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# EFFECT OF BAOBAB SEED WEIGHT (*Adansonia digitata l.*) ON SEED GERMINATION AND SEEDLING GROWTH IN THE NURSERY IN BENIN

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## ABSTRACT

The Baobab, *Adansonia digitata* L, is one of the major multi-purpose local woody species which are widely sold and used for food, medicine and crafts. It is threatened by a decline in its population because of deforestation and its overuse. This study aims at investigating the effect of baobab seed weight (*A. digitata*) on the seed germination and seedling growth in the nursery in Benin. A total of 420 seeds have been collected from trees randomly selected and remote from each other at least 10km apart in order to avoid collecting seed species genetically very close. All the seeds were weighed. The numerical classification is carried out using Microsoft Excel software to generate 3 morphotypes based on seed weight. The results showed that the morphotype 1 and morphotype 3 had heavy seeds weight whereas the morphotype 2 had of light seeds weight. In morphotype1, the seeds from Guinean and Sudanian zone are dominant in a percentage of 38.07 and 32.48 per cent respectively. The morphotype 2 is mostly made up of seeds from the Guinean and Sudano-Guinean zone; that are represented in proportions almost identical in the percentage of 37.5 and 35.7 per cent respectively. The morphotype 3 is dominated by the seeds from Sudanian zone (50.98%), followed by the seeds from Sudano-Guinean zone (43.13%). Plants from Sudano-Guinean zone are averagely heavy in weight and are very tall, with largest diameter, high germination rate (91, 66%) and highest number of leaves, and high germination rate (91, 66%). Trees of Sudanian zone have heaviest seed weight and have tallest seedlings and the best germination rate (94.44%). Trees of Guinean zone have seeds which are light in weight and are relatively short. They have low germination rate (54.16%) with low number of leaves.

**Keywords:** climatic zone, germination rate, weight of seeds.

  

## INTRODUCTION

The non-wood forest products play a capital role in term of their contribution to the health care, energy, food, monetary income and other good things for a human being (Mahapatra et *al*., 2005). Rural populations have confined relations with the non-wood forest product in general and wild fruits in particular. In Benin, 814 medicinal species and 128 wild fruits were identified as the non-wood forest products that are used by the rural population (Sinsin et Owolabi, 2001). In Africa, the projections indicate that in 2085, 25 to 42% of the vegetable species could be extinct because of the loss of 81 to 97% of their habitats (Boko et *al*., 2007). Nowadays, certain species become rarer in their natural habitats because of the threats of biodiversity. Among the non-wood forest products, Baobab (*Adansonia digitata*), is one of economic key species used in the daily diet by the rural community in West Africa (Codjia et *al*., 2001; Sidibe´&Williams 2002; Assogbadjo et *al*., 2005a, b; Chadare et *al*., 2008 ; Buchmann et *al*., 2010 ; Kaboré et *al*., 2011 ; Rabi'u et *al*., 2013). In Senegal as in Benin, the baobab belongs to the priority species (Soloviev et *al*., 2004; Faye et *al*., 2010). The authorization of the European Union, the last year, to incorporate baobab fruit pulp in drink, gave it heavily economic value on international scale. In Benin, rather than 200 tons of baobab seeds coated with pulp, 10 tons of pulp and 1 ton of green leaf powder are commercialized and generated respectively and it yields15 million FCFA (US$ 30,000), 400000 FCFA (US $ 800) and 200000FCFA (US $400) to 139 traders involved in the sale of those different products (Assogbadjo et *al*., 2006). In Benin, the literature review on this specie revealed that there appears to be no previous study conducted on the effect of Baobab seed weight (*Adansonia digitata*) on seed germination and seedling growth. For this reason the study was initiated to see the relationship between Baobab seed weight, seed germination and seedling growth.

