

## Research Article

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# Thermal treatments for enhancing the dormancy of cotton (*Gossypium*) seed

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### Abstract

Cotton like other seeds has a hard and impermeable coat, which therefore makes it necessary to understand its nature to germinate under favorable conditions. This study keeping the importance in view was carried out to assess the effect of thermal treatments on dormancy of cotton (*Gossypium*) seed at Department of Farm Structures, Sindh Agriculture University, Tandojam. Selected seeds obtained from Latif Experimental Farm were treated with tap water and by immersing them in hot water of 70 and 80°C at three different durations *i.e.* of 5, 10 and 15 minutes. The experimental design was subjected to complete randomized design, replicated thrice. The results revealed that cotton seeds when immersed at 70°C for 10 minutes provided better results with maximum values of 75%, 10.71% and 3.38 for germination percentage, germination rate and seed vigour index, and least values for mortality. The results were statistically significant ( $p \leq 0.05$ ) for germination percentage, seed vigour index, dormancy and mortality, whereas germination rate was found to be non-significant. It was also observed that the seeds were very sensitive at high temperature which after treatment rotted and succumbed. Thermal treatment at a temperature of 70°C for 10 minutes based on above study is strongly recommended to be adopted at farm level.

**Keywords:** Cotton seed; Germination; Growth parameter; Seed dormancy; Thermal treatment

### Introduction

Cotton (*Gossypium*) is an important cash crop and source of raw material for the textile industries and foreign exchange of Pakistan [1]. Pakistan for cotton is ranked as 4th largest consumer and 3rd to export [2]. Cotton in Pakistan is grown by almost 26% of farmers. Its contribution to agriculture and GDP accounts for 8.2% and 2% respectively. It is considered to be the

oldest seed known, which is being cultivated since 3500 BC in Indus Valley [3]. Cotton worldwide is a source of income to more than 250 million peoples [4]. It is being produced in 70 countries of World, where the countries including China, US, Pakistan and India contributes two third of it [5]. Cotton as a major export material earning sizable foreign exchange is reducing its yield due to many factors,

including a major attack of pathogens which are now controlled by defensive genes [6].

Seed dormancy is the nature's way of setting time which allows it to germinate when conditions are favourable [7]. It's an innate property of seeds that determines the environmental conditions in which seeds can germinate, while viable seeds that do not germinate are called dormant [8]. The seed dormancy is referred as the resting stage of an embryo with low germination of viable and freshly harvested grains. This mechanism is important for seed survival, especially in harsh environmental conditions [9]. Seed dormancy according to Copeland [10], is a genetically inherited trait whose intensity is modified by the environment during seed development. Black and Halmer [11] reported that dormancy is a mechanism used by plants to prevent germination during unfavorable conditions that is when the probability of seedling survival is very low.

Many methods and mathematical expressions have been proposed or discussed to enhance the germination process [12]. Dormancy can be a barrier to germination of an intact viable seed under favourable condition [13]. A dormant seed in a specified duration isn't capable to germinate under any environmental condition, which otherwise is favourable

for germination until the seed becomes non-dormant [7]. Immersing seed in boiling water was an effective way to enhance the dormancy of seed, which was caused due to its water-impermeable seed coat [14, 15]. Dormancy with age decreases its viability, where the common problems related with its conventional propagation through seeds is considered to be low germination [16, 17]. Along with water availability, temperature is also an important environmental factor in determining the possibility of seed germination [18]. Hard impermeable testa in seeds prevents imbibition of water and germination [19, 20], for which they require treatments before sowing to obtain rapid germination [21, 22]. Keeping the above facts in view, the current study was proposed to investigate the effect of different hot water treatments on dormancy of cotton (*Gossypium*) seed.

#### Material and methods

A laboratory experiment observing the influence of different hot water treatments on cotton seed was carried out at the Department of Farm Structures, Faculty of Agricultural Engineering, Sindh Agriculture University, Tandojam. Cotton seeds collected from Latif Experimental Farm were cleaned and then graded for experimentation under different treatments (Table 1).

