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Research Article

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Characterisation of the biological cycle of plants from two types of *Desmodium adscendens* (sw.) plant material for domestication in Daloa (Cote d'Ivoire)

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ABSTRACT

Desmodium adscendens (Sw.), the wild plant used to treat diverse pathologies, is menaced by deforestation and herbicides. It needs to be domesticated, starting with a study of its biology to preserve it and also to ensure healthy seedlings. It is in this context that this study was carried out to study the biology of *Desmodium adscendens*. To this end, grains and stem cuttings harvested in the wild from the plantations were grown outside the field on a block system. This consists of three blocks, with each block constituting a replication. After the crop was planted, germination and budburst rates, and quantitative parameters (stem length, number of branches, spread and flowering rate) were determined at one, two and three months after sowing. In addition to these parameters, a number of morphological parameters were determined. The results showed that bud burst was faster than germination. Also, in terms of growth parameters, plants grown from stem cuttings obtained better values with a large difference compared to those grown from grains. In addition, plants grown from grainss have a longer growing cycle (90 days) than plants grown from stem cuttings, which have an average growing cycle of 49 days. Its morphological structure is similar to that of legumes, with indeterminate growth. However, propagation by grains or stem cuttings is possible, depending on the objectives set. In short, *Desmodium adscendens* can be used as a cover plant in agroforestry systems and for soil restoration.

Keywords: *Desmodium adscendens*, crops, phenological phase, Daloa, Côte d'Ivoire

INTRODUCTION

Deforestation impacts all tropical forests, especially in the Amazon, equatorial Africa, and Southeast Asia (Kouassi *et al*., 2015). From 1990 to 2020, the global forest area decreased by 178 million hectares (FAO & UNEP, 2020). Côte d'Ivoire is also affected; its forest cover declined from an estimated 16 million hectares in the 1900s (Chatelain *et al*., 2004) to approximately 2.97 million hectares in 2021 (Cuny *et al*., 2021), primarily consisting of classified forests, national parks, and reserves. Over the past decade, ongoing crises in Côte d'Ivoire have hindered the development of effective forest protection policies, resulting in illegal and uncontrolled occupation of protected areas (Kouassi *et al*., 2015). A direct result of deforestation is the decline or extinction of certain plant species. In light of threats to plant biodiversity, there is increasing interest in the domestication of wild species to conserve and develop under-utilized plant resources (Tenaillon *et al*., 2023). *Desmodium adscendens*, a native forage legume, is one such species being domesticated in the Daloa region of Côte d'Ivoire, where the soil and climate conditions support its cultivation (Kouadio *et al*., 2021; Lal, 2015). A thorough understanding of the biology of *Desmodium adscendens* during the domestication phase is essential to optimise the cultivation technique and improve its yield. This study therefore aims to assess the main biological traits of this species to be domesticated under the soil and climate conditions in Daloa. More specifically, the growth parameters of plants obtained from the two types of *Desmodium adscendens* planting material will be analysed, and the morphological characteristics of plants obtained from the two types of planting material will be described and identified. The results of this study will make it possible to identify the most relevant agronomic characteristics to be selected to develop a new *Desmodium adscendens* crop adapted to local needs, thus contributing to the supply of pharmaceutical industries interested in this plant.

MATERIALS AND METHODS

Study site

The experiment was carried out at the experimental farm of the Jean Lorougnon Guédé University in Daloa. Daloa is a town in central-western Côte d'Ivoire. The Daloa region is a forested area and is the capital of the Haut-Sassandra region (Koukougnon, 2020). Soils in the Daloa region are predominantly ferralitic. They are very deep with a high organic matter content. These ferralitic soils are suitable for agriculture and lend themselves to all types of crops (Soro *et al*., 2015).

Plant material

The plant material consisted of *Desmodium adscendens* grains and stem stem cuttings (Figure 1) collected from palm, cocoa and rubber plantations in Assouba (Aboisso, Côte d'Ivoire). This area is one of the major ecological zones where *Desmodium adscendens* grows naturally.

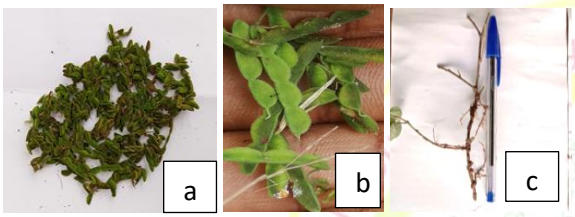

Figure 1: Plant material used
a & b: pods ; c: stump of *Desmodium adscendens*

Preparing the plot and setting up the trial

The experimental plot was prepared in two stages. The first involved clearing and weeding the plot using a machete. The second stage involved levelling the ground using a daba. The grainss and stem cuttings were sown in 5-litre buckets, the bottoms of which were perforated with a nail. The system used for the experiment was a block system (Figure 2). It is made up of three blocks, with each block constituting a repetition. Within each block, there are two sub-blocks, each containing 30 buckets in which the stem stem cuttings and grainss were grown. The sub-blocks are ten metres apart. The spacing between the buckets is 1 m.