## MATERIALS AND METHODS

The seeds were collected from three climatic zones of Benin (Sudano-Guinean zone, Guinean zone, and Sudanian zone) but the experiment was conducted in the Guinean zone specifically in the University of Abomey- Calavi, in the field of Faculty of Agricultural Sciences (FSA). In each zone, two villages were randomly selected. The seeds were collected from trees randomly chosen and were distant apart at least 10km in order to avoid collecting seed species genetically very close. A total of 140 seeds were gathered from each climatic zone and kept in three different bags. After collecting, a total of 420 seeds, they were weighed in the Genetic laboratory of the Faculty using an electronic balance of precision. Three experimental factors such as climatic zones (Guinean zone, Sudanian zone and Sudano-Guinean zone), morphotypes and blocs were considered during the experimentation. Each experimental unit (polyethylene bag) contained one grain. The experimental design was a split plot with 2 repetitions. A total of 192 pots were sown

  

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with 48 pots from Guinean zone, 72 from Sudanian zone and 72 from Sudano-Guinean zone. The 48 were used at the Guinean zone level because this zone didn't comprise the seeds of morphotype 3. At each experimental unit level, the number of seeds germinated and the germination date were counted and written down on the collection sheet. The mensuration (height, collar diameter and sheet number per plant) was collected within interval of 10 days. The calliper with precision of mm was used to measure seedling diameter and height is measured with precision of 0.1 m. The percentage of seed germinated was computed using following formula:

$$Tg = \frac{seed\ number\ germinated}{seed\ number\ sowed} X\ 100$$

The repeated measurement ANOVA was done to see whether the seed germination rate, height, collar diameter, and sheet number of seedlings differs from one climatic zone to another. The statistical test was performed through SAS 9.2 and Microsoft Excel software. Also, the Excel spreadsheet was used to design figures.

## RESULTS

Three morphotypes with correlation coefficient $R^2$ equal 0.54 were obtained from cluster analysis (Figure1). Those morphotypes are: the morphotype 1 is comprised seeds which weights between 421 mg and 517 mg; the morphotype 2 composed of seeds which weigh between 264 mg and 417mg and the morphotype 3 consists of seeds which weigh between 522 mg and 718mg. To identify the proportion of seed per climatic zones represented in each morphotypes, the percentage of seed per climatic zone per morphotypes was calculated and through the Excel spreadsheet the figure 2 was designed. The analysis of figure 2 showed that in the morphotype 1, the seeds from Guinean zone were abundant (38, 07%) followed by seeds of Sudanian zone (32, 48%) and Sudano- guinean (29, 44%). The morphotype 2 is composed seeds of Guinean zone and Soudano-Guinean zone in proportion almost identical with 37, 5 and 35, 7 per cent respectively. The proportion of seeds from Sudanian zone was 26, 78% in morphotype 2. In the morphotype 3, seeds from Sudanian zone are dominant (50, 98%) and followed of seeds from Sudano-Guinean (43, 13%). The seeds from Guinean zone are represented in low proportion (5, 88 %.) in morphotype 3. The ANOVA results from sheet numbers and seedlings diameter revealed a heavily significant difference among seeds from different climatic zones, blocs and morphotypes whereas the result obtained for seedlings'height indicated that seedlings' height didn't vary among climatic zones and blocs, but differed only among morphotypes when the factor time is considered (Tables 1, 2 and 3). The ANOVA results for germination rate revealed there is a significant difference among seeds from different climatic zones and morphotypes for factor time (Table 4). To identify the climatic zones that presented higher germination rate, the

  

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cumulative percentage of seed germination for each climatic zone was calculated and Microsoft Excel spreadsheet was used to draw the figure 3. The analysis of figure 3 showed that seeds from Sudano-Guinean zone have highest germination rate (94, 44%) followed by the seeds from Sudanian zone (91, 66%), and seeds from Guinean zone had low germination rate (54, 16%). This result shows that heavy weight seeds from Sudano-Guinean and Sudanian zone have best germination rate compared to the light weight seeds from Guinean zone. To appreciate seedlings growth parameters of different morphotypes the figures 4, 5 and 6 were drawn. The analysis of figure 4 showed that the seedlings from Sudanian zone which consists mostly of seeds heavy weight (522 mg and 718 mg) are highest height followed by seedlings from Sudano-Guinean composed of averagely heavy weight seeds (421 mg and 517 mg), and seedlings from Guinean zone consisted of light weight seeds (264 mg and 417 mg) had small seedlings height. When the parameter diameter was considered, the figure 5 indicated that the seedlings from Sudano-Guinean zone have biggest diameter and followed by Sudanian zone seedlings. But, the plants from Guinean zone presented the low seedlings diameter. The figure 6 showed that the sheets number carried by seedlings from Soudano-Guinean zone are highest followed by Sudanian zone seedlings while the seedlings from Guinean zone carried less sheets number comparatively to the seedlings from Sudano-Guinean and Sudanian zone.

