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GERMINATION FREQUENCY OF WOODY SPECIES IN EXOTIC PLANTATION AND BUSH FALLOW LAND AREA IN UMUAHIA, ABIA STATE

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ABSTRACT

In a field study involving 21-year old exotic plantations and a bush fallow land use system at Forestry Institute of Nigeria (FRIN) Umuahia, Abia State, the germination of indigenous woody species and litterfall were monitored. Enumeration of indigenous woody species was carried out within a 3.5 x 3.5 quadrat plot. The *Pine/Gmelina* mixed stand had the highest level of germination among the exotic plantations with a total population of 140 species with 14 families followed by *Pine* stand with 121 species and 14 families while *Gmelina* stand had the least germination with 115 species and 11 families. *Pine* stand was significant (P<0.05) with the highest annual litterfall (10.000 kg/ha yr), followed by the *Pine/Gmelina* mixed stand (7.904 kg/ha yr), while the *Gmelina* had the least value of 7.875kg/ha among exotic plantation. The bush fallow system gave the least value of 5.014 kg/ha yr of annual litterfall. Higher quantity of floor litter and reduced light- reach to the floor inhibited the germination of native woody species. Mixed stands of exotic species favour conservation of native woody species.

KEY WORDS: Exotic plantation, fallow, woody species, germination.

INTRODUCTION

Plantations have been shown to resuscitate the productive potential of degraded lands in the tropics (Sanchez *et al.,* 1985), and a substantial regeneration of native species may occur under these plantations. Thus, plantations are regarded as "foster ecosystem", which stimulate the regeneration of a semi-natural forest community more rapidly than would occur naturally on abandoned unplanted lands (Lugo, 1988). In fact, plantations accumulate species as fast as secondary forests, suggesting a similarity in ecological function (Brown and Lugo, 1990). Plantation forestry of fast growing species began in the tropics as a substitute for unmanaged natural stands with their diminishing wood resources (Evans, 1986). In Nigeria, the plantation forest comprising of exotic species such as *Gmelina arborea, Pinus carribaea, Nuclea diderrrichii* and others occupy about 2,160.26 km^2 out of the 96,518 km^2 total land area of forest estate (Abayomi *et al.,* 1992).

Studies on successional patterns in Nigerian forest ecosystems have identified that the pattern of succession, the floristic composition, and structure of the initial re-growth depend on the availability of propagules within or close to the site, the initial migration of shade tolerant primary species and the ability of the species to adapt and mature to reproductive age thereby accomplishing its life cycle (Kio, 1978; Okali and Ola-Adams, 1987; Swaine and Hall, 1983). Some tropical tree species have features such as winged and small sized seeds that enhance their chances of colonizing new sites.

The forests have established major pathway of recycling of nutrients from plant to soil through litterfall. It is known that the quantity and character of forest litterfall varies between tree species, stand age and pattern of development, particularly as regards to the contribution of water and nutrient availability (Binkley, 1986; Poglase and Attiwill, 1992). Usually, there is rapid decomposition of plant litter at the onset of the rainy season, which brings about increases in nutrients accumulation over relatively short period (Swift *et al.,* 1981). This tends to encourage seedling germination in both natural and plantation forests. Some dormant seeds of tree species that have been on the forest floor for some years due to unfavourable climatic conditions begin to sprout. It is commonly observed that the germination of both indigenous and non-indigenous tree species in these plantations occur often times after the rains following a round of litterfall. Vegetation covers introduce extensive modification in ecological pattern with regard to microclimate, the soil and above ground interaction; however, the modification may be dependent on the tree species. Thus, different woodlands have differing ability for seedling germination, which is affected by the type of species (Eriksson, 1995); seed size and dispersal ability (Dzwonka, 2001) and dormancy characteristics. Although plantations of exotic species have for significant period replaced part of what had existed as the natural forest estate in Nigeria, the pattern with which native species to Nigeria could regenerate and develop within such plantations are not certain. This information will be indicative of the pattern of accommodation and interaction existing between species of diverse origin.

MATERIALS AND METHODS

Study Area Description

The investigations on germination of indigenous woody species and litterfall were carried out in pure *Gmelina arborea* and *Pinus sp.* Plantation and a mixed *Gmelina/Pine* plantation at the Forestry Research Institute of Nigeria (FRIN), Abia State, Nigeria that were established in 1983. A nearby 1.5 ha fallow land was used as control plot. Umuahia is within the lowland rainforest zone of Nigeria (Keay, 1959), which lies on latitude 05°29'N and longitude 07°33'E. The area has a

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mean annual rainfall of 2238mm distributed over eight months of rainy season period (March to October) with bimodal peaks in June/July and September (Anon. 2004). The soil type is ultisol. The minimum and maximum temperature is 23°C and 32°C respectively, and relative humidity of 60 – 80% (Anon. 2004).

