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Growth Performance of Eucalyptus globulus Labill. (blue gum) Seedling Coppices as Influenced by Stump Diameter

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Abstract: Eucalyptus globulus **is an economically important tree of the Myrtaceae family. Its wood is used for construction, furniture, fuel, plywood, tools, and utility poles; leaves possess medicinal properties; flowers are a source of nectar; and wide-spreading, dense root system is important for soil stabilization. The species is characterized by a high coppicing potential. The growth of coppice shoots is limited by many factors, such as parent tree species, size and abiotic conditions. This study was aimed at quantifying the regeneration performance of shoots (including number of shoots, number of leaves, leaf length, leaf width, number of branches, and shoot height) from the stumps of *E. globulus* seedlings drawn from two diameter classes, namely 1 – 4 mm and 5 – 8 mm. Data were collected three months after the initiation of treatments and subjected to analysis of variance. An increase in stump diameter resulted in increases in the number of leaves, leaf dimensions, number of branches, and shoot height. Though existent, the trend was not statistically significant for number of shoots. The results indicate that shoots from larger stumps have a stronger regenerative ability than counterparts from small-sized stumps. This study provides essential information relevant to seedling coppice management in *E. globulus*.**

Keywords: **Coppice regeneration, *Eucalyptus globulus*, Leaf dimensions, Shoot Morphology, Stump size.**

I. INTRODUCTION

The genus *Eucalyptus* (Myrtaceae) consists of over 700 species [1]. It is comprised of some of the most widely planted forestry species in the world, some of which have been cultivated for over 150 years [2], [3]. Over 100 countries are involved in growing Eucalyptus plantations [4]. Eucalyptus is a controversial forestry tree that is valued, on the one hand, for its economic benefits while simultaneously recognized as problematic due to its associated negative environmental externalities [5]. It has been reported to impede the establishment of other plants by out-competition for moisture and nutrients as well as inhibit understory flora by foliar secretion of allelopathic chemicals [6]. Phenol and terpene compounds have been implicated in the phytotoxic suppression of other vegetation [7]. Furthermore, the tree can spread fire readily, potentially causing grave damage to surrounding areas while resisting the fire itself. The eucalypt's prolific seed producing habit and ability to resprout in the aftermath of fire has conferred upon it a strong colonization potential. The combination of its flammability and colonizing capacity has made eucalyptus a potential threat to local ecosystems. In contrast, many plantations of *Eucalyptus* have been found to be important contributors to biodiversity rehabilitation [8].

Eucalyptus globulus is an evergreen tree of the Myrtle family that usually grows up to 70 m tall, with a straight, cylindrical bole of up to 200 cm in diameter [7]. It is a plant mainly of the warm temperate zone and the subtropics that is occasionally cultivated at elevations up to 3,100 m in the tropics [9]. The species grows best in areas with mean annual temperature of 18 - 23° C (tolerates 6 - 30° C, severely damaged at 0° C), 500 - 2,400 mm mean annual rainfall, and pH 5 - 7 [7], [10]. Native to southeastern Australia, it is the most extensively planted eucalypt species in the world [11]. It has naturalized and formed landraces in many regions of the world. The wide distribution is credited to its ability to tolerate extreme environmental conditions [12]. Motivated by large economic returns from a fast growth rate, wide adaptability, and high productivity [13], significant plantings of *E. globulus* have been made across the landscape of the Western Highlands of

Cameroon. The tree is used for mining timber and poles that are extensively used in construction [7]. Its leaf extracts have shown antibacterial, antifungal and antiviral properties [14], [15]. In addition, the special fragrance of an essential oil leaf extract is used in perfumery for Eau-de-Cologne, air fresheners, bath oils, and speciality perfumes [16]. *Eucalyptus globulus* is also a good supplier of fuel both in the form of firewood and charcoal as its wood burns freely leaving little residual ash [17], an attribute that has tremendously improved the livelihood of rural people through its contribution to household income. Other uses include honey production from the flowers, plantings for erosion control, windbreaks, shelterbelts, and drying up of swamps for land reclamation [18].

