ISSN: 2347-4688, Vol. 6, No.(3) 2018, pg. 344-354

Current Agriculture Research Journal

Journal Website: www.agriculturejournal.org

Effect of Pre-Sowing Treatments on Seed Germination and Seedling Growth of Silver Butterfly Tree (*Bauhinia rufescens*)

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Abstract

Three experiments were conducted in a plastic greenhouse at the Sinna Garden of the Crop Science Department of the University of Ghana, Legon, Accra to investigate into pre-sowing treatment (water treatment, growth regulator, and sulphuric acid scarification and water soaking) effects on seed germination and seedling growth of *Bauhinia rufescens* from October to December, 2011 and January to April, 2012, respectively. The experimental design used was complete randomized design. There were 4 treatments in experiment 1, 7 in experiment 2 and 6 in experiment 3. Each experiment was replicated five (5) times. The results showed that *Bauhinia rufescens* seeds soaked in hot water at 65 ^{0}C for 60 minutes gave the highest mean germination rate, tallest plant height and highest number of leaves per plant at 49 days after soaking. It also had the widest stem diameter, highest fresh shoot and root weight, highest fresh root and dry root weight and number of roots per seedling. Seeds soaked in 500 ppm Gibberelic acid (GA_3) produced the highest number of leaves per plant and tallest plants at 49 DAS. Seeds soaked in 750 ppm GA_3 had the highest number of leaves per plant at 49 DAS and highest fresh shoot weight. Seeds soaked in 1000 ppm Promalin differed significantly from 500 ppm GA_3 and the control in germination percentage. Seeds soaked in 1000 ppm Promalin differed significantly from 500 ppm GA_3 and the control in germination percentage. Acid scarified seeds for 60 minutes plus soaking in tap water for 24 hours differed significantly from the seeds treated with other growth regulator rates plus 24 hours soaking in germination percentage. Acid scarified seeds for 45 minutes plus soaking in tap water for 24 hours had the tallest plant and highest number of leaves per plant at 49 DAS, widest stem diameter, highest fresh shoot and root weight and dry shoot weight. Soaking seeds in hot water at 65 ^{0}C for 60 minutes and/or in acid (H_2SO_4) for 45 minutes plus soaking in tap water for 24 hours is recommended as pre-sowing treatment for *Bauhinia rufescens* for maximum mean germination rate and vigorous vegetative growth of seedlings.

Article History

Received: 03 July 2018
Accepted:13 December 2018

Keywords

Bauhinia rufescens,
Growth regulator,
Pre-sowing treatment,
Sulphuric acid,
Water treatment.

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Doi: http://dx.doi.org/10.12944/CARJ.6.3.13

Introduction

Trees form an integral part of the ecosystem and offer innumerable benefits to humans and the environment as a whole. Most trees and shrubs in cities are planted to provide beauty or shade. Trees in landscape function differently based on the type and purpose. Shrubbery (small trees) fits much better in walkways in landscape designing, whereas larger trees function best in parks and along streets. Flowering trees augment the aesthetic and recreational elements of the ecosystem. Planting of trees in urban settings also helps to reduce air pollution. *Bauhinia rusfecens* is among the most popular ornamental shrub, which belongs to the family Fabaceae (Leguminosae). This species is characterized by the production of seeds enclosed in pods and colourful flowers and is mostly used as avenue plants for decoration along streets and pathways. The tree can also be used as a hedging plant, as it can thrive in saline soils and tolerate drought. It is also used as a specimen plant.

Germination of seed is an important means of propagation practised for mass production of woody plant species. However, it is often a laborious process as germination by seed takes a considerable amount of time. Slow germination, especially with the leguminous species is noted to be as a result of the hard seed coat which impedes the imbibition of water. The hard seed coat of some legumes are relative in the sense that various species, various stages of maturity and various individuals within an apparently homogenous seed lot exhibit different degrees of resistance to imbibition. Seed propagation of species requires growers to rely on information from closely related horticultural species for seeds treatment requirements. Leguminous species have hard seed coats that not does allow easy germination. Since the seed coat is seen as a hindrance to uniform and rapid germination, there is a need for more radical pre-treatments to enhance germination. The objective of this study was to determine the best possible pre-sowing treatment method that maximizes the seed germination and initial seedling growth of *Bauhinia rusfecens* in the nursery. Tchoundjeu observed that the species is scarcely propagated and grows mainly in the wild. This, according to the author, is due to poor germination. Hence, seeds require pre-treatment before planting in the nursery.