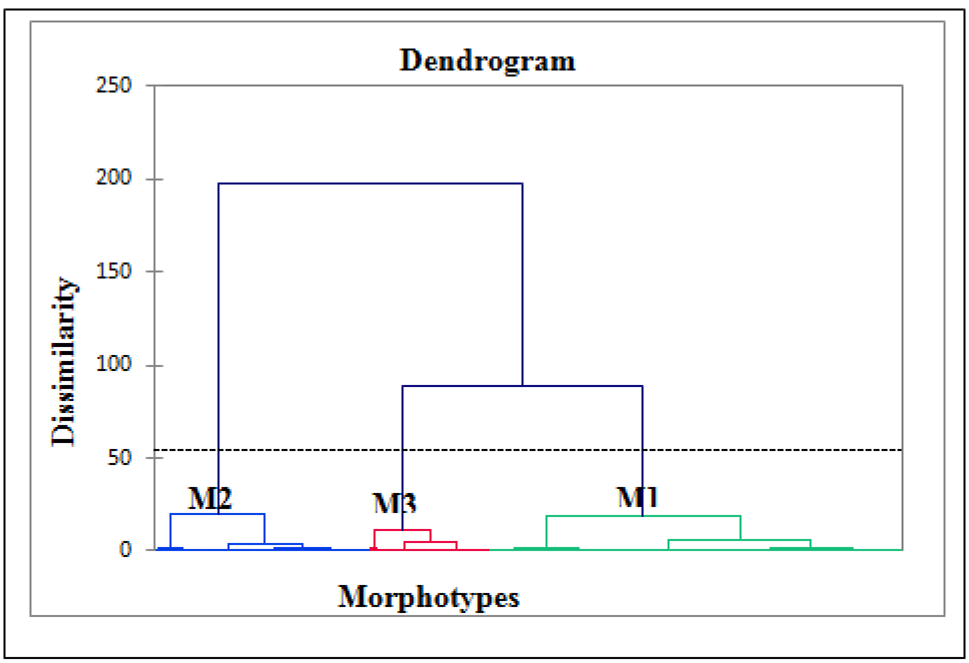


**Figure 1: Dendrogram relative to the different morphotypes types**

  

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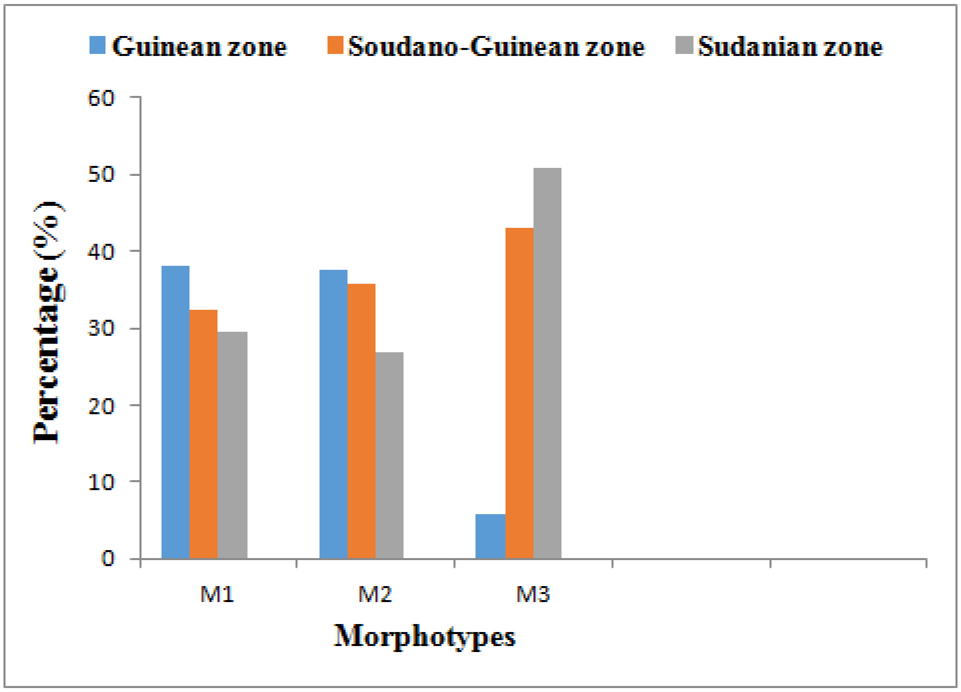


