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Dormancy breaking and the influence of gibberellic acid on the early growth of *Tamarindus indica* seedlings in Mubi, Nigeria

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Abstract

The purpose of this study was to determine the appropriate methods of breaking seed dormancy, level of water uptake, and the influence of gibberellic acid on the early growth of *Tamarindus indica* seedlings. The scarification methods used included: concentrated sulphuric acid (H_2SO_4), manual scarification, flaming, hot and cold water treatments. The experiments were conducted in the laboratory on Petri dishes and in potting media. GA_3 was used to optimize the production of seedlings by spraying the solution on the foliage. The treatment for 10 minutes with Conc. H_2SO_4 gave the maximum germination percentage and water uptake (80.41%). GA_3 enhances the growth of the seedlings by increasing the height, the number of leaves and stem girth at eight weeks after sowing. In conclusion, all the scarification treatments applied to the seeds of *T. indica* proved effective. The ten (10) minutes treatment with concentrated H_2SO_4 was the best treatment for breaking seed dormancy of *T. indica*. And gibberellic acid enhanced early and fast seedling growth as it increase height, number of leaves and stem girth of *T. indica*.

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Introduction

Tamarindus indica L. of the family Fabaceae is an important food plant in the tropics. It is a multipurpose tree of which almost every part finds at least some use (Kumar *et al.,* 2014), either nutritional or medicinal. Tamarind is indigenous to tropical Africa but it has been introduced and naturalized worldwide in over 50 countries. The major production areas are in the Asian countries, for example in India and Thailand and also in countries such as Bangladesh, Sri Lanka, Thailand and Indonesia. Africa, on the whole, does not produce tamarind on a commercial scale. Minor producing countries in Africa are Senegal, Gambia, Kenya, Tanzania, Nigeria and Zambia (El-Siddiq *et al.,* 2006).

In Nigeria, particularly in the northern parts of the country, which is inhabited mostly by the Hausa-Fulani tribes; it is known as 'tsamiya'. The pulp is used as a sweetener in sorghum and millet porridge while the other parts of the plant are used as antioxidant (Sugii, 2003), anti-hepatoxic (Joyeux *et al*., 1995), anti-inflammatory, anti-mutagenic (Pamela, 2012) and anti-diabetic (Maiti *et al*., 2004). The plant is a slow-growing one; and long-lived tree that reaches under favorable condition a height of 12-24m and a trunk circumference of 7.5m. The matured tree under favorable conditions may annually yield 150-225kg of fruits (Morton, 1987). Tamarind wood is useful in making furniture, wheels, mallets, mortars, pestles, ploughs, tent pegs, canoes, side planks for boats, cart shafts and axles, and naves of wheels, toys, oil presses, sugar presses, printing blocks, tools and tool handles, turnery, and so on (Bhadoriya *et al*., 2011).

In northern Nigeria where the effect of deforestation, erosion and desert encroachment is alarming, it is therefore expedient to minimize this problem through afforestation programmes. However, to achieve the aim of any afforestation programme, seed collection and germination must be taken into consideration. Germination of seeds is often very difficult for many useful species principally because of dormancy (Basra, 2006). Seeds are expected to germinate easily when favorable conditions for germination such as water, temperature, and light are provided to them, but this is not so in the case of some seeds. The seed does not readily germinate even if such conditions for germination are provided. The population of *T. indica* is declining yearly in Mubi due to over exploitation and lack of management. In view of this, therefore, appropriate methods of breaking seed dormancy of *T. indica*, water uptake and hormonal influence in the early growth of this valuable economic tree, thus enabling large scale seedling production were studied.

Materials and methods

Study Area

The study was carried out in Mubi North Local Government Area of Adamawa State, Nigeria. Mubi is situated between latitude 10° 16 North and longitude 13°16 East; and it is three hundred and five meters (305) above the sea level. It has an area of about 961.39km². It falls within the Sudan Savanna zone characterized by two distinct seasons (rainy and dry seasons) of varying duration and intensity (Adebayo and Dayya, 2004).The trend of annual rainfall in Mubi is generally a downward trend. However, the annual rainfall is about 1056 and has an average temperature of 32°C (Adebayo, 2004).

Experimentation

The research work comprised of laboratory test and nursery activity. Seeds of fully matured *T. indica* fruits were obtained from Shuwa in Madagali local government area of Adamawa State, Nigeria. The seeds obtained were subjected to viability test using the simple floating method. Ten (10) seeds were used for each treatment; and all seeds used were thoroughly cleaned, dried and kept in a tight container to maintain viability (Pamela, 2012).