Materials and Methods

Seed Collection and Preparation

Mature dry pods of *Bauhinia rufescens* were collected from the Department of Parks and Gardens in Accra in the second week of August 2011 for the initial experiment which was to determine the percentage imbibition for the plant species. The subsequent experiment was to determine the pre-sowing treatments effects on the germination and growth parameters of the plant species. For the second experiment, matured pods were collected from tree stands within the University of Ghana Botanical Gardens, in December, 2011. The pods were split open manually and the seeds removed from the pods. Healthy seeds were selected from among the whole lot and cleaned. The seeds were then sun-dried for a week and stored at room temperature in clear polythene bags.

Temperature, radiation and relative humidity data in the germination environment were recorded and are presented in Table 1.

Table 1: Monthly Temperature, Relative Humidity and Radiation in the Plastic Chamber during the experimental period

	Relative Humidity (%)		Temperature (°C)		Radiation (cal/cm²)	
Month/Year	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum
			2011			
October	93.1	38.2	42.0	24.6	359.9	0.6
Nov.	92.2	39.0	41.2	26.4	929.6	-
Dec.	91.1	18.3	42.9	25.7	731.7	5.9
			2012			
January	92.5	12.4	45.6	25.5	705.3	-
February	89.2	26.1	46.1	25.5	881.3	-
March	92.3	29.7	45.0	26.7	778.6	-
April	93.0	30.0	45.2	26.8	780.5	-

Imbibition and Standard Germination Experiments

The preliminary test included an imbibition test to determine the absorption rates of the seed species. One hundred seeds were soaked in tap water in a beaker for 12, 24, 48, 72, 96 and 120 hours and percentage rate of absorption were calculated. For the imbibition test results, see appendix 1. A total of 20 seeds were used for each treatment. Seeds were sown in seed trays containing a mixture of river sand and soil collected from the University of Ghana farm. Germination experiments were carried out in a completely randomized design with five replicates. Germination was monitored daily and recorded. Seeds were considered to have fully germinated upon emergence of a healthy, white radical.

Determination of Germination Parameters

Germination parameters determined are as follows:

- Germination Percentage = number of seeds germinated/number of tested seeds X 100.
- Germination Mean Time (GMT) is given, according to Scott *et al.,*[4] as:

$$(\text{GMT days}) = \sum T_1 N_1 / S$$

Where

T_1 is the number of days from the beginning of the experiment,

N_1 is the number of seeds germinated per day and

S is the total number of seeds germinated.

Speed of Germination Test

this, according to Hartmann *et al.,*[5] involves the use of the formula:

$$\text{Mean Days} = \frac{A_1T_1 + A_2T_2 + \ldots A_xT_x}{A_1 + A_2 + \ldots A_x}$$

Where:

A_1 is the number of seeds germinated

T_1 is the number of days of germination

- Co-efficient of Velocity, according to Hartmann *et al.,*[6]

$$\frac{A_1 + A_2 + \ldots A_x}{A_1T_1 + A_2T^2 \ldots A_xT_x} \times 100$$

Where:

A1 is the number of seeds germinated

T1 is the number of days of germination

Seed Treatment and Scarification

A total of 100 seeds were treated as follows:

Tap Water Treatment

Seeds were soaked in ordinary tap water for 12, 24 and 48 hours after which they were removed and sown directly.

Hot Water Treatment

Seeds were soaked in hot water at 65°C for 10 and 60 minutes.

Chemical Scarification

Seeds were soaked in 95% sulphuric acid (H_2SO_4) for 10, 20, 30, 45 and 60 minutes after which the seeds were soaked in tap water for 24 hours.

Growth Regulators

Gibberellic acid treatment

Seeds were soaked in 500, 750 and 1,000 ppm gibberellic acid solutions for 24 hours.

Promalin Treatment

Seeds were soaked in 500, 750 and 1,000 ppm Promalin solutions.

Control seeds

Seeds were not given any treatment.

