Asian Journal of Research in Botany

Volume 7, Issue 1, Page 13-24, 2024; Article no.AJRIB.96558

Effect of Different Seed Treatment Methods on the Germination of *Senna occidentalis* L. 1829 (Coffee Senna) in Sokoto, Sudan Savanna Ecosystem, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/96558

Original Research Article

Received: 02/01/2023
Accepted: 16/02/2023
Published: 03/01/2024

ABSTRACT

Background and Objective: Seed treatment is an act of subjecting a seed into water, chemical or heating medium often to break its dormancy and enhance its embryo to germinate into a seedling within the shortest time possible. Therefore, seed dormancy has remained the greatest challenging

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issue in seedling production for any reason in plant production programme the world over. This study was carried out to determine the effect of different seed treatment methods on the germination of *Senna occidentalis* L. 1829 (Coffee Senna) in Sokoto, Sudan Savanna ecosystem, Nigeria.

Materials and Methods: Hence, three (3) in vitro germination tests at different levels were conducted at Agricultural Chemical Laboratory of the Usmanu Danfodiyo University Sokoto, for thirty six (36) days period to tackle seed dormancy difficulties of *S. occidentalis*. This was with the view to providing some basic information on the matter due to the socioeconomic nutritional potentials of the plant to man in the Sudano-Sahelian ecosystem.

Results: The study determined 2 days soaking (83.00%), 15 minutes hot water (76.65%) and 10 minutes chemical (H_2SO_4) (90.02%) methods as the best germination tests for the seed germinability of *S. occidentalis* in the study area and the results were reported in percentages. However, the field experiment in turn, revealed that germination percentages of *S. occidentalis* (Coffee Senna) seeds obtained were 45.78% at Fadama habitat and 35.56% at upland location, respectively.

Conclusion: Therefore, the best methods determined in this study are recommended for practice in the seedling production of *Senna occidentalis* L. 1829 (Coffee Senna) and its allied species in the study area.

Keywords: Seed treatment methods; Germinability; S. occidentalis (Coffee Senna); laboratory/field experiment; Sudan savanna ecosystem; Sokoto Nigeria.

1. INTRODUCTION

S. occidentalis (L.) (Synonyms: C*assia occidentalis* L. and *Ditremexa occidentalis* L.) belongs to the family Fabaceae, commonly referred to as the bean family. The common names of this plant include Senna Weed, Coffee Senna, Septic Weed, Ant Bush and Arsenic Bean with other vernacular names as “Sanga – Sanga” in Hausa and “Sanga-Sangahi” in Fulfulde. Literature searches revealed the species of this plant not to have been domesticated. However, they grow in the wild as weed. The contributions of the plant and its leaves as medicinal and dietary food vegetables to the populace in Sokoto (the study area) have made the species very popular and common to the local communities of Sudan Savanna, North-Western Nigeria [1]. According to Bulus et al. [2], most people are currently incorporating the non-conventional (wild) food plants in their diets to provide not only nutrients but also traditional treatment for various ailments, sicknesses and diseases. Tukan et al. [3] have also reported that over the last two decades, wild or semi-wild plants have been nutritionally indispensable because of the presence of higher vitamins, minerals, essential fatty acids and fibre contents in them. In addition, some of the plants also enhance taste and colour in diets [4] when added (serving as spices). Furthermore, high protein content was also reported to be available in some wild vegetables growing in Botswana [5] (an African country).

Coffee Senna is a tropical and sub-tropical plant occurring more naturally than planted in both upland and Fadama areas of the study area [6]. It is commonly found in fertile cultivated meadows and river or gully flow areas recognized and preserved for its medicinal value than nutritional contribution to the inhabitants of the study area. All its parts – mainly roots, stems and leaves, flowers and fruits are used in the preparation of traditional medicines either singly or in concoction with other parts of other plants for treatments of different ill-health conditions. The plant is used in the study area for the treatment of typhoid fever, malaria, cough, throat inflammation, asthma and snake bites. The plant is also used in treating dysentery, hemorrhoids, constipation, abdominal problems, general body weakness and convulsion, which is normally prepared in form of pap. Moreover, it is used to check chest pain and liver detoxification [7,8].

