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Effect of acid scarification and organic manure application on seed germination and early seedling growth of *Vachellia Nilotica*

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Abstract

This study assessed the effect of acid scarification and organic manure on seed germination and early seedling growth of *Vachellia nilotica.* Seeds of *V. nilotica* were soaked in tetra-oxo-sulphate (vi) acid at 25%, 50%, 75%, and 98% concentration for 5, 10 and 15 minutes for each concentration respectively. After soaking, the seeds were removed, washed and rinsed in running tap water to remove the acid. Sixty seeds for each treatment and untreated seeds (control) were sown in a bowl previously filled with topsoil and watered for germination. Number of seeds germinated per day was monitored and recorded for each treatment. For early growth experiment, seedlings with relatively uniform height were selected from all the treatments and transplanted into polythene pots filled with topsoil amended with different organic manure viz: poultry dropping, cow dung, poultry dropping +cow dung and control. Watering was done once a day throughout the duration of the experiment. Growth parameters (i.e heights, stem diameter, number of leaves, and leave area) were measured over a period of 8 weeks. Results on germination showed that seeds treated with 98% acid concentration for 15 minutes had the lowest mean germination time (MGT) of 5.96 days and highest germination percentage (GP) of 51.7%, while results on seedling growth showed that soil amended with cow dung had the highest mean value of growth performance for all the parameters examined. It was recommended that soaking for 15minutes in 98% acid concentration should be adopted for optimum seed germination while cow dung should be used as organic manure.

Keywords: Acid Scarification, Organic Manure, Seed Germination, Seedling Growth, *Vachellia Nilotica*

1. Introduction

Vachellia nilotica belongs to the sub family of *caesalpinioideae* and family of *Fabaceae* (LPWG, 2017) [9]. It is a multipurpose tree native to Nigeria and is recognized by the name Scorpion mimosa. It is called Bagaruwa in Hausa and is a great source of livelihood (Issoufou, 2020) [7]. The species has a wide range of distribution throughout the tropical and subtropical area of the world and occupies wide range of natural habitats (Auwal *et al*., 2015) [3]. In parts of Africa, *Vachellia species* are shaped progressively by grazing animals such as gazelle, gerenuk and giraffe. The genus in Africa has thorns in defense against such herbivory. Other well-known species of Vachellia are *Vachellia karroo*, *V. xanthophloea* and *V. sieberiana*, (Kyalangaliwa *et al*. (2013) [8].

V. nilotica is an invaluable tree species that play important role in the life of local community people as it provides food, fibre, fodder, timber, gum or resin, medicine, apiculture, fuel, tannins and also gives contribution in soil erosion control, nitrogen fixation, soil improvement, intercropping, boundary demarcation and support (Meena, 2015) [10]. It is a multipurpose plant that has been used broadly for the treatment of various diseases, in traditional practice; the plant is used for the treatment of tuberculosis, pneumonia, gonorrhea and small pox (Singh *et al*., 2009) [15]. It is an elite species in the Great Green Wall project, a project of plantation initiated by sahelian countries to fight desertification (Hannani and Chehma, 2012) [6].

The tree grows up to 20 m high with a dense spherical crown, stems and branches usually dark to black colour, fissured bark, grey-pinkish slash, exuding a reddish low-quality gum. The tree has thin, straight, light-grey spines in axillary pairs, usually in 3 to 12 pairs and 5 to 7.5 cm long in young trees. Mature trees are usually without thorns and it is imperative in traditional rural and agro-pastoral systems (Shittu, 2010) [14].

Vachellia nilotica is known to grow in the wild, and there has been an increase in the demand for this species in recent years. Attempts by foresters to propagate or regenerate the plant on a large scale has not yielded desired result due to dormancy.

Some farmers complained of poor germination rates after direct seeding of *V. nilotica* (Siri Holmberg, 2013) [16]. In the present study, treatments with varying concentration of tetra-oxo-sulphate (vi) acid (H_2SO_4) for varying time periods is considered for breaking the seed dormancy of this multipurpose species and subsequent germination of the seed and growth of the seedlings for plantation establishment.