Performance of Seedlings Developed from Treated Seeds

Plant height, number of leaves per plant, stem diameter, fresh root weight, fresh shoot weight, dry root weight and dry shoot weight were measured on five plants which were randomly left to grow in the pots after germination. Plant height was measured from the base of the plant at the soil level to the tip of the top most leaf first at two weeks after germination and then weekly until the eight weeks after sowing. The number of leaves per plant was counted two weeks after sowing. Since the plants have pinnate leaves, one pinnate leaf was counted as one at one week interval. The stem diameter of the plant was measured at the eighth week with a vernier caliper from five centimetres (5cm) above the collar of the shoot. Total fresh weight of the plants was measured

by weighing shoots of all five plants per pot, one after the other, using the digital electric scale. The fresh shoot and root weight was determined at the end of the eighth week. Shoots were separated from the roots by cutting and then weighed. Fresh shoots and roots were separated, enveloped per each treatment and dried in an electric oven at 60° C for 48 hours and weighed on the digital electric scale.

Analysis of Data

Analysis of Variance (ANOVA) was carried out to test the effects of seed treatments and significant differences between means were estimated by the Least Significant Difference at 5% level. Statistical analyses were carried out using the Genstat 5 Statistical Package.

Results

Germination Data

Germination Analysis of *Bauhinia rufescens* as Influenced by Water Treatment

Water treatment had no significant effect on *Bauhinia rufescens* seeds in germination percentage and Coefficient of variation (Table 2). There was a significant difference between treatments in germination mean rate (GMR). Seeds soaked in hot water at 65°C for 60 minutes differed significantly from seeds soaked in tap water for 24 and 48 hours and the control in germination mean rate (Table 2). Seeds soaked in tap water for 48 hours differed significantly from seeds soaked in hot water at 65°C for 60 minutes in germination mean time. There was no significant difference between seeds soaked in tap water for 24 hours, 48 hours and the control in germination mean time (Table 2).

Table 2: Effect of water treatment on germination of *Bauhinia rufescens* seeds

Treatment	G (%)	CV (%)	MR	MT/day
Control	53	48.1	0.039	16.6
Soaking in tap water for 24 hours	76	43.5	0.045	22.4
Soaking in tap water for 48 hours	71	33	0.043	22.9
Soaking in hot water at 65°C for 60 minutes	75	37	0.099*	10.2
LSD (P = 0.05)	NS	NS	0.018	6.75

G = germination percentage, CV = co-efficient of variation, MR = germination mean rate, MT = germination mean time.

Vegetative Growth

Plant Height

There was a significant difference between seeds soaked in hot water at 65°C for 60 minutes from seeds soaked in tap water for 24 and 28 hours and the control in plant height from 21 to 49 DAS (Table 3). There was no significant difference between seeds soaked in tap water for 12 hours from seeds soaked in tap water for 24 hours from 21 to 42 DAS in plant height. The control produced the shortest plant height from 35 to 49 DAS (Table 3).

Number of Leaves Per Plant

There was an increase in number of leaves per plant among treatments for the entire soaking period (Table 3 above). Seeds soaked in hot water at 65°C for 60 minutes differed significantly from seeds soaked in tap water for 24 and 48 hours and the control in number of leaves per plant from 14 to 28 DAS. Seeds soaked in tap water for 24 hours and the control had the same number of leaves per plant at 14 and 28 DAS (Table 3). There was no significant difference between seeds soaked in tap water for 24

hours, 28 hours, hot water at 65 ^{0}C for 60 minutes and the control in number of leaves per plant from 35 to 49 DAS although seeds soaked in hot water at 65 ^{0}C for 60 minutes produced the highest number of leaves per plant for the same growing period (Table 3).

Plant Biomass

There was no significant difference between the control and the other treatments in stem diameter at 49 DAS although differences exist among treatment with the widest stem diameter produced by seeds soaked in hot water at 65 ^{0}C for 60 minutes (Table 4). There was a significant difference between seeds soaked in hot water at 65 ^{0}C for 60 minutes from the other treatment in fresh shoot weight. Seeds soaked in hot water at 65 ^{0}C for 60 minutes differed significantly from seeds soaked in tap water for 24 hours and the control in dry shoot weight, fresh root weight and dry root weight. There was a significant difference between seeds soaked in hot water at 65 ^{0}C for 60 minutes and the control in number of roots per seedling. The control produced the least fresh shoot and root weight, dry shoot and root weight except the stem diameter (Table 4).