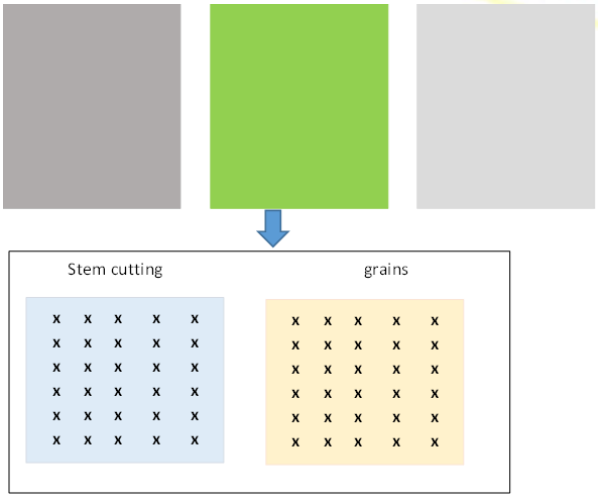

Figure 2. Experimental Dispositif
X : Buckets

Data collection

Germination and budburst parameters:

- Germination and budburst rates.

These rates were evaluated according to the following formula:

TG = (NGG/NTGS) X 100 ;

TD = (NBD/ NTB) X100

TG: germination rate; NGG: number of grains germinated; NTGS: total number of grains sown; TD: bud burst rate; NBD: number of stem cuttings burst; NTB: total number of stem cuttings.

- Germination and bud burst time.

This is the time (in days) that elapses between sowing and the total appearance of a seedling.

The germination and bud break capacity of stem cuttings has been expressed as a function of time.

Agromorphological parameters

Growth and development parameters such as stem length; number of branches; and plant spread were determined at one month (30 days), two months (60 days) and three months (90) after sowing. Flowering and fruit formation times were also determined. In addition to these parameters, the various phenological phases from germination to flowering were noted.

Statistical analysis

The data collected were processed using IBM SPSS software.

RESULTS AND DISCUSSIONS

Evaluation of the germination and budburst rate of *Desmodium adscendens*

The results of the evaluation of the germination and bud burst rates showed that five days after sowing, the stem cuttings had begun to bud (Figure 3). However, no germination was recorded in the seeds. On the 7th day after sowing, half (50%) of the number of seeds had germinated. By the 12th day after sowing, the maximum number of seeds and stem cuttings had germinated. However, budburst progressed more quickly than germination.

Growth parameters of plants grown from *Desmodium adscendens* stem cuttings and seeds at different dates after sowing

Stem length

The results showed that one month after sowing, the difference in size between plants grown from stem cuttings and those grown from seeds became apparent (Figure 4). The results showed that up to two months after sowing, plants grown from cuttings had long stems, unlike those grown from seed. However, from three months onwards, the difference between plants grown from stem cuttings and those grown from seeds became less significant. However, the stems of plants grown from stem cuttings developed faster.

