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Full Length Research Paper

The effects of different treatments on seed germination of the *Cassia fistula* L. and *Cassia nodosa* Buch.-Ham. ex Roxb. in Kuwait

H. S. Al-Menaie*, O. Al-Ragam, A. Al-Shatti, M. Mathew and N. Suresh

Arid Land Agriculture and Greenery Department, Kuwait Institute for Scientific Research, P. O. Box 24885, Safat 13109, Kuwait.

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Most of the trees introduced for the development of landscape agriculture in Kuwait are meant only for foliage and greenery purpose. Therefore, the study was initiated to introduce flowering trees of the genus cassia (*Cassia fistula* L. and *Cassia nodosa* Buch-Ham. ex Roxb.) to the landscape architecture of Kuwait and to break their seed dormancy. Three experiments were conducted on both species to determine the effect of various treatments such as surface sterilization, mechanical scarification, hot water, sulfuric acid, water soaking, growth regulators and acid scarification on seed germination. In all the experiments, daily observations were recorded for two months after sowing. For experiment 1, mechanical scarification resulted in better germination for heavy seeds of *C. nodosa* compared to unscarified seeds. For *C. fistula*, treatment T6 (HSH) was the best in germination (85%). Regarding experiment 2, T8 showed the highest germination ratio (18%) followed by T9 and T12 for *C. nodosa*. In *C. fistula* T18 was the best method for high germination (84%) followed by T16 with germination of 34%. In experiment 3, 20% germination was observed in T3 and T7 for *C. nodosa* followed by T1 with a germination of 17%. For *C. fistula* highest germination (83%) was observed in T11 followed by T12 with germination of 77%.The study proved that seed treatments are necessary to overcome dormancy in cassia seeds. However, further experiments should also be conducted to draw a satisfactory conclusion regarding seed germination of *C. nodosa* and *C. fistula* since germination is influenced by various factors.

Key words: *Cassia*, dormancy, seed germination, surface sterilization, mechanical scarification, hot water, sulfuric acid, water soaking, growth regulators, acid scarification.

INTRODUCTION

Kuwait Institute for Scientific Research (KISR) has developed a comprehensive plant introduction plan for Kuwait (KISR, 1996) and afforestation in Kuwait is carried out regardless of the harsh environmental conditions like severe drought, scarcity of water and less fertile soils. For the success of ornamental plant introduction in Kuwait, it is important to select plants that have the ability to adapt to harsh arid conditions. Most of the introduced trees that are presently adorning the skyline of Kuwait are for foliage and greenery purpose only. Therefore, introducing flowering trees is the obvious way to break the dormancy of the urban landscape by adding ornamental value while also diversifying the available greenery pallet. Several ornamental trees are being evaluated for their susceptibility to the harsh environmental conditions. Pink shower or *Cassia nodosa* Buch.-Ham. ex Roxb. and *golden shower* (*Cassia fistula* L.) or golden shower are two flowering trees from genus cassia which are well known mainly for their landscaping attributes. Cassias are ornamental plants of great beauty. *C. fistula* is a medium-sized multipurpose deciduous tree species, which can grow on poor shallow to fairly good soil (Luna, 1996). This is a fine flowering tree which is moderately drought and salt tolerant and widely

*Corresponding author. E-mail: hmanaie@safat.kisr.edu.kw. Tel: (+965) 24989806. Fax: (+965) 24989809.

grown as an ornamental tree in tropical and subtropical areas of the world. In a study to evaluate a large number of ornamental plants, it was found to be tolerant to hard climates of the summer in Kuwait (Bhat and Al-Menaie, 1999). Its flowers are pleasantly fragrant also. *Cassia nodosa* or pink shower is also a dense flowering deciduous ornamental tree. Both trees are well known mainly for their landscaping attributes, tolerance to drought conditions and low maintenance requirements (Ghouse et al., 1980). These characteristics make them a very suitable candidate for Kuwait and attempts have been made to introduce these trees to Kuwait conditions (Al-Menaie, 2008). However introduction of any plant into a new region requires thorough study with respect to its germinability and growth requirements.

