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Research Paper

Effect of fruit ripeness status and netting on the germination and early growth of *Dennettia tripetala* G. Baker seedlings.

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Abstract. *Dennettia tripetala,* an important medicinal and socio-cultural fruit crop in Nigeria has germination and early growth problems. This study set out to investigate fruit ripeness status and appropriate growing environment for raising it. The study was carried out in the nursery and laid out in completely randomized design (CRD) pattern with four treatments, each having four replicates and 20 seeds. The treatments were ripe netted (RN) ripe un-netted (RU), un-ripe netted (UN) and unripe un-netted (UU). Temperature and humidity values were recorded in and outside the net, germination and early growth data taken. Data subjected to evaluation by percentages, analysis of variance and treatment means separated using least significant difference (LSD) at 5% level of probability. The UU seeds germinated in 26 days, UN (33 days), RU (26.5 days) and RN (31 days). Germination rate was moderate for both ripe and unripe. Percentages were 56, 53, 60 and 65 for UU, UN, RN and RU respectively. At termination, seedling heights were 6.6 cm (UN), 6.3 cm (UU), 44.7 (UN), 27.4 (RU) and 43.1 (RN) leaf of seedlings in the open were eaten by small animals. Seedling growth was significantly better under netting irrespective of seed ripeness status. Both unripe and ripe fruit seeds could be sown but netting must be provided to enhance seedling growth and survival. Further research is needed in aspects of best sowing time, depth of sowing, cotyledon fullness, watering regimes and response of seedlings to fertilizer application.

Keywords: *Dennettia tripetala*, fruit, germination, netting, ripeness.

INTRODUCTION

Forests in Nigeria are greatly exploited for various resources that satisfy the needs of the people. Some of the needs include timber, food, fodder, firewood, medicine, chemicals, agricultural implements, household utensils and cultural items. There is however great variation within and between communities in the use of plants and other forest products especially the NTFPs (Non Timber Forest Products). Over the centuries, the benefits of these NTFPs have been enduring and playing great roles in the lives of people particularly those of rural areas. All world leaders agree about the fact that the continuous existence of many societies and their livelihoods rest on the sustainability of the biodiversity of their forests as this ensures the availability of more goods and services. However, deforestation is threatening the survival and health of natural forests with man being at risk of losing his resources and benefits too. Lapido (2010) puts the deforestation rate in Nigeria at about 3.5%, translating to a loss of 350,000 to 400,000 hectares of forest land per year. The commonest reasons for deforestation include removal of forest to make way for urbanization, infrastructural development, agriculture (especially plantation agriculture) logging and in recent times fires and wars (Oboho, 2014).

Oboho and King (1994) were of the view that the role of forest is possible because it is near the rural people, able

Figure 1. *Dennettia tripetala* tree showing its fruits.

to produce a diversity of products from season to season and from year to year. If properly maintained, the resources are renewable and require low financial, infrastructural and energy inputs to produce useful products.

Many forest fruit trees of great socio-economic value to the people are among the NTFPS. Some of these include *Irvingia gabonensis, Treculia africana, Pentaclethra macrophylla, Dacryodes edulis, Dennettia tripetala, Dialium guineense, Monodora brevipes* and *Garcinia kola*. For many of the listed, there is great pressure on their fruits, seeds leaves, bark and roots because of the various benefits they offer. Despite the invaluable potential of these species, they face threats of extinction as most of them are obtained from the wild; there is poor harvesting method as well as large scale habitat loss, fragmentation and degradation. The IUCN red alert status for *D. tripetala* is threatened as a result of those among other factors.

Continuous availability of valued crops from the forests can be achieved through proper management of natural forests, enrichment planting, low impact logging and sustainable forest management. To forestall threats of extinction, Egharevba et al. (2005) recommended the domestication and development of suitable production practices for the sustenance of indigenous economic fruit trees.