2. Materials and method

The study area

The study was carried out at the nursery unit of the Department of Forest Resources Management, University of Ilorin. The Nursery is geographically located on longitude 04º40˙39˝ E and latitude 08º29˙9" N. Total annual rainfall ranges from 1,000 mm to 1,500 mm. with distinct wet and dry seasons. The rainy season is between March and November with the peak between September and early October. The relative humidity ranges from 75% to 88% from May to October, while in the dry season it ranges from 35% to 80%. The mean monthly temperature varies from 25˚C to 38˚C (Olanrewaju, 2009) [12]. The soil is loamy sand and the vegetation of the area is guinea savannah with scattered trees (Adeniyi, 2017) [1].

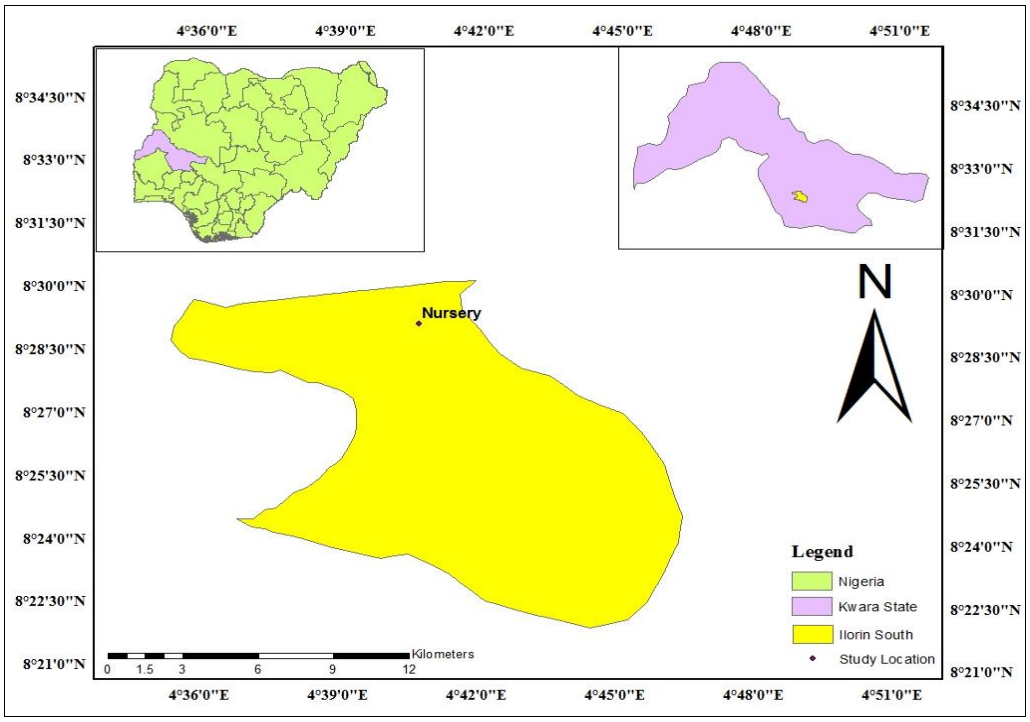

Fig 1: Map of the study area

Seed collection and processing

The seed pods were collected under matured trees of the species in a farmstead around Ilorin Airport. The pods were broken to remove the seeds. Thereafter, floatation method was performed to test for the seed viability. The viable seeds were air-dried and kept in a tray in the laboratory. The seeds were treated by soaking in different concentrations of tetra-oxo-sulphate (vi) acid at varied time to break the seed dormancy.

Experimental procedure

The study consists of two experiments viz; (i) germination experiment and (ii) growth experiment. Under germination experiment, seeds of *V. nilotica* were soaked in tetra-oxo-sulphate (vi) acid at 25%, 50%, 75%, and 98% concentration for 5, 10 and 15 minutes for each concentration respectively. After soaking, the seeds were removed, washed and rinsed in running tap to remove the acid. Sixty seeds of each treatments including control were sown in bowls previously filled with topsoil and watered for germination to take place. Number of seeds germinated per day was monitored and recorded for each treatment. till no further germination is observed.

