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USES, GERMINATION ECOLOGY AND MODES OF PROPAGATION OF *Pilliostigma thonningii* (SCHUM) MILNE-REDHEAD IN THE GUINEA SAVANNA ZONE OF NIGERIA

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ABSTRACT

The values of Piliostigma thonningii include its use in such areas as herbal medicine, as a browse for livestock and possible uses in ecosystem stabilization. It is these uses that necessitated an investigation into its mode of germination and propagation. The germination trials revealed that the seeds have seed coat dormancy, and this can be broken by subjecting them to concentrated sulphuric acid for up to 20 min. The seeds had a very wide tolerance range for the concentrated acid (up to 120 min), indicating the extent of the thickness of the testa. The rooting trials showed quite convincingly that P. thonningii cannot be propagated by vegetative means. Its frequent occurrence along the roadsides was attributed to dispersal by livestock.

INTRODUCTION

Philiostigma thonningii is mostly a shrub, but some have grown into small sized trees called microphanerophytes. Its taxonomy and distribution are well documented in the flora (1 and 2). It occurs in parts of West, East, North, South and Central Africa which possess similar environmental conditions like the Guinea Savanna Zone of Nigeria. Irvine (3) reported on some of its uses.

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The abundance of *P. thonningii* in the Guinea Savanna Zone of Nigeria, as well as its use as a browse by both livestock and wildlife necessitated, in the first place, an investigation into its ecology and biology (4).

The main purpose of this paper, therefore, was to bring to the fore the large potentials of this largely forgotten weedy shrub in the Guinea savanna zone of Nigeria. Having established its many uses, it became necessary to examine its modes of germination and propagation.

The study areas were located in the following parts of Nigeria: Kainji (Kwara State), Mokwa (Niger State), Yelwa (Sokoto State) and Edunabon (Oyo State) and these are areas where the plant is abundant.

Potential uses in the ecosystem

P. thonningii serves as a browse plant; its leaves, when young, are eaten by livestock, while its fruits in both fresh and dry conditions are relished by both livestock and wildlife. The nitrogen content of its leaves have been assessed and the level found to compare favourably with those of other browse plants in the same area. This identifies the plant as an important browse plant in the Guinea Savanna Zone of Nigeria. Moreover, in view of the fact that it flushes in the middle to late dry season when most of the herbaceous pasture species have shriveled and died, it has the potential to complement them as a source of forage during the dry season.

Because of its dense foliage it can provide cover for human beings especially during the dry season and can even create a suitable habitat for animals in view of the shade its dense foliage casts on the ground. Shrubs and trees which are able to provide cover and food are critical in creating wildlife habitats and maintaining their populations (5).

The cover which the sense shade provides over the soil surface will also be important in reducing the direct impact of rain

and wind, thereby decreasing their erosive influence. It can also reduce the direct impact of sunshine, thereby decreasing evapotranspiration.

They could also be important in promoting soil fertility. This has been reported for other shrubs (6). Nitrogen was concentrated in the soil under the canopy of shrubs, thus constituting "Islands of fertility" in the ecosystems (7). Such shrubs also play a vital role in the cycling of nutrients and their destruction can cause a significant reduction in ecosystem productivity (8). By restoring soil fertility and vegetation cover in those areas destabilized by improper land use, plants may be important in preventing desert encroachment (6).

Medicinal and other uses

The root, stem, leaves, pods and seeds have been identified as having medicinal and other uses. Some of these uses have been reported while some others were elicited from interviews conducted on the local people in the course of preliminary investigation on the status of the plant in the Guinea Savanna Zone of Nigeria (3).

Among the Hausas, Fulanis, Kambaris and Nupes, the water from the boiled leaves is used to remove guinea worms from the feet of infected persons and also treat dysentery and general body pains. The leaves are used in Tanzania for treating snake bites, while the young leaves are squeezed into sores to cure dog bite (3). In some parts of Yoruba land, the leaf decoction is used for bathing newborn babies and as a drink to save them from rickets. The leaves are also used in preparing eye lotion (9).