Table 3: Effect of water treatment on growth of *Bauhinia rufescens* seedling

	Plant height (cm) (Days after soaking)					
Treatment	14	21	28	35	42	49
MS + no soaking (Control)	2.8	5.93	10.1	12.57	16.53	19.2
TWS for 24 hrs	2.63	4.83	9.77	13.5	17.5	20.33
TWS for 48 hrs	2.6	6.93	10.3	15.03	19.53	22.63
HWS at 65°C for 60 minutes	5.23	9.27	14.6	18.17	22.07	25.6
LSD (P = 0.05)	0.93	2.66	2.01	2.59	2.32	1.83
Number of Leaves per plant						
MS + no soaking (Control)	4	7	10	13	17	22
TWS, 24 hours	4	6	10	13	16	21
HWS, 65˚C, 60 Minutes	6	9	13	15	19	25
LSD (P = 0.05)	1.4	2.1	1.9	NS	NS	NS

MS = mechanical scarification, TWS = tap water soaking, HWS = hot water soaking

Table 4: Effect of water treatment on growth of Bauhinia rufescens seedling

Treatment	Stem Diameter (mm)	Fresh Shoot Weight (g)	Dry Shoot Weight (g)	Fresh Root Weight (g)	Dry Root Weight (g)	No. of roots per seedling
MS (Control)	2	1.23	0.36	0.42	0.1	9.0
TWS, 24 hours	1.8	1.28	0.4	0.44	0.11	10.0
TWS, 48 hours	2.0	1.56	0.47	0.51	0.13	10.0
HWS, 65°C, 60 minutes	2.0	1.79	0.54	0.6	0.15	11.12
LSD (P = 0.05)	NS	0.19	0.07	0.09	0.02	1.32

Germination Analysis

Germination Analysis of *Bauhinia rufescens* Seeds as Influenced by Growth Regulators

There was a significant difference in germination percentage between seeds soaked in 1000 ppm Promalin from that of the seeds soaked in 500 ppm GA_3 or with that the control (Table 5). However, seeds soaked in 500 ppm GA_3 had the same germination percentage as the control. There was however, no significant difference between seeds soaked in growth regulators in germination percentage. There was no significant difference between seeds soaked in 1000 ppm GA_3, 1000 ppm Promalin, 500 ppm GA_3, 500 ppm Promalin, 750 ppm GA_3, 750 ppm Promalin and the control in coefficient of variation, germination mean rate and germination mean time although differences exist among treatments (Table 5).

Table 5: Effect of growth regulators on germination of *Bauhinia rufescens* seeds

Treatment	G (%)	CV (%)	MR	MT
Control	58	46.6	0.054	18.63
Soaking in 1000 ppm GA_3	73	45.9	0.047	21.48
Soaking in 1000 ppm Promalin	81	46.9	0.045	22.28
Soaking in 500 ppm GA_3	58	45.4	0.045	22.2
Soaking in 500 ppm Promalin	66	47	0.053	18.89
Soaking in 750 ppm GA_3	75	54.6	0.047	21.11
Soaking in 750 ppm Promalin	69	48.5	0.048	21.05
LSD (P = 0.05)	15.68	NS	NS	NS

Growth Analysis

Plant Height

Growth regulators significantly affected plant height of *Bauhinia rufescens* plant from 21 DAS to 49 DAS. There was no significant difference between seeds soaked in growth regulators and the control in plant height at 14 DAS (Table 6). Seeds soaked in 1000 ppm GA_3 produced the tallest plants from 14 DAS to 42 DAS and the shortest plants in the control from 14 DAS to 35 DAS. Seeds soaked in 1000 ppm GA_3 differed significantly from 500 ppm GA_3, 1000 ppm Promalin and the control from 21 DAS to 35 DAS in plant height. There was a significant difference between seeds soaked in 1000 ppm GA_3 from 1000 ppm Promalin and the control at 42 DAS in plant height. Seeds soaked in 500 ppm GA_3 differed significantly from seeds soaked in 750 ppm Promalin and 1000 ppm Promalin at 49 DAS in plant height (Table 6).

Number of Leaves Per Plant

Growth regulators did not significantly affect the number of leaves per plant for the entire growing period (Table 6). There was no significant difference between seeds soaked in growth regulators with the control in number of leaves per plant for the entire growing period although differences exist between treatments. Seeds soaked in 750 ppm GA_3 and 1000 ppm GA_3 produced the same number of leaves from 14 DAS to 35 DAS. However, seeds soaked in 500 ppm GA_3 and 750 ppm GA_3 produced the same and the highest number of leaves per plant at 49 DAS (Table 6).

