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Effect of Pre-Sowing Treatments on Seed Germination and Establishment of *Bauhinia rufescens*

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ABSTRACT

The aim of the present study was to investigate the effect of various pre-sowing treatments on the germination of *Bauhinia rufescens* seeds. The pre-sowing treatments were made up of boiling seeds in water for up to 15 min and soaking seeds in water at room temperature for a number of days. Data collected was used to calculate cumulative germination percentage, germination value, speed of germination, mean daily germination and coefficient of velocity and was analyzed using analysis of variance at 5%. Treatment 1 (<10 sec boiling) produced the highest cumulative germination percentage of 77. Soaking seeds in water at room temperature for any number of days (T3, T4, T7, T11, T14) did not have any significant effect on germination, neither did boiling seeds for 15 min (T2) and the control (T15). Apart from T1, all the other treatments had a cumulative germination percentage of less than 20 at the end of the experiment. Boiling of *Bauhinia rufescens* seeds in water for less than 10 sec (T1) proved to be the most effective pre-sowing treatment to enhance germination under field conditions. Soaking of seeds in water for any number of days could not improve germination.

Key words: Cumulative germination percentage, germination energy, germination value, speed of germination, co-efficient of velocity

INTRODUCTION

Bauhinia rufescens Lam. is a wild growing branched shrub or small tree which grows up to 7.6 m high. It produces white flowers and dark brown to blackish, often twisted several- seeded pods. The seeds have very thick seed coat and are found in the drier savannah (Orwa *et al*., 2009).

The plant has become popular over the years as an ornamental plant; used for the establishment of hedges, edges and to a less extent as small trees in ornamental gardens. As a hedge it improves the beauty of a garden when well cut and can serve as a boundary fence, a screen, or a noise breaker (Anonymous, 2008; Abbiw, 1990).

As a wild growing plant it is effective in controlling erosion, provides habitat for wild life and is used as a forage plant. In addition it is a source of medicine and helps to improve rangeland aesthetics (Busso *et al*., 2005). It is however, less known and is of only local significance (Abbiw, 1990). Thus, there is no comprehensive data on it and because of that literature on it is often old, difficult to find or available locally (Boffa, 1999; National Research Council (US.). Board on Science and Technology for International Development, 1996).

The use of *Bauhinia rufescens* as an ornamental plant is losing its attraction due to the difficulty in establishing the plant by seed. Propagation is mostly by seed (Connor, 2008) although

it can also be by vegetative means (Anonymous, 2008). The plant produces seeds with tough and hard seed coats (Connor, 2009), a condition which makes germination uneven and erratic (Alderete-Chavez *et al*., 2011). Earlier study by Anonymous (1998), Connor (2008) suggests that treatment of seeds with boiling water or scarification with 97% sulphuric acid enhances germination. However, among local gardeners in Ghana several suggestions exist. These suggestions include direct sowing and soaking of seeds in water for a period ranging from overnight to two weeks.

This study was conducted to investigate and determine the best pre-sowing treatment for the establishment of the plant by seed.

MATERIALS AND METHODS

Location of project: Two experiments (using the same parameters) were carried out in the Botany Department of the University of Cape Coast between 2008 and 2009.

Treatments: Pure seeds of *Bauhinia rufescens* were subjected to a total of 8 treatments, each with 100 seeds in 4 replications. Some seeds were boiled in water for 15 min (Anonymous, 2008) at 100°C; the temperature measured with a thermometer. The seeds were then allowed to cool naturally in the water after the heat source had been removed. Other seeds were put in boiling water for less than 10 sec and immediately removed from the heat source and allowed to cool in the water. Other treatments involved soaking seeds in tap water for a number of days ranging from overnight to 21 days. The control was not given any treatment. Table 1 summarizes the treatments.

Planting, watering and weed control: All seeds were sown on the same day. Seeds were sown by drilling in trenches filled with topsoil. The trenches were dug 30×30 cm deep and 50 cm apart. Watering was consistent and thoroughly done throughout the experimental period to ensure constant moisture supply to the seeds. The planted area was also clear- picked of weeds periodically.

Data taken: The following data were taken

- Number of days taken to observe the first emergence
- Number of seedling on first day of emergence
- Cumulative daily germination count

Table 1: Summary of treatments for experiments 1 and 2

Symbols			
Expt 1	Expt 2	Treatment	Treatment duration
T_1	T_1	Seeds put in boiled water @ 100°C	<10 sec
T_2	T_2	Seeds boiled in water @ 100°C	15 min boiling
T_3	T_3	Seeds soaked overnight in water @ room temperature	Overnight soaking
T_4	T_4	Seeds soaked in water @ room temperature for 3 days	3 days soaking
T_7	T_7	Seeds soaked in water @ room temperature for 9 days	9 days soaking
T_{11}	T_{11}	Seeds soaked in water @ room temperature for 15 days	15 days soaking
T_{14}	T_{14}	Seeds soaked in water @ room temperature for 21 days	21 days soaking
T_{15}	T_{15}	Seeds given no treatment	Control

Assessment of germinated seeds: The effect of the pre-sowing treatments on seeds was assessed by counting the number of seeds germinating every three days as suggested by Schmidt (2000). Germination was as described by Hossain *et al.* (2005) and germination percentage was calculated as suggested by Cicek and Tilki (2007).