Enumeration of tree Seedlings germination in the Exotic Plantation and Bush Fallow System.

Enumeration of germinated woody seedlings in the pure stands of *Gmelina sp., Pinus sp.* and *Pine/ Gmelina of* mixed stand was carried out using wooden quadrat plot of 3.5m x 3.5m size. Four quadrats were randomly placed on each of the stands and woody seedlings above 20cm were counted, identified and tagged with ribbon for recognition. The seedlings of woody species that were recruited within the randomly placed wooden quadrat were uprooted, taken to the herbarium section of the Department of Forestry and Environmental Management, Michael Okpara University of Agriculture, Umudike for proper identification of the indigenous species. The exercise of tagging, counting and identification was done at a monthly interval for 12 months.

Litterfall collection

Total litterfall in the separate stands of pure *Gmelina, Pine*, *Pine/*Gmelina of mixed stand, and a bush fallow system were assessed bi-weekly and on a monthly basis for one year (September 2003 – August 2004). The litters were collected with 1m x 1m x 0.2m wooden trays whose base was covered with 1mm polyethylene sieve. The purpose of litterfall assessment was to determine the total annual quantity of litterfall from the various stands. Monthly collections of the litterfall were initially weighed and bagged, before oven drying for 5 days at 60°C to constant weights. The data on annual litterfall were presented in a bar-chart while the recruitment potentials of the four plant communities were determined using frequency of occurrence.

RESULTS AND DISCUSSION

Litter fall

Total annual litterfall was heaviest in Pine stand (10.000 kg/ha yr) than the other 3 vegetation studied. The annual litterfall from the 4 different stands in progressive order of quantity beginning from the least is bush fallow<*Gmelina sp.* < *Gmelina/Pine* < *Pine* (Figure 1). The litterfall recorded under Pine is relatively higher than the 9.024 kg/ha yr recorded under a monoculture of *Tectona grandis* L. (Egunjobi, 1974), and 8.20 kg/ha yr recorded in a mature mixed forest (Happold, 1977) at Gambari. Generally it has been reported that the evergreen vegetation like Pine stands produced more total annual litter than the deciduous vegetation (Vogt *et al.,* 1986; Bray and Gorham, 1964). The evergreen species (Pine stand) has the largest total litterfall input of (10.000kg/ha), followed by *Pine/Gmelina* stand (7.904kg/ha) while bush fallow had the least annual litterfall (5.014kg/ha). The value for bush fallow presumably was as a result of human disturbance such as collection of stakes and fuel wood, and possibly the types of species that existed therein – the species, and possibly the types of species that existed therein which had slow growth rate and low level of litter production.

