provide readily available

energy to stimulate germination.²⁰ The seeds of the six plants belonging to poaceae which were different in size and mass were subjected to a variety of temperature condition to determine their percentage germination as well as germination rate.

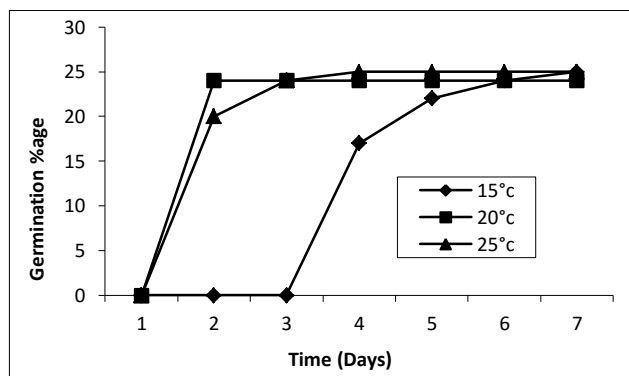


Figure 6: Time course of seed germination of *Pennisetum glaucum* L. at 15°C, 20°C and 25°C temperatures.

Table 1: Anova Table for seed germination at 0.05 level of significance

ANOVA Table for seed germination at 0.05 level of significance.				
Source of variation	D.F	sum of square (SS)	Mean square (MS)	computed F
1 Triticum aestivum				
Group SS	2	22.5714	11.2857	
Error SS	18	1626.5715	90.365	0.1248
2 Hordeum vulgare				
Group SS	2	94.5714	47.2857	
Error SS	18	1017.4286	56.5238	0.8365
3 Zea mays				
Group SS	2	338.6667	169.3333	
Error SS	18	4569.4286	253.8571	0.667
4 Setaria italic				
Group SS	2	100.6666	50.3333	
Error SS	18	142.5715	7.9206	6.3547
5 Secale cereals				
Group SS	2	194.3809	97.1904	
Error SS	18	1326.8572	73.7142	1.3184
6 Pennisetum glaucum				
Group SS	2	298.6667	149.3333	
Error SS	18	1875.1429	104.1746	1.4334

Table 2: Mean values seed germination % of six species of Poaceae at different temperatures.

Species Name	15°C	20°C	25°C
<i>Triticum aestivum</i> L.	25%±14.43376 {5}	25%±14.43376 {4.4118}	25%±14.43376 {3.125}
<i>Hordeum vulgare</i> L.	25%±14.43376 {7.5}	24%±13.85641 {5.4}	25%±14.43376 {3.9063}
<i>Zea mays</i> L.	21%±12.12436 {7.7}	24%±13.85641 {5.739}	24%±13.85641 {7.2}
<i>Setaria italic</i> L.	6%±3.464102 {4.125}	6%±3.464102 {4}	10%±5.773503 {4.3}
<i>Secale cereals</i> L.	22%±12.70171 {6.1111}	21%±12.12436 {6.3}	24%±13.85641 {6}
<i>Pennisetum glaucum</i> L.	25%±14.43376 {6.5476}	24%±13.85641 {2.7692}	25%±14.43376 {3.4090}

S.E ± the values in parenthesis are the T_{50} for respective temperatures and germination % age.

The temperature is one the important abiotic factor that greatly influences the seed germination and rate. It also has been proposed that the size of certain oat seed

species greatly matter for their percentage yield and germination.²¹ When the seed of *Triticum aestivum* L. imbibed at constant temperature of 15°C, 20°C, and 25°C show a maximum germination of 25% than the seed of *setaria italic* L. with 6% germination at three different temperatures. The role of temperature on the germination % age and rate along with seed mass has also been reported.²² The seed of *Hordeum vulgare* L. at varying temperature of 15°C, 20°C, and 25°C show a 2% germination percentage where as the seed of *Pennisetum glaucum* L. at constant temperature showed 24% germination.

The seeds of *Zea mays* L. at constant temperature of 15°C, 20°C, and 25°C show a maximum germination of 24% then the seed of *Secale cereals* L. at same temperature but with 21% germination.

Great variation in germination percentage of the seeds belonging to the same family observed at three varying temperature. Furthermore, the seed size and mass are one of the important characters influencing the germination percentage and rate the selection of the seed on the basis of above feature enhance the germination.²³

Quercus semiserrata Roxb results between 90% and 28% light did not vary significantly. An interaction of seed weight, microsite and light appears to lay optimal conditions for seed germination and early seedling growth.²⁴

The same fact was observed in different species of lentils having 2 different categories on the basis of weight.²⁵

The test statistic ANOVA was applied to determine positive effects of seed mass and size on germination rate and % age of six cereal grains of the same family. The results obtained are significant for all species except *setaria italic* L. Table (1).

CONCLUSION

The most of the cereal grains belonging to family Poaceae vary in that seed mass and size which greatly influence the percentage germination and rate. The size and mass of seed are one of the characteristic features which influence the germination percentage and rate of the grains. Certain environmental factors like temperature, light, and moisture play a structural role in promoting seed germination. The difference in seed mass and size play an important role as ecological factors in maintaining species in changing environment.

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