Acid Treatment

Twenty seeds in two groups of ten were soaked in concentrated H_2SO_4 in separate beakers for the period of 5 and 10 minutes respectively. The seeds were removed, washed with several changes of clean water. The seeds of the first group were sown in moisten cotton wool on a petri dish while those of the second group were planted in the potting medium to determine the rate of water uptake and germination (Bello and Gada, 2015).

Scarification method

Twenty seeds were divided into two groups of ten, each group were placed between coarse gravels and paper and abraded for 10 and 20 minutes respectively. The ten seeds of one group were sown in the potting medium while the ten (10) seeds of the other group were broadcasted on moistened cotton wool in a petri dish to determine the rate of water uptake and germination.

Flaming method

Twenty (20) seeds, divided into two groups of ten (10), were pre-treated with flame while oscillating with a spoon to avoid burning. The ten (10) seeds of one and the second groups were subjected to 1 and 2 minutes treatment respectively and allowed to cool down. The seeds of one group (1 minute treatment) were sown in a potting medium while the seeds of the second group (2 minutes treatment) were placed on moisten cotton wool on a petri dish to determine the rate of water uptake and germination (Sugii, 2003).

Hot Water Treatment

Two beakers were filled with water and brought to boiling at 100^{o} C using electric heater. Ten seeds were soaked for one minute and another ten for 2 minutes respectively; the treatments were allowed to cool down to 20^{o}C. The first group was placed on moistened cotton wool while the other group was sown in the potting medium to determine the rate of water uptake and germination (Bello and Gada, 2015).

Cold Water Treatment

Seeds for this treatment were soaked in cold water at room temperature for 24 and 48 hours respectively; half of the pre-treated seeds were sown in the potting medium and the remaining half on moistened cotton wool to determine the rate of water uptake and germination (Bello and Gada, 2015). The control was set up by sowing the seeds directly without treatment in polythene bags and Petri dish to determine the rate of water uptake and germination.

Determination of water uptake

As described by Mcwatters *et al.* (2002), after subjecting the seeds to pre-treatments, seeds were air dried for 24 hours and measured to obtain the initial mass (W_i) ; the weighing was repeated after 24 hours intervals for two days to obtain the final weight (W_f) and water uptake was determined as thus:

$$\frac{W_f - W_i}{W_i} \times 100$$

Germination Percentage

Germination of seeds in Petri dishes was observed daily for two weeks. Germinated seeds were counted and recorded by paying attention to the first leaf emergence as well as the radicle. At the end of the germinating period, the rate of germination and germination percentage was determined (Stephen, 2009), using the formula below:

$$\text{Germination\%} = \frac{\text{Number of Seeds Germinated}}{\text{Number of Seeds Sown}} \times 100$$

Preparation of gibberellic acid solution (GA_3)

1000 mg of the plant growth regulator was added to a 1000ml volumetric flask. About 10ml of ethanol was added to dissolve the powder. Distilled water was finally added to the solution to bring the volume to 1 liter. A hand-held sprayer was used to directly spray on the plants as foliage spray aiming for a drip down coverage when the seedlings reached a height of 6cm. This was done early in the morning to avoid rapid drying of the spray solution, due to transpiration (Kumar *et al.*, 2014).

Determination of seedling growth

The growth parameters such as: shoot length which was determined using a meter rule taken from the apical bud of the plant to the base of the shoot; stem girth using thread and then placed on a meter rule and number of leaves was determined by physical counting using a blunt needle edge at the periods of 6 and 8 Weeks After Sowing (WAS) (Bello and Gada, 2015).

Results and discussion

The effects of human activities on the ecosystem have escalated due to increase population, thereby affecting the biodiversity and the environment. To achieve the aim of any regeneration programme, seed collection

and germination must be taken into consideration. Although, germination of seeds with hard seed coats is difficult because of dormancy (Bello and Gada, 2015), however when physiological dormancy is broken, the embryo gain sufficient growth potential to overcome the restraint of the seed coats (Baskin and Baskin, 2004).In this study, seeds treated with concentrated H_2SO_4 for 10 minutes have the maximum germination percentage in 3 days as a result of which it was found to be the best method of breaking seed dormancy of *T. indica* whereas the control gave the minimum germination percentage (Table 1). Similar outcome was reported by Bello and Gada (2015).

Table 1. Effect of Different Treatments on the Germination of *T. indica*.

Treatment	Time (Min/Hr)	NDCG	GP (%)
Conc.H_2SO_4	5min	3^{a}	80^{a}
Conc.H_2SO_4	10min	3^{a}	100^{b}
Manual scarification	10min	7^{b}	80^{a}
Manual scarification	20min	7^{b}	80^{a}
Flaming	1min	14^{c}	60^{c}
Flaming	2 min	14^{c}	60^{c}
Hot water	1min	21^{ac}	60^{c}
Hot water	2min	21^{ac}	60^{c}
Coldwater	2min	21^{ac}	80^{a}
Cold water	48hrs	21^{ac}	60^{c}
Control		30^{bc}	50^{bc}

Means with the same superscript letter along the column are not significantly different from each other at $p<0.05$.