Production practice for sustainable use can be achieved through regeneration. Regeneration is the act of renewing the forest by establishing young trees naturally or artificially. The regeneration of *D. tripetala* is faced with various problems among which are, those relating to germination, high rate of fruit deterioration upon falling from mother tree, as well as the high rate of consumption of its seeds by man/animals. According to Osaigbovo et al. (2010), *D. tripetala* has inconsistent fruiting, poor seed germination and slow seedling growth. Attempts at artificial regeneration of the crop have been carried out by stem cutting (Onefeli and Akinyele, 2014). Many times, cuttings are not easily accessible because of paucity of young trees of this crop in the forest; so there is still need to rely on the use of seeds for regeneration or engage in micro-propagation techniques that are more expensive to carry out. For resource poor farmers, it would be worthwhile to focus on appropriate nursery practices that would ensure the production of seedlings for plantation establishment at low cost. It is therefore the aim of this study to investigate the fruit ripeness status and appropriate growing environment for raising seedlings of *D. tripetala*.

Also, FAO (1996) global plant for the conservation and sustainable use of plant genetic resources for food and agriculture which was adopted in 1996 by approximately 150 countries identified the improved conservation and use of neglected and underutilized species as one of its 20 main activities. This study intends to contribute to the store of knowledge in this regard.

Description of *Dennetia tripetala*

Dennettia tripetala is a small-medium sized woody tree that grows up to 12 to 18 m in height and 0.6 m in girth (Keay, 1989) with dense compact crown (Figure 1). Bole is generally very short, slash brown, fibrous and strongly scented. The leaves are 8 to 15 cm long, 3.81 to 6.35 cm broad, elliptic to ovate, shortly acuminate, broadly connate (united with others of the same kind especially of

Figure 2. *Dennettia tripetala* fruits.

Figure 3. *Dennettia tripetala* seeds.

sepals and petals) to rounded at the base, glabrous above, sometimes sparsely and finely hairy beneath, with about 10 pairs of thin irregular lateral nerves branched and looped well away from the margin, the nerves forming an open network. The young leaves have instinctive spicy taste (Achinewhu et al., 1995). The flowers are light brown outside, reddish inside, usually in small clusters on the young or older woods, stalks up to 0.63 cm in length, hairy with very small bracts, small broad sepals, dark brown and shortly hairy. Petals are ovate, about 1.27 cm in length, leathery, shortly hairy. It flowers from October to December. Flowers are light outside, reddish inside and usually small clusters on the young or older woods (cauliflorous). Fruits (Figure 2) are berries with finger like carpel constricted between. The seeds are obtain between March and June. They are edible, with peppery, spicy taste, green at first but eventually turn reddish pink when ripe. The number of seeds (Figure 3) in each fruit range between 1 and 10 depending on fruit length. The wood is soft, white coloured and prone to termite attack.

The fruit is eaten as a masticator which when chewed produces a unique peppery effect (Keay, 1989). Its fruits and leaves are used as seasoning which are added to food such as meat, soup, sausage and in some special local dishes and vegetables (Ejechi and Akpomedaye, 2005). It is rich in minerals and vitamins, containing 15.31% crude protein, 62% carbohydrates, 9.8% crude fibres and 3.47% crude lipids. The mineral content includes calcium (1.80%), phosphorus 0.33%, potassium (2.57%) and magnesium (0.42%) while the vitamins comprise mostly water-soluble such as ascorbic acid, thiamine, riboflavin and niacin (Okwu and Morah, 2004). The peppery fruits are applied to food meant for pregnant women and are important in the diets of postpartum women during which time, it is claimed that species and herbs aid uterine contraction.

The leaves are used for the treatment of cough, asthma, catarrh, toothache, diarrhoea and rheumatism. They can also be combined with mango leaves for the treatment of mild fever and pharmacologically the oil extracted from the fruit of *D*. *tripetala* is used in the manufacture of mouth wash (Nwinuka and Nwiloh, 2009). Ejechi and Akpomedaye (2005) also revealed that fruits of *D. tripetala* contain an essential oil which has been used as an effective preservative for stored grains such as cowpea and maize without negatively affecting their viability.

The fruits are used in entertaining guests, a sign of good reception and taken with kola nuts, garden egg and palm wine in parts of Nigeria where it serves also for cultural entertainment of guests, particularly during coronation, new yam festivals, weddings and marriage festivals (Ewere, 1998).