The Fulanis, Hausas and Nupes use the bark extract to cure stomach pains and indigestion. Several other uses of the bark which include dressing wounds and ulcers, relief of toothache, coughs, colds, chest pains, diarrhoea, dysentery and leprosy have been reported (3).

Wickens (9) reported that the roots are used in curing venereal diseases and also have contraceptive and anti-helminthic properties.

Irvine (3) also reported that the fruits are used in the Ivory Coast as part of an ingredient for curing coughs, bronchial colds and toothaches.

The Fulanis eat the seeds and the roasted seeds are used as a black dye, while the hard pods are used to smoothen pottery (3). Irvine (3) also reported that the people around lake Chad eat the seeds which are also boiled, pounded and used a drink.

In all parts of the Guinea Savanna visited, the fibre from the stem is used as a rope by the native in tying their local fence called "zana" (Hausa). This is because the fibre is very strong and durable. The Hausa/Fulanis, living around New Bussa, use the leaves in wrapping moin-moin.

In Ipetumodu and Edunabon (Oyo State) the Yorubas use the stem in rain-making.

Because of its numerous uses and potential uses, an attempt was made to determine how to germinate and propagate the plant.

MATERIALS AND METHODS

The seeds used for the germination trials were collected from the Kainji area and four treatments were used:

- Some of the seeds were not treated before germinating them;
- Some were scarified;
- Some were treated with concentrated sulphuric acid for varying periods of time, viz: 5, 10, 15, 20, 40, 60, 80, 100 and 120 min.
- Some others were given heat treatment at varying temperatures, viz: 40, 50, 60, 80, 90 and 110^{0}C, and for 10 and 20 min for each temperature treatment.

The first two treatments above were kept on a window sill where they received alternating light (12 hr) and dark (12 hr). The other

batch was covered in black polythene bags and kept in a cupboard in a room. This was subjected to 24 hr of darkness. The last two treatments were only kept on a window sill where they were subjected to alternating light and dark conditions.

As a further test on the effect of alternating light and dark and total darkness on percentage germination, some of the seeds that were treated with acid for 20 min were divided into two batches of four replicates each, each replicate containing twenty seeds per petri dish. One batch was allowed alternating light and dark while the other was kept in total darkness. This additional treatment became necessary because the untreated and scarified seeds used earlier gave poor germination. 20 min was chosen because it had been found earlier that it was effective in breaking dormancy. These were treated like the others and examined regularly for germination.

The 20 seeds in each Petri dish were placed on top of a double layer of filter paper. There were four replicates per treatment, so that 80 seeds were used per treatment.

All the petri dishes were regularly watered lightly and observations were made on them daily.

Percentage germination was computed after fourteen days when most of the seeds had germinated and fungal infection had set in.

An attempt was made to determine if *P. thonningii* could be propagated by vegetative means. This involved rooting trails on cuttings and the procedures adopted were as follows: both current year's twigs and older twigs were cut with a sharp knife into short lengths, making sure that each piece contained at least three or more nodes. The cuttings were planted in plastic pots, containing top soil collected from places where *P. thonningii* thrives. Four cuttings were planted per pot and there were four replicates per treatment.

The following treatments were given to each set of twigs, i e. both young and old twigs.

- Planted vertically without rooting hormone (indole-acetic acid, IAA).
- Planted vertically with rooting hormone (IAA)
- Planted horizontally without rooting hormone
- Planted horizontally with the soil fully covering the stems.

The whole set up was watered lightly and examined for rooting and sprouting daily. The experiment was terminated after two weeks.

RESULTS

There was no rooting from cuttings with or without rooting hormones; the cuttings died after ten days.

The results of the germination trials are shown (Table I). The untreated and scarified seeds showed very poor germination in both alternating light and dark and total darkness. There was also not much difference in the performance of the seeds kept in alternating light and dark and those kept in total darkness.

Acid-treated seeds showed high percentage germination, especially from 10 min upwards. Acid treatment for periods 60 to 120 min was well tolerated by the seeds.

Not much difference could be observed in the performance of the seeds treated with acid for 20 min and kept in alternating light and dark and total darkness; they all showed high percentage germination. The slightly lower value for the one kept in the dark could be attributed to one of the seeds being diseased.