Regeneration of *E. globulus* is mainly from seed. Capsules release seed immediately on ripening and the seed is dispersed by wind. Newly released seeds germinate within a few weeks if conditions are suitable. Trees usually begin to produce seeds at 4 to 5 years and yield heavy seed crops in most locations at 3- to 5-year intervals [19]. Regeneration from seeds involves many stages in the life cycle of plants, with seed and seedling stages recognized as the most important for their success [20]. In the Western Highlands of Cameroon, *E. globulus* stands and agroforestry systems are frequently under disturbance from collection of non-wood products by humans and browsing of associated flora by herbivores. These and other anthropogenic and natural disturbance regimes related to wind and storm events often result in breakages of seedlings stems at random positions. Coppice shoots take origin from dormant buds suppressed in the bark or adventitious buds in the cambial layer beneath the bark [21]. Growth of coppice shoots is influenced by several factors, including stem size, height of cutting, root/shoot ratio after stem decapitation, and species [22], [23], [24]. This study tested the effect of stump diameter on growth performance of *E. globulus* seedling coppice shoots.

II. MATERIALS AND METHODS

A. Study Site

The experiment was conducted in a nursery at The University of Bamenda campus in Bambili (1444 m asl; 5.983° N, 10.250° E), North West Region, Cameroon. Bambili is amongst the four main villages that make up Tubah, one of the seven subdivisions in the Mezam Division of the Region. The site is characterized by a rainy (March - September) and dry (September - March) season. The mean annual rainfall is 2095 mm. The wettest months are July, August, and September with rainfall in excess of 350 mm in each month while January is the driest month with 6 mm of precipitation. With average temperatures (high/low) of 29.8/16.1 °C and 21.6/15.6 °C, the warmest and coldest months are February and August, respectively [25]. Meanwhile the village's mean annual temperature is 22.51 ºC. With a yearly average of 75.96 %, relative humidity ranges from 40.48 % in January to 95.63 % in August. The rainfall [mm]/temperature [°C]/humidity [%] for the months of April, May, June, and July when the experiment took place were 150.85/23.91/77.91, 226.98/22.27/88.16, 267.63/21.04/92.7, and 386.02/20.05/95.61, respectively [26].

B. Experimental Design

Treatments were comprised of two stump diameters, namely 1 – 4 mm and 5 – 8 mm. Potted seedlings of *Eucalyptus globulus* were obtained from the Reforestation Task Force nursery in Mile 6, Bamenda III Subdivision, Mezam Division. The substrate was sandy-loam soil collected from the nursery. Stems of the seedlings were clipped off 6 cm aboveground and then separated in to two groups of 10 as per stump diameter treatment. The cuts on the seedlings were made straight and transversely using secateurs. Each of the treatments was replicated twice. Irrigation was mainly from rainfall. The natural precipitation was, however, supplemented with watering using normal tap water when need arose. The irrigation gradually became purely natural as the experiment progressed further into the rainy season. Weeds that emerged from the substrate were regularly hand-picked. N-P-K 20-10-10 was applied midway into the experiment that commenced on April 15 and ended on July 15, 2023.

C. Data Collection

At the end of the experiment, five stumps bearing sprouts were randomly selected from each treatment and replication from which data were collected. The number of shoots was determined after which the dominant shoot was identified for height measurement. Additionally, number of branches and leaves on the dominant shoot was noted. Dimensions of the most recent fully mature leaf were recorded: leaf length was measured from the upper edge of the leaf to the lowest point whereas leaf width taken to be the widest region across the lamina perpendicular to the length.

D. Data Analysis

The data were checked for fulfilment of the ANOVA assumptions of normality and homoscedasticity. The effect of stump diameter on the growth variables was then tested using the following ANOVA model:

$y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + e_{(ij)k}$

where y_{ijk} is observed value of the response variable, μ is the overall mean, α_i is the fixed effect of stump diameter, β_j is the random effect of replication, $(\alpha\beta)_{ij}$ is the bi-factorial interaction, and e_{ijk} is the random experimental error term. The analyses were performed in Data Desk 6.01 at $p = 0.1$.

III. RESULTS AND DISCUSSION

The growth status of sprouts is an important indicator that determines the competitive success amidst neighboring plants [27]. In the present study, the growth of shoots that resulted from coppicing of decapitated seedlings of *Eucalyptus globulus* was, in general, positively affected by an increase in stump diameter. Number of leaves, leaf length, leaf width, number of branches, and shoot height markedly increased from the 1 – 4 mm to 5 – 8 mm diameter class treatment (Fig. 1). Even in the lone case of number of shoots where the response was not statistically significant, there was a tendency for the pattern. The choice of the seedling stage was motivated by the understanding that the effect of diameter on the growth of sprouts is dependent on age [28]. Diameter related modification of coppice shoot growth has been reported for other species. In downy birch (*Betula pubescens*), for instance, number of sprouts, sprouts height and biomass were all favoured by an increase in stump diameter [29]. Same has been reported for willows (*Salix* spp.) in a study where leaf width and leaf length were also positively affected [30].

