

Full Length Research Paper

# Analysis of dendrometric characteristics of *Acacia senegal* (L.) Willd. (Fabaceae) in the semi-arid Sahelian area: A case study of silvopastoral zone in Senegal

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The study gives an analysis of the dendrometric parameters of a middle Sahelian species (*Acacia senegal*) in semi-arid environment to get better knowledge of its behavior. The research lays the principle that the species behaves differently according to the ecogeographical stations. So, its characteristics change from one environment to another. That is why it is important to do a specific study for every big zone. The study was done in Silvopastoral zone, more particularly in the area where *A. senegal* is popular in the country. The study aims to deepen the knowledge of *A. senegal* dendrometric parameters. The following parameters were measured: diameter of the base, breast-height diameter (1.3 m), breast-height circumference, total height of the tree, length of the trunk and width of the houppier. The sample consists of a population of 76 feet locust trees in Senegal. The study confirmed the hypothesis that the characters of the species vary according to the zone where it is found.

**Key words:** *Acacia senegal*, dendrometry, Sahel, Senegal.

## INTRODUCTION

Rain forests have a global role in the stabilization of the climate; besides holding some carbon (Clark, 2004), they refresh the atmosphere and favor precipitation. The populations and local residents of the forests gain from the vegetation which gives them life and other immediate profits (Ickowicz, 1995).

*Acacia senegal* is a shrub rarely exceeding 6 m height. It presents a very muddled shape at early age; later, it

transforms into a tree and short trunk further with natural pruning, which starts from the third year. Its grey bark is cracked on the trunk; has grey - clear or grey - darkened and smooth young twigs and branches. These are branched out, giving rise to a crown with parasol shape. The trunk rarely exceeds 1 m. The longevity of the species does not seem to exceed 25 - 30 years (Poupon, 1984).

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**Photo 1.** *Acacia senegal* in pure plantation (Thiam, on 2013).

**Table 1.** Sample distribution and average height according to the tree age.

Year of planting	Age (years)	Number	%
1991	15	18	23.7
1999	12	6	7.8
2002	9	10	13.2
2004	7	18	23.7
2005	6	16	21.1
2006	5	8	10,5
	Total	76	100

Rural populations develop some strategy to combat desertification and degradation (Jouve, 1997).

To get some water during rain scarcity, the gum tree develops a root system that is very important (Photo 1). The side roots colonize the superior horizons of the ground of about ten meters around the trunk. Parallel to this running system, the species develops a pivot of more than 10 m depth as compared to the grown-up subjects. The plant adapts well to arid conditions (Barry et al., 1984).

In Senegal, the area where *A. senegal* locust tree is distributed is limited to the north by the valley of the Senegal River and to the South by 800 mm pluviometer (Bille, 1997).

The zone sheltering the best natural plantation of gum trees, which is the main part where Arabic gum in Senegal is produced, can be subdivided into four sub-zones: the North sandy Ferlo, the South sandy Ferlo, the armoured Ferlo and the Ferlo of transition (Hiernaux et al., 1994).

Drought causes approximately 60% disappearance of trees. Also, the fire on dunes and rodents in the slums destroy numerous individual trees (Diouf, 2010).

The objective of the study was to improve the knowledge on the dendrometric measures of *A. senegal* in semi-arid Sahelian zone in Senegal.

### Presentation of the study area

Of 70 000 km<sup>2</sup> surface (more than a third of the territory), the Silvopastoral zone or Ferlo is in the south of the pond of the Senegal River and is part of the Sahelian Zone (CSE, 2009). The central geographical coordinates are 15° 53 ' N; 15° 15 ' W 15.88, 15.25; the height is about 25 m. For "Vallée du Ferlo", the ground remains relatively flat.

The climate is of tropical, semi-arid, monomodal type with very hot variant (Toure, 2002). The annual precipitation is 300 mm (Station of Linguère). Harmattan contributes to the erosion of its grounds and desertification is aggravated by droughts cyclic as in the 1973s, 1983s and 1984s.

The vegetation is thinned out there. The landscapes consist of dry savanna, steppe and dune. Thorny plants survive in the area more easily than other species. In rainy season, the region covers itself with a fine herbaceous carpet, but for the rest of the year, the grounds are naked and particularly vulnerable. Goats compete for shoots in the herds of zebus led by the Peulh shepherds (Thiam, 1998).

### MATERIALS AND METHODS

The main materials used are: Libra of 100 kg capacity, rope, saw, knife, machetes, iron pickets, decameter, long ribbon-meter of 1.5 m, precision balance of 5 kg, chain saw, forest compass, GPS, digital camera.