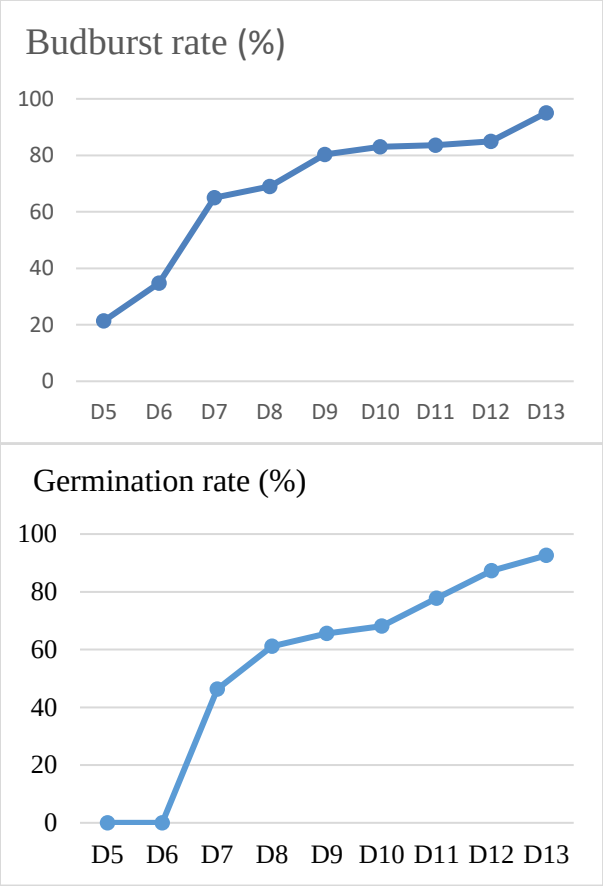

Figure 3. Curves of germination and budburst rate times (days) D: number of days after sowing

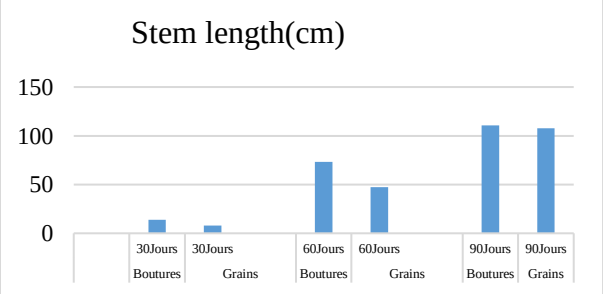

Figure 4. Histograms of stem lengths evolution
Boutures : stem cutting ; grains: seed and jours : days

Branches number

The results showed that there was little difference between the average number of branches (Figure 5). However, during the first two months, plants from stem cuttings recorded more branching. From three months onwards (90 days), the number of branches became greater in plants grown from seeds than in those grown from stem cuttings.

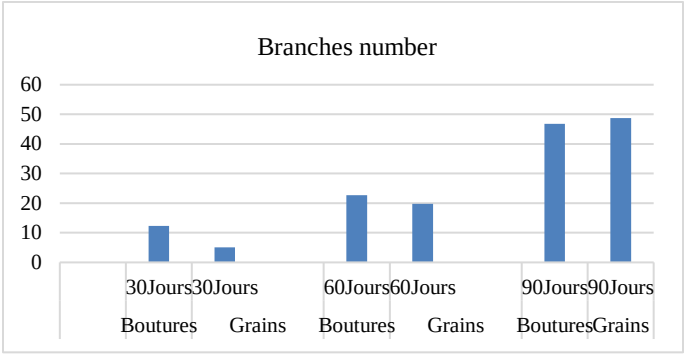

Figure 5. Histograms of changes in the number of branches
Boutures : stem cutting ; grains : seed and jours : days

Plants spans

The result shows the average span of plants grown from *Desmodium adscendens* stem cuttings and seeds over three months (Figure 6). The differences between the average sizes of plants grown from cuttings and those grown from grain were greater before the first three months. However, after three months, the difference observed between the average spans of plants grown from the two types of plant material became small.

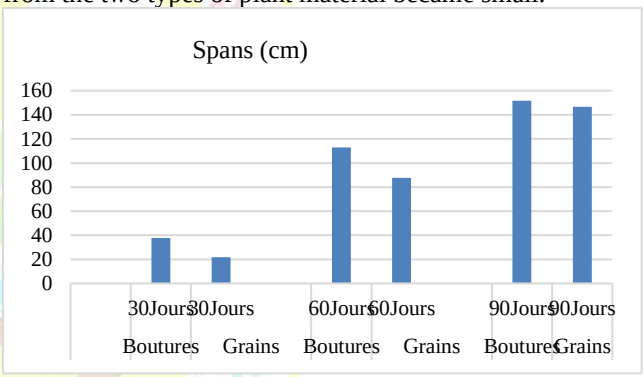

Figure 6. Histograms of changes in plant spans
outures : stem cutting ; grains : seed and jours : days

3.1.1.3. Flowering rate of *Desmodium adscendens*

The results show that plants grown from stem cutting are quick to flower, unlike those grown from seed (Figure 7). Thus, 50% of plants from stem cuttings flowered within 60 days compared with 115 days for plants from seeds.