The speed of germination or peak value which is defined as the maximum mean daily germination at a given time was calculated by dividing the highest cumulative germination percentage by the number of days taken to reach that germination percentage (Hossain *et al.*, 2005; Cho, 2010).

Other parameters determined were the pattern of germination, germination value and the co-efficient of velocity (Hartmann *et al.*, 1997; Idu *et al.*, 2007; Cicek and Tilki, 2007).

- **Coefficient of velocity-** is an index of rapidity or the rate of germination of seeds (Hartmann *et al.*, 1997; Islam *et al.*, 2008)
- **Germination energy-** number of days taken to attain 50% germination and is defined by Islam *et al.* (2009); Willan (1985) as the percentage by number of seeds in a given sample which germinate within a given period of time. It is also used to measure velocity of germination, speed of germination (Schmidt, 2007; Cho, 2010), mean germination time (Kitchen and Monsen, 2001)
- **Rate of Germination-** number of days required to attain 50% of germination capacity (Willan, 1985; Hartmann *et al.*, 1997)
- **Speed of germination-** defined as the maximum daily germination reached at any time (Hossain *et al.*, 2005)

Field lay-out and design: The experiment was laid out in a Randomized Complete Block Design with four replications.

Statistical analysis: Data obtained was organized and analysed using Microsoft excel and Genstat 3 discovery edition software and was subjected to a one-way analysis of variance at 5% significance level using Genstat software.

RESULTS

The results from the two experiments showed a similar pattern and were pulled together and summarized as follows.

Germination pattern: Germination delayed for all treatments. Seeds took between 6.7 and 14.75 (1-2 weeks) days to start germinating.

The earliest to germinate was T11 taking between 6.7 and 8 days. Treatment 2 (T2) and T1 were the last to germinate, taking between 14.75 and 12.75 days (Table 2).

About 15 days (two weeks) after sowing all treatments had started germinating with T14producing the highest number of 5-6 germinated seeds (Table 3).

After the initial slow pace of germination, most treatments started experiencing dramatic increases in the number of germinated seeds 20 days after sowing. Treatment 4 (T4), T11 and T14 however, started experiencing increases a little earlier. For most treatments this trend continued until about 37 days after sowing when the increase in the number of germinating seeds started to decline (Table 3).

Table 2: Mean values for number of days to first germination and number to first germinate

Treatments	Days to 1st germination	Number to 1st germinate
T1	12.75^{bc}	1.00^{a}
T2	14.75^{ab}	1.75^{a}
T3	10.75^{ab}	2.00^{a}
T4	9.75^{a}	1.25^{a}
T7	11.00^{a}	2.50^{a}
T11	8.70^{a}	3.25^{a}
T14	9.25^{a}	5.00^{a}
T15	12.50^{ab}	1.50^{a}
SED	1.703	1.422
LSD	3.543	2.957

LSD: Least significance value at 5%. Same letters within a row show no significant difference at 5%

Table 3: Summary of means for germination percentage on various days

Days after sowing	T1	T2	T3	T4	T7	T11	T14	T15	LSD
10	0.00^{a}	0.25^{ab}	1.75^{ab}	1.00^{ab}	1.50^{ab}	3.25^{b}	6.50^{c}	0.50^{ab}	3.122
13	1.00^{a}	0.25^{a}	2.00^{ab}	2.50^{ab}	2.50^{ab}	5.75^{bc}	6.50^{c}	0.75^{a}	3.782
16	1.00^{a}	1.00^{a}	4.25^{a}	4.25^{a}	5.50^{a}	11.75^{b}	12.50^{b}	1.50^{a}	5.659
19	10.75^{bc}	2.00^{a}	5.50^{ab}	6.00^{ab}	8.50^{bc}	12.50^{bc}	13.25^{c}	3.25^{a}	5.822
22	21.25d	2.50^{a}	7.25^{ab}	8.25^{abc}	10.50^{bc}	12.50^{bc}	13.75^{c}	4.75	6.419
25	35.50^{c}	6.75^{a}	9.00^{ab}	9.75^{ab}	11.50^{ab}	13.00^{ab}	15.25^{b}	7.00^{a}	6.848
28	47.75^{b}	10.00^{a}	14.00^{a}	13.50^{a}	12.75^{a}	14.75^{a}	15.75	9.00^{a}	6.937
31	66.25^{b}	10.25^{a}	14.25^{a}	15.25^{a}	13.50^{a}	15.50^{a}	16.25^{a}	10.75^{a}	6.968
34	71.50^{b}	11.25^{a}	15.25^{a}	15.75^{a}	15.75^{a}	16.25^{a}	16.50^{a}	14.25^{a}	7.471
37	77.00^{b}	11.50^{a}	15.50^{a}	15.75^{a}	15.75^{a}	16.25^{a}	16.50^{a}	16.50^{a}	7.744
40	77.00^{b}	12.00^{a}	15.50^{a}	15.75^{a}	15.75^{a}	16.25^{a}	16.50^{a}	15.25^{a}	7.837