Mure (2013) while investigating the marketing and contribution of pepper fruits (*D. tripetala*) to rural household income in the rainforest belt of Nigeria observed that income from sale of pepper fruits represented between 2.63 and 17.2% is total household income in the fruit season months. As a shrub, *D. tripetala* plays an important role as the integral part of the structure of traditional home garden (Nwachukwu et al., 2010).

MATERIALS AND METHODS

Study site

The study was carried out at the nursery of the Department of Forestry and Wildlife, Faculty of Agriculture, University of Benin, Benin City. The central point of the nursery is located at latitude 06° 24' 0.38"N and longitude 005° 37′ 24.0"E and altitude of 106 m (GPS Location). The general topography of the University of Benin can be described as a low and sandy flat land; the geology is reported to have been formed out of relatively undisturbed thick layer of sedimentary sands and sandy clays of tertiary age. The temperature of the Benin City environment ranges between 27 and 32°C for most of the year during the day. Atmospheric humidity ranges from 75% at 12 noon and over 95% at 6.00 am. During the

Table 1. Germination and growth parameters values for *Dennettia tripetala.*

Treatments	Days to emergence	Percentage germination	Plant height (cm)	No. of leaves	Leaf chlorophyll concentration index (CCI)	Collar girth (cm)
Unripe un-netted	26[b]	60[a]	6.3[a]	2.8[b]	31.3[b]	0.7[a]
Unripe netted	33[a]	55[a]	6.6[a]	4.0[a]	44.7[a]	0.7[a]
Ripe un-netted	31.75[a]	27.5[b]	5.1[b]	2.3[b]	27.4[b]	0.4[b]
Ripe netted	26.5[b]	31.25[b]	5.2[b]	3.5[a]	43.1[a]	0.7[a]
LSD	3.92	3.73	0.52	0.70	8.81	0.13

Means followed by different letters are significantly different at 5% level of probability

Harmattan which occurs from the month of December to February, cold, dry dusty North-Easternly winds bring about a considerable drop in the relative humidity. The main rainy season predominantly with South-West to West wind is from the month of May to October and the annual rainfall is 2,078 mm (Master Plan, 1993).

METHODOLOGY

D. tripetala seeds were raised in germination trays filled with garden top soil. Matured fruits of the crop were procured from New Benin Market in Benin City. The fruits were depulped, seeds extracted, washed and air dried for 2 days. A total of 320 seeds were sown; 160 seeds being placed under fine, mesh net (Agro net 0.4 mm pore diameter) and the other 160 seeds were sown in the open (un-netted). For each of the sections, 80 seeds were ripe and 80 were unripe (green) matured seeds. Routine nursery management practices like watering and weeding were carried out. Microclimate site data of temperature and relative humidity percentage were taken twice daily at 10 am and 5 pm and their means for the period taken. The wet and dry bulb thermometer was used to get mean temperature value. The relative humidity percentage was taken as the depression of the wet bulb on Celsius scale of the table of wet and dry thermometer readings. The experiment was laid out in completely randomized design (CRD) pattern with four treatments, each having four replicates and each replicate having 20 seeds making 80 seeds per treatment. The treatments were:

Ripe netted (RN), Ripe Un-netted (RU), Unripe netted (UN) and Unripe un-netted (UU).

The data obtained were subjected to evaluation of percentages and analysis of variance (ANOVA), while the treatment means were separated using Least Significant Difference (LSD) test at 5% level of probability.

The germination aspect spanned seven (7) weeks and seedling growth parameters, started three weeks after germination and attainment of first 2-leaf stage, for eight (8) weeks. Days to germination was taken as the mean of the number of days from sowing to the first raise of the cotyledon above soil level for each treatment. The growth parameters measured on weekly basis were: plant height, collar girth, number of leaves and chlorophyll concentration index (CCI). The leaf chlorophyll content estimates were taken as CCI from recently expanded leaf using chlorophyll meter for the measured seedlings in each treatment.