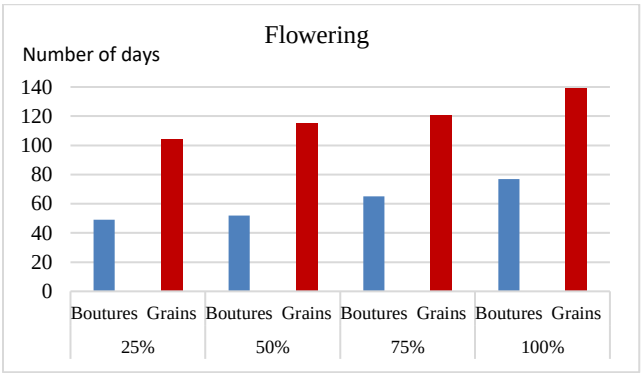

Figure 7. Flowering rate of plants grown from stem cuttings and seeds
Red histogram: stem cutting ; blue histogram : seed

Development cycle of *Desmodium adscendens*

The different phenological phases of *Desmodium adscendens* plants grown from stem cuttings and seeds were summarised according to the number of days after planting (Table I). Plants grown from stem cuttings had an average vegetative cycle of between 5 and 49 days, compared with a vegetative cycle of between 7 and 90 days for plants grown from seeds. The first flowers appeared on the 50th day with the stem-cutting plants. Plants grown from stem cuttings therefore have a shorter vegetative cycle than plants grown from seeds.

Table I. Presentation of the different phenological phases of plants grown from two types of *Desmodium adscendens* plant material

Phenological phase	Duration of phenological phase (days)	
	Plant material	
	Stem cutting	Grains
Vegetative cycle duration	5-49	7-90
Budbreak / Germination	5-15	7-20
Growth	15-25	30-45
Ramification	25-49	45-60
Flowering	48-60	90-120
Fruiting	60-90	105-150
Resumption of growth	90 and more	150 and more

NB: *Desmodium adscendens* is a plant with indeterminate growth.

Morphological description of the vegetative organs of *Desmodium adscendens*

The *Desmodium adscendens* plant has a fasciculated root system, with abundant roots forming a dense network in the first soil horizons. The stem is creeping, up to two metres long. It is quadrangular in shape, and devoid of hairs, giving it a smooth appearance with knots and numerous branches extending from the base of the plant (Figure 8 e & f). The leaves are entire during the early stages of growth and become trifoliate, with oval-oblong leaflets after about a month after germination. The leaflets are 2 to 6 cm long. Unlike stem cuttings, which regenerate seedlings similar to adult plants (Figure 8 d), seeds germinate epigenetically (Figure 8 a) while developing a seedling with whole leaves (Figure 8 b). These leaves are smooth, circular and spherical (Figure 8 c).

Morphological description of the reproductive organs of *Desmodium adscendens*

The flowers of *Desmodium adscendens* are grouped in terminal or axillary clusters (Figure 9 a & b). They are papilionaceous, rose-purple and about 8 mm long. The calyx is gamosepal with five unequal lobes. The corolla has five petals, with a standard, two wings and a carina. It contains ten diadelphous stamens (9 fused and 1 free). The ovary is superect, surmounted by a style and a stigma. It develops after fertilisation to form the fruit. The fruits are flat, linear pods, 2 to 5 cm long, divided into monosperm segments that disarticulate at maturity with kidney-shaped, reddish-brown seeds (Figure 9 c, d, e & f). The pods have dense hairs that enable them to adhere to fur and clothing.

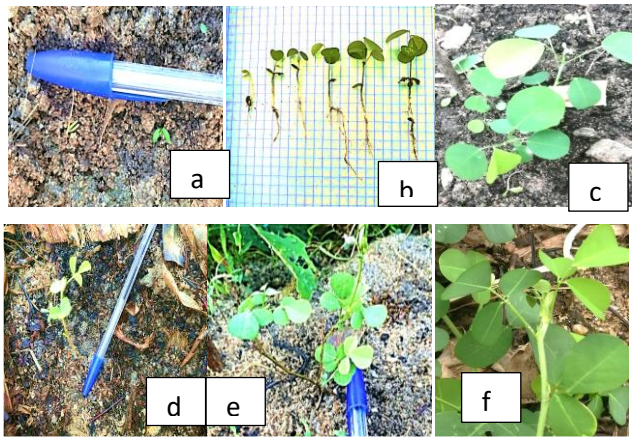

Figure 8. Presentation of the growth organs of *Desmodium adscendens*
a: germination; b & c: primary growth; d: bud burst; e: flowering of a plant from a stem cutting and f: elongation of the stem and formation of compound leaves.