Growth experiment consists of 4 treatments viz: topsoil without amendment (T_1), topsoil amended with poultry dropping (T_2), topsoil amended with cow dung (T_3), topsoil amended with poultry dropping +cow dung (T_4). Twenty seedlings with relatively uniform height were selected from all the treatments and were transplanted into polythene pots filled with different growth media. Growth parameters (i.e heights, stem diameter, number of leaves, and leave area) were measured over a period of 8 weeks. The treatments were replicated five (5) times.

3. Calculations

$$\text{Germination Percentage} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}} \times 100 \text{ (Zarchini } et\ al.\text{, 2011) [18]} \quad (1)$$

$$\text{Mean germination time (MGT)} = \frac{\text{Number of seeds germinated per day X Day after sowing}}{\text{Total number of seedlings germinated}} \text{ (Gairola, 2011) [5]} \quad (2)$$

$$\text{Spread of Germination} = \text{First day of germination} - \text{Last day of germination} \quad (3)$$

Data analysis

Data collected were subjected to analysis of variance (ANOVA) at 5% level of significance using SPSS package. The means were separated using Duncan Multiple Range Test (DMRT).

4. Results

Effect of acid scarification on germination of *V. nilotica* seed

The result in table 1 shows that seeds treated with 98% acid concentration for 15 minutes had the least mean germination time (MGT) of 5.96 days followed by 75% acid concentration for 15minutes (6.93 days) while 50% acid concentration for 5minutes had the highest MGT value (27.4 days). Similarly, acid treatment at 98% concentration for 15minutes had the highest germination percentage (GP) (51.7%), this was followed by acid treatments at 98% concentration for 10minutes (41.7%), 75% concentration for 10minutes (33.3%) while the least GP was recorded for the control treatment (8.3%).

Table 1: Effect of acid conc. and treatment time on germination of *V. nilotica* seeds

Germination parameters	Control	25% Conc.			50% Conc.			75% Conc.			98% Conc.		
	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13
		5min	10min	15min	5min	10min	15min	5min	10min	15min	5min	10min	15min
Mean germination time (days)	25.8	26.3	25	24.9	27.4	26.2	18.5	12.75	11.2	6.93	18.56	9.56	5.96
Germination time spread	16	31	35	29	24	27	28	13	17	9	12	16	22
Germination percentage (%)	8.3	10	16.6	13.3	13.3	16.6	20	13.3	33.3	35	15	41.7	51.7

Germination Time Spread (GTS) of *V. nilotica* seed

Fig 2, 3 and 4 summarize the germinations time spread of *V. nilotica* seed at the different acid concentrations and exposure time. The result in figure 2 showed that 98% acid conc. and 75% acid conc. for 5 minutes, had 1 and 7 total seed germination on 11th day after sowing respectively. Acid conc of 50% for 10 minutes had a total of 6 germinated seeds on 23rd days after sowing (Fig.3). while fig. 4 showed that 25% acid conc. for 15 minutes had 8 germinated seeds on 33rd days after sowing.

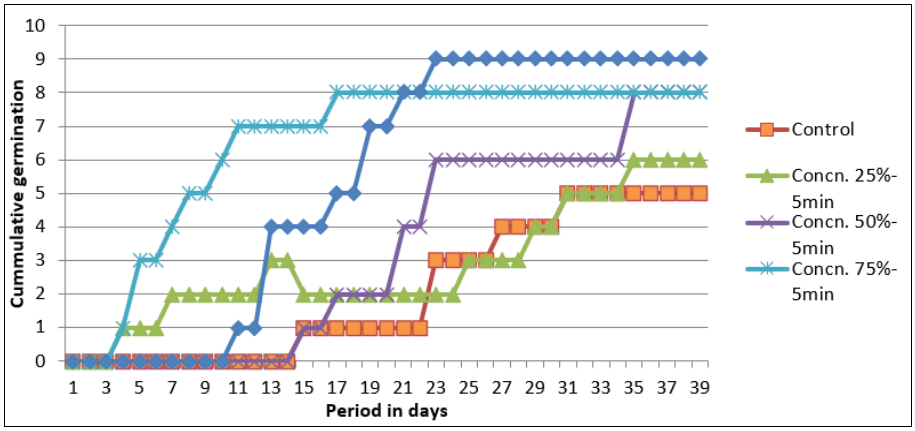

Fig 2: Germination of *V. nilotica* seeds for the control and acid treatments for 5 minutes

