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# Bark Thickness and Diameter Variation in *Spirostachys africana*, a Multipurpose Tree Commonly used in Households in Southern Botswana

**Ronnie Mmolotsi*, Ishmael Kopong and Melusi Rampart**

*Department of Crop Science and Production, Botswana College of Agriculture, Gaborone, Botswana*

## Abstract

This study was carried out to assess the bark thickness at different tree sizes and heights within *Spirostachys africana*. Data was collected from a natural stand in southern part of Botswana. Bark thickness and stem diameter were measured at different heights in the tree stem. The results showed strong linear relations between the DBH, tree height and bark thickness. There were significant differences in the diameters are different heights. The relationship between the DBH, tree height and bark thickness at the DBH showed a fair relationship ($r^2$=0.64) that is logarithmic. The mean taper coefficient was calculated 0.304 ± 0.028. Taper coefficients varied between a minimum of 0.19 and a maximum of 0.42. The mean modified artificial form factor was calculated using nine (9) sample trees, yielding a mean of 0.50 ± 0.03. DBH showed a fair linear relationship with a lower $r^2$ value of 0.3671.Bark thickness, like diameter showed a strong taper and linear relationship ($r^2$=0.9731) from the base of the stem to the top of the stem. The highest proportion of the double bark production was measured at 12.89%. The relationship between parameters was fair at $r^2$=0.6346. At the lower tree diameters, there is a rapid increase in bark thickness. Above diameters of 25cm in the stem, bark thickness increases at a lower rate.

**Keywords:** *Spirostachys Africana*; Bark thickness; Diameter at breast height; Botswana

## Introduction

*Spirostachys africana* is an indigenous to southern Africa and valuable for it timber. The tree is valuable ecologically since various parts are consumed by wild animals [1].The wood is also used for household construction [2] and carving [3]. In Botswana *S. africana* is valued for its durable, strong attractive wood and medicine [4]. Wood of *S. africana* is commonly used for making local furniture and for making fencing posts. Bark is an important part of the tree that provides protection against natural agents that attack the tree. Bark provides protection against attacking insects and fire attacking the tree [5]. Trees growing in areas that have frequent fires have evolved to have thick and flakey bark.

Tree bark is also important for various other purposes. Bark is important as forage for wild animals [1], used for fibre, medicine [6], for cork and for bedding in animal housing and mulching landscape plants. Barks of *Prunus africana* and *Trichilia emetica* are important as medicine [6,7]. Fresh bark of Bark of *S. africana* exudes white gum that is known to be poisonous and used medicine in some cases. The bark can therefore important and can potentially be used for several of the above listed purposes. It is therefore important to assess the size and quality of bark in this local tree.

Several reports on bark thickness have been reported in the literature [4,8-10]. Bark volume equations have also been reported in the literature [11]. The least bark thickness has been recorded at and thickest barks diameters have been reported at base which decreases with increasing stem height. Bark ratio was shown to decrease with increase in tree height [11]. Bark thickness were also reported to be influenced by disturbance factors such as fires, site conditions and foraging animals. Importance of bark and its size and thickness has been stated. The information on volume, thickness and taper in bark of local trees is lacking. This paper therefore seeks to investigate variation in thickness of bark in a local tree species *Spirostachys africana*.

## Methodology

### Study area

*Spirostachys africana* was measured in three natural stands in the south east district, with geographical position (S 24° 44’ 36.6 and E 025° 49’ 6.5). The GPS positions were recorded using a GPS model GPSmap 62s. The area is a generally rocky with a slope varying between 5 and 15%. The area is grazed and browsed by domestic animals. It is also utilized local people for various products. Local farmers obtained firewood and construction wood from the area.