**Table 1. Thermal treatments**

Symbol	Treatment
T <sub>1</sub>	Soaking in tap water for 5 min
T <sub>2</sub>	Soaking in tap water for 10 min
T <sub>3</sub>	Soaking in tap water for 15 min
T <sub>4</sub>	Soaking in hot water at 70°C for 5 min
T <sub>5</sub>	Soaking in hot water at 70°C for 10 min
T <sub>6</sub>	Soaking in hot water at 70°C for 15 min
T <sub>7</sub>	Soaking in hot water at 80°C for 5 min
T <sub>8</sub>	Soaking in hot water at 80°C for 10 min
T <sub>9</sub>	Soaking in hot water at 80°C for 15 min

### Germination test

Seed breaking dormancy method as described by Al-Fredan and Ali [23] was adopted for experimentation. The seeds were immersed in boiling water of 70 and 80 °C, which then were allowed to boil at three different duration *i.e.* 5, 10 and 15 minutes. The sterilized petri-dishes were prepared keeping a piece of 8 cm tissue paper with no gap between them. Dishes after preparing were labelled as per adoption of treatments (Table 1), placing twenty randomly selected seeds in each petri-dish.

### Germination percentage (GP)

Germination percentage is the ratio of germinated seeds to total number of seeds kept in petri-dish. Similar method has also been used by Asl *et al.* [24],

$$GP = \frac{\text{Total seed germinated}}{\text{Total number of seedssown}} \times 100$$

### Germination rate

It is defined as the number of seeds germinated in unit time. Germination rate was calculated according to the formula described by Asl *et al.* [24],

$$GR = \sum \frac{S_i}{D_i}$$

### Seed vigour index (SVI)

This is calculated by determining the germination percentage and seedling length of the same seed lot. The seed lot showing the higher seed vigour index is considered

to be more vigorous. The seedling vigour index (SVI) was calculated using following formulae [25],

$$SVI = \text{Seedling length (cm)} \times \text{Germinated percentage} / 100$$

### Dormancy (%)

Dormancy is the ratio of number of germinated but viable seeds to total number of seeds initiated [26],

$$\text{Dormancy} = \text{Number of germinated but viable seeds} / \text{Number of seeds initiated} \times 100$$

### Mortality (%)

Mortality is the ratio of number of unviable seeds to total number of seeds initiated. It was calculated using following formulae [26],

$$\text{Mortality} = \text{Number of unviable seeds} / \text{Number of seeds initiated} \times 100$$

### Statistical analysis

The experimental design was laid out as complete randomized design (CRD). Statistix software (Ver. 8.1) was used for analysis of variance and the data was analyzed at a significant level of  $p \leq 0.05$ .

### Results and discussion

The analysis of variance as affected by different thermal treatments is presented in (Table 2). The study revealed significant differences ( $p \leq 0.05$ ) for germination percentage, seed vigour index, dormancy and mortality, whereas the germination rate was found to be non-significant.

**Table 2. Analysis of variance as affected by different treatments**

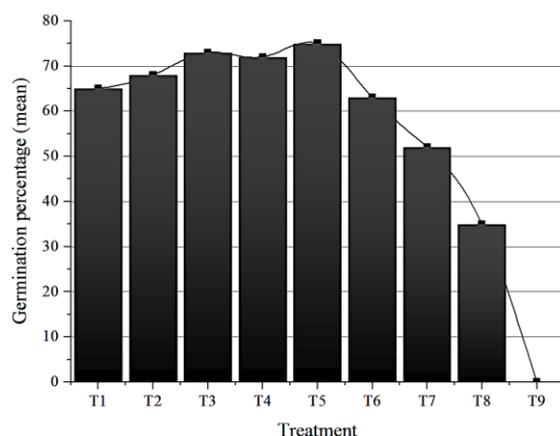
Source	Sum of Squares	Mean Square	F Value	P Value
GP	11653.55556	11653.55556	38.58084	0.0000 **
GR	40.23045	40.23045	4.08017	0.06046 <sup>NS</sup>
SVI	30.91601	30.91601	6.41768	0.0221 **
Dormancy	1605.55556	1605.55556	21.42725	0.0000 **
Mortality	1073.38889	1073.38889	10.39462	0.0053 **