Table 6: Effect of growth regulators on the growth of Bauhinia rufescens seeds

	Plant height (cm) (Days after soaking)					
Treatment	14	21	28	35	42	49
Control	3.73	6.9	11.57	14.67	17.9	21.3
500 ppm GA_3	3.37	7.07	12.27	15.7	20.07	23.73
750 ppm GA_3	5	9.17	14.07	17.27	20.97	23.53
1000 ppm GA_3	5.33	10.27	14.57	17.93	21	22.27
500 ppm Promalin	4.27	9.03	13.17	16.3	20.23	21.97
750 ppm Promalin	4.67	8.57	13	16.03	19.03	19.2
1000 ppm Promalin	3.87	7.5	12.47	15.77	17.83	19.53
LSD (P = 0.05)	NS	1.96	1.92	1.93	1.99	3.11
Number of leaves per plant						
Control	5.0	8.0	12.0	14.0	17.0	23.0
500ppm GA_3	5.0	8.0	11.0	15.0	19.0	28.0
750ppm GA_3	6.0	9.0	13.0	17.0	23.0	28.0
1000ppm GA3	6.0	9.0	13.0	17.0	20.0	25.0
500ppm Promalin	5.0	9.0	12.0	15.0	20.0	23.0
750ppm Promalin	5.0	9.0	11.0	15.0	19.0	21.0
1000ppm Promalin	5.0	8.0	11.0	14.0	17.0	20.0
LSD (P = 0.05)	NS	NS	NS	NS	NS	NS

Effect of Growth Regulators on Mean Stem Girth, Fresh Shoot Weight, Dry Shoot Weight, Fresh Root Weight, Dry Root Weight and Number of Roots per Seedling

There was no significant difference between seeds soaked in different growth regulators and the control in stem diameter, fresh root weight, dry shoot weight, dry root weight and number of root per seedling (Table 7). There was a significant difference between seeds soaked in 750 ppm GA_3 from seeds soaked in 500, 750 and 1000 ppm Promalin in fresh shoot weight (Table 9). There was however, no significant difference between 750 ppm GA_3 from 500 ppm GA_3 and the control in fresh shoot weight at 8 WAP (Table 7).

Table 7: Effect of growth regulators on growth of *Bauhinia rufescens* seed

Treatment	Stem diameter (mm)	Fresh Shoot weight (g)	Dry Shoot weight (g)	Fresh Root weight (g)	Dry Root weight (g)	No. of roots per seedling
Control	2.0	1.86	0.55	0.55	0.12	11
500ppm GA_3	1.8	2.03	0.57	0.44	0.1	9
750ppm GA_3	2.0	2.06	0.64	0.44	0.14	10
1000ppm GA_3	2.0	1.64	0.6	0.49	0.13	11
500ppm Promalin	2.0	1.66	0.78	0.56	0.16	11
750ppm Promalin	1.8	1.50	0.49	0.58	0.14	8
1000ppm Promalin	2.0	1.35	0.47	0.38	0.14	9
LSD (P = 0.05)	NS	0.40	NS	NS	NS	NS

Germination Analysis

Germination Analysis of *Bauhinia Rufescens* Seeds as Influenced by Acid (H_2SO_4) Scarification and Tap Water Soaking

There was a significant difference between seeds scarified with acid for 60 minutes plus soaking in tap water for 24 hours from seeds scarified with acid for 10, 20, 30 and 45 minutes plus soaking in tap water for 24 hours and the control in germination percentage (Table 8). The control however, had the least germination percentage.

There was no significant difference between treatments in coefficient of variation and germination mean time although differences exist among treatments. There was a significant difference between acid scarified seeds for 60 minutes plus soaking in tap water for 24 hours from the control when mean germination rate was considered (Table 8). There was no significant difference in mean germination rate between seeds scarified with acid for 10, 20, 30 and 45 minutes plus soaking in tap water for 24 hours (Table 8).

Table 8: Effect of acid (H_2SO_4) scarification on germination of Bauhinia rufescens seeds

Treatment	G (%)	CV (%)	MR	MT
Control	37.3	35.8	0.027	23.2
AS for 10 min + TW soaking for 24 hours	46.7	17.7	0.054	18.5
AS for 20 min + TW soaking for 24 hours	54	22.4	0.059	17.1
AS for 30 min + TW soaking for 24 hours	55.3	20.4	0.064	15.6
AS for 45 min + TW soaking for 24 hours	44	16.9	0.065	15.4
AS for 60 min + TW soaking for 24 hours	86	19.4	0.068	14.9
LSD (P = 0.05)	22.26	NS	0.013	NS

G = germination percentage, CV = coefficient of variation, MR = germination mean rate, MT = germination mean time. AS = acid (H_2SO_4) scarification, TW = tap water.