Cassia seeds which belong to the family Leguminosae usually exhibit seed coat imposed dormancy which may be due to impermeability of testa to water (Rolston, 1978). The most common cause of delay in seed germination is the blocking of water entry into the seed (Cavanagh, 1980). For germination to start, the impermeable seed coat must be rendered permeable. Hence pre-sowing treatment of cassia seeds was deemed necessary and need definite treatments for breaking seed dormancy (Nalawadi et al., 1977; Ramamoorthy et al., 2005). Therefore, in the present investigation, three experiments were conducted at KISR for *C. nodosa* and *C. fistula* seeds with a view to determine treatments that promote maximum germination and produce superior quality seedlings. The objective of the study was to establish changes if any, occurring in the seed coat which increase seed coat permeability and ensure availability of moisture in the embryo to trigger the process of germination.

MATERIALS AND METHODS

Experiment 1 - Effect of surface sterilization, mechanical scarification and hot water treatment on germination

Mature dry seeds of *C. nodosa* and *C. fistula* were extracted from pods collected from Egypt and individual seed was weighed. Seeds having a weight $\leq$ 0.15 g were denoted as light seeds and >0.15 - 0.35 g were denoted as heavy seeds. To control fungal infection during germination, seeds were surface sterilized in 20% chlorox for ten minutes. The treatments included mechanical scarification and hot water treatment of light and heavy seeds of both *C. nodosa* and *C. fistula*. There were 8 treatments with 20 seeds/ treatment for each species. Each treatment includes 5 replications with 4 seeds/ replication. Forty (40) seeds each of light and heavy seeds were scarified using sandpaper (mechanical scarification) and the remaining 40 seeds were kept unscarified. Twenty seeds each from the mechanical scarified and unscarified seeds were treated with hot water at 65°C for five minutes and the remaining half of the seeds were soaked in distilled water. The treatments were denoted as follows:

T1 Light Mechanical Scarified Distilled Water (LSD)
T2 Light Unscarified Distilled Water (LUD)
T3 Light Unscarified Hot Water (LUH)
T4 Light Mechanical Scarified Hot Water (LSH)
T5 Heavy Unscarified Hot Water (HUH)
T6 Heavy Mechanical Scarified Hot Water (HSH)
T7 Heavy Mechanical Scarified Distilled Water (HSD)
T8 Heavy Unscarified Distilled Water (HUD)

The beakers with the treated seeds were labeled as per the treatments done and kept at room temperature for 48 h. Then the seeds were transferred to 9 cm Petri dishes lined with moistened filter paper and were then wrapped in aluminum foil. The Petri dishes were kept in a germination chamber. The observations on the number of seeds germinated were recorded daily for a period of two months.

Experiment 2 - Effect of sulphuric acid treatment and water soaking on germination

A randomized plots experimental design was adopted for the study. Six hundred seeds each from both the species collected from Egypt. There were twelve treatments with five replications for each treatment and ten seeds were tested for each replication (one seed in each pot). The twelve pre-sowing seed treatments used in the experiment for *C* was as follows:

- The seeds were scarified with H_2SO_4 (36N) for five minutes. After 5 min seeds were washed thoroughly in tap water to remove any trace of acid. Then the seeds were dropped into water at 21°C and soaked for 24 (T1), 48 (T2) and 72 h (T3).
- The seeds were scarified with H_2SO_4 (36N) for five minutes. After 5 min seeds were washed thoroughly in tap water to remove any trace of acid. Then the seeds were dropped into water at 50°C and soaked for 24 (T4), 48 (T5) and 72 h (T6).
- Seeds were dipped in distilled water for 5 min, then dropped into water at 21°C and soaked for 24 (T7), 48 (T8) and 72 h (T9).
- Seeds were dipped in distilled water for 5 min, then dropped into water at 50°C and soaked for 24 (T10), 48 (T11) and 72 h (T12).

The same experiments were repeated for *C. fistula* with treatments T13 - T24. Treated seeds were sown in 10 cm plastic containers and kept in shade house. Data on germination were recorded on daily basis for a period of two months from the date of sowing, and the final germination percentage was calculated at the end of the experiment.

Experiment 3 - Effect of growth regulators and acid scarification on germination

Gibberellic acid (GA) can act as a substitute for light and temperature and promote germination in several plants by overcoming seed dormancy. Immersion in concentrated sulphuric acid (H_2SO_4) has been successfully used as a means of scarifying impermeable seeds (Teem et al., 1980). Hence, the objective of this experiment was to determine the effect of various concentrations of GA and H_2SO_4 scarification on germinability of cassia seeds and the seeds from India was used. Two hundred and forty seeds each of *C. nodosa* and *C. fistula* were subjected to different treatments which included acid scarification with concentrated H_2SO_4 for different time periods, hot water treatment, treatment with gibberellic acid and control (Table 1).