**Figure 2: Proportion of seeds per climatic zone per morphotype**

**Table 1: ANOVA results on seedlings number leaves of *A . digitata***

| Sources | DF | Types III SS | Mean square | p-value | Pr>Fr |
|---|---|---|---|---|---|
| Time | 3 | 1828.40 | 609.46 | 213.98 | 0.00* |
| Blocs | 1 | 81.79 | 81.79 | 3.88 | 0.05 ns |
| Time* Blocs | 3 | 117.46 | 39.15 | 13.75 | 0.00* |
| Provenances | 2 | 210.93 | 105.46 | 5.00 | 0.00* |
| Time*provenances | 6 | 132.46 | 22.01 | 7.73 | 0.00* |
| Morphotypes | 2 | 230.43 | 115.21 | 5.47 | 0.00* |
| Time*morphotypes | 6 | 49.03 | 8.17 | 2.87 | 0.00* |
| Blocs*provenances | 11 | 294.00 | 26.72 | 1.27 | 0.24 ns |
| Time*blocs*provenances*morphotypes | 33 | 216.23 | 6.55 | 2.30 | 0.00* |
| Error | 135 | 2844.84 | 21.07 | | |

Ns : Non-significant * Significant at 5%

  

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**Table 2: ANOVA results from seedlings height of *A. digitata***

| Sources | DF | Types III SS | Mean square | p-value | Pr>Fr |
|---|---|---|---|---|---|
| Time | 3 | 3162.25 | 1054.08 | 28.00 | <0.0001** |
| Blocs | 1 | 82.47 | 82.47 | 0.81 | 0.36 ns |
| Time* Blocs | 3 | 182.75 | 60.91 | 1.62 | 0.18 ns |
| Provenances | 2 | 517.01 | 258.50 | 2.55 | 0.08 ns |
| Time*provenances | 6 | 311.87 | 51.97 | 1.38 | 0.22 ns |
| Morphotypes | 2 | 1345.23 | 672.61 | 6.63 | 0.001* |
| Time*morphotypes | 6 | 207.07 | 34.502 | 0.92 | 0.48 ns |
| Blocs*provenances | 11 | 749.54 | 68.14 | 0.67 | 0.76 ns |
| Time*blocs*provenances*morphotypes | 33 | 1253.23 | 37.97 | 1.01 | 0.45 ns |
| Error | 135 | 13697 | 101.46 | | |

Ns : non-significant * Significant at 5%

**Table 3: ANOVA results from seedlings diameter of *A. digitata***

| Sources | DF | Types III SS | Mean square | p-value | Pr>Fr |
|---|---|---|---|---|---|
| Time | 3 | 4.88 | 1.62 | 362.29 | < 0.00* |
| Blocs | 1 | 0.03 | 0.03 | 0.74 | 0.39 ns |
| Time* Blocs | 3 | 0.02 | 0.009 | 2.11 | 0.09 ns |
| Provenances | 2 | 0.48 | 0.24 | 5.85 | 0.00* |
| Time*provenances | 6 | 0.04 | 0.006 | 1.49 | 0.18 ns |
| Morphotypes | 2 | 0.54 | 2.27 | 6.56 | 0.00* |
| Time*morphotypes | 6 | 0.05 | 0.009 | 2.22 | 0.04* |
| Blocs*provenances | 11 | 0.29 | 0.02 | 0.64 | 0.78 ns |
| Time*blocs*provenances*morphotypes | 33 | 0.21 | 0.006 | 1.47 | 0.04 ns |
| Error | 135 | 5.64 | 0.04 | | |

Ns : non-significant * Significant at 5%

  