Growth Analysis

Plant Height

There was a significant difference between seeds scarified with acid for 20 minutes + soaking in tap water for 24 hours from the control in plant height at 14 DAS (Table 9). There was however, no significant difference between acid scarified seeds for 10, 20, 30 and 45 minutes plus soaking in tap water for 24 hours in plant height at 14 DAS. There was no significant difference between seeds scarified with

acid scarification 10, 20, 30, 45 and 60 minutes plus soaking in tap water for 24 hours and the control in plant height from 21 to 49 DAS although differences exist among treatments with acid scarified seeds for 20 minutes plus soaking in tap water for 24 hours recording the tallest plant at 21, 28 and 35 DAS (Table 9).

Table 9: Effect of acid (H_2SO_4) scarification on growth of *Bauhinia rufescens* seeds

	Plant height (cm) (Days after soaking)					
Treatment	14	21	28	35	42	49
Control	5.1	9.4	13.4	16	20.23	21.5
AS 10 min + TW	7.57	9.77	12.5	14.8	17.7	18.8
AS 20 min + TW	8.63	13.23	16.67	19.47	22.67	23.93
AS 30 min + TW	8.3	13.43	17.17	19.9	22.1	23
AS 45 min + TW	7.77	12.1	16.3	19.5	23.12	24.67
AS 60 min + TW	8.23	12.37	15.17	17.87	21.73	23.43
LSD (P = 0.05)	2.23	NS	NS	NS	NS	NS

AS = acid scarification, TW = soaking in tap water for 24 hours

Number of Leaves Per Plant

There was no significant difference between seeds soaked in acid scarification for 10, 20, 30, 45 and 60 minutes plus soaking in tap water for 24 hours and the control in number of leaves per plant from 14 to 49 DAS although differences exist among treatments with the highest number of leaves per plant recorded by seeds soaked in acid scarification for 45 minutes and soaking in tap water for 24 hours and the least with seeds soaked in acid scarification for 10 and 60 minutes and soaking in tap water for 24 hours during the same growing period (Table 10).

Effect of Acid (H_2SO_4) Scarification and Water Soaking on Stem Diameter, Fresh Shoot Weight, Dry Shoot Weight, Root Fresh Weight, Root Dry Weight and Number of Roots Per Seedling

There was no significant difference between treatments in stem diameter, fresh shoot weight, dry shoot weight, fresh root weight, dry root weight and number of roots per seedling although differences exist among treatments with acid scarified seeds for 45 minutes plus soaking in tap water for 24 hours recording the highest stem diameter, fresh shoot weight, dry shoot weight and fresh root weight (Table 11).

Table 10: Effect of acid (H_2SO_4) scarification on growth of *Bauhinia rufescens* seeds

	Number of leaves per plant (Days after soaking)					
Treatment	14	21	28	35	42	49
Control	7.0	10.0	13.0	17.0	24.0	27.0
AS 10 min + TW	8.0	9.0	13.0	17.0	23.0	26.0
AS 20 min + TW	8.0	12.0	17.0	21.0	25.0	28.0
AS 30 min + TW	8.0	11.0	15.0	18.0	20.0	23.0
AS 45 min + TW	8.0	12.0	17.0	21.0	28.0	31.0
AS 60 min + TW	9.0	12.0	15.0	19.0	23.0	26.0
LSD (P = 0.05)	NS	NS	NS	NS	NS	NS

AS = acid scarification, TW = soaking in tap water for 24 hours

Table 11: Effect of acid (H_2SO_4) scarification on growth of *Bauhinia rufescens* seeds

Treatment	Stem diameter (mm)	Fresh Shoot weight (g)	Dry Shoot weight (g)	Fresh Root weight (g)	Dry Root weight (g)	No. of roots per seedling
Control	2	1.59	0.48	0.43	0.12	8
AS 10 min + TW	1.7	1.77	0.54	0.62	0.15	8
AS 20 min + TW	2	1.99	0.62	0.65	0.19	8
AS 30 min + TW	2	1.79	0.6	0.58	0.18	8
AS 45 min + TW	2.1	2.15	0.63	0.71	0.19	8
AS 60 min + TW	2	1.91	0.56	0.69	0.19	7
LSD (P = 0.05)	NS	NS	NS	NS	NS	NS

