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Pest Status of Termites on Different *Eucalyptus* Species in Afaka, Nigeria

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ABSTRACT: *Eucalyptus* is one of the exotic tree species used for fuel wood and utility pole purposes in Northern Nigeria. The early stages of its plantation establishment face the challenges of insect attack, especially the subterranean termites. The pest status of termites on *Eucalyptus* tree species is a prerequisite for effective management strategies. This study assessed the pest status of termites on four *Eucalyptus* tree species: *Eucalyptus camaldulensis*, *Eucalyptus citriodora*, *Eucalyptus cloeziana* and *Eucalyptus tereticornis* in Afaka, Kaduna State, Nigeria. The four *Eucalyptus* species were planted in the field in a Randomized Complete Block Design and replicated three times. Seedling mortality counts were taken at 1, 2, 3, 6 and 12 months after transplanting. Mortality data were subjected ANOVA and significant means were separated using Tukey's HSD ($p = 0.05$). The results showed that lower significant seedling mortality (9.66 ± 5.3%) was observed in *E. camaldulensis* at 1 month after transplanting. Seedling mortalities within a period of 1 – 12 months after transplanting ranged from 9.66±5.43 – 74.65±8.97%, 34.29±4.80 - 66.87±1.72%, 27.32±2.08 - 61.24±5.85% and 18.01±3.05 - 63.61±2.49% in *E. camaldulensis*, *E. citriodora*, *E. cloeziana* and *E. tereticornis*, respectively. It is therefore concluded from this study that the first year of *Eucalyptus* plantation establishment is critical for termite infestation and requires a prompt decision to embark on termite management strategies.

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Eucalyptus belongs to the family Myrtaceae. It is a large genus of aromatic trees of over 600 species indigenous to Australia and Tasmania. It is one of the most widely cultivated of all plants, over wide geographic and environmental gradients throughout the world (Coppen 2002). *Eucalyptus* species are widely grown in the tropics and subtropics, especially in Brazil, India, and China, and thus are of great commercial importance (FAO, 2010). Booth (2013) reported that *Eucalyptus* is grown on more than 20 million ha of plantations globally. Different species of *Eucalyptus* have been used for large-scale afforestation and reforestation in China and this has resulted in China having the greatest amount of global *Eucalyptus* plantation area (FAO, 2010). The habit of *Eucalyptus* species used for plantations worldwide is characterized by a long bole with a small terminal crown. These species mostly originate in the wetter forest of the eastern seaboard of the Australian continent and they include *E. grandis*, *E. saligna*, *E. globulus*, *E. terticornis*, *E. nitens*, *E. dunii* and *E. smithii* (Coppen, 2002). Another worldwide grown species, *E. camaldulensis*, has as natural habitat woodland but due to its good adaptability to many differing habitats it probably has the widest natural distribution of all *Eucalyptus* species. Some of the reasons for planting *Eucalyptus* include, high growth rates, wide adaptability to soils and climate, ease of management through coppicing and valuable wood properties. It is grown for multiple uses including construction timber, fuel, pulp, plywood, poles, firewood, charcoal, essential oils, productions of plant growth regulators, for tannin extracts and industrial chemical additives (Coppen, 2002). Termites feed on the tap root of the saplings a few centimeters below the soil surface and taper it out like a sharpened pencil,