The leaves and sometimes with flowers are cooked specially in pots and used as vegetable food. While in another case, the leaves are harvested, cooked, dried, stored and later mixed with grounded powder of cereal crops such as rice, guinea corn and maize, steamed on pots and used as food in African societies especially in dry and early rainy seasons when cereal staples are in short supply. The seeds as well are roasted and made into a coffee - like drink, tea or food additives in the study area. The plant is less grazed by animals. It provides shelter to many small animal populations such as ants,

insects, reptiles, and the like. It also supports soil with nutrients in the study area. The plant stalks when dry are used as fuel wood for cooking in rural houses. The plant is scarcely and arbitrarily propagated sporadically and by direct seeding planting on land during rainy season mostly, talk less of dry season in the study area [1,6].

In the light of the foregoing, this study was aimed at investigating the effect of different methods of seed treatment on the germination of *S. occidentalis* (Coffee Senna) using different means and times at different conditions and locations in the study area. This has become necessary as a case study in order to proffer additional comprehensive information on the seed germinability abilities of the selected wild plant (*S. occidentalis*) in the study area and also to enhance its possible domestication as well as its conservation and hence increase in plant resources of food security in nature.

2. MATERIALS AND METHODS

2.1 Study Area/Site

The study site was the Agricultural Chemical Laboratory, Fadama land and upland locations in Usmanu Danfodiyo University, Sokoto which is located at the Northern part of Sokoto city in Wamakko Local Government Area, Sokoto, Sokoto State, North-Western Nigeria (Longitude 5° 13′ 53″ East and Latitude 13° 3′ 5″ North). The altitude of the study location is 308m above sea level [9-11].

Fig. 1. Map of the Study Area (Source: Alkali et al. 2018) [28]

Fig. 2. An Image Showing the Stem, Branches, Seeds and Flowers of Coffee Senna (*Senna occidentalis*) (Source: WIKTROP – Weed Identification and Knowledge in the Tropical and Mediterranean Areas)

2.2 Seed Collection

Seeds of *S. occidentalis* (L.) were collected by hand-picking of fully ripe pods from parent plants. After hand-picking, the pods were then crushed manually and carefully. Good seeds were sorted out from the bad ones and then washed in order to remove dirt and other foreign materials. After washing, the seeds were carefully sun-dried and gently packed in large paper envelope. The seeds were then stored under metal cabinets at room temperature (28±2ºC) using floatation method of extraction. The viable seeds sank to the bottom of the water while the unviable or damaged ones floated [12,13] and thereafter discarded.

2.3 Seed Dormancy Tests

For the seed dormancy tests, three (3) seed treatment methods were tried for all the seeds of the plant species obtained from the study area in order to determine the best method that will give higher germination rate of the seeds under room temperature (28±2ºC) in the laboratory. This was achieved before field sowing of the seeds in beds. The methods are:

2.3.1 Ordinary water treatment

For the ordinary water treatment method, viable seeds of *S. occidentalis* were placed in ordinary collected tap water maintained at room temperature (28±2ºC) for different periods of time (treatments) ranging from one (1) day, two (2) and three (3) days. Thus, the seeds not soaked in water were taken as the control. After soaking, the seeds were rinsed in clean running water and put in 12 petri-dishes measuring 9cm each. In each of the petri-dishes, soaked filter paper was inserted for germination of the seeds. Each treatment was therefore replicated thrice (i.e. 10 seeds were soaked for each treatment and the control = 10 x 3 x 4 = 120 seeds) [13].

2.3.2 Hot water treatment

For the hot water treatment method, viable seeds were placed in muslin cloth and dipped in boiling water (in a beaker). The seeds were then allowed to stand for 5 minutes**,** removed and cooled in tap water at room temperature (28±2ºC). The seeds were thereafter placed in 12 petri-dishes measuring 9cm each. In each of the petri-dishes, soaked filter paper was inserted for germination of the seeds. The same treatment was repeated for 10 and 15 minutes, respectively and replicated thrice. Untreated seeds not dipped in hot water were the control (i.e. 10 x 3 x 4 = 120 seeds) [14].

2.3.3 Acid treatment

For the acid treatment method, viable seeds were soaked in Sulphuric acid (H_2SO_4) – tetraoxosulphate (VI) acid for certain periods of

time, varying from 5, 10 and 15 minutes, respectively. The seeds were washed in several changes of clean water and then placed in 12 petri-dishes of 9cm each. In each of the petri-dishes, soaked filter paper was inserted for germination of the seeds at room temperature (28±2ºC) [15]. Each treatment was replicated thrice with untreated seeds as control.

