Plant Archives Vol. 24, No. 2, 2024 pp. 738-742 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2024.v24.no.2.103

INTERACTIVE EFFECTS OF STUMP DIMENSIONS ON MORPHOLOGICAL TRAITS OF *EUCALYPTUS GLOBULUS* (BLUE GUM) SEEDLING COPPICE SHOOTS

Georgette Oyang Ekanya, Mariline Nkenkuh Loh and Titus Fondo Ambebe*

Department of Forestry and Wildlife Technology, College of Technology, The University of Bamenda, Bambili, Cameroon.
*Corresponding author E-mail : ambtitus@yahoo.com
(Date of Receiving-17-05-2024; Date of Acceptance-04-07-2024)

ABSTRACT

Field grown *Eucalyptus globulus* (blue gum) seedlings are the subject of decapitation by disturbance.The coppicing ability of the residual stumps and growth of new shoots are influenced by intrinsic and extrinsic factors which may interact with each other. To investigate the combined effects of stump diameter and stump height on production and growth of coppice shoots, *E. globulus* seedlings were subjected to two stump diameters (0.1 – 0.4 and 0.5 – 0.8 cm) and two stump heights (6 and 12 cm) for three months. The treatments were laid out in a split-plot design with stump diameter as the whole plot and stump height as the sub-plot. Data were subjected to split-plot ANOVA and Scheffé's test. Leaf width, number of branches, and shoot height increased with stump diameter. The 12 cm stump height reduced leaf length while it increased number of leaves. There was a significant effect of treatment interactions on number of shoots, leaf length and number of leaves. Number of shoots was reduced by the lower stump height treatment level exclusively at 0.1 – 0.4 cm stump diameter. A similar but inverse trend was observed for leaf length. On its part, number of leaves differed between stump heights only at the 0.5 – 0.8 cm diameter class which resulted in higher values than itslower diametercounterpart. The findings suggest that the stump dimensions should be taken into consideration in the management of *E. globulus* coppice shoots as they may interact synergistically in increasingfoliage area for interception of photosynthetically active radiation.

Key words : Coppice silviculture, *Eucalyptus globulus*, Stump size, Shoot morphology, Western Highlands of Cameroon.

Introduction

Eucalyptus globules (common name: blue gum; family: Myrtaceae) is a fast growing evergreen tree that attains a height of 55 m, exceptionally 70 m, and diameter of 200 cm with the bole cylindrical and bearing branches for less than half the total tree height (Eldridge *et al.*, 1993; Vaughan, 2008). New growth can be up to 2.5 m per year in young plants initially, slowing down later. The narrow crown becomes rounded for trees growing in the open. With origins in Tasmania and south-eastern Australia, *E. globulus* is the most extensively planted eucalypt species with over 1,000,000 hectares worldwide (Praciak, 2015). It grows best in areas where annual daytime temperatures are within the range 18 - 23°C, but can tolerate 6-30°C, occurring in temperate, subtropical and tropical countries.It is found at altitudes of 0 - 1000 m in temperate climates and 2000 - 2800 in the tropics (Vaughan, 2008). It is occasionally cultivated at elevations of over 3000 m in the tropics (Fern, 2014). Though tolerant to 550 - 1800mm, the species prefers an average annual rainfall of 700 - 1400 mm and pH range of 5 - 7. Because *E. globulus* is an obligate initial colonizer, it does not spread easily into established forest. It can, however, extend into non-forest or disturbed ecosystems, eventually forming a monoculture that excludes other plants through allelopathic suppression from phenol and terpene compounds of the leaves (Abbas and Al-Jasimee, 2018).

Eucalyptus globulus possesses two silvical properties that make it well suited for natural regeneration.

First, it is a prolific seed producer. Theseeds are 2-3 mm long, irregularly elliptical, and dull black (Orwa *et al*., 2009). They are lightweight and easily wind-dispersed following opening of capsules. Seeds exhibit good germination under favourable temperature conditions. Second, it has the ability to reproduce vegetatively by coppicing (Oballa *et al*., 2010). The shoots arise from dormant buds on the side of stumps or adventitious buds developing in the cambial layer beneath the bark (Jarman and Kofman, 2017). The development of buds is initiated by a change in plant hormone levels following removal of the crown or stem. A common silvicultural practice in *E. globulus* forests involves thinning coppices, and then retaining and tending the best for the next generation of trees. In other species exhibiting the phenomenon, coppice shoots are detached from stumps and transplanted (Chinaka, 1998). Coppicing is considered to be a means of natural rejuvenation of old trees and stands (Hilton, 1992). In fact, advanced regeneration from coppices has become a major method for the renewal of eucalyptus forests.