A completely randomized block design (CRBD) was adopted for the study. 30 seeds were tried in each treatment. Treated seeds were sown in 15-cm plastic containers in three replicates with 10 seeds for each replication. Daily observations were-taken for the germination experiment for a period of two months from the date of sowing. Based on the data, germination percentage and germination energy were assessed**.** The germination energy is defined as the germination percentage when the mean daily germination

Table 1. Seed treatments on *Cassia.*

Soaking	Duration	*C. nodosa*	*C. fistula*
Concentrated H_2SO_4	15 min	T1	T9
	30 min	T2	T10
	45 min	T3	T11
	60 min	T4	T12
Distilled water at 40°C	5 min	T5	T13
Gibberellic acid (250 ppm) for 24 h	24 h	T6	T14
Gibberellic acid (500 ppm) for 24h	24 h	T7	T15
Control		T8	T16

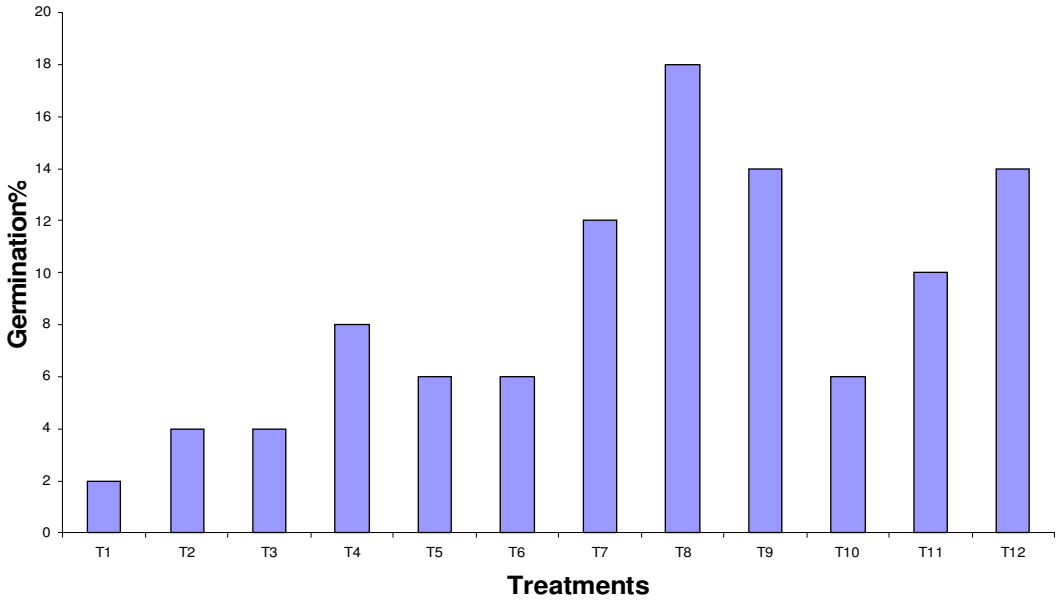

Figure 1. The germination rates in different seed treatments for *C. nodosa*.

(cumulative germination percent divided by the time elapsed since sowing date) reached its peak.

RESULTS

Experiment 1

It was obvious that the germination percentage was very low in all the treatments for *C nodosa*, although the treatments T6 and T7 observed germination 10%. However for heavy seeds, mechanical scarification resulted in better germination compared to unscarified seeds. For *C. fistula* seeds the treatment T6 was the best in a germination percentage of 85%. Treatments T7 and T8 observed 40% germination. Among light seeds, higher germination percentage (50%) was recorded in T1 followed by T2 with a germination percentage of 22%. Treatments T3 and T4 recorded similar germination percentage (11%).

Experiment 2 - Effect of sulphuric acid treatment and water soaking on germination

The seed germination data were analyzed using R analysis of variance procedure (Crawley, 2005) to estimate the significance of treatments on the germination of cassia seeds.

C. nodosa: Among the different treatments, T8 showed the highest germination ratio (18%) followed by T9 and T12 with 14% germination ratio (Figure 1). Statistical analysis showed that there was no significant difference between the different seed treatments in *C. nodosa*.