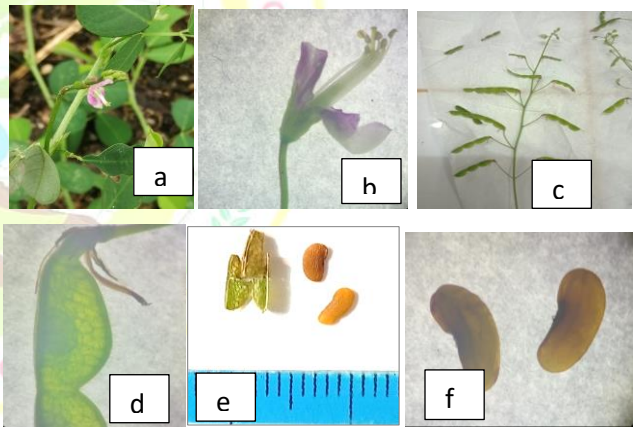

Figure 9. Presentation of the reproductive organs of *Desmodium adscendens*
a & b: presentation of the inflorescence; c & d: morphology of the pod and e & f: morphology of the seed.

Germination time and bud burst time were significantly different. The delay was shorter for stem cuttings than for seed. These results could be explained by the fact that sown stem cuttings have a higher hormonal balance than seeds. In addition, stem cuttings have meristems in the axillary buds (Véronique *et al.*, 2021). Also, regular irrigation and soil rich in organic matter are factors that can encourage early rooting of cuttings, while leading to their observed rapid bud burst (Bah *et al.*, 2021). On the other hand, the delay in germination is linked to integumentary dormancy induced by the rigidity of the

endocarp, which can constitute a physical barrier to the imbibition of the embryo, to gas and respiratory exchanges and the emergence of the radicle (Lompo *et al*., 2019). Seed dormancy can hurt germination rates (Rajib *et al.*, 2023). Similar results were obtained by Joseph *et al*. (2023) on seeds of *Guibourtia tessmannii* (Harms) JL. of the Fabaceae-Cesalpinioidae family. These authors reported that seeds with a pericarp germinated with difficulty compared to those without a pericarp. On the other hand, Božena *et al.* (2024) reported that *Amorpha fruticosa* L. (Fabaceae) seeds sown without storage conditions germinated within a short time.

The results of the growth variables determined 45 days after sowing showed that the plants grown from stem cutting obtained better values than those grown from seed. This was due to the rapid bud break observed in the sown stem cuttings. In addition, the stem cuttings already contain sufficient quantities of certain growth hormones to have a positive impact on the speed of growth in these plants. Contrary results were obtained by Nguema *et al.* (2013) on Jatropha curcas L. According to their work, plants from Jatropha stem cuttings grow slowly compared with those from seeds. From 90 days after sowing, plants grown from seeds recorded better values for growth parameters. Plants grown from stem cuttings flow faster than those grown from seed. The stem cuttings already contain the same hormones as the original mother plant. Similar results were obtained by Nguema *et al.* (2013) on Jatropha Curcas L.

The study of the different phenological phases of *Desmodium adscendens* shows that this species has a rhythmic growth. It has a stem elongation phase lasting around 45 days and a secondary organ development phase. *Desmodium adscendens* is a species with indeterminate growth, and its cycle continues after fruiting. Naturally, it flowers during the summer. However, in cultivation, it flowers for three months and can flower as the branches develop under normal conditions. *Desmodium adscendens* has a fasciculated root system, with its roots forming nodules as it grows. This species belongs to the legume family and can be used in the same way as groundnuts, beans and soya to improve soil fertility. Its leaf morphology is similar to that of groundnuts, but the difference lies in the stem and fruit. Its fruits (pods) are articulated and hairy, just like those of Desmodium affine and other Desmodium species, enabling them to be spread by humans and wild animals (Freitas *et al*., 2014). The physical appearance of the seed shows that it is first covered by a very rigid shell and then by an inner integument. This aspect is thought to be responsible for the seed's resistance to biological aggressors and also helps to extend its lifespan. Consequently, the tegument may act as an inhibitor of the seed's metabolic reactions in sparse rainfall (Berghouti *et al*., 2022), and thus be responsible for its late germination.

CONCLUSION

The results of this study show that *Desmodium adscendens* can be propagated by cuttings as well as by seeds. However, vegetative propagation results in earlier bud break than germination, which is slow. This study revealed a first growth stage, characterised by the formation of whole leaves. The second stage was observed after a month, with the appearance of compound leaves and the formation of secondary organs. Plants grown from stem cuttings flowered more quickly than those grown from seed. In terms of flower morphology, the flower is structured in such a way as to avoid cross-pollination. But it should be noted that seed propagation would also be advantageous in terms of avoiding the persistence of certain contaminants in the plant.

In addition, this study opens up perspectives on the influence of environmental factors that could influence the growth and development of *Desmodium adscendens.*

CONFLICT OF INTEREST

The author here declares that there is no conflict of interest in the publication of this article.

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