#### Documentation

This work is based on the knowledge of *A. senegal* in respect to its ecology, historic and political aspects of reforestation in Senegal; as well as its adaptability to drought conditions, and the constraints in the agrosilvopastoral systems.

#### Sampling

The investigations were performed on individuals of more than 5 years old (Table 1). The measured tree parameters are as follows: total height (m); length of the trunk (m); base diameter (cm); circumference of breast height level (cm); crown width (m); and diameter at breast height (cm).

To realize the various sites, the geographical address and coordinates were obtained by means of a GPS. For every age, individual samples were the object of the investigation. The study is thus done on 9 sites (Tables 2 and 3).

#### Dendrometric measures

The various moderate parameters in every tree are the following

**Table 2.** Presentation of the sites of the study.

Site number	Site name (village)	Number of trees	Programs
1	Thiékène Ndiaye	6	POA
2	Nguith	8	Asyila
3	Gouloum	12	Asyila
4	Warkhokh	8	Asyila
5	Tessékéré	6	GMV
6	Labgar	8	GMV
7	Widdou Thingholy	11	GMV
8	Sombe	8	Asyila
9	Dahra CRZ	9	CNRF
	TOTAL	76	

**Table 3.** Height age.

Age	12	9	7	6	5	4	2
Average height	5	4.2	3.4	2.7	2.7	1.7	1.5

ones: a- total Height of the tree; b- Length of the trunk; c- Diameter on the base; d- Diameter at breast-height; e- Circumference at 1.3 m; f- Width of the houppier.

## RESULTS

### Total height of tree

Calculations made from data showed a general average of 3.1 m with a standard deviation of 1.2. This shows that the dispersion around the mean is very tight. Thus, the tree is believed to measure up with the age of senescence, which is 12 years for our sample (Figure 1).

### Length of trunk

For our sample, the length of the trunk, taken between base and first branches, varies between 0.2 and 1.7 m. The length of the trunk does not have a large variation, unlike the total height that displays a net variation based on age. The age of maximum growth is 12 years, as well for the trunk than for the total height.

### Crown width

The crown width is not a good parameter based on the age of the individuals; its variation is not very marked (Figure 2).

### Circumference of breast height

The largest circumference is obtained at 12-year-old. Beyond this age, the circumference decreases because

of the decline in the rate of humidity and the decrease in the thickness of the bark which is more and more fibrous.

## DISCUSSION

The height of the tree varies according to the soil level. So trees in the depressions are longer than those at the top of dunes. This is certainly due, as confirmed by Gaye (1984), to the availability of the groundwater; and in the development, swiveling is very important to the species.

Beyond 12 years, locust tree of senegal begins to lose a part of its bark because of senescence and infestation of termites. The various variables measured on the ground were analyzed under the angle of their extremes (Figures 3, 4 and 5). The latter allowed us to know the limit of the growth of the locust tree of senegal in the context of the Sahelian zone, particularly in the area of the study.

The various obtained parameters show that we have shrub of Sahelian type (chap). *A. senegal*, due to its adaptability to difficult conditions, presents a small-sized morphology, which makes it a good food for small animals, particularly goats. The covering on the ground depends on the density of the species but the width of houppiers starts with a small cover on the ground. In pure plantation, the spaces are on average 5 m by 5 m, with 400 feet per hectare. So, the projection on the ground gives enough covering because of the strong density of plantation. This situation provokes a competition between trees, slows down growth and reduces the rubber productivity.

For more important space (8m by 10 m) with a work on the preliminary ground before the plantations are buried, the plant develops normally and benefits mostly from some ground water.

## Conclusion

Many studies were made on *A. senegal* to know its characteristics (FAO/ANGMV, 2010). In spite of these