Note: \*\* represents significant and <sup>NS</sup> represents non-significant at  $p \leq 0.05$

### Mean germination percentage of cotton seed

Mean Germination percentage of cotton seed with different hot water treatments is shown in figure 1. The mean germination with tap water for 5, 10 and 15 minutes was observed to be 65%, 68% and 73% respectively, for hot water at 70°C for 5, 10 and 15 minutes the germination percentage of cotton seed was found to be 72%, 75% and 63% respectively and for hot water at

80°C for 5, 10 and 15 minutes the germination percentage of cotton seed was observed to be 52%, 35% and 0% respectively. The results showed that the mean germination percentage was observed higher when cotton seed was treated at 70°C for 10 min, and resulted less when treated in hot water at 80°C for 15 min. The results are in line with Kebreab and Murdoch [27] and Bewley et al. [18], whom also reported that seed germination was higher when treated with hot water.



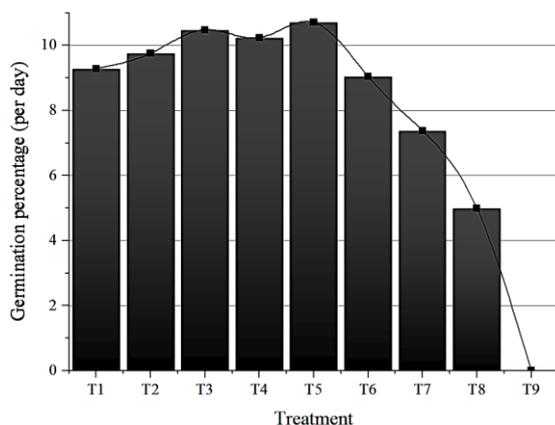
**Figure 1. Mean Germination Percentage of Cotton seeds at different hot water treatments**

### Mean germination rate of cotton seed

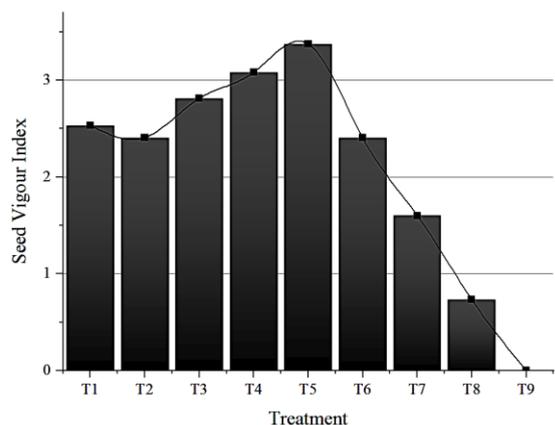
Mean Germination rate of cotton seed with different treatments is shown in figure 2. The mean germination rate with tap water for 5, 10 and 15 minutes was observed to be 9.29, 9.76 and 10.48% respectively, for hot water at 70°C for 5, 10 and 15 minutes the germination rate of cotton seed was found to be 10.24, 10.71 and 9.05% respectively and for hot water when treated at 80°C for 5, 10 and 15 minutes the germination rate of cotton seed was found to be 7.38, 5 and 0% respectively. Mean germination percentage was observed to be higher (10.71%) when treated at 70°C for 10 min, and less (0%) when treated in hot water at 80°C for 15 min. The results are in line with Tung and Serrano [9] and Nega et al. [28], whom with hot water treatment observed better results for rice seed and carrot.

### Seed Vigour Index (SVI) of cotton seed

Seed vigour index (SVI) of cotton seed with different treatments is shown in figure 3. The SVI with tap water for 5, 10 and 15 minutes was observed to be 2.54, 2.41 and 2.81 respectively, for hot water at 70°C for 5, 10 and 15 minutes the SVI of cotton seed was observed to be 3.08, 3.38 and 2.41 respectively and for hot water treated at 80°C for 5, 10 and 15 minutes the SVI of cotton seed was recorded to be 1.60, 0.74 and 0 respectively. The results showed that the SVI was higher when the seed was treated at 70°C for 10 min, and resulted less when treated in hot water at 80°C for 15 min. Similar variation in results has been observed by Buriro et al. [29], they reported that SVI of rice seed was greater with 317.57, which then decreased with increasing temperature. Similar findings has also been reported for Cassia fistula seeds by Babeley and Kandyia [30].