Heat treatment without acid treatment resulted in poor germination and in most cases no germination at all. However, when subjected to heat treatment after acid treatment, the germination was good, except for those kept at 80°C for up to 20 min.

The mode of germination is epigeal. A longitudinal section of one of the seeds to show the thickness of the testa is shown (Fig. 1).

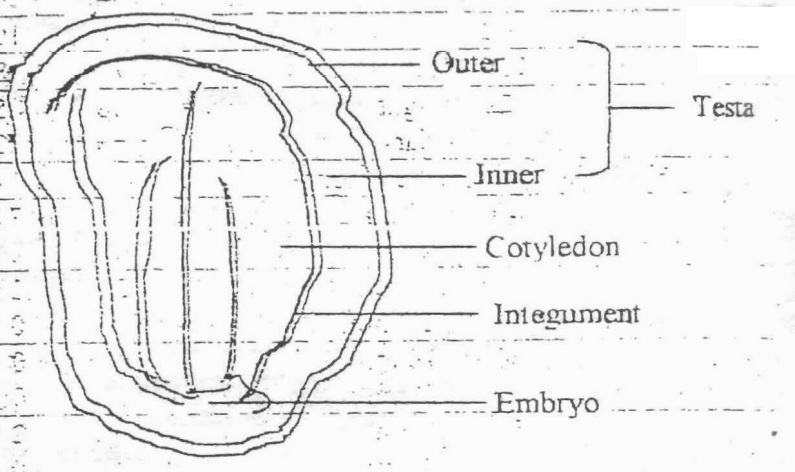

Fig. 1: Longitudinal section of a seed of *P. thonningii*

From the observations made in the field, the seedling density was very low in the Guinea Savanna Zone. This contrasts sharply with the Edunabon area (Derived Savanna) where a high population of the seedlings was observed.

Table 1: Percentage germination of the seeds of *P. thoningii* from various treatments

SN			NSS	NG	% G
1.	Untreated	light	80	2	2.5
		dark	,,	2	2.5
2.	Scarified	light	,,	24	30.0
		dark	,,	24	30.0
3.	Acid – 5		,,	30	37.5
	5		,,	56	70.0
	10		,,	80	100.0
	15		,,	80	100.0
	20		,,	80	100.0
	40		,,	56	70.0
	60		,,	64	80.0

	80		,,	64	80.0
	100		,,	80	100.0
	120		,,	79	98.8
	20	light	,,	68	85.0
		dark	,,	58	72.5
4.	Heat (before acid treatment)				
	40	10 min.	,,	6	7.0
		20 min.	,,	0	0
	50	10 min.	,,	2	2.5
		20 min.	,,	0	0
	60	10 min.	,,	0	0
		20 min.	,,	0	0
	80	10 min.	,,	2	2.5
		20 min.	,,	0	0
	90	10 min.	,,	0	0
		20 min.	,,	0	0
	110	10 min	,,	4	5.0
		20 min	,,	0	0
5.	Heat (after acid treatment)				
	40	10 min	,,	77	96.0
		20 min		80	100.0
	50	10 min	,,	77	96.0
		20 min		80	100.0
	60	10 min	,,	74	92.5
		20 min		77	96.0
	80	10 min	,,	61	76.0
		20 min		21	26.0
	90	10 min	,,	15	18.8
		20 min		0	0
	110	10 min	,,	0	0
		20 min		0	0

NSS = No. of seeds sown NG = No. that germinated
% G = % germination

DISCUSSION AND CONCLUSION

The very poor germination recorded by untreated seeds is a good reflection of the extent of the dormancy problem occasioned by the very thick and hard testa. Scarification did not improve the situation very much, but marginal improvement recorded could be attributed to reduced thickness of the tests resulting in a more effective water absorption.

The results also indicated that acid treatment was very effective in breaking seed coat dormancy. Significantly enough the seeds tolerated the concentrated acid after prolonged exposure for up to 120 min, probably reflecting the extent of the thickness of the testa pointed out earlier. In the case of *Indigofera pulchra*, a herbaceous legume, Jayeola (10) found that treatment with concentrated sulphuric acid for more than 15 min inhibited germination.