LSD: Least significant value at 5% T: Treatment. Values having same letters within a row show no significant difference at 5%

Germination of seeds: Seeds started germinating about 1-2 weeks after sowing and continued until the experiment was ended 6weeks later. Treatment 1, T1 (<10 sec boiling) produced the highest number of germinated seeds while T2 (15 min boiling) produced the lowest number. The number of germinated seeds for the control T15 was not significantly different from T2 at 5% when the experiment ended.

The number of days seeds were soaked in water at room temperature did not have any significant effect at 5% on the number of seeds germinating 22 days after sowing. The number of seeds germinated from treatments soaked in water ranged from 13-17 at the end of the experiments (Table 3). The period of time seeds were exposed to boiling in water however a significant effect on germination had. Germinated seeds ranged from 9-77 at the end of the experiment (Table 3).

Germination percentage or capacity: The cumulative germination percentage recorded at the end of the experiment ranged between 9 and 77%. Treatment T_1 (<10 sec boiling) recorded the highest cumulative germination percentage of 77%. The lowest percentage of 9 was observed in T_2 (15 min boiling) and was significantly different from T_1 at 5%. There was no significant difference between the control T_{15}, T_2 (15 min boiling) and the other treatments (Table 3).

Germination speed: Most treatments attained to 10% germination 21-37 days after sowing. T14 was the first to attain to 10% germination 12-19 days after sowing. The last is T2 which took about 37 days. T1 attained it about 22 days after sowing while the control T15, took about 33 days.

Table 4: Mean daily germination, germination value and coefficient of velocity

Treatments	Mean daily germination (MDG)	Germination value (Gv)	Coefficient of velocity (Cv)
T1	2.015^{c}	154.20^{b}	3.80^{a}
T2	0.315^{ab}	4.10^{a}	4.13^{ab}
T3	0.397^{ab}	6.10^{a}	5.38^{b}
T4	0.427^{ab}	6.90^{a}	4.44^{ab}
T7	0.345^{ab}	6.60^{a}	4.78^{ab}
T11	0.433^{b}	7.00^{a}	5.93^{b}
T14	0.440^{b}	8.90^{a}	6.09^{b}
T15	0.365^{ab}	5.50^{a}	3.76^{a}
SED	0.104^{a}	8.64^{a}	17.84
LSD	0.2157	17.84	1.339

LSD: Least significance value @ 5%. Same ^{alphabets} within a row show no significant difference @ 5%

However, T1 showed the most dramatic gain in germination percentage, attaining to 50% germination 31 days after sowing. It produced the highest cumulative germination percentage (77%) 37 days after sowing. None of the other treatments attained 20% cumulative germination (Table 3) at the end of the experiment.

Germination value (Gv): T1 recorded the highest germination value of 154. The rest of the treatments had values ranging between 4 and 18 (Table 4) and were not significantly different (5%) from one another although they all differed significantly from T1.

Co-efficient of velocity (Cv): T14 recorded the highest co-efficient of velocity of germination of 6 followed by T11 (5.93). It was significantly different from T1 and the control T15 but not different from the other treatments at 5%. T15 had the lowest value of 3.76 (Table 4) and was not significantly different from T1 (3.86).

DISCUSSION

The pattern of germination confirms observations by Hartmann *et al.* (1997) that seeds show an initial delay in germinating. Also germination is slow at the beginning but is followed by rapid increase in the number of germinated seeds before it decreases in rate of appearance (Pourhadian and Khajehpour, 2010). The initial delay in germination could provide an opportunity where weed seeds on the field can be chemically controlled till the much late germinating *Bauhinia* seeds begin to emerge. At the same time spreading out of germination over a long period may be a disadvantage in terms of competition against weed seeds which germinate earlier (Revell and Taylor, 1998).