However, it should be noted that all the treatments in the three (3) methods identified above were watered with distilled water at 12 hours' interval daily; according to the need, up to the end of the experimental period (i.e. 36 days).

2.3 Experimental Design and Site Selection

The experimental design adopted for this study was complete randomized block design (CRBD). Seven by seven (7/7) meters Fadama and upland sites were obtained at Kwalkwalawa Fadama, Sokoto and Usmanu Danfodiyo University, Sokoto Botanical Garden and then used for direct seeding planting of the specimens in beds.

2.4 Beds Preparation and Layout

For beds preparation and layout, three (3) beds were prepared for sowing of the seeds of the plant species. During sowing of the seeds, cow dung manure was composted to each of the beds and then mixed thoroughly before planting to enhance moisture retention in the beds. The size of each bed was 1.8/1.2 meters long with 50cm spacing in between the beds for easy watering and weeding.

2.5 Seed Rate, Planting and Spacing

Viable seeds from the seed lot that were kept in metal cabinets in paper envelops for all the study plant species were sorted out and then planted in the beds at each of the two locations (Fadama and upland locations). Twenty four (24) holes in six by four (6/4) rows were dug and then planted at 1.5cm depth. Five (5) seeds per hole of 30cm inter-row and intra-row spacing were sown, giving a total of 120 seeds of *S. occidentalis* per bed sown.

2.6 Watering Regimes and Weeding

The beds planted with seeds of *S. occidentalis* were watered with watering cans twice daily for five (5) weeks until seedlings become established under observation during the harmattan season. Therefore, a total watering of seventy (70) times was achieved in thirty five (35) days. Weeding was conducted regularly and carefully based on the need for it per each bed.

2.7 Data Analysis

Data generated for this study were collected on a daily basis and then analysed using percentages in tables. The data were entered into a spreadsheet using Microsoft Excel 2013. Seed germination percentage was calculated for days after sowing per seed treatment times (days/minutes).

3. RESULTS

3.1 Laboratory Experiment Germination Test Results

The laboratory experiment germination test results were reported based on ordinary water (soaking) treatment method; hot water treatment method; and chemical (H_2SO_4) treatment method for the seeds of *S. occidentalis* (Tables 1 - 3) respectively as presented below:

3.1.1 Ordinary water treatment

Results in Table 1 indicates that at the end of the 36 days observation period, the unsoaked seeds (control) and seeds soaked in ordinary water for two (2) days commenced germination on the 5th day and germination for all the treatments ceases on the 23rd day of the observation period except that of the control which ceases on the 24th day. The highest daily percentage (%) germination of 10.00% was recorded only in both 2- and 3-days treatments with highest occurrence in 2 days treatment. This had led the 2 days treatment to be the most effective ordinary water treatment method accounted for the highest percentage (%) seed germinability of 83.00%, followed by both 1- and 3-days treatments (70.00%) with control being the least (56.64%).

3.1.2 Hot Water Treatment

Germination results of the seeds of *S. occidentalis* treated with hot water medium (Table 2) revealed that germination for both control and 10 minutes commenced on the 5th day after treatment but ceases on the 20th day for the control, 23rd day for 10 minutes treatment

and on 24th day for 5- and 15-minutes treatments with highest daily % germination of 10.00% occurring in all the treatments including the control. Highest percentage (%) seed germinability of 76.65% was recorded at 15 minutes treatment.

Table 1. Cumulative Percentage (%) Germination of *S. occidentalis* Seeds Treated at Different Times (Days) Using Ordinary Water (Soaking) Treatment Method

Days After Sowing	Seed Treatment Times (Days)			
	Control	**1 Day**	**2 Days**	**3 Days**
1	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
5	3.33	0.00	3.33	0.00
6	0.00	0.00	0.00	0.00
7	6.67	3.33	0.00	6.67
8	3.33	6.67	3.33	6.67
9	0.00	6.67	0.00	10.0
10	6.67	3.33	10.0	3.33
11	3.33	3.33	0.00	10.0
Daily % Germination				
12	3.33	3.33	10.0	6.67
13	3.33	3.33	10.0	0.00
14	6.67	6.67	0.00	10.00
15	0.00	0.00	3.33	3.33
16	3.33	6.67	0.00	3.33
17	0.00	3.33	10.0	3.33
18	3.33	0.00	6.67	0.00
19	3.33	6.67	0.00	3.33
20	3.33	6.67	3.33	0.00
21	0.00	3.33	6.67	0.00
22	0.00	3.33	0.00	0.00
23	3.33	3.33	6.67	0.00
24	3.33	0.00	6.67	3.33
25	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00
29	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00
31	0.00	0.00	0.00	0.00
32	0.00	0.00	0.00	0.00
33	0.00	0.00	0.00	0.00
34	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.00
36	0.00	0.00	0.00	0.00
% Germination	**56.67**	**70.00**	**83.00**	**70.00**

