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# Natural seed germination and seedling dynamics in cultivated population of *Cassia fistula* Linn. in Nigeria

**Olubukanla Tejumola Okusanya[1]*, Olusola Olanrewaju Shonubi[2] and Sadat Elutola Babalola[2]**

[1]Department of Biological Sciences, Applied Biology and Biotechnology Unit, Covenant University, Ota, Ogun State Nigeria.
[2]Department of Botany, University of Lagos, Akoka-Yaba, Lagos State, Nigeria.

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**For the first time, natural seed germination in cultivated population of *Cassia fistula* Linn. is reported in this paper. Natural seed germination occurred under many mother trees at Covenant University, Ota, Ogun State, Nigeria; while no germination occurred under some other mother trees. Random soil samples were taken in representative areas and analysed. Seedling dynamics were also investigated by fencing the seedlings around five mother trees, mapping and following their survival with time. Soil samples obtained where there was germination are loose, black soils with high moisture and humus contents and mean pH of 7.2 while soil samples obtained where there was no germination are hard, red lateritic clay soils with significantly lower moisture and humus contents and mean pH of 6.4. The seedlings study showed that some seedlings were more or less in a straight line from broken and rotted pods buried in the soil or covered in debris. Other seedlings were single, in pairs or in groups of three or four. A seed germinated within a pod and grew out of a small hole in the pod, with the radicle coming out first and by the next day, the cotyledons emerged. In the first few weeks of study, the number of seedlings in each fenced area increased with time, thereafter the number decreased accompanied by yellowing of leaves. There was also increased growth of surrounding weeds mainly grasses, as well as about 60% reduction in light intensity on the seedling floor due to the development of new foliage on the mother trees. The reduced number of seedlings under the mother trees was attributed to increased inter specific competition as well as reduced light intensity reaching the seedlings since *C. fistula* is not shade tolerant. Consequently, cultivated *C. fistula* like the natural population may not regenerate well in nature and its continued existence may depend on artificial conservation through its use as ornamental and medicinal plant.**

**Key words:** Natural germination, seedling dynamics, cultivated population, *Cassia fistula,* Nigeria.

## INTRODUCTION

*Cassia fistula* Linn. Is an ornamental and medicinal deciduous tree commonly called “golden shower tree” and “Indian Laburnum”. It is of the large genus Cassia and it belongs to the subfamily Caesalpiniaceae and the family Fabaceae (Sartorelli et al., 2009). Its origin is in the Indian subcontinent and is distributed in various tropical regions including Asia, South America, Australia and Africa (Orwa et al., 2009). It is widely used for landscaping

*Corresponding author. E-mail: Okusanya41@yahoo.com, Tel: +234 8037162461.

not only because of its golden yellow flowers which last for several months, but it also has landscaping properties like drought tolerance and low maintenance requirement (Ghouse et al., 1980). As a result of these, *C. fistula* is the dominant landscaping species at Covenant University, Ota, Ogun State, Nigeria. It flowers nearly all year round (August – June) and produces enormous amounts of seeds that do not germinate readily in nature. There are many publications about the species from the tropical and subtropical regions (Nalawadi et al. 1977; Babely and Kandya 1988; Todaria and Negim 1992; Aref, 2002; Karaboon et al. 2005; Al-Menaie et al., 2010) but virtually none from sub-Saharan Africa. The species thus became our research plant to provide some data from this region.

Seed dormancy in *Cassia fistula* Linn. is a widely investigated and well documented aspect of the species from virtually all tropical regions; namely Nalawadi et al. (1977) in India; Babely and Kandya (1988) in Egypt; Karaboon et al. (2005) in Thailand; Al-Menaie et al. (2010) in Kuwait and only recently Babalola et al. (2014) in Nigeria. Several experiments have been carried out to break the dormancy of the seeds in view of the fact that the species has many uses, in particular as an ornamental and medicinal plant. The cheapest and probably the most efficient method to break seed dormancy in the species is by immersion of the fresh seeds in hot water (80 to 100°C) for about 2 to 5 min or in concentrated sulphuric acid for about 5 min (Babely and Kandya, 1988; Karaboon et al., 2005; Babalola et al., 2014).

Even though many germination experiments in the laboratory have been reported, there are only few reports about the regeneration of *C. fistula* in nature (Pokhriyal et al., 2010; Ballabha et al., 2013). There is virtually no report of natural germination (regeneration) in cultivated population of *C. fistula.* It was therefore of scientific interest to investigate natural seed germination (regeneration) if any, in cultivated population of *C. fistula.* This paper reports the investigation of natural seed germination of the species under cultivated mother trees at Covenant University, Ota, Ogun State, Nigeria, where the species is the dominant ornamental plant; about 250 individuals having been planted since the founding of the University in 2002. In addition, the dynamics of five different seedling populations under five mother trees were monitored to determine their survival with time. Analysis of soil samples taken under the five mother trees where there was regeneration and under another five trees where there was no regeneration was carried out to determine the possible reasons for the situation.