The western highlands of Cameroon consists of a chain of volcanic mountains that contain the largest remaining patches of afromontane forest in West Africa. *Eucalyptus globulus* is a key component of the biome. It that is highly valued by inhabitants of the area for its economic and pharmaceutical contribution to well-being. The strong and moderately durable wood is used for light and heavy construction, poles, posts, plywood, flooring, furniture, tools, and boxes. The tree is asource of fuelwood and charcoal whose sales constitute a major income generating activity in the area. The leaf and its essential oil are used forantiseptic and medicinal purposes. Its flowers constitute a source of nectar for bees and dense root system makes the tree suitable for erosion control. The trees are used as windbreaks and for drying up of swamps while young plants make a good living fence because of their unpalatability to livestock. *Eucalyptus globules* stands and agroforestry systems are frequently under disturbance from collection of non-wood products, wind, storms, browsing of associated flora and other activities by human and non-human agents. These and other disturbance regimes often result in breakages of seedlings stems at random positions. As expected, the stump resulting thereof should resume growth by coppicing. However, coppice regeneration is influenced by several factors, including stem diameter, height of cutting, root/ shoot ratio after stem decapitation, and species among others (Tschaplinsk and Blake, 1989; Shackleton, 1997; Shackleton, 2000). Moreover, these factors may interact with each other in affecting coppicing and the growth of coppice shoots in unpredictable ways. In a study involving five stump diameter classes, for instance, *Quercus dealbata* produced maximum number of shoots in stumps of > 15-30 cm diameter while *Alnus nepalensis* showed maximum coppicing in those of > 30-45 cm (Khan and Tripathi, 1986). In another study, Ward and Williams (2018) found higher rates of sprouting in red maple than other species at a given diameter class. The present study explored the combined effects of stump diameter and stump height on growth of the *E. globulus* coppice shoots. The findings are crucial for decision making pertaining toretentionof truncated seedlings for regeneration of the species.

Materials and Methods

Description of study site

The experiment was carried out in a nursery of the Department of Forestry and Wildlife Technology at The University of Bamenda campus in Bambili. Bambili is one of the constituent villages of Tubah Sub-Division in the Mezam Division of the North West Region of Cameroon. It lies between latitudes 5° 60’ 0’’ and 6° 05’ 0’’ North of the Equator and longitudes 10° 12’ 0’’ and 10° 22’ 0’’ East of the Greenwich Meridian (Taffouo *et al.*, 2018). The area is characterized by a rainy that runs from March to September and a dryseason from September to March. July, August and September are the wettest months with rainfall in excess of 350 mm each while January is the driest with only 6 mm of precipitation. The mean annual rainfall, temperature and relative humidity are 2095 mm, 22.51°C and 75.96%, respectively. 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 (Loh and Ambebe, 2024). Bambili has an undulating topography with altitudes varying between *ca* 900 and 2270 m (Yerima and Van Ranst, 2005).

Experimental design

Potted seedlings of *Eucalyptus globules* were obtained from the Reforestation Task Force nursery located at Mile 6, Bamenda III Sub Division, Mezam Division. The substrate was sandy-loam soil collected from the nursery. Treatments were comprised of two stump diameters and two stump heights. Stem diameter of seedlings was determined with a Vernier caliper at heights of 6 cm and 12 cm from the root-shoot junction. Where the diameter was either 0.1 – 0.4 cm or 0.5 – 0.8 cm at the given height, slanting cut was made transversely through the stem that permitted the free drainage of water from the surface of the stump. The tool used for cutting was a pair of secateurs. An experiment was laid out in a split-plot design with stump height as the sub-plot, stump diameter as the whole plot and the nursery as the field. There were ten stumps per treatment combination that 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 exclusively natural as the experiment that started on 15 April 2023 progressed further into the rainy season. N-P-K 20-10-10 was applied midway into the experiment. Any weeds that emerged from the substrate were removed by hand.

Data collection

On 15 July 2023, five coppiced stumps were randomly selected from each treatment combination and replication from which data were collected. Shoot production was determined as the number of sproutsper stump. The dominant shoot on the stump was then identified for height measurement with a meter rule. Additionally, branches and leaves on the dominant shoot were counted. 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 was taken to be the widest region across the lamina perpendicular to the length.

Data analysis

All data were examined for normality of distribution using normal probability plots and homogeneity of variance using scatter plots. After ascertaining that the ANOVA assumptions were fulfilled by the data, the effect of stump diameter, stump height, and their interaction on morphology were tested with 2-way split-plot ANOVA. When the ANOVA showed a significant interaction for a given parameter, Scheffé's test was used for pair-wise means comparison. All the analyses were conducted in Data Desk 6.01 at $p = 0.1$.