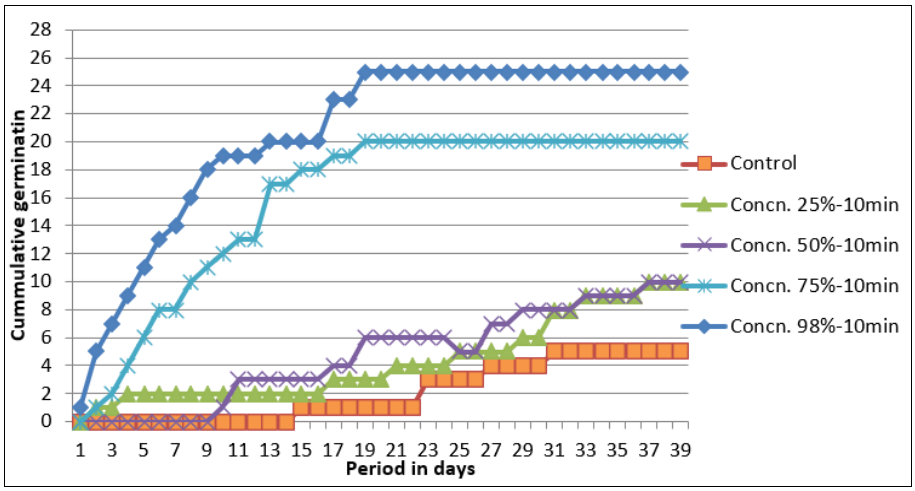

Fig 3: Germination of *V. nilotica* seeds for the control and acid treatments for 10 minutes

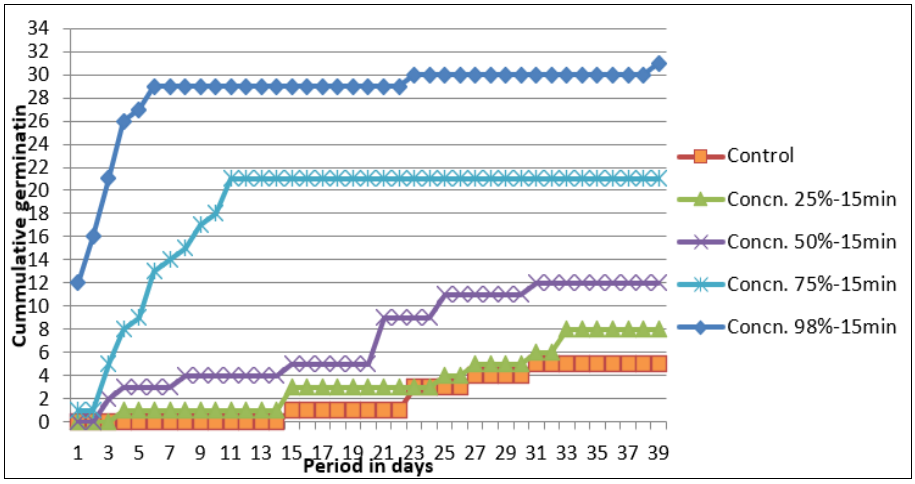

Fig 4: Germination of *V. nilotica* seeds for the control and acid treatments for 15 minutes

Effect of different organic manures on the growth of *Vachellia nilotica* seedlings

The result shows that seedlings grown on soil amended with cow dung have the highest height value throughout the growth period. This was followed cow dung + poultry droppings and control treatments respectively. The result also showed that mean diameter of seedlings grown on soil amended with cow dung has the highest value throughout the growth period, followed by seedlings grown on cow dung + poultry droppings and control treatments respectively (table 3). The result shows that 2 weeks after transplanting (WAT), diameter of seedlings grown on soil amended with cow dung has the highest mean value (0.49cm) followed by cow dung + poultry droppings (0.46cm) while poultry droppings had the least value (0.35cm). At 4, 6, and 8WAT, seedlings diameter followed the same trend as obtained for 2WAT. The result furthermore shows that seedlings diameter was not significantly different ($p<0.05$) for all the treatment at 2WAT.