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severing the main root system from the stem. An early symptom of attack is the flaccid, drooping appearance of the tender terminal leaf pairs while the lower leaves remain green and apparently healthy. At this stage, the plant can be pulled off the ground with very little force, because the tap root has been almost severed. In older saplings, the tap root is extensively ring-barked and the smaller roots are tapered off. Because the feeding occurs underground, usually up to 20 cm below the soil surface, early stages of attack are not recognizable and by the time the symptoms appear the plant is damaged beyond recovery. In India, peak incidence of termite attack occurs within four months of planting out the container saplings, although staggered deaths continue to occur almost every month during the first year, sometimes with a second peak during the next planting season (Nair and Varma, 1985). In African countries, where older saplings are killed, most losses occur in the first year of planting, particularly in the first few months (Brown, 1965). Healthy and vigorously growing plants may be attacked by some termite species while stressed plants may be prone to attack by other species. For example in Zambia, Nkunika (1980) found that *Macrotermes falciger* attacked the tap root of vigorous *Eucalyptus* saplings while *Odontotermes* sp. fed on the roots of moribund saplings. In general, several interacting factors may influence the incidence of attack such as the species of termites present, their population density and seasonal activity rhythm. The occurrence, population changes and foraging activities of termite species in different *Eucalyptus* species plantations in the northern Guinea savannah of Nigeria have also been documented (Alamu *et al*., 2018; Alamu and Ewete, 2021; Alamu *et al*., 2021). Some of these species include *Macrotermes* sp., *Odontotermes* sp., *Amitermes evuncifer*, *Microtermes* sp., *Ancistrotermes* sp. and *Trinervitermes germinates. Eucalyptus* was first introduced to Nigeria in 1916; and has since been adapted and thrives well because its plantation requires non-expensive inputs for propagation (Onifade, 2001). In northern Nigeria, *Eucalyptus* trees are essentially utilized as fuels, timber in construction and poles for electricity and telecommunication transmission line. They have also been exploited commercially for Apiculture; production of wood and essential oils and also for medicinal purposes (Adeniyi *et al*., 2006; Ayepola and Adeniyi, 2008; Gero *et al*., 2012; Abubakar and Mahdi, 2015). With the economic and environmental values attributed to *Eucalyptus* worldwide and the establishment of its plantation in Nigeria, especially in the northern Guinea Savanna agro-ecology, there is the need to provide adequate information on the pest status of termites associated with this tree species. Therefore, the objective of this study was to assess field mortality by subterranean termites on seedlings of four *Eucalyptus* species.

MATERIALS AND METHODS

Brief background history of the study site: The Forestry Research Institute of Nigeria (FRIN) and Japan International Cooperation Agency (JICA) in semi-arid areas had a bilateral project between the governments of Japan under the auspices of Japan International Cooperation Agency (JICA) and the Federal Ministry of Science and Technology (FMST) through its relevant Institute, Forestry Research Institute of Nigeria (FRIN). The project was located in Afaka, Kaduna State between latitudes 10º 33'N, 10º 41' and longitudes 07º 26'E, 07º 28'E in the northern Guinea Savanna Agro-ecological zone of Nigeria. The project started in August 1986 and was commissioned in 1988. The agreement for the technical cooperation that lasted for 5 years was signed in Lagos on 22 August 1986. Under the agreement, the Federal Government of Nigeria cooperated with the government of Japan in implementing the Trial Afforestation Project in semi-arid area for the purpose of developing afforestation techniques and thus contributing to the development of science and technology in the management of semi-arid forests of Nigeria.

Production, field establishment and mortality assessment of experimental plants: Matured seeds of *E. camaldulensis, E. citriodora, E. tereticornis* and *E. cloeziana* were collected from *Eucalyptus* plantations in Trial Afforestation Research Station, Afaka. Seeds of each *Eucalyptus* species were mixed with fine sand in equal ratio and sown in germination boxes using river sand as germination medium. The boxes were covered with mulch and watered lightly until germination. After germination, at 2 - 3 leaf stage, the seedlings were pricked individually into polythene pot containing soil mixture of river sand, top soil and cow dung in ratio 2:2:1, respectively. Thereafter, the seedlings were arranged under a light shade and watered daily before 9.00 a.m. After 4 months in the nursery, the seedlings were transplanted in the field.