Results

Leaf width, number of branches and shoot height were markedly influenced by stump diameter but not stump height (Table 1), showing increases from the 0.1 – 0.4 cm to 0.5 – 0.8 cm treatment level (Fig. 1). These parameters were unresponsive to any treatment combination.

There was a marginally significant effect of stump height on number of leaves and leaf length. In addition, the interactive effect of stump diameter and stump height was marginally significant for number of shoots and significant for number of leaves and leaf length (Table 1).

Table 1 : ANOVA *p*-values for the effect of stump diameter and stump height on morphological traits of *Eucalyptus globulus* coppice shoots.

Source	Stump diameter	Stump height	Shoot diameter × Shoot height
No. of shoots	0.7422	0.3855	0.1257
No. of leaves	0.1475	0.1216	0.0797
Leaf length	0.1374	0.119	0.0614
Leaf width	0.0449	0.3193	0.3145
No. of branches	0.0315	0.344	0.1939
Shoot height	0.1413	0.1761	0.8109

Values of number of shoots were highest in the 0.5 – 0.8 cm stump diameter class at 12 cm and lowest in 0.1 – 0.4 cm at 6 cm. However, the difference between the former and either of the other remaining two treatment combinations was statistically insignificant. Similarly, the 0.1 – 0.4 cm and 0.5 – 0.8 cm stump diameter classes at 6 cmstump height had a comparable effect on this parameter (Fig. 1).

Number of leaves increased from the 0.1 – 0.4 cm to 0.5 – 0.8 cm stump diameter class at each stump height. However, the margin of increase was significantly greater at the 12 cm than 6 cm stump height treatment level. In contrast, stump length did not differ for this trait at the lower diameter treatment level (Fig. 1).

Leaf length declined from the 0.1 – 0.4 cm to 0.5 – 0.8 cm stump diameter at each stump height. However, the magnitude of change was higher at 6 cm than 12 cm stump diameter. There was no significant difference between the stump height treatment levels at the higher stump diameter class for this trait. Leaf length was significantly lower at the 12 cm than 6 cm stump height in 0.1 – 0.4 cm stump diameter (Fig. 1).

Discussion

With the exception of number of shoots per stump which showed a partial tendency, we recorded an increase inmorphological growthtraits of *E. granulus* seedling stump sprouts in the present study. This trend has been reported for other species. In downy birch (*Betula pubescens*), number, height and biomass of sprouts have shown positive responsesto stump diameter elevation (Hytönen, 2019). Likewise in the study of (Zou *et al.*, 2020), sprout height, leaf width, leaf length and other shoot growth parameters of shrub willows (*Salix* spp.) like were significantly positively correlated with stump diameter. The pattern is also documented for the Chinese guger tree (*Schima superba*) (Zhao *et al.*, 2018) and small-leaved lime (*Tilia cordata*) (Matula *et al.*, 2012). While, the higher number of shoots in larger stumps