### Data collection

Bark thickness was measured at the tree base, DBH (1.3 metres) and at 1.3 metres above the DBH using a bark gauge. Bark thickness was measured at two different and opposite directions around the stem and the average used for each position. Tree diameter was measured at the same positions using a caliper and total tree height was measured using a suunto clinometer. A modified artificial form factors were calculated using the following formula:

$$\text{Artificial form factor} = \frac{Vt0.6}{(gbh)(ht)}$$

Where, Vt – total volume at a minimum diameter of 6 cm diameter

gbh – basal area

ht – total height

***Corresponding author:** Ronnie Mmolotsi, Department of Crop Science and Production, Botswana College of Agriculture, Private Bag 0027, Gaborone, Botswana, Email: rmmolots@bca.bw

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## Data analysis

Parameters recorded include DBH, DBH thickness, base diameter bark thickness, upper bark thickness and total tree height. The above parameters were statistically analyzed to test significance using single factor ANOVA of Minitab release 15. Means differences were assessed using standard errors of means. Relationships between different parameters were estimated using regression and logarithmic analysis.

## Results

### Change in diameter over height

The average diameter at breast height was 18.13 cm and tree height of 6.8 metres. There was a significant difference in diameters at different heights (F, 5.5 and P=0.007) showing that there a change in diameter. Figure 1 shows the strong taper in the stem of this tree with a $R^2$ value of 0.9731. The mean taper coefficient is 0.304 ± 0.028. Taper coefficients varied between a minimum of 0.19 and a maximum of 0.42. The mean modified artificial form factor was calculated using nine (9) sample trees, yielding a mean of 0.50 ± 0.03. The minimum form factor was recorded at 0.3 and a high of 0.68.

### DBH and total height

The relationship between the DBH and the total height and bark thickness at the DBH showed a fair linear relationship with a lower $r^2$ value of 0.3671 (Figure 2). The linear relationships seem to be a fair estimator of relationships between the two parameters.

### Bark thickness

Bark thickness, like diameter showed a strong taper and linear relationship (r2=0.9731) from the base of the stem to the top of the stem (Figure 3). There a significant difference in bark thickness between bark measured at the base, basal height and the top of the stem (F=4.69 and P=3.16).

### Bark proportion

The lowest proportion was calculated at base of the tree stem, increased through the DBH and highest at the top point of the stem (Figure 4). The highest proportion of the double bark production was measured at 12.89%. The lowest double bark proportion was measured at 10.33% at the base.

### Bark thickness and DBH

The relationship between DBH and bark thickness shows a logarithmic relationship (Figure 5). The relationship between parameters is fairly strong with $r^2$=0.6346. At the lower tree diameters,