## MATERIALS AND METHODS

### Study site

The cultivated population of *C. fistula* is situated at Covenant University, Ota, Ogun State, SW Nigeria. Ota lies at longitude 03.20E and latitude 07.45N. Mean annual rainfall is about 1370 mm falling for about ten months in the year (February – November). Mean maximum temperature is 32°C and mean minimum temperature is 27°C. The University is on a flat plain on an elevation of 24 m above sea level. The original vegetation was tropical rain forest and there are still relics of tropical rain forest trees like *Ceiba petandria, Tetracarpidium conophorum* and *Chlorophora excelsa* on the University campus. All the 244 flowering cultivated *C. fistula* trees along the major roads on the University campus were numbered and tagged. Seedlings at all stages of development were carefully checked for, underneath the canopy of each tree.

### Seedling dynamics

Areas under 5 mother trees, numbers 3, 4, 7, 196 and 213, with germinated seedlings were fenced off with wire net to prevent any anthropogenic activities. Each area was about 60 $m^2$. The seedlings were then counted and mapped; the growth and survival of the seedlings were followed over time. Every two weeks, the five selected tree sites were visited to map new seedlings as well as record the survival and morphology of the old seedlings. These observations were carried out for five months, May to October 2014.

### Soil analysis

Three random soil samples were taken from under each of the five trees where regeneration occurred and had been fenced off for seedling dynamics study (trees number 3, 4, 7, 196 and 213). In addition, under each of five other trees where there was no regeneration (trees number 78, 198, 199, 234 and 235), three random soil samples were also taken. This was to determine what might be responsible for lack of regeneration. The three soil samples taken under each tree were bulked for analysis and the following soil characteristics were determined (i) colour (ii) type (iii) pH (iv) moisture content and (v) humus content.

## RESULTS AND DISCUSSION

Of the 244 trees investigated, there was seedling regeneration under 190 trees. Forty trees could not regenerate because their surroundings were paved with concrete as walk-way. Only ten trees actually did not regenerate. Under many trees that regenerated, it was noticed that pods had been cracked open or rotted under the mother trees. Some seedlings were just sprouting from the ground with yellow cotyledons only (Figure 1a). On closer inspection, many more seedlings with 2, 4 or 6 paired green leaflets were discovered (Figure 1b) indicating that they had germinated sometime earlier before our inspection. This indicated that even though *C. fistula* seeds show dormancy, yet, they are capable of natural germination (regeneration), a condition never before reported in cultivated population of *C. fistula.*

Most of the seeds that germinated were under debris or buried in loose, dark and wet humus soil with high moisture content (Table 1 and Figure 1a) which ensured that they had water which is essential for germination. A high percentage of the seedlings was noted to be growing in small soil depressions which may contain


(A) (B)

**Figure 1.** (a) Three young seedlings (I – III) of *C. fistula* just sprouting from the broken pods, (b) A group of four seedlings at the two or three paired leaves stage.

**Table 1.** Analysis of soil samples taken from cultivated *C. fistula* population at Covenant University, Ota, Nigeria.

| | Tree number | Colour | Type | pH | Moisture content (%) | Humus content (%) |
|---|---|---|---|---|---|---|
| | 3 | Grey | Silt | 6.99 ± 0.4 | 16.85 ± 0.11 | 25.04 ± 0.24 |
| | 4 | Black | Humic | 7.07 ± 0.2 | 15.93 ± 0.20 | 18.09 ± 0.17 |
| | 129 | Black | Humic | 7.38 ± 0.5 | 22.53 ± 0.17 | 20.76 ± 0.66 |
| | 199 | Greyish Black | Silt | 7.11 ± 0.2 | 17.45 ± 0.12 | 22.74 ± 0.76 |
| A | 200 | Black | Humic | 7.25 ± 0.3 | 18.21 ± 0.23 | 24.17 ± 0.88 |
| Mean | | | | 7.16 ± 0.2 | 18.19 ± 2.56 | 22.16 ± 2.79 |
| | 79 | Reddish brown | Lateritic | 6.14 ± 0.2 | 10.27 ± 0.14 | 12.56 ± 0.27 |
| | 198 | Reddish | Clayey | 6.53 ± 0.3 | 7.88 ± 0.11 | 11.38 ± 0.18 |
| | 199 | Reddish | Lateritic | 6.88 ± 0.1 | 8.05 ± 0.23 | 10.96 ± 0.23 |
| | 234 | Reddish | Lateritic | 6.96 ± 0.2 | 8.21 ± 0.10 | 12.95 ± 0.60 |
| B | 235 | Brown | Clayey | 5.88 ± 0.2 | 7.53 ± 0.31 | 13.44 ± 0.08 |
| Mean | | | | 6.48 ± 0.5 | 8.39 ± 1.08 | 12.26 ± 1.05 |