Discussion

All seed treatments (water, acid and plant growth regulators) did not significantly affect the co-efficient of variation. However on the average, seeds soaked in water performed better (76%) (germination percentage, germination mean rate, plant height at 49 DAS, fresh shoot and dry shoot weight, fresh root and dry root weight and number of roots per seedling) as compared to the untreated seeds (53%). Seeds soaked in hot water at 65 ^{0}C for 60 minutes had the highest germination mean rate, tallest plant and highest number of leaves per plant at 49 DAS, widest stem diameter, highest fresh shoot and root weight, fresh root and dry root weight and number of roots per seedling.

Soaking of *Bauhinia rufescens* seeds in hot water at 65°C for 60 minutes might have softened the seed coats and allowed for the imbibition of water. This might have contributed to the highest germination mean rate. It was observed that the hot water immediately cracked the seed coats, allowing for the imbibition of water. This confirmed the assertion by Asiedu *et al.,* that boiling of *Bauhinia rufescens* in water for less than 10 seconds was the most effective pre-sowing treatment. The effectiveness of hot water in breaking physical dormancy of leguminosae seeds has been ascribed to its ability to create tension which subsequently causes cracking of the macroscleroid layer.

With respect to the plant growth regulators, gibbereliic acid performed better than Promalin treatments as well as the untreated seeds. Seeds soaked in 500 ppm GA_3 and 750 ppm GA_3 produced the same and highest number of leaves per plant, tallest plant at 49 DAS and highest fresh shoot weight, respectively. This attest to the report by Hartmann[2] that soaking in 500 ppm GA_3 gave the best plant height and number of leaves per plant and that GA_3 had a positive effect on shoot development and vigour. Seeds soaked in 1000 ppm Promalin differed significantly from 500 ppm GA_3 and the control in germination percentage. This contradicts the findings of Quaye that soaking seeds in 500 ppm of gibberellic acid (GA_3) gave the best germination percentage. Seeds scarified with acid for 60 minutes plus soaking in tap water for 24 hours differed significantly from the control in germination percentage and mean germination time. This might be due to the fact that the acid scarification was able to effectively dissolve the seed coat and also enhanced imbibition of water. This confirms the findings of Schimdt *et al.,* that acid scarification is effective and practical for breaking seed coat dormancy.

Acid scarified seeds for 45 minutes plus soaking in tap water for 24 hours had the tallest plant and highest number of leaves per plant at 49 DAS, widest stem diameter, highest fresh shoot and root weight and highest dry shoot weight. The highest germination percentage and germination mean time might have resulted in greater seedling growth.

Conclusion

The results of the study provided evidence of the importance of pre-sowing treatments on seed germination in *Bauhinia rufescens*. Water and plant growth regulators significantly affected the germination and growth of *Bauhinia rufescens* and

can be effectively used in breaking its seed dormancy. To enhance germination mean rate and also for tallest plant height, higher number of leaves per plant ,widest stem diameter, highest fresh shoot and root weight, fresh root and dry root weight and number of roots per seedling horticulturists are encouraged to soak *Bauhinia rufescens* seeds in hot water at 65 ^{0}C for 60 minutes. It is advised that horticulturists soak seeds in 1000 ppm Promalin or in acid scarification for 60 minutes plus soaking in tap water for 24 hours for higher germination percentage. However, for higher number of leaves per plant, tallest plant and highest fresh shoot weight horticulturists could also soak Bauhinia rufescens seeds in 500 ppm GA_3 and 750 ppm GA_3, respectively. For tallest plant and highest number of leaves per plant, widest stem diameter, highest fresh and root weight and fresh root weight Bauhinia rufescens seeds could be soaked in acid scarification for 45 minutes plus soaking in tap water for 24 hours.

Acknowledgements

The authors would like to acknowledge the management and staff of Department of crop science of the University of Ghana, Legon for the provision of necessary materials/resources for the experiment to be successfully carried out.

APPENDIX 1

Imbibition Test for 20 seeds each of the *bauhinia rufescens*

Item	Initial weight (kg)	Soaking for 24 hours	Soaking for 48 hours	Soaking for 72 hours	Soaking for 96 hours
Bauhinia rufescens	2.5	3.7	4.1	4.7	4.8
Percentage imbibition	2.5	48%	64%	88%	92%

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