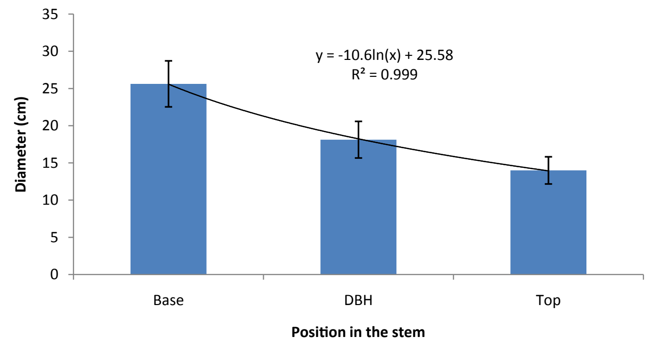


**Figure 1:** Stem taper in *S. Africana*.

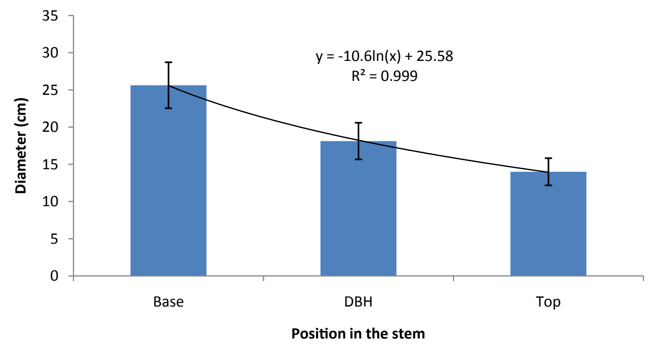


**Figure 2:** DBH and tree height relationship.

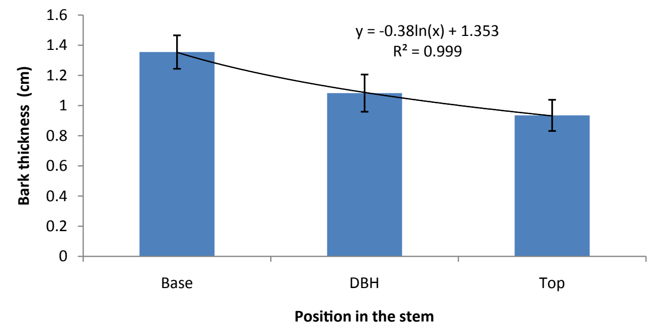


**Figure 3:** Bark thickness and tree height.

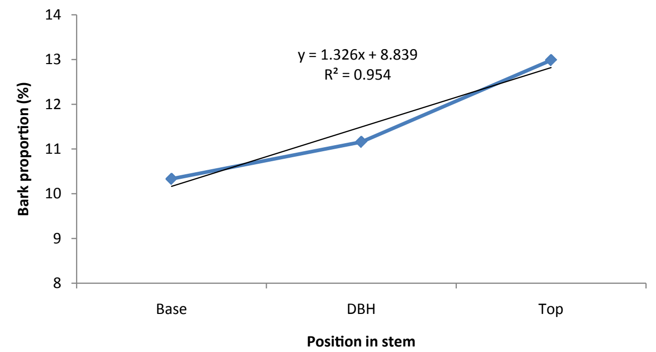


**Figure 4:** Proportion of bark thickness.

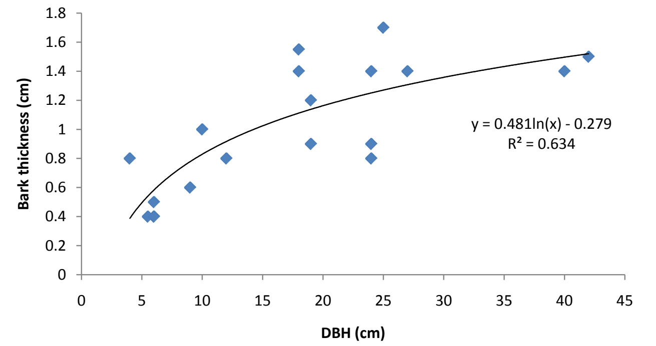


**Figure 5:** Variation in bark thickness at DBH.

there is a rapid increase in bark thickness. Above diameters of 25 cm, bark thickness increases at a lower rate.

## Discussion

Data tested showed a general decrease in diameter in height. There is therefore sharp taper in tree stem of *Spirostachys africana*. Bark thickness in *Spirostachys africana* decreased with an increase with tree height. Similar trends in bark diameter have been reported in the literature [11,13]. Relatively high form factors above 0.6 have been reported [8]. The low form factor is the stem *S. africana* will result in the reduced wood recovery. The tree is often multi-branched and often and this also affects the form factor. This may also suggest that there will be a large proportion of waste especially in the form of slabs and edgings.

There is a fairly weak relationship between diameter and tree height. Approximately 36.71% of the stem height in this species can be estimated using the tree DBH. Similar linear relationships have been reported in Norway spruce and Pine species [12]. Double bark proportion increased from base of the stem, through the DBH and highest at the top of the stem. Studies have reported increases in bark proportion with an increase in stem height [13]. The relationship between DBH and bark thickness is fairly strong. At the lower tree diameters, there is a rapid increase in bark thickness. Above DBH of 25cm, bark thickness increased at a lower rate. Linear relationships between DBH and bark thickness have been reported in literature with $r^2$ values ranging between a low value of 0.14 and with highest at 0.93 [5].

## Conclusions

Tree bark in *Spirostachys africana* is thickest at the tree base and decreases with tree height. Bark ratio on the other hand increases with stem height. The form factor is generally low and may be due to branching and tree forking. The relationship between tree DBH and height were relatively weak. The relationship between bark thickness versus tree height, bark proportion versus position in the stem, and DBH versus bark thickness showed very strong relationships.

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