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**Table 4: ANOVA results on seeds germination rate of *A digitata***

| Sources | DF | Types III SS | Mean square | p-value | Pr>Fr |
|---|---|---|---|---|---|
| Time | 205 | 622.64 | 3.03 | 120.20 | 0.000** |
| Blocs | 1 | 5.29 | 5.29 | 0.19 | 0.60 ns |
| Time* Blocs | 205 | 3.51 | 0.01 | 1.02 | 0.41 ns |
| Provenances | 2 | 699.04 | 349.52 | 12.70 | 0.000** |
| Time*provenances | 410 | 38.66 | 0.09 | 5.60 | 0.00* |
| Morphotypes | 2 | 57.38 | 28.69 | 1.04 | 0.35 ns |
| Time*morphotypes | 410 | 10.04 | 0.02 | 1.45 | 0.000** |
| Blocs*provenances | 11 | 388.37 | 35.30 | 1.28 | 0.23 ns |
| Time*blocs*provenances*morphotypes | 2255 | 41.490 | 1.09 | 0.00 | 0.18 ns |
| Error | 178 | 4897.11 | 27.5 | | |

Ns: non-significant  *Significant at 5%  ** Significant at 1%

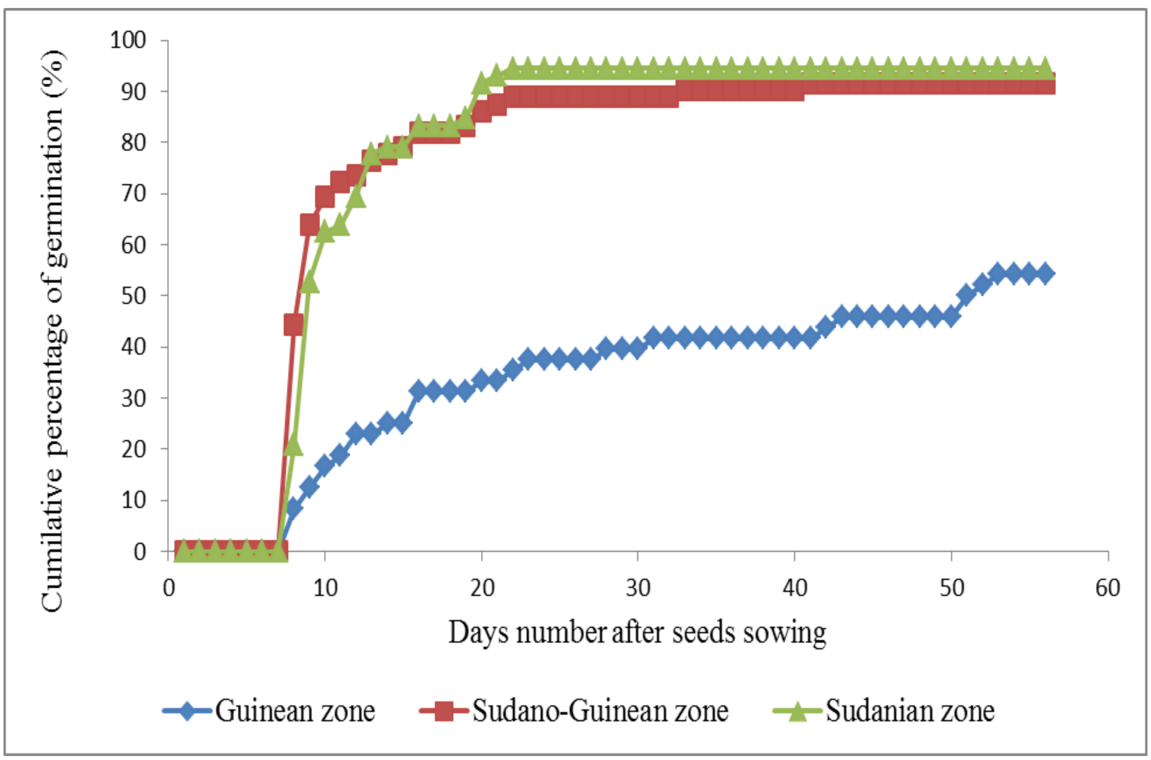


**Figure 3: Cumulative percent of A. digitata seeds germination per climatic zones**

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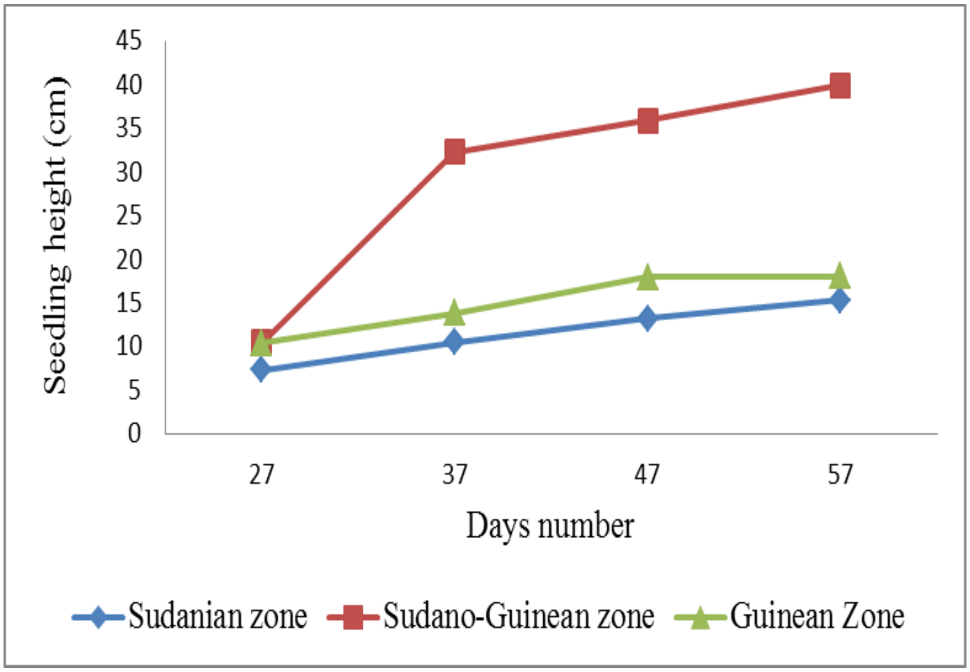


**Figure 4: *A. digitata* seedlings height variation per climatic zones**

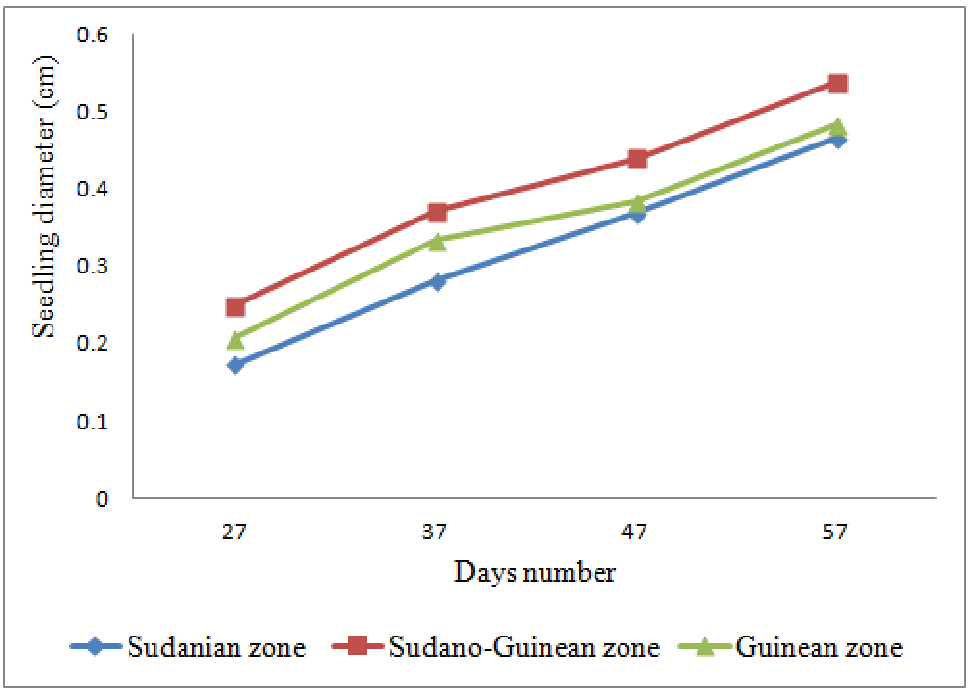


**Figure 5: *A. digitata* seedlings diameter variation per climatic zones**

  

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