A: Soil samples under trees with seedlings regeneration, B: Soil samples under trees without seedlings regeneration.

relatively more moisture than the surrounding. Air and temperature were not limiting factors. Thus the seeds had the conditions necessary for germination (Mayer and Poljakoff-Mayber, 1982)

In some cases, the seedlings were in more or less a straight line showing their positions when they were seeds in the pods. The seedlings in a straight line were nearly at the same developmental stage indicating that the seeds germinated about the same time. Obviously, the seeds must have been scarified by some physical factors. These may include scarification by the broken pod fragments and/or soil particles (Brown, 1972) or the rupturing of the hard seed coat by continuous wet condition of the soil during the rainy season (Brown, 1972; Villiers, 1972). An interesting and unusual germination was observed in one instance; the radicle of a germinating seed was found protruding from a hole in a pod and bending towards the soil (Figure 2a). The next day, the cotyledons grew out of the hole and the seedling stood erect in the soil (Figure 2b). This confirmed that seeds of cultivated *C. fistula* can and do germinate in nature. It also showed that the pods must be broken or decayed to allow the seeds access to germination factors and before the seedlings could emerge. It is also clear

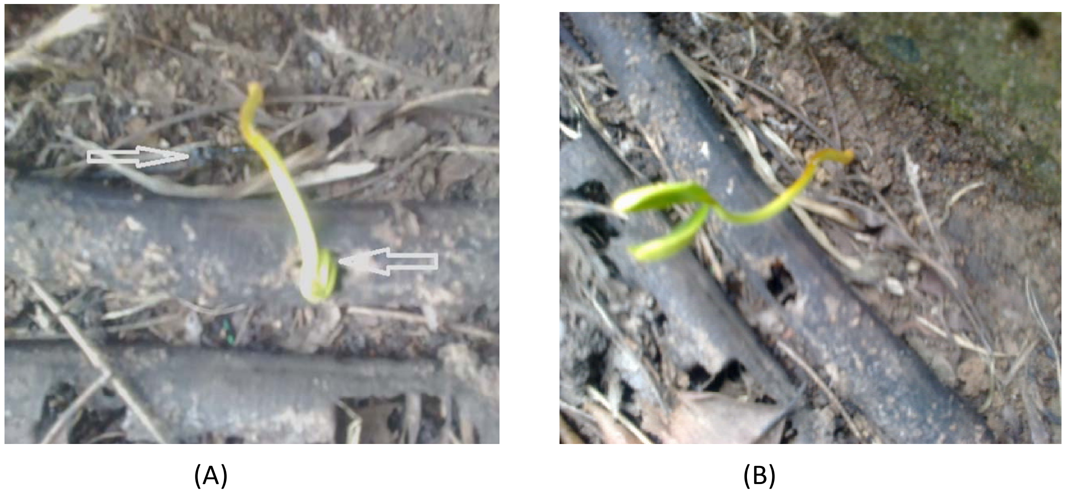


**Figure 2.** (a) The radicle of a seedling protruding from a hole in the pod of *C. fistula* and just touching the soil. To the left of the seedling is the big black ant and to the right is the hole in the pod, (b) The seedling fully emerged from the hole in the pod. On the pod is the hole through which the seedling emerged.