RESULTS

Site mico climate

The mean temperature values for the netted section was 30.07°C at 10 am and 29°C at 5.00 pm and for the un-netted section it was 32.57°C at 10 am and 30.14°C at 5.00 pm. The mean relative humidity for the netted section is 91.29% at 10.00 am and 97.14% at 5:00 pm; and 83.71% at 10:00 am and 95.28% at 5:00 pm in the un-netted section.

Germination

Germination and early growth values are as shown in Table 1. *D. tripetala* seeds exhibited epigeal germination, specifically of the phanerocotylar type. The radical of the seed developed into the primary root which attained 4.3 cm length before the cotyledons began to push out above the soil level, indicating emergence/germination (Figure 4).

After 26 days, the new seedling emerged with the hypocotyle forming a hook like structure through the soil surface. The hook stayed 3 days before the cotyledons were lifted above the soil level. Between 4 and 7 days, the cotyledons being exhausted of nutrients dropped and the first two leaves were exposed. They are greenish yellow at first, later turning green and becoming more photosynthetically active. It was also observed that few seeds took much longer time for their hooks to lift the cotyledons above soil level. They did not produce any leaf by the time the cotyledons withered off.

The UU seeds exhibited emergence in 26 days after sowing while the unripe (UN) took 33 days. The ripe (RU) seeds took 26.5 days for emergence and (RN) took 31 days. There was no significant difference ($P < 0.05$) in the days to emergence for the various treatments.

Figure 4. *Dennettia tripetala s*eed showing emerging radicle.

The UU seeds had 56% germination; others were 53% (UN), 60% (RN) and 65% (RU). There was statistical difference between germination values of ripe and unripe seeds irrespective of netting. However, only values of RU were statistically higher than the others.

Peak germination values occurred at 3 weeks after emergence for UU, 4 weeks for UN, 5 weeks (RN) and 6 weeks (RU). The peak germination was attained earlier by the unripe seeds with or without netting.

Early growth

D. tripetala exhibited slow growth rate in the nursery. At termination of experiment, (eleven weeks emergence) seedling heights were 6.6 cm (UN), 6.3 cm (UU), 5.2 cm (RN) and 5.1 cm (RU). This means that growth rate was about 0.60 cm for the unripe and 0.47 cm per week for the ripe irrespective of treatment. There were statistical differences in the height values.

The numbers of leaves were as follows: 2.8 (UU), 4.0 (UN), 2.3 (RU) and 3.5 (RN) the values were statistically different, but RN and UN values were not different statistically. Similarly, RU was not significantly different from UU. In the unshaded section, leaves of seedlings were continuously being eaten up by small animals like insects, lizards and mollusc. The young seedlings attempted regrowth following defoliation, enabling some few leaves to remain.

Chlorophyll concentration index values were 31.3 (UU), 44.7 (UN), 27.4 (RU and 43.1 (RN), values were also statistically significant; the netted values being statistically higher irrespective of ripeness status.

Collar girth values were as follows: UU (0.7 cm), UN (0.7 cm), RN (0.7 cm) and RU (0.4 cm). Value for the ripe un-netted was statistically different from the other treatments.

DISCUSSION

Results indicated that there were differences in days to germination, time to attain peak germination, percentage germination as well as the growth parameter values for the various treatments given, although levels of significance differed.

The un-netted seeds (ripe and unripe) germinated earlier than the netted seeds (ripe and unripe). This is an indication that the species is probably positively photoblastic and needing more direct exposure to sunlight in order to germinate. The netting probably had reduced this factor, hence the numerical difference. There could also be the possibility that netting and the associated environmental modification aided the inhibitory capacity of the chemicals in the seeds in delaying emergence. However, 5 to 7 days difference in time of germination is not a serious challenge in the raising of crop in nursery. The unripe seeds had lower germination values than ripe seeds irrespective of netting.

That the germination percentage values of the UU and UN were not statistically different from the RN probably indicate that ripeness status of the fruits conferred similar germination potential on the seeds and was therefore not critical as long as the fruit has attained maturity. Cavero et al. (1995) working on Spanish pepper cultivars similarly observed that seeds from half ripe fruits had a poorer germination behaviour than those taken from ripe fruits especially at 13°C. Also, Nwachukwu et al. (2010) working on *D. tripetala* observed that the red matured seeds and yellow matured seeds were statistically the same but significantly different from the mean of green matured seeds. The red matured seeds had the highest germination rate.