The experimental plot was cleared and laid out into 12 sub-plots of 5 m x 5 m dimension. The sub-plots were separated with a border of 2.5 m between the sub-plots and blocks. Each *Eucalyptus* species representing the treatments was replicated three times and arranged in a Randomized Complete Block Design. Planting space of 1.5 m x 1.5 m was used in each plot giving a population of 30 stands per plot. The seedlings were transplanted between 7.00 and 9.00 a.m. at the rate of one seedling per hole. Weeding of the plots commenced one month after transplanting and

continued monthly thereafter. Weekly observations were made on the seedlings to ascertain when termites started attacking the seedlings. Mortality count of seedlings commenced two weeks after transplanting and continued at two weeks interval for 3 months after transplanting (MAT). Further mortality counts were taken at 6 MAT and 12 MAT. Seedlings showing characteristic symptoms of termite attack namely, drooping appearance of the tender terminal leaf pairs, stem girdling at the soil or below soil level, lodging of the seedling and the presence of termite mud tube on the seedlings were counted and expressed as percentage mortality. Samples of termites associated with *Eucalyptus* seedlings were collected in glass vials containing 70% ethanol for identification. Data on seedling mortality was transformed using arcsine before being analyzed using ANOVA while means were separated using Tukey's HSD test ($p \leq 0.05$).

RESULTS AND DISCUSSION

Mortality of Eucalyptus seedlings: At one month after transplanting (MAT), percentage mortality of *E. citriodora*, *E. cloeziana* and *E. tereticornis* seedlings was not significantly different but significantly ($p \leq 0.05$) higher than seedling mortality in E. *camaldulensis* (Table 1). There were no significant differences in seedling mortality among the four *Eucalyptus* species at 2 months after transplanting, but the highest seedling mortality of 52.10% was recorded in *E. citriodora*. With an average of 59.41% and 61.98% at 3 and 6 MAT, respectively seedling mortalities in *E. citriodora* were significantly ($p \leq 0.05$) higher than seedling mortality in *E. tereticornis* but not significantly different from seedling mortalities in *E. camaldulensis* and *E. cloeziana*. At 12 MAT, there were no significant differences in the percentage mortality of seedlings among the four *Eucalyptus* species.

Table 1. Mean percentage (±S.E) seedling mortality of four *Eucalyptus* species due to termite infestation in Afaka, Kaduna State, Nigeria

	Months after transplanting				
Eucalyptus species	1	2	3	6	12
E. camaldulensis	9.66 ± 5.34b	44.34 ± 3.58a	49.50 ± 2.25ab	54.75 ± 1.17ab	74.65 ± 8.97a
E. citriodora	34.29 ± 4.80a	52.10 ± 1.73a	59.41 ± 0.88a	61.98 ± 2.06a	66.87 ± 1.72a
E. cloeziana	27.32 ± 2.08a	47.64 ± 5.28a	55.00 ± 4.91ab	56.96 ± 5.01ab	61.24 ± 5.85a
E. tereticornis	18.01 ± 3.05a	46.27 ± 0.67a	48.52 ± 1.16b	50.81 ± 2.26b	63.61 ± 2.49a

Means followed by the same letter in the column are not significantly different

The highest seedling mortality of 74.65% was recorded in *E. camaldulensis* and the lowest (61.24%) was recorded in *E. cloeziana*. The mortality of *Eucalyptus* seedlings due to termites' infestation in the field was similar among the four *Eucalyptus* species seedlings. As a result of termites' infestation, more than 40% and 60% seedling mortality was recorded among the four *Eucalyptus* species within the space of 2 and 12 months respectively after transplanting. At this stage, the seedlings were young and tender, and possibly secondary metabolites that could confer resistance might have not been formed or deposited in plant tissues. Similar findings showed that in most areas of Uganda and Brazil, an average of between10 and 70% of planted *Eucalyptus* trees and seedlings are killed by termites (Mazodze, 1995; Wilcken *et al*., 2002). Termites' infestation was noted at the collar of the seedlings shortly after they were transplanted from the nursery into the field. Also dead seedlings that were uprooted were observed to have lost their roots to termite's attack. A high rate of attack, which decreased with time, was observed in the first three months that followed transplanting and was common to the four *Eucalyptus* species under investigation. It has also been reported in India that peak incidence of termite attack occurs within four months of transplanting *Eucalyptus* seedlings in the field (Nair, 2007).

Conclusion: The results of this study showed that *Eucalyptus* seedlings are sensitive to termite infestation within the first year of its establishment in the field. High seedling mortality recorded at this period is a signal for prompt management strategies to be put into action for effective termite control and field establishment of *Eucalyptus* tree seedlings.

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