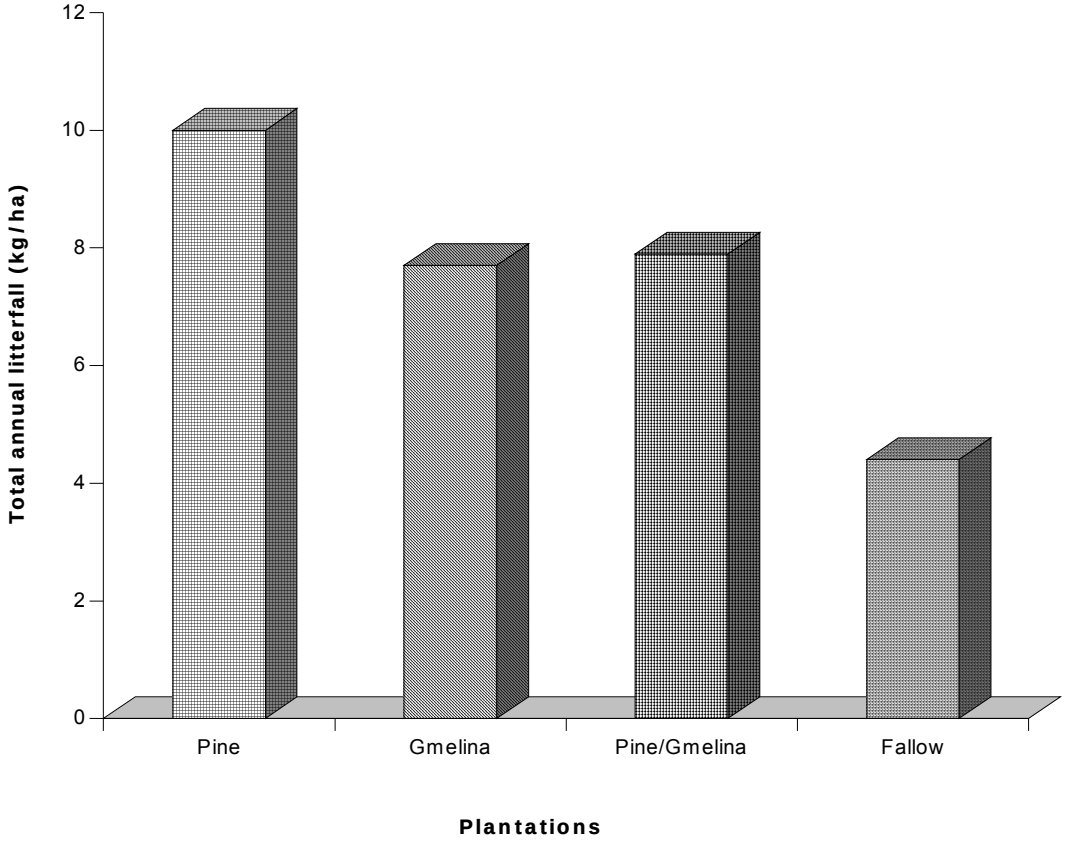

Fig. 1: Total annual litterfall in the Pine, pure Gmelina, Pine/Gmelina mixed plantation and the bush fallow system.

Germination Potentials of the Three Exotic Plantation and Bush Fallow System

A total of 26 families were enumerated in the study (Table 1). Three families:- Apocunaceae (*Funtumia elastica, Hedrathara bartai, Landolphia owariensis* and *Rauvolfia vomitoria*), Connaraceae (*Agalaea trifolia, Cnestis ferruginea*), and Rubiaceae (*Heinsia crinata, Mytragyna spp.*) were recruited in the entire four plant communities. Most of the species mentioned above possessed wing-like seeds and/or are dispersed through explosive mechanisms, which are features that aid colonization by species (Froborg and Eriksson, 1997). Four families Euphorbiceae (*Alchornea cordiolia, Maesootrya spp., Microdesmis uberula*), Icacinaceae (*Icacina trichantha*), Moraceae (*Antiaris toxicaria, Ficus sp., Milicia excelsa*) and Rutaceae (*Arapliosis soyauxii*) were recruited in three out of the four plant communities. Eleven other families:- Anarcadiceae (*Spondias mombin*), Araceae (*Amaphophalus sp.,*), Athyriaceae (*Diplazium sp.*), Bignoniaceae (*Newbouldia laevis*), Menispermaceae (*Sphenocentrum jollyanium*), Mimesideae (*Albezia ferruginea*), Myrtaceae (*Eugenia uniflora*), Rhizophoraceae (*Rhizophora spp.*) and Rosaceae (*Dactylaedenia barteri*) were respectively represented by a single species each in the four types of vegetation studied. Floor litter has negative influence on recruitment of most woodland species (Sydes and Grime 1981a,b; Facelli and Pickett, 1991; Eriksson, 1995; Brunet and Von Oheimb, 1998; Dzwonka, 2001a,b). In this study, it seems that recruitment of native species in plantation of exotic species declined with quantity of litter generated although other factors may also be operating. Heavy mat of litter could be suppressing the protrusions seedlings as the quantity increases.

Table 1: Germination frequency of woody species in exotic plantations and fallow system land areas.

Family	Pine	Gmelina	Pine/Gmelina	Fallow system
Acanthaceae	0	0	15	20
Anacardiaceae	0	0	6	0
Apocynaceae	11	11	23	10
Araceae	0	0	9	0
Athyriaceae	0	0	10	0
Bignoniaceae	0	0	0	9
Caesalpiniodeae	0	0	6	7
Celastracea	0	0	12	0
Combretaceae	2	0	0	0
Commelinaceae	40	11	0	4
Connaraceae	25	60	16	30
Euphorbiacea	1	6	0	15
Icacinaceae	2	12	0	25
Lecythidacea	10	2	0	0
Menispermaceae	7	0	0	0
Mimessoideae	0	0	6	0
Moraceae	3	0	11	10
Myrtaceae	2	0	0	0
Papilionoideae	5	0	4	0
Passifloraceae	1	3	0	0
Rhizophoraceae	0	0	8	0
Rosaceae	0	0	0	3
Rubiceae	10	3	7	3
Rutaceae	0	1	7	15
Sapindaceae	2	3	0	0
Sterculiaceae	0	3	0	4
Total No. of families in occurrence	**14**	**11**	**14**	**13**
Total No. of woody plants encountered	**121**	**115**	**140**	**155**

Suitable microsites, weather and the availability of seeds are major factors determining the success of seedling recruitment (Eriksson and Ehrlen, 1992; Ehrlen and Eriksson, 2000). Seed availability is in turn influenced by such factors as seed production, dispersal and seed predation (Jensen, 1985; Eriksson, 1995).