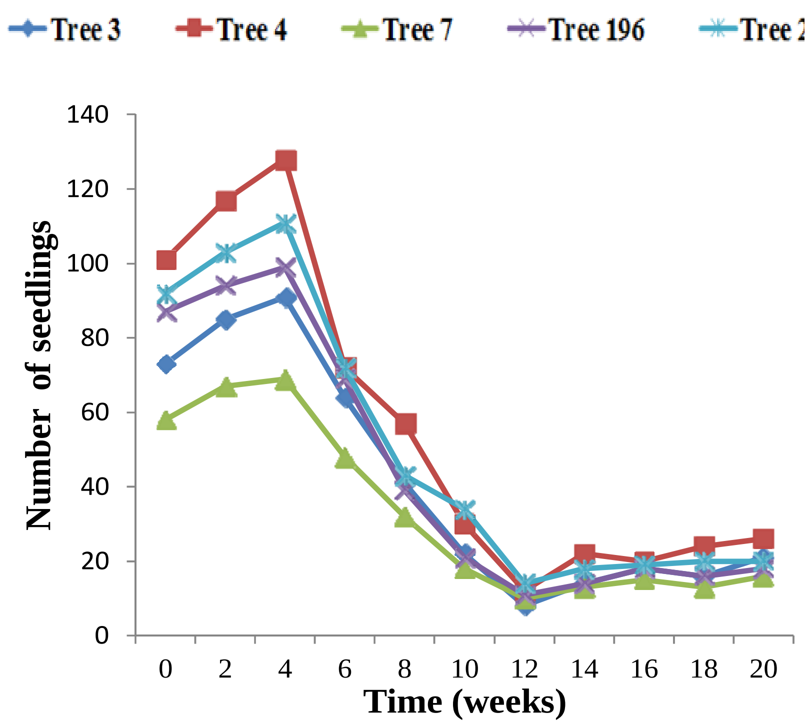


**Figure 3.** Seedling dynamics of *C. fistula* under five mother trees in Covenant University, Ota, Nigeria.

that the pods must somehow delay seed germination, probably to a more favourable time, until they break or decay. The hole in the pod was thought to have been made by the big black ants *Polyrhachis vicina* Roger (Figure 2a) which are very common in the area. An experiment is already in progress to determine how long it takes for pods to degrade or rot to a level that can allow seeds to germinate and grow out of the pods. The result will be related to the length of time it takes for the seeds to lose viability (Babalola et al., 2014).

Figure 3 showed that in all the investigated five sites with seedlings, there was increased number of seedlings in the first month, most likely due to the wet weather in May-June which aided more germination. Afterwards, there was reduced number of seedlings culminating in the lowest values during the dry August break in rainfall (week 12, Figure 3). Thereafter, there was a slight increase in seedling number which more or less levelled off. Just as the seedlings were growing and more seeds were germinating, surrounding weeds, mainly grasses, were also flourishing. Consequently, there was increased competition all around. At the same time, the crowns of the mother plants became denser as a result of the development and growth of new foliage, thus the amount of light reaching the ground floor and the seedlings was severely reduced. Mean light intensity in the open was 20860 watts while on the seedling floor it was 8178 watts, showing a reduction of about 60%. Yellowing of the seedling leaves was also observed before the seedlings died.

Aref (2002) reported that reduced light intensity has a deleterious effect on seed germination and seedling growth of *C. fistula*. Alvarez-Buylla and Martinez-Ramous (1992) indicated that reduced light was one of the factors that led to the mortality of young plants. Similarly, Seiwa (1998) reported abrupt decrease in *Acer mono* in understory sites, but continued increase in gaps and forest edge. Thus the drastic reduction in the seedling population of *C. fistula* with time under the mother trees could be as a result of increased inter specific competition as well as reduced light intensity. The seedling regeneration may be explained by the differences between the soil samples; the loose, dark humus soil with high moisture and organic contents was found under the mother trees where there was regeneration and the hard, red lateritic soil with low moisture and organic contents was under the trees which had no regeneration (Table 1). It is easier for the pods to be buried and decayed in the moist, humus soil than to do so in the hard, less moist red lateritic soil. Humus binds soil particles and holds soil moisture (Nalawadi et al., 1977). The low soil moisture in the red lateritic soils may militate against seed germination and establishment. The similar soil pH values (Table 1) may not have much effect on regeneration.

If the sampling for seedlings had been carried out only in May/June, *C. fistula* could have been classified as having good regeneration (Pokhriyal et al., 2010); but this could have been otherwise if sampling was done in October (Ballabha et al., 2013). Thus, sampling should be carried out over a period of time by researchers in other to correctly determine the quality of regeneration of a tree. Nonetheless, this investigation has clearly shown that like naturally growing population of *C. fistula,* cultivated population may regenerate under suitable conditions. While the regeneration of *C. fistula* in nature is either to replace old dying mother trees or to provide resources, it is not clear what the use of regenerated seedlings in cultivated population would be as they may eventually be shaded out by the mother tree.

Observations over several years need to be carried out with the regenerated seedlings. On the other hand, layering from the roots of the mother trees of *C. fistula* has been observed, as seen in the cultivated population at Covenant University, to be very successful in providing new, strong and vigorously growing shoots along with the mother trees.

A species like *C. fistula* that has been cultivated and nurtured over many generations may have lost its competitive ability. Thus, even as *C. fistula* seeds are able to germinate in nature, the seedlings may not be able to survive to sapling stage and reach maturity on their own in nature (Ballabha et al., 2013) due to their poor survival with the low light intensity prevailing under the mother trees (Aref, 2002). Thus the perpetuity of *C. fistula* may depend on its use as ornamental and medicinal plant or on the occasional dispersal of the seeds to more favourable open spaces. Consequently, since *C. fistula* may not perpetuate itself well in nature, it appears that artificial regeneration by cultivation may be the major way to conserve the species.

## Conflict of Interest

The authors have not declared any conflict of interest.

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