***C. fistula*:** Analysis indicated that there was significant difference at $P \leq 0.001$ with standard mean error of ±7.23

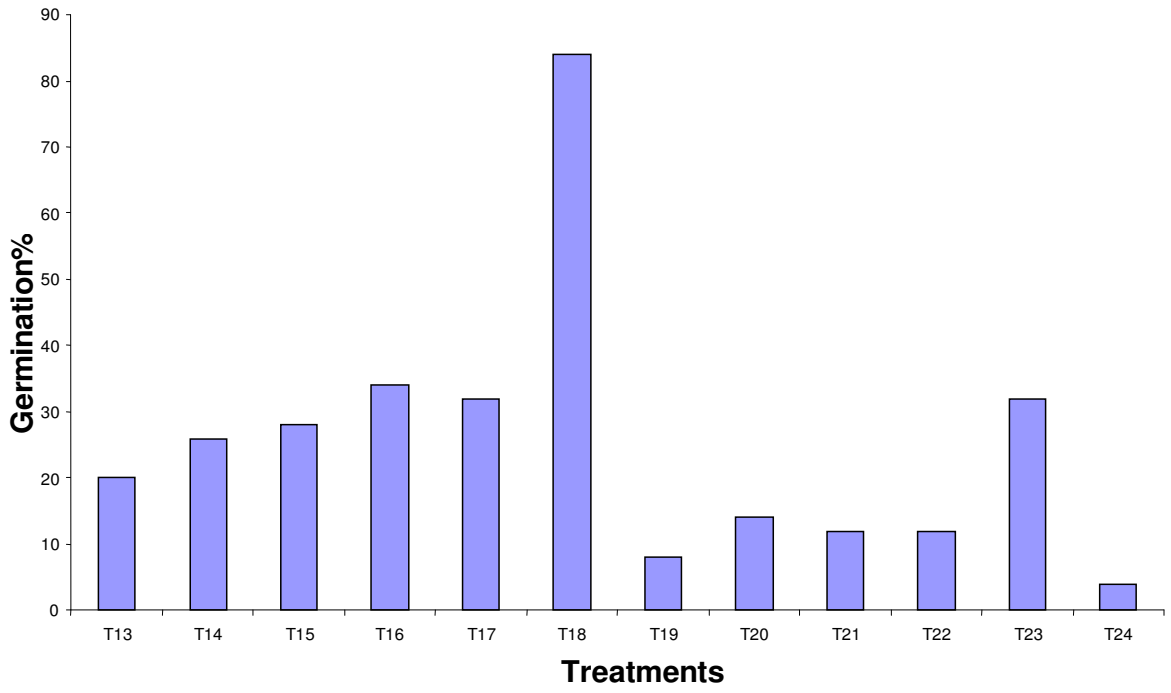

Figure 2. The germination rates in different seed treatments for *Cassia fistula*.

Table 2. Germination percentage of *Cassia nodosa* seeds (Experiment 3).

No.	Treatment	Germination percentage (%)	Germination energy (%)
T1	H_2SO_4 scarification for 15 min	17	5.95
T2	H_2SO_4 scarification for 30 min	0	4.76
T3	H_2SO_4 scarification for 45 min	20	3.53
T4	H_2SO_4 scarification for 60 min	0	6.52
T5	Distilled Water at 40^0C for 5 min	7	1.41
T6	GA (250ppm) for 24 h	10	2.12
T7	GA (500 ppm) for 24 h	20	2.83
T8	Control	0	0.00
	Significance	***	
	SEM	$\pm$6.78	

SEM = Standard error of mean;*** = Significant at P ≤ 0.001.

among the different germination treatments in *C. fistula*. Comparison of various treatments revealed that T18 was the best method for high germination (84%) (Figure 2) followed by T16 with a germination percentage of 34%. Treatments T17 and T23 showed a germination percentage of 32%. T24 showed the lowest germination percentage (4%).

Experiment 3 - Effect of growth regulators and acid scarification on germination

The effect of presowing treatments was assessed periodically by counting germinated seeds and results are presented in Tables 2 and 3.

C. nodosa: The highest germination percentage (20%) was observed in T3 and T7 followed by T1 with a germination of 17%. Control plot yielded no germination, indicating the fact that *C. nodosa's* seeds require presowing treatments for good germination. Highest germination energy (6.52%) was found in T4 followed by T1 with 5.95% and for the control plot the value was zero.