Table 2: Effect of different organic manures on the height of *Vachellia nilotica* seedlings

Treatments	Growth period				
	Initial reading	2WAT	4WAT	6WAT	8WAT
CD	12.00±0.00^{a}	17.10±1.53^{a}	22.34±1.78^{a}	26.82±.90^{a}	34.36±1.92^{a}
CP	12.00 ±0.00^{a}	16.02±2.37^{a}	21.18±1.93^{a}	24.80±1.65^{a}	28.00± 2.28^{ab}
PD	12.00±0.00^{a}	11.28± 6.37^{b}	12.40± 6.99^{b}	14.64±8.20^{b}	17.98±10.06^{c}
CT	12.00±0.00^{a}	14.84±1.9^{ab}	19.06±2.89^{a}	22.26±3.30^{a}	26.60±3.12^{b}

Key: CD = Cow dung, CP = Cow dung+ poultry droppings, PD = Poultry droppings, CT = Control.
NB: Means with the same alphabets as superscript in the column are not significantly different ($p<0.05$).

Table 3: Effect of different organic manures on the stem diameter of *Vachellia nilotica* seedling

Treatments	Growth period				
	Initial reading	2WAT	4WAT	6WAT	8WAT
CD	0.04±.0.0^{a}	0.049±0.05^{a}	0.055±.03^{a}	0.065±0.06^{a}	0.077±0.08^{a}
CP	0.04± 0.00^{a}	0.046±0.04^{a}	0.049±0.02^{ab}	0.056±0.05^{ab}	0.071±0.03^{a}
PD	0.04± 0.00^{a}	0.035±0.02^{a}	0.038±0.02^{b}	0.042±0.02^{b}	0.048±0.03^{b}
CT	0.04±0.00^{a}	0.044±0.00^{a}	0.046±0.00^{ab}	0.050±0.02^{ab}	0.062±0.03^{ab}

Key: CD = Cow dung, CP = Cow dung+ poultry droppings, PD = Poultry droppings, CT = Control.
NB: Means with the same alphabets as superscript in the column are not significantly different ($p<0.05$).

Effect of different organic manures on the number of leaves of *Vachellia nilotica* seedling

Table 4 shows the result for seedling number of leaves under the different organic manures soil amendments. The result shows that seedlings grown on soil amended with cow dung have the highest leaf no throughout the growth period. This was followed cow dung + poultry droppings and control treatments respectively. The result furthermore shows that seedlings leaf no was not significant different ($p<0.05$) at 2, 4 and 6WAT for all the treatments.

Table 4: Effect of different organic manures on the number of leaves of *Vachellia nilotica* seedling

Treatments	Growth period				
	Initial reading	2WAT	4WAT	6WAT	8WAT
CD	8.60 ±0.55^{a}	13.20±21^{a}	20.40±4.2^{a}	25.20±2.95^{a}	31.00±1.87^{a}
CP	8.20±0.84^{a}	12.40±2.07^{a}	17.80±3.19^{a}	22.40±3.05^{a}	26.60±2.88^{ab}
PD	8.20±0.84^{a}	10.00±5.79^{a}	14.00±8.22^{a}	17.20±9.98^{a}	20.40±11.46^{b}
CT	8.20±.84^{a}	12.20±2.17^{a}	17.60±4.04^{a}	22.40±3.58^{a}	25.20±3.42^{ab}

Key: CD = Cow dung, CP = Cow dung+ poultry droppings, PD = Poultry droppings, CT = Control.
NB: Means with the same alphabets as superscript in the column are not significantly different ($p<0.05$).