Table 2. Cumulative Percentage (%) Germination of *S. occidentalis* Seeds Treated at Different Times (Minutes) Using Hot Water Treatment Method

Days After Treatment	Seed Treatment Times (Minutes)			
	Control	5 Minutes	10 Minutes	15 Minutes
1	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
5	3.33	0.00	3.33	0.00
6	0.00	0.00	0.00	0.00
7	3.33	0.00	0.00	3.33
8	0.00	0.00	0.00	0.00
9	0.00	0.00	6.67	3.33
10	10.0	0.00	6.67	13.33
Daily % Germination				
11	3.33	0.00	0.00	3.33
12	0.00	0.00	3.33	0.00
13	3.33	6.67	10.0	6.67
14	6.67	3.33	6.67	20.0
15	3.33	10.0	0.00	0.00
16	0.00	6.67	3.33	0.00
17	3.33	3.33	3.33	10.0
18	0.00	6.67	3.33	3.33
19	3.33	6.67	6.67	3.33
20	3.33	6.67	3.33	0.00
21	0.00	6.67	3.33	6.67
22	0.00	0.00	3.33	0.00
23	0.00	3.33	0.00	3.33
24	0.00	3.33	0.00	0.00
25	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00
29	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00
31	0.00	0.00	0.00	0.00
32	0.00	0.00	0.00	0.00
33	0.00	0.00	0.00	0.00
34	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.00
36	0.00	0.00	0.00	0.00
% Germination	**43.31**	**63.34**	**63.32**	**76.65**

3.1.3 Chemical Treatment Method

The seed germination of *S. occidentalis* for the chemical (H_2SO_4) treatment method commenced three days after treatment for the 10 minutes treatment only (Table 3). Germination for the control and 15 minutes treatment commenced simultaneously on the 5th day, while that of 5 minutes commenced on the 9th day after treatment. Germination began to cease on the 17th day after treatment for the control and 15 minutes treatment; 20th day for the 10 minutes treatment and 22nd day for the 5 minutes treatment with the highest daily percentage (%) germination of 13.33% occurring in 15 minutes treatment. 10 minutes treatment had the highest percentage (%) seed germinability of 76.68%, followed by 5 minutes (63.34%), then 15 minutes treatment (53.33%) and control was the least (50.00%).

Table 3. Cumulative Percentage (%) Germination of *S. occidentalis* Seeds Treated at Different Times (Minutes) Using Chemical (H_2S0_4) Treatment Method

Days After Treatment	Seed Treatment Times (Minutes)			
	Control	**5 Minutes**	**10 Minutes**	**15 Minutes**
1	0.00	0.00	0.00	0.00
2	0.00	0.00	0.00	0.00
3	0.00	0.00	0.00	0.00
4	0.00	0.00	3.33	0.00
5	3.33	0.00	0.00	3.33
6	0.00	0.00	0.00	0.00
Daily % Germination				
7	6.67	0.00	0.00	0.00
8	3.33	0.00	6.67	3.33
9	6.67	3.33	6.67	13.33
10	3.33	6.67	0.00	6.67
11	6.67	6.67	6.67	6.67
12	3.33	0.00	16.67	10.0
13	6.67	16.67	6.67	0.00
14	3.33	0.00	6.67	3.33
15	0.00	6.67	6.67	6.67
16	3.33	13.33	3.33	0.00
17	3.33	0.00	6.67	0.00
18	0.00	6.67	6.67	0.00
19	0.00	0.00	3.33	0.00
20	0.00	0.00	3.33	0.00
21	0.00	0.00	0.00	0.00
22	0.00	3.33	0.00	0.00
23	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00
26	0.00	0.00	0.00	0.00
27	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00
29	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00
31	0.00	0.00	0.00	0.00
32	0.00	0.00	0.00	0.00
33	0.00	0.00	0.00	0.00
34	0.00	0.00	0.00	0.00
35	0.00	0.00	0.00	0.00
36	0.00	0.00	0.00	0.00
% Germination	**50.00**	**63.34**	**90.02**	**53.33**