The diversity and complex relationship of plants that grow on and in the soil affect the quality of forest sites. However, the accumulation of organic material as a thick mat on the surface soil, due to an increased production of litter and a reduced rate of decomposition might have led to the relatively low recruitment of indigenous tree species in plantation. The *Pine/Gmelina* mixed stand had the highest recruitment of indigenous tree species than the exotic plantation. This plant community (*Pine/Gmelina* stand) could have offered more microsites than *Pine* stand, and *Gmelina* stand (Ehrlen and Eriksson, 2000). Allelopathy is widespread occurrence among woody plants and agricultural and wild species of many kinds (Tukey, 1969; Whittaker and Feeny, 1971). Allelopathic substances play important roles in plant interrelations either directly when absorbed by the neighbouring plant or indirectly by modifying the environment through an accumulation or alteration of other site factors.

The families Combretaceae (*Combretum sp.*), Menispermaceae (*Sphenocentrum jollyanum*), and Myrtaceae (*Eugenia uniflora*) were only recruited in the

Pine plantation. The canopy structure of the *Pine* trees allowed relatively more light penetration, a factor known to encourage recruitment of these species. In the *Pine* and *Gmelina* plantations, the families mostly recruited are *Commelinaceae* and *Connaraceae*. The families are represented by *Palisota hirsute, Agalaea trifoli* and *Cnestis ferruginea.* The fruits and seeds of these species could germinate almost immediately if safe sites are provided. However, in the *Pine/Gmelina* mixed stand, the families mostly recruited were *Apocynaceae, Connaraceae* and *Acanthanceae* represented by *Acanthus montanus, Funtumia elastic, Hedrathara bartai, Agalaea trifolia.* These species appear to be more shade-tolerant to the dense canopy cover of the *Pine/Gmelina* mixed stand. Families such as Anacardiaceae (*Spondias mombin*), Araceae (*Amaphophalus sp.*), Athyriaceae (*Diplazium sp.*), Celastraceae (*Hippocratea pallens*), Mimesoideae (*Albizia ferruginea*), and Rhizophoraceae (*Rhizophora spp.*) were only recruited in the *Pine/Gmelina* mixed plantation. In the bush fallow system, the families mostly recruited are the Connaraceae, Icacinaceae, Acanthaceae, Euphorbiaceae and Rutaceae. These families are represented by A*galaeae trifolia, Cnestis ferruginea, Icacina trichantha, Acanthus montanous* and *Alchornea cordifolia*. These species have seeds that easily germinate and reproduce fast under safe sites. The family Bigoniaceae (*Newbouldia laevis, Spaathodea*) was only recruited in the fallow system that may have strong preference to communities with relative high stability and organic matter. Stability of plant community system may be identified as a significant factor that promotes diversity and recruitment.

The fallow land use system with 13 families in occurrence had the highest population with 155 species. The *Pine/Gmelina* mixed stand with 14 families in occurrence had the highest recruitment of indigenous tree species among the exotic plantations with a population of 140 species. The *Gmelina* plantation with 11 families in occurrence had the least recruitment with a population of 115 species. The pure *Gmelina* stand was established farther away from the fallow plot, a condition that could be responsible for the lower pattern of recruitment in addition to other operating factors. Also proximity to a source of viable propagules such as existing mature plant communities is an advantage to be considered in recruitment of new species into a plantation (Spur and Barnes, 1973).

In all, plant communities are originating on its own which affords some level of stability within the plant system. Furthermore, there is little diversity in terms of species richness.

CONCLUSION

This study contributed to our understanding of recruitment of indigenous woody species and litterfall in land use systems involving exotic plantations and bush fallow. It was shown that the highest quantity of litterfall produced by the *Pine* plantation did not favour more recruitment of the indigenous woody species. The accumulation of organic material as a thick mat on the surface soil, due to an increase production of litter buried the propagules further into the soil, suppressed the development of some indigenous species within its stand. The *Pine/Gmelina* stand had the highest recruitment of indigenous woody species among the exotic plantations. The mixed stand provided more diverse and favourable microsites, which encouraged indigenous species recruitment. The mixed stands should be promoted while establishiong plantations in order to encouraged conservation of native woody species.

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