Effect of different organic manures on the leaf area of *Vachellia nilotica*

Table 5 shows the result for seedlings leaf area under the different organic manure soil amendments. The result shows that leaf area was highest for seedlings grown on soil amended with cow dung, this was followed by cow dung + poultry droppings and control treatment. The result also shows that leaf area was significantly lower for seedlings grown on soil amended with poultry droppings at 2, 4 and 6WAT. However, leaf area was not significantly deferent ($p<0.05$) for all the treatments at 8WAT.

Table 5: Effect of different organic manures on the leaf area of *Vachellia nilotica* seedling

Treatments	Growth period				
	Initial reading	2WAT	4WAT	6WAT	8WAT
CD	95.60±3.07[a]	195.36±6.72[a]	507.72±12.38[a]	815.60±29.92[a]	1019.14±45.89[a]
CP	94.10±3.70[a]	188.92±10.96[a]	446.70±57.03[ab]	639.40±45.82[ab]	975.46±84.62[a]
PD	74.80±41.83[a]	129.76±76.56[b]	337.64±19.46[b]	498.32±29.15[b]	715.42±41.38[a]
CT	91.54±1.99[a]	153.38±31.48 [ab]	399.96±16.28[ab]	613.72±95.75[ab]	868.82±11.66[a]

Key: CD = Cow dung, CP = Cow dung+ poultry droppings, PD = Poultry droppings, CT = Control.
NB: Means with the same alphabets as superscript in the column are not significantly different ($p<0.05$).

5. Discussion

The low mean germination time (MGT) obtained for seeds scarified with 98 % conc. acid in this study could be attributed to softness of the seed coat through the corrosive action of the acid, this enhances permeability of the seed to water and air. This assertion is in agreement with Olujobi *et al.,* (2010) [13] who reported rapid germination of *Afzelia Africana* seed treated with conc. H_2SO_4. The high germination percentage obtained for seeds socked in 98 % tetra-oxo-sulphate (vi) acid for 15 minutes in this study compare to other lower concentration showed that the higher the acid concentration the greater the germination percentage. This assertion corroborates the report by Olujobi *et.al.,* (2022) [14] and Azad *et.al.,* (2012) [4] on *Albizia lebbek* seed scarified in H_2SO_4 at different concentration.

It was also observed that seeds scarified with acid at low concentration for longer time performed well in terms of percentage germination, this suggest that increasing treatment time enhanced seed germination. This observation could be attributed to the highly desiccant effect of the acid on the seed coat with longer treatment time, thereby allowing easier water uptake and oxygen diffusion. This assertion further confirms the report of Okunomo and Bosah, (2007) [11] that seeds of *Acacia senegal* treated with acid for 15 minutes gave 90% germination.

The observed better performance of seedlings grown on soil amended with organic manure (particularly cow dung) could be attributed to better nutrient absorption which favoured faster seedling growth. This assertion corroborates the findings of Agbo-Adediran *et al.* (2020) [2] that cow dung is best used as organic manure for raising seedlings of *Entandrophragma angolense* during its early growth stage in the nursery. The better growth performance of seedlings in soil amended with cow dung over that of poultry droppings is an indication that cow dung is a high-quality manure that decompose and mineralized fast to release the nutrients for subsequent seedling uptake. In this case there is a synchrony between nutrient release and uptake at this early growth stage. On the other hand, the poultry droppings undergo curing before decomposition and mineralization thereby delaying the release of nutrient for seedling uptake.

6. Conclusion and recommendation

The study showed that the germination percentage of *V.nilotica* improved significantly when seeds were pretreated with 98 % concentration of tetra-oxo-sulphate (vi) acid for 15minutes. This implies that using high acid concentration with increasing treatment time will break the barrier of dormancy in *V. nilotica* seed. The study further showed that seedlings grown on soil amended with cow dung manure perform best in terms of growth parameters measured (i.e height, collar diameter and number of leaf) throughout the growth period. Based on these findings, it is recommended that socking in 98% tetra-oxo-sulphate (vi) acid for 15minutes should be adopted for breaking dormancy in *V. nilotica* seed and cow dung manure should be used as organic manure for raising seedlings of *V.nilotica* during its early growth stage in the nursery.

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