3.2 Field Experiment Germination Test Results

Table 4 had presented the germination test results of the field experiment for the seeds of *S. occidentalis* treated for 10 minutes with H_2SO_4. Germination was presented as daily percentage germination and percentage germinability of the three replicate blocks of the study species. Germination of the seeds of *S. occidentalis* commenced on the 7th day after treatment and sowing but ceases until the 16th day after treatment and sowing when it consecutively continues and ceases on the 35th day of the experimental period with highest daily percentage of 36.11% occurring on the 22nd day of the experimental period and of 45.78% germinability for Fadama location. Results for the germination of the seeds of *S. occidentalis* presented in Table 4 were for those seeds treated with chemical treatment method for 10 minutes. *S. occidentalis* seeds commenced germination on the 5th day after treatment and sowing and ceases on the 35th day of the experimental period with the highest daily percentage germination of 16.67% occurring on the 22nd - 24th day of the experimental period and 35.56% seed germinability for upland location.

Table 4. Cumulative Percentage (%) Germination of *S. occidentalis* Seeds Sown at Fadama and Upland Locations, Treated at 10 Minutes Time Using Chemical (H_2SO_4) Treatment Methods

Days After Sowing	Upland Treatment	Fadama Treatment
1	0.00	0.00
2	0.00	0.00
3	0.00	0.00
4	0.00	0.00
5	1.39	0.00
6	0.00	0.00
7	0.00	1.39
8	2.78	0.00
9	0.00	0.00
10	1.39	0.00
11	1.39	0.00
12	0.00	0.00
13	5.56	0.00
Daily % Germination		
14	0.00	0.00
15	2.78	0.00
16	5.56	4.17
17	5.56	2.78
18	6.94	6.94
19	11.11	9.72
20	8.33	22.22
21	6.94	23.61
22	12.50	36.11
23	16.67	15.28
24	16.67	25.00
25	0.00	6.94
26	16.67	5.56
27	8.33	6.94
28	13.89	9.72
29	1.39	5.56
30	0.00	6.94
31	2.78	4.17
32	11.11	2.78
33	8.33	16.67
34	4.17	15.28
35	2.78	1.39
36	2.78	0.00
%Germination	**35.56**	**45.78**

4. DISCUSSION

4.1 Laboratory Experiment: Ordinary Water Treatment

It can be observed that the trend of the results (Table 1) showed steady increase in the daily percentage germination and percentage germinability values from 1 - 3 days pre-treatments in comparison with the control treatment which were statistically non-significant. This results agreed with the reports of Hossain et al. [16]; Eghoruba et al. [17]; and Feike et al. [18] that seeds soaked in water overnight before planting showed highest seed germination in comparison with any other method of breaking seed dormancy in most plant species including *S. occidentalis* (Coffee Senna). This finding was also supported by Anonymous [19], who reported that soaking of seed in water can be used to tackle all the different types of seed dormancy. According to Anonymous [19], this can be achieved by modifying hard seeds coat, removing inhibitors and softening the seeds. The advantage of the above methods is that they ensure adequate absorption of water by the seeds. However, the continued increase in germination percentage due to increase in the number of days of pre-treatment methods showed clearly the relevance and indispensability of moisture increase to softening the hard seed coat of the study species. At this juncture, based on the above reason, Awodola [20] reported that soaking of seed in water is the

simplest and widely used pre-germination treatments for breaking seed dormancy in the plant world. However, the finding in this study implies that pre-treatment of seeds with ordinary water before sowing decreases germination in the seeds of *S. occidentalis* (Coffee Senna). Thus, soaking of seeds in water for breaking dormancy is not required for the seeds of *S. occidentalis* (Coffee Senna) in the study area.