Key: NDCG= Number of Days to Complete Germination; GP= Germination Percentage

The seeds of *T. indica* have both physical and physiological dormancy; and if seed coats of such seeds are scarified, the mechanical restriction would be decreased and the seeds could imbibe water thus, embryo is able to expand (germinate). Water uptake in seeds treated with concentrated sulphuric acid for 10 minutes gave the maximum percentage of water uptake while control gave the minimum percentage of water uptake (Table 2). All the scarification treatments weaken the seed coat of the tamarind thereby, making it water permeable. This is in agreement with the findings of Chaves *et al.* (2017) who affirmed that scarification treatments could overcome physical dormancy of seeds by causing many randomly located cracks in the seed coat, which then function as sites of water entry.

Table 2. Percentage Water Uptake of Seed Sown in Moistened Cotton Wool.

Treatments Time (Min/Hr)	Percentage Water Uptake (%)
Conc. H_2SO_4 5 min	77.04^{a}
Conc. H_2SO_4 10 min	80.41^{b}
Manual scarification 10 min	71.60^{a}
Manual scarification 20 min	70.38^{a}
Flaming 1 min	20.97^{c}
Flaming 2 min	32.00^{bc}
Hot water 1 min	61.58^{ba}
Hot water 2 min	57.14^{ab}
Cold water 24 hrs	39.37^{bc}
Cold water 48 hrs	43.83^{ac}
Control	14.29^{ca}

Means with the same superscript letter along the column are not significantly different from each other at $p<0.05$.

Table 3. Dormancy breaking and effect of GA_3 on the growth of *T. indica*.

		Effect on growth at different weeks after sow ING (WAS)					
		Stem Girth (cm)		No. of leaves (cm)		Height (cm)	
Treatment	Time	6 WAS	8 WAS	6 WAS	8 WAS	6 WAS	8 WAS
Conc. H_2SO_4	5 min	0.3^{a}	0.7^{a}	15.33^{a}	38.00^{a}	12.3^{a}	18.5^{b}
Conc. H_2SO_4	10 min	0.5^{b}	0.8^{b}	12.67^{b}	40.00^{ab}	11.0^{ab}	19.2^{a}
Manual scarification	10 min	0.2^{c}	0.7^{a}	14.67^{ab}	29.33^{c}	10.0^{b}	16.8^{ab}
Manual scarification	20 min	0.4^{ab}	0.8^{b}	16.00^{a}	35.33^{a}	11.2^{ab}	15.1^{c}
Flaming	1 min	0.5^{b}	0.8^{b}	8.67^{c}	18.67^{c}	10.9^{b}	13.6^{ac}
Flaming	2 min	0.2^{c}	0.8^{b}	10.00^{ab}	14.00^{ac}	8.7^{c}	13.2^{ac}
Hot water	1 min	0.2^{c}	0.7^{a}	10.67^{ab}	28.00^{c}	8.2^{c}	13.1^{ac}
Hot water	2 min	0.3^{a}	0.7^{a}	11.33^{b}	22.00^{c}	11.4^{ab}	14.9^{bc}
cold water	24 hrs	0.3^{a}	0.7^{a}	12.67^{b}	32.00^{a}	8.5^{c}	12.9^{ac}
Cold water	48 hrs	0.3^{a}	0.7^{a}	10.67^{ab}	25.33^{c}	10.3^{b}	14.7^{bc}
Control		0.1^{bc}	0.2^{c}	11.33^{b}	12.00^{ac}	6.3^{ac}	6.9^{ba}

Means with the same superscript letter along the column are not significantly different from each other at $p<0.05$.

Plant hormones are involved in every aspect of plant growth and development. Natural or synthetic hormones can be applied on seeds, leaves and fruits so as to promote physiological changes in germinating seed, seedling vigor, growth and development of roots and leaves as well as an increase in organic matter (Viera and Castro, 2004). Observation of the seedlings and analysis of variance showed that

gibberellic acid sprayed on the foliage of the *T. indica* seedlings at six WAS significantly promoted seedling height, number of leaves and stem girth at 8 WAS as shown in Tables 3. This work concord with the report of Davies (2004) who concluded that gibberellins affects plant growth when applied exogenously, alone or in association with other plant growth regulators.

Conclusion

In conclusion, all the scarification treatments applied to the seeds of *T. indica* proved effective. The ten (10) minutes treatment with concentrated H_2SO_4 was the best treatment for breaking seed dormancy of *T. indica*. And gibberellic acid enhanced early and fast seedling growth as it increase height, number of leaves and stem girth of *T. indica*.

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