C. fistula: Highest germination percentage (83%) was observed in T11 followed by T12 with a germination

Table 3. Germination results of *Cassia fistula* seeds (Experiment 3).

No	Treatment	Germination percentage (%)	Germination energy%
T9	H_2SO_4 scarification for 15 min	20	5.21
T10	H_2SO_4 scarification for 30 min	37	6.36
T11	H_2SO_4 scarification for 45 min	83	17.67
T12	H_2SO_4 scarification for 60 min	77	17.67
T13	Distilled Water at 40^0 for 5 min	0	0.00
T14	GA (250ppm) for 24 h	0	1.41
T15	GA (500 ppm) for 24 h	7	1.41
T16	Control	3	1.41
	Significance	***	
	SEM	$\pm$8.06	

SEM = Standard Error of Mean;*** = Significant at P ≤ 0.001.

percentage of 77%. Treatments T10 recorded 37% germination rate followed by T9 with a germination percentage of 20%. Control plot yielded the lowest germination percentage (3%).Treatments T11 and T12 recorded similar germination energy (17.67%). Treatments T14 and T15 observed same energy value of 1.41% whereas for the control plot the germination energy was 3%.

DISCUSSION

Experiment 1

For *C nodosa*, mechanical scarification resulted in better germination in heavy seeds compared to unscarified seeds. This may be due to the fact that mechanical scarification might have helped in physically breaching the impermeable layer in the seed coat allowing water and oxygen to enter the seeds and permit the embryo to overcome the mechanical restriction of surrounding tissues. This agrees with the results of Lopes et al. (1998) for *C. grandis* and *Caesalpinea ferrea*. Todaria and Negim (1992) also found that mechanical scarification is effective in breaking the dormancy of *C nodosa* seeds. For *C. fistula* mechanical scarification combined with the effect of hot water rendered seed coat more permeable thus resulting in better germination.

Experiment 2 - Effect of sulphuric acid treatment and water soaking on germination

C. nodosa: Among the different treatments studied, T8 showed the highest germination ratio. The result is supported by an earlier study by Matias et al. (1973) which showed that soaking in water for 2 - 48 h has helped to improve the seed germination of *Acacia, Albizia* and *Pinus* trees. Also, Kobmoo and Hellum (1984) have proved that hot water treatment is the quickest, cheapest and simplest method for releasing seed coat dormancy.

***C. fistula*:** T18 was the best method for high germination (84%) followed by T16 with a germination percentage of 34%. The results agree with the study of Nalawadi et al. (1977) that seeds soaked in concentrated H_2SO_4 for 5 - 20 min and then soaked in water for 24 h observed good results compared with the seeds soaked in water alone.

Experiment 3 - Effect of growth regulators and acid scarification on germination

C. nodosa: For *C. nodosa* the highest germination percentage (20%) was observed in T3. Control plot yielded no germination, indicating the fact that *C. nodosa's* seeds require presowing treatments for good germination.

C. fistula: Highest germination percentage (83%) was observed in T11 and the control plot yielded the lowest germination percentage (3%).

Conclusion

The results of the study demonstrate that the beneficial effects of a number of pre-sowing treatments in improving the germination of cassia (*C. nodosa* and *C. fistula)* seeds. During the search the effect of surface sterilization followed by mechanical scarification, effect of sulfuric acid treatment and water soaking and effect of growth regulators and acid scarification on germination of *C nodosa* and *C. fistula* seeds were determined.

***C. nodosa*:** For experiment 1, scarified heavy seeds soaked in water resulted in better germination. Regarding experiment 2 seed soaking in water (21℃) for 48 h showed the highest result and for experiment 3, H_2SO_4 scarification for 45 min was the best.

***C. fistula*:** For experiment 1, scarified heavy seeds soaked in hot water were the best. Regarding experiment 2, H_2SO_4 scarification followed by dropping in hot water

at 50°C resulted in higher germination and for experiment 3, H_2SO_4 scarification for 45 min resulted in better germination.

The described procedures have proved that seed treatments are necessary to overcome dormancy in *Cassia* seeds. However, further experiments should also be conducted to draw a satisfactory conclusion regarding seed germination of *C. nodosa* and *C. fistula* since germination is influenced by various factors.

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