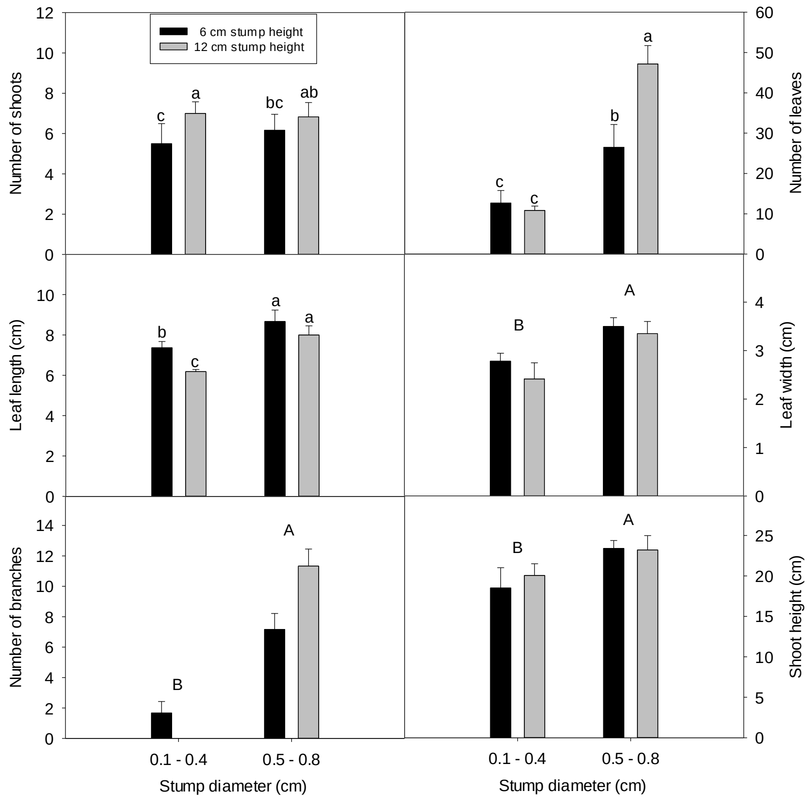

Fig. 1 : Effects of stump diameter and stump height (Mean ± SE, n = 5) on morphological traits of *Eucalyptus globulus* coppice shoots. The upper- and lower-case letters above the bars denote effects of stump diameter and stump diameter ×stump height interaction, respectively. Different letters indicate significant differences.

was likely favoured by a larger surface and more buds, the overall lower growth of emergents from smaller stumps may be associated to a limited absorptive power of a smaller root system anda smaller reservoir of available carbohydrates (Clarke *et al*., 2013). Brix and Ebell (1969) have demonstrated the promoting effect of increased nitrogen uptake on leaf length and width, number of leaves per shoot, stem height, branch length,and number of branches.The decision toexperiment seedlings was based on a recognition that coppicing ability is more necessary for this growth stage as trees are less likely to succumb to disturbances because of their largersizes. Forstumps of plants that are advanced in age, thickness of the bark and vitality of dormant buds may impose additional controls oncoppice regeneration (Kramer and Kozlowski, 1960; Vesk and Westoby, 2004; Zhao *et al*., 2018).

The beneficial effect of taller stumps on growth of coppice shoots has been reported previously for several species. Thetrend exists forstem height in red alder (*Alnus rubra*; Harrington, 1984), mountain maple (*Acer spicatum*), paper birch (*Betula papyrifera*) and pin cherry (*Prunus pensylvanica*) (Jobidon, 1997). In the case of Nepalese alder (*Alnus nepalensis*), Khasi Schima (*Schima khasiana*), banj oak (*Quercus dealbata*) and paisang (*Quercus griffithii*), leaf production responded positively to stump height increase (Khan and Tripathi, 1989). Perhaps the most interesting finding of the present study is the augmentation of the positive effect of stump diameter increaseon number of leaves by the increase in stump height. Elevated photosynthetic capacity due to increased light interception by a larger foliage area can lead to enhanced growth. Superior early growthperformance places a plant at a competitive advantage over associated vegetation on regeneration sites. On the other hand, low stump height reduced the negative effect of low stump diameter on leaf length. Leaf width also showed a tendency for the pattern. Given that coppice shoots tended to be shortest at low stump height in this stump diameter class, it is likelythat shading from other treatmentsresulted in the larger leaf sizes in this treatment.

Conclusion

Here, we explored effects of factorial combinations of stump dimensions on morphology of *E. globulus* coppice shoots. Significant main effects of stump diameter and stump height were detected for the growth traits examined. There were, however, interactive effects of treatments indicating dependencies between the factors in affecting the plants. The most interesting finding of the investigation is that the positive effect of larger stump diameter on number of leaves can be augmented by increasing stump height.

References

Abbas, M.K. and Al-Jasimee K.H.A. (2018). Allelopathic effect of *Eucalyptus* spp. Leaves on some chemical constituents of seedlings of two ornamental plants. *Plant Archives*, **18(2)**, 1967-1973.

Brix, H. and Ebell L.F. (1969). Effects of nitrogen fertilization on growth, leaf area and photosynthesis rate in Douglas-Fir. *Forest Science*, **15(2)**, 189-196.

Chinaka, C. (1998). Orchard practice for the African breadfruit (*Treculia Africana*) in Nigeria. Extension Bulletin No. 85. Forestry Series No. 3.

Eldridge, K.G., Davidson J., Harwood C.E. and Van Wyk G. (1993). *Eucalypt domestication and breeding*. Oxford, UK: Clarendon Press.

Clarke, P.J., Lawes M.J., Midgley J.J., Lamont B.B., Ojeda F., Burrows G.E., Enright N.J. and Knox K.J.E. (2013). Resprouting as a key functional trait: how buds, protection and resources drive persistence after fire? *New Phytologist*, **197(1)**, 19-35.

Fern, K. (2014). *Eucalyptus globulus*. Useful Tropical Plants Database 2014.