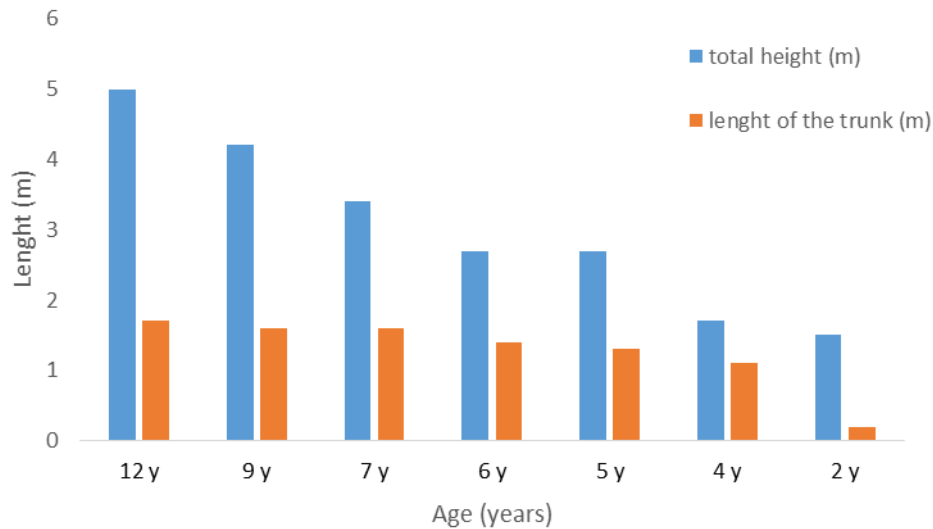


Figure 1. Measures of length of trees.

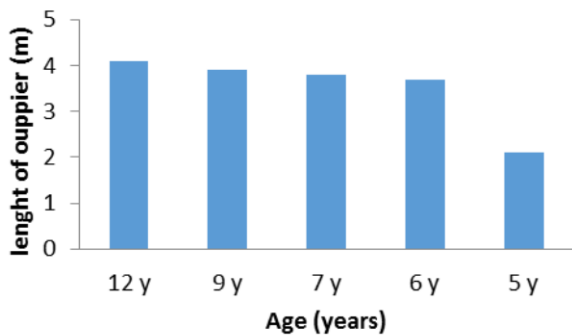


Figure 2. Average crown width.

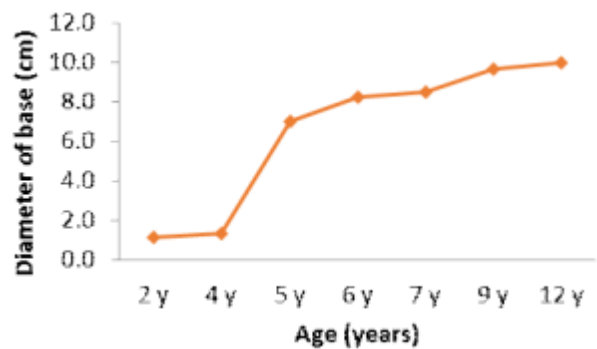


Figure 4. Diameter of base on the age of tree.

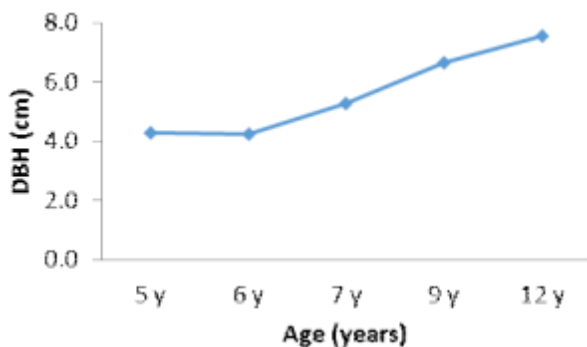


Figure 3. DBH depending on the age of the trees.

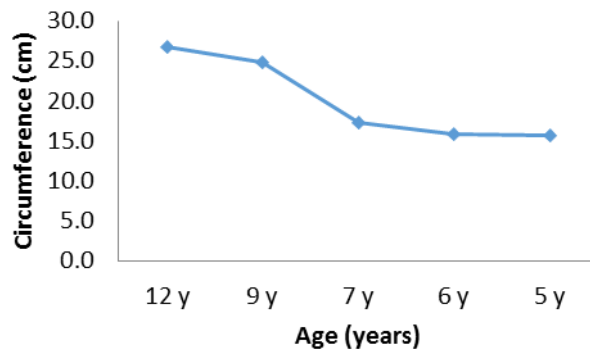


Figure 5. Average girth at 1.3 m.

efforts, few made a reference to the middle Sahelian dry and semi-arid Africa *A. senegal*. The study of the species in a specific environment justifies itself in many respects.

Indeed, many results used before now do not take into account the specificities of the species (Ndiaye, 2004). The main ligneous botanical species in silvopastoral

zone should be the object of specific study and kept in a database, as a system of follow-up of the dynamics. It appears that the study of the species offers several assets which are among others, the consideration of the conditions of the environment and the dynamics of the forest ecosystems.

### Conflict of Interests

The authors have not declared any conflict of interests.

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