**Figure 2. Mean germination rate (%) per day of Cotton seeds at different hot water treatments**



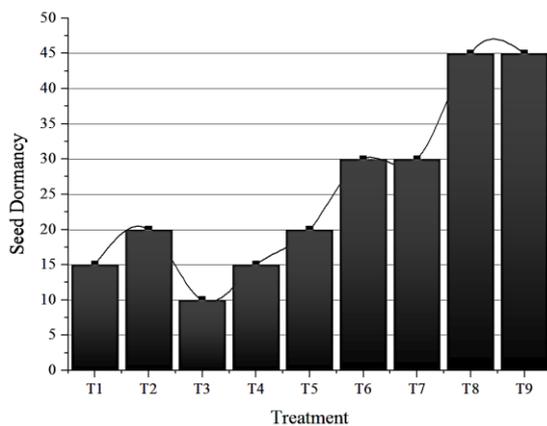
**Figure 3. Seed Vigour Index (SVI) of Cotton seeds at different hot water treatments**

#### **Dormancy (%) of cotton seed**

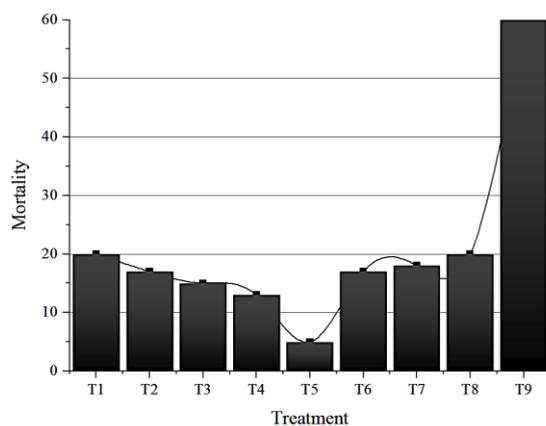
Dormancy of cotton seed with different treatments is shown in figure 4. The dormancy with tap water for 5, 10 and 15 minutes was observed to be 15, 20 and 10 % respectively, for hot water at 70°C for 5, 10 and 15 minutes the dormancy of cotton seed was found to be 15, 20 and 30% respectively and for hot water at 80°C for 5, 10 and 15 minutes the dormancy of cotton seed was recorded to be 30, 45 and 45% respectively. Similar increase of dormancy with increasing temperature has also been reported by the findings of Soliman and Abbas [31] and Karaboon et al. [32].

#### **Mortality of cotton seed**

Mortality of cotton seed with different treatments is shown in figure 5. The mortality with tap water for 5, 10 and 15 minutes was observed to be 20, 17 and 15% respectively, for hot water at 70°C for 5, 10 and 15 minutes the mortality of cotton seed was observed to be 13, 5 and 17% respectively and for hot water at 80°C for 5, 10 and 15 minutes the mortality of cotton seed was recorded to be 18, 20 and 60% respectively. The results are in line with those of Ren and Tao [26], they reported that mortality for seed when treated with hot water was observed to be greater than that of abrasion.



**Figure 4. Dormancy (%) of Cotton seeds at different hot water treatments**



**Figure 5. Mortality (%) of Cotton seeds at different hot water treatments**

### Conclusion

The results concluded that the germination response of cotton was significantly affected ( $p \leq 0.05$ ) by pre-sowing thermal treatments. Germination results of cotton seeds was better observed when treated at 70°C for 10 min. Seed when treated at high temperature rotted and succumbed, indicating that they were very sensitive. The current study strongly suggests the adoption of this thermal treatment (70 °C for 10 min) at farm level to overcome the problems of low germinations.

### Authors' contributions

Conceived and designed the experiments: ZA Khan & KA Ibupoto, Performed the experiments: ZA Khan & LA Jafferi, Analysed the data: SH Chattha & I Arshad, Contributed reagents/ materials/ analysis

tools: ZA Khan, SH Chattha, SA Soomro & LA Jafferi, Wrote the paper: ZA Khan & SA Soomro.

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