The failure of the hypocotyle hooks of some seeds to lift cotyledons above soil level early and the subsequent leaflessness from such seeds upon emergence could be related to cotyledon filling and/or sowing depth. This needs further investigation.

For observed seedling growth parameters, values were in favour of the netted treatments irrespective of ripeness status. It could be that the netting acted as partial shading and created a more ameliorating growth condition for the young seedlings in terms of temperature, humidity (obvious from the site values) and protection from the direct impact of rain drops. Working with seeds of *Calyptranthes pallens*, *Eugenia* sp., *Hypelate trifolia* and *Metopium brownii* in Hellshine hills, Jamaica, McLaren and McDonald (2003) also found that seedling survival was lower in unshaded plots; also seedling size was positively affected by shading with seedlings within the partially shaded plots attaining the highest basal diameter while seedlings in the heavily shaded plots were the tallest. Fajinmi and Fajinmi (2010) similarly observed increase plant height and plant bearing capacity in okra (*Abelmoscus esculentus*) growing under netting.

The higher values of leaf number observed with the netted seedlings are a pointer to positive promotion of the seedling growth. All things being equal, more leaves and more chlorophyll concentration index for a seedling indicates photosynthetic capacity, hence production of more biomass and growth. Chlorophyll, the green pigment of plants is the most important pigment active in photosynthetic process (Remison, 2013). It is a very important process by which green plants synthesizes organic matter in the presence of light. Although there are conflicting views regarding the direct relationship between chlorophyll content and rate of photosynthesis, but theoretically it is obvious that the rate of photosynthesis should increase with an increase in the chlorophyll content provided the other factors are also favourable (Vain, 2007).

Un-netted seedlings (irrespective of ripeness status) had the lowest number of leaves. Achinewhu et al. (1995) observed that the young leaves of *D. tripetala* had instinctive spicy taste. This could be the cause of the leaves being eaten up in the un-netted section. Oboho (2014) observed some mollusc feeding on seedlings of *D. tripetala* in the nursery. Licciardi et al. (2007) also observed that net covering has been used as a physical barrier excluding pest and diseases from growing plants. The higher number of leaves on the netted seedlings also physiologically translated into higher values of chlorophyll concentration index and collar girth. Nwachukwu et al. (2010) suggested that since the best germination rate was given from red matured fruits, the species could be multiplied through wildings. This study however gives impression that apart from the inherent slow growth rate of *D. tripetala,* the continuous defoliation and loss of leaves by small animals is a critical issue in its regeneration and survival and even more so in the wild. Indeed, the vulnerability of it leaves (photosynthetic seat) to phytophagous animals could be strongly implicated in the slow growth rate.

CONCLUSION

The study has examined the growing environment and seed ripeness status that would promote seedling production of *D. tripetala* in the nursery with a view to enhancing domestication. The seeds irrespective of ripeness status and netting took between 26 and 33 days to germinate. Germination rate was moderate irrespective of ripeness status. The unripe seeds gave 56 and 53% germination under unnetted and netted conditions respectively while the ripe netted seeds gave 60% and ripe unnetted was 65%. The best growth parameter values of seedlings in terms of plant height, number of leaves, chlorophyll concentration index were however obtained for the unripe and ripe netted seeds. It became apparent that netting was very useful in protecting the young seedlings of *D. tripetala* in the early growing stage against the small animals that fed on the leaves as well as ameliorating the growing environment in a manner similar to partial shading.

It is recommended that seeds from both matured ripe and unripe fruits of *D. tripetala* could be used to raise seedlings but netting must be provided to enhance the growing environment for the seedlings as well as protect them from defoliation by small animals. More research is needed in the aspect of seed sowing time, depth, cotyledon fullness, watering regime and fertilizer application with a view to promoting its raising in the nursery and subsequent domestication.

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