4.2 Laboratory Experiment: Hot Water Treatment

The results of Table 2 can be simultaneously observed to increase steadily from 5 - 15 minutes with hot water treatment in the daily percentage germination. However, the results were statistically non-significant and higher than the control value somehow in *S. occidentalis* (Coffee Senna). The above finding agreed with reports of Valenti et al. [21]; Davis et al. [22]; Mackay et al. [23] and Centenera et al. [25] who observed that seeds immersed in 1 - 10 times volume of boiling water (100ºC) improved germination. The observation reported in this study also agreed with the finding of Duguma et al. [25] who reported that seeds treated with hot water at 100ºC increased germination with increasing ratio of seeds to water in comparison with the control treatment. However, this observation had disagreed with the report of Sasaki [26] who observed that hot water treatment was less effective. Possibly, the above observation could be the reason why control treatment percentage germinability for hot water treatment was quantitatively higher than 5 - 15 minutes treatment at 15 minutes period. Therefore, hot water treatment is the best treatment method for breaking seed dormancy for higher germination in seeds of *S. occidentalis* (Coffee Senna).

4.3 Laboratory Experiment: Chemical Treatment

The findings of higher percentage germinability were presented in Table 3 as for 5, 10 and 15 minutes chemical treatment method in comparison with the control. Even though, the result is not statistically significant, it agreed with the report of Anonymous [19] who observed that chemical scarification of seeds increase the percentage of seeds that germinate. The result of the chemical treatment reported in this study also agreed with the report of Moussa and Margolis [27] and Souza and Marcos-Filho [29] who observed that chemical treatment of hard seed coat facilitated and increased the germination rate of many seeds with hard and water impermeable seed coats. This might be a reason why 10 minutes chemical treatment showed high germination rates than all the other treatments with the control inclusive in *S. occidentalis* (Coffee Senna). However, in this study, the control proved the best as per Table 3. This finding implies that chemical treatment was the best for *S. occidentalis* (Coffee Senna) than the other treatments in the study area.

4.4 Field Experiment: Fadama and Upland Habitats

It can be observed from the results of the field experiment for Fadama and upland habitats obtained in this study that at Fadama habitat, *S. occidentalis* (45.78%) had quantitatively higher percentage germinability than upland habitat (35.56%) as in Table 4. This disagreed with the report of Sasaki [26] who observed that hot water treatment was less effective for breaking seed dormancy. Rather, it further confirmed that hot water treatment was a successful medium for treating seeds of *S. occidentalis* (Coffee Senna) for direct sowing into the soil at Fadama location.

5. CONCLUSION

Results of the laboratory experiments revealed that 2 days ordinary water treatment as well as 15 minutes hot water treatment and 10 minutes chemical treatment methods for *S. occidentalis* (Coffee Senna) seeds were the best methods which gave 83.00%, 76.65% and 90.02% percentage (%) seed germinability in the study area. The field experiment in turn, revealed 45.78% at Fadama habitat and 35.56% at upland location for *S. occidentalis* (Coffee Senna), respectively in the study area. The effect of seed dormancy was observed on the germination of the seed sown in both Fadama and upland locations; hence, some could not germinate in the field (during dry season) until during the subsequent rainy season. But all things being equal, the required stands of the study species at each location were obtained from the experiment.

6. RECOMMENDATIONS

To amalgamate the findings of this research study on the effect of different treatment methods on seed germinability of *S. occidentalis* (Coffee Senna), the following were recommended:

- For higher germination percentage of the seeds of the study species (*S. occidentalis*) in the field, 10 minutes chemical (H_2S0_4) treatment method was recommended as the best method for seed pre-treatment.
- Sowing the seeds of the study species into the field should be carried out during the rainy season; hence, some seeds that failed to germinate during the dry season, germinated at the early rainy sub-season in this study.
- Therefore, cultivation of the study species at any sub-season is hereby recommended to the farmers and for scientific researches especially at Fadama location.
- For further study and ensuring food security, similar research should be conducted on other similar species to bring out more of their potentials for domestication and conservation as well as enhancing more sources of food supply in the universe and advancement of knowledge.

ACKNOWLEDGEMENTS

We are grateful to Mal. Ahmad Modi Bodinga, for his support, patience and kindness during the laboratory experiment. We are also thankful to Late Alhaji Muhammad Dan-Ige, Mal. Aliyu Jabo, Mal. Ahmad Muhammad Dan-Ige, Mal. Basiru Aliyu Kwalkwalawa, and late Mal. Umaru Mai Gadina for their patience, assistance and support in ensuring the security of the experimental sites at both Fadama and upland locations.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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