The optimal level for acid tolerance could not be determined when the seed showed such a wide tolerance to it. It was reasoned that in nature seeds could hardly be subjected to such as highly concentrated acid for up to 120 min. However, for the purpose of germinating the seeds, 20 min exposure to concentrated acid is recommended because germination is good at this exposure

In the natural environment acid reaction as a means of breaking seed dormancy may not be possible because the level of acidity in the soil determined in the study plots is low (between pH 5 and 6) (4).

It is obvious from the results that subjecting the seeds to varying temperatures alone did not break the dormancy. On the other hand, if dormancy was first broken by acid treatment and the seeds subsequently subjected to varying temperatures, germination was not inhibited until at about 80^0C, indicating that the seeds must be tolerant to that level of variation in the temperature of its environment. Since its natural environment is subject to periodic burning, this resistance offers some adaptation for surviving in

such an environment. However, if the temperature of the fire was much than 80^0C or lasts for more than 10 min at this temperature, the chances were that testa will be charred and the embryo killed.

The fact that both alternating light and dark and total darkness did not produce any noticeable effect on percentage germination probably indicates that the seeds are not sensitive to such treatment. This could be an advantage in the wild where the seeds could find themselves temporarily or permanently buried in the soil.

Attempts to propagate *P. thonninggii* from cuttings failed. There was no rooting from the cuttings after two weeks when they also died. This confirms an earlier observation that *P. thonningii* cannot be propagated by vegetative means (11).

Since animals, both wildlife and livestock, relish the pods, they probably constitute the main agents of dispersal. The seeds are covered with a hard testa so that they can easily pass through the guts of these animals and be deposited in their faecal matter where they can germinate if the conditions are favourable (Fig. 1). The level of pH and temperature in the gut of the animals may not affect this thick and hard testa. The high incidence of *P. thonningii* along the roadsides in both the northern and southern parts of the country suggests that the seeds might have been brought there by cattle or livestock.

Seedlings were very scanty in nearly all the plots sampled in the three study areas of Mokwa, Kainji, and Yelwa and were not encountered at all in many others, even under female plants which has been found to have produced a large quantity of pods (4). This contrasted sharply with species like *Butyrospermum paradoxum*, *Detarium microcarpum*, *Burkea africana* and *Combretum molle* which produced a large seedling population around them. However, a fairly large number of seedlings was encountered under female plants in the Edunabon area.

The low seedling density in the area sampled in the Guinea Savanna Zone may be attributed to the following factors:

- heavy predation of pods by wildlife and livestock;
- damage to the pods and seeds by an insect pest-a beetle, called *Caryedon serratus*, whose destructive effect can be total in some places (4);
- dormancy problem arising from its very thick and hard testa. This will make germination a much slower process, thereby predisposing the seeds to greater predation by wildlife, livestock and insect pests (especially termites) which abound in the Guinea Savanna Zone;
- browsing of the young leaves by livestock unlike the leaves of *Detarium* and *Combretum* which are unpalatable and those of *Burkea* which are only occasionally consumed (12);
- the frequency and intensity of fire. This will destroy most of the seeds if it is sufficiently intense and if it is regular this my completely eliminate the chances of seedling establishment.

The greater seedling density observed in the Edunabon area may be related to the low wildlife, livestock and termite density in that area and the southern parts of the country generally. It is also possible that in the southern parts of the country with more varied diet, such rare species like *P. thonningii* may be avoided. This is in accordance with the observation that animal preferences for browse vary widely with the season and the availability of alternative vegetation so that the palatability of a flora can often not be predicted from past observations (13).

In spite of the problems facing the propagation and germination of *P. thonningii* now, they are still well maintained and abundant in the disturbed areas of the Guinea Savanna (4). Their level of abundance now, and the fact that there is no evidence of vegetative reproduction, may mean that the great abundance currently being maintained must have arisen from seed germination. However, the increasing irrelevance of germination these days as a means of propagation may lead one to speculate that probably the conditions under which *P. thonningii* reproduced profusely from seeds are changing in the Guinea Savanna Zone.

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