The experimental period was 6 weeks during which about 90% of the treatments had less than 20% cumulative germination. This may not conclusively suggest slow germination (Anonymous, 1993; ISTA, 1995) for those treatments (T2, T3, T4, T7, T11, T14, T15). But Thomson and El-Kassaby (1993) were of the view that the earlier seeds germinate, the better their chances of survival on the field, thus a low germination speed of less than 20% in about 6weeks is a sign of slow and poor germination. It is also a sign of erratic germination (Hudson, 1989; Schmidt, 2000) which proves that the pre-sowing treatments were not effective. The effectiveness of any pre-sowing treatment is seen in how early treated seeds germinate and is usually between 2-3 weeks (Anonymous, 1993; Hudson, 1989).

In contrast, T1 showed a higher germination speed when it attained 50% germination in about 31 days after sowing. This view is supported by Hossain *et al.* (2005) who used different days treatments attained to 50% germination to determine which one had a higher germination speed. The shorter the time taken to achieve 50% germination, the greater the germination energy of the seeds and the higher the germination speed (Willan, 1985).

The results contradict observations by Anonymous (2003) and Connor (2009) who reported that seeds with hard seed coat will germinate readily if soaked for 1-2 days in water at room temperature and that *Bauhinia* seeds germinate readily from seed, thus does not need any pre-sowing treatment for excellent germination. *Bauhinia rufescens* like other members of the genus is a hard seeded fabaceae (Alderete-Chavez *et al.*, 2011; Connor, 2008) and require pre-sowing treatment (Anonymous, 1998); not-with-standing the fact that seeds with hard seed coat usually takes more time to germinate with lower germination percentage (Hossain *et al.*, 2005). Irregular germination in the genus has been attributed to impermeability of the seed coat (Alderete-Chavez *et al.*, 2011) as well as other inhibiting factors contributing to dormancy (Schmidt, 2000); thus the ineffectiveness of the 1-21 days of soaking in water to enhance germination.

The high cumulative germination percentage of 77 observed in T1 (<10 sec.boiling) 6 weeks after sowing is supported by Le Houerou (2005), Anonymous (1998) and Le Houerou (1983) who reported that boiling of *Bauhinia rufescens* seeds in water enhances germination. It also supports Anonymous (2011) and Pieterse (2001) who successfully used hot water to break dormancy in seeds with hard-seed coat. It is rather at variance with (Connor, 2002) that satisfactory germination occurs only after 52 weeks. T1 (<10 sec boiling) may have had a better effect because of the washing away or alteration of the chemical structure of the inhibiting substances (Pieterse, 2001) and the effect of the pre-sowing treatment on the seed coat (Alderete-Chavez *et al.*, 2011).

The large difference between T1 (<10 sec boiling) and the rest of the treatments confirm earlier observations by Ehiagbonare and Onyebi (2009) that not all viable seeds will germinate. It also showed that the right pre-sowing treatment is needed to quicken germination of *Bauhinia rufescens* seeds. An effective pre-sowing treatment will result in high germination percentage (Idu *et al.*, 2007). Where a pre-sowing treatment is not very effective seeds will take a longer time to germinate (Anonymous, 1993) and will produce low germination percentage (Hossain *et al.*, 2005).

The high germination value (154) observed in T1 compared with that of the other treatments is indicative of the generally high vigor of the seeds (Willan 1985; ISTA, 1995) and the positive effect the pre-sowing treatment had on germination (Schmidt, 2000).

The low germination values observed in the other treatments according to Thomson and El-Kassaby (1993) may not necessarily be due to low viability as it could occur in seeds with high viability.

High co-efficient of velocity according to Nettles and Poe (1973), Busso *et al.* (2005) and Isfahan and Shariati (2007) is indicative of high germination percentage or capacity; seeds taking less time to germinate and rapidly (Hartmann *et al.*, 1997). Thus the lower the coefficient of velocity the lower the germination percentage and the longer seeds take to germinate (Isfahan and Shariati, 2007). This is however not supported by the results of the experiment for treatments which recorded high co-efficient of velocity. Actually, the observed trend in the values of Coefficient of Velocity (CV) of the treatments was rather irregular. Although CV is an important measure for describing seed vigor (Islam *et al.*, 2008) it may be difficult to use because of its high sensitivity

to small changes in environmental conditions, thus requiring a very high level of precision (Agrawal and Dadlani, 1995); a condition difficult to attain under field conditions.

CONCLUSION

The germination of *Bauhinia rufescens* seeds is erratic but is improved significantly by boiling the seeds in water for less than 10 sec and allowing the seeds to cool down completely in the water before sowing. This was observed to produce more germinated seeds and within a shorter period of time than the other treatments investigated in this study. Soaking seeds in water at room temperature for a number of days as a pre-sowing treatment did not have any significant effect on the ability of the seeds to germinate; neither did the control which involved sowing seeds direct without any pre-sowing treatment. Although pre-sowing treatment influenced the number of days it took for treatments to produce their first germinated seedlings, this did not significantly influence the final germination percentage.

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