Harrington, C.A. (1984). Factors affecting initial sprouting of red alder. *Canadian J. Forest Res.*, **14(3)**, 357-361.

Hilton, G.M. (1992). *Functional ecology of woodlands and forests*. Springer Science and Business Media.

Hytönen, J. (2019). Stump diameter and age affect coppicing of downy birch (*Betula pubescens* Ehrh.). *Europ. J. Forest Res.*, **138**, 345-352.

Jarman, R. and Kofman P.D. (2017). Coppice in brief. COST Action FP1301 Reports. Freiburg, Germany: Albert Ludwig University of Freiburg.

Jobidon, R. (1997). Stump height effects on sprouting of mountain maple, paper birch and pin cherry - 10 year results. *The Forestry Chronicle*, **73(5)**, 590-595.

Khan, M.L. and Tripathi R.S. (1989). Effects of stump diameter, stump height and sprout density on the sprout growth of four tree species in burnt and unburnt forest plots. *Acta Oecologica*, **10(4)**, 303-316.

Khan, M.L. and Tripathi R.S. (1986). Tree regeneration in a disturbed sub-tropical wet hill forest of north-east India: effect of stump diameter and height on sprouting of four tree species. *Forest Ecol. Manage.*, **17(2-3)**, 199-209.

Kramer, P.J. and Kozlowski T.T. (1960). *Physiology of trees*. McGraw-Hill Book Co. Inc., New York.

Loh, M.N. and Ambebe T.F. (2024). Growth performance of *Eucalyptus globulus* Labill. (blue gum) seedling coppices as influenced by stump diameter. *Int. J. Life Sci. Res.*, **12(1)**, 36-40.

Matula, R., Svátek M., Kùrová J., Úradníèek L., Kadavý J. and Kneifl M. (2012). The sprouting ability of the main tree species in Central European coppices: implications for coppice restoration. *Europ. J. Forest Res.*, **131(5)**, 1501-1511.

Oballa, P.O., Konuche P.K.A., Muchiri M.N. and Kigomo B.N. (2010). *Facts on growing and use of eucalyptus in Kenya*. Kenya Forestry Research Institute, Nairobi, Kenya.

Orwa, C., Mutua A., Kindt R., Jamnadass R. and Simons A. (2009). Agroforestree Database: A tree reference and selection guide version 4.0 (http://www.worldagroforestry.org/af/treedb/)

Praciak, A. (2015).*Eucalyptus globulus* (Tasmanian blue gum). CABI Compendium. https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.22680. Accessed 15 April 2024.

Shackleton, C.M. (1997). The prediction of woody productivity in the savanna biome, South Africa, *PhD Thesis*, University of the Witwatersrand, Johannesburg.

Shackleton, C.M. (2000). Stump size and the number of coppice shoots for selected savanna tree species. *South Afr. J. Bot.*, **66(2)**, 124-127.

Taffouo, V.D., Muyang R.F., Mbouobda H.D. and Fotso (2018). Effect of indigenous and effective microorganism fertilizers on soil microorganisms and yield of Irish potato in Bambili, Cameroon. *Afr. J. Microbiol. Res.*, **12(15)**, 345-353.

Tschaplinsk, T. and Blake T.J. (1989). Photosynthetic re-invigoration of leaves following shoot decapitation and accelerated growth of coppice shoots. *Physiologia Plantarum*, **75**, 157-165.

Vaughan, G. (2008). *Eucalyptus globulus* Labill. [Internet] Record from PROTA4U. Louppe, D., Oteng-Amoako A.A. and Brink M. (Eds). PROTA (Plant Resources of Tropical Africa / Ressourcesvégétales de l'Afriquetropicale), Wageningen, Netherlands. <http://www.prota4u.org/search.asp>. Accessed 11 April 2024.

Vesk, P.A. and Westoby M. (2004). Funding the bud bank: A review of the costs of buds. *Oikos*, **106(1)**, 200-208.

Ward, J.S. and Williams S.C. (2018). Effect of tree diameter, canopy position, age, and browsing on stump sprouting in Southern New England. *Forest Science*, **64(4)**, 452-460.

Yerima, B.P.K. and Van Ranst E. (2005). Major Soil Classification Systems used in the Tropics: Soils of Cameroon. Trafford Publishing, Canada.

Zhao, H., Wu Z., Qiu Z., Li Z. and Zhou G. (2018). Effects of stump characteristics and soil fertility on stump resprouting of *Schima superba*. *CERNE*, **24(3)**, 249-258.

Zou, Y., Li X. and Yang G. (2020). Sprout regeneration of shrub willows after cutting. *Plants*, **9(12)**, 1684.