The beneficial effect of stump diameter on growth may be attributed to greater concentrations of nitrogen and carbohydrates in larger than smaller stumps. These resources can be derived from external and internal sources. External nitrogen is taken up from the soil nitrogen pool by roots while the carbohydrates are the product of atmospheric carbon dioxide assimilation [31]. The greater leaf dimensions of shoots in the larger stump diameter category is indicative of a larger surface area for capture of photosynthetic active radiation for enhanced photosynthesis and growth in this treatment. Although we did not examine root growth in this study, we believe that a bigger root system in this diameter class would have augmented the uptake of soil nitrogen to support the elevated photosynthetic rates. Internal sources of carbon and nitrogen come from storage [32]. Reserves of total non-structural carbohydrates and total non-structural nitrogen compounds supply carbon and nitrogen for sink demand [33], [34]. It is unclear if the latter hypothesis was applicable to the diameter-related growth trends in this study since we did not analyze tissue contents of carbohydrate and nitrogen.

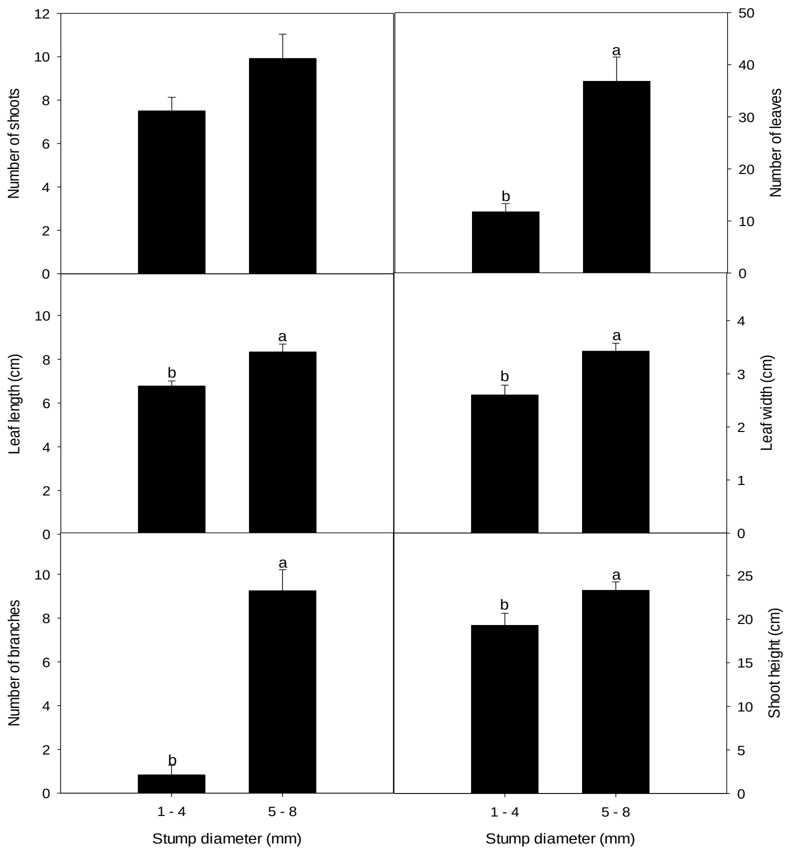

Fig. 1. Effect of stump diameter (Mean ± SE) on growth parameters of *Eucalyptus globulus* coppice shoots

IV. CONCLUSION

In this study, the growth of shoots that resulted from coppicing of decapitated seedlings of *Eucalyptus globulus* was, in general, positively correlated to stump diameter. Even in the lone case of number of shoots where the response was not significant, there was a tendency for an increase with stump diameter. Stump diameter is, therefore, an important predictor of sprout regeneration in *E. globulus* seedlings. The higher growth of shoots from large- than small-diameter stumps gives them a greater competitive ability against other vegetation for a higher survival potential in the field. The findings have important implications for management as tending coppice shoots from larger diameter seedlings may be a better option for regeneration of the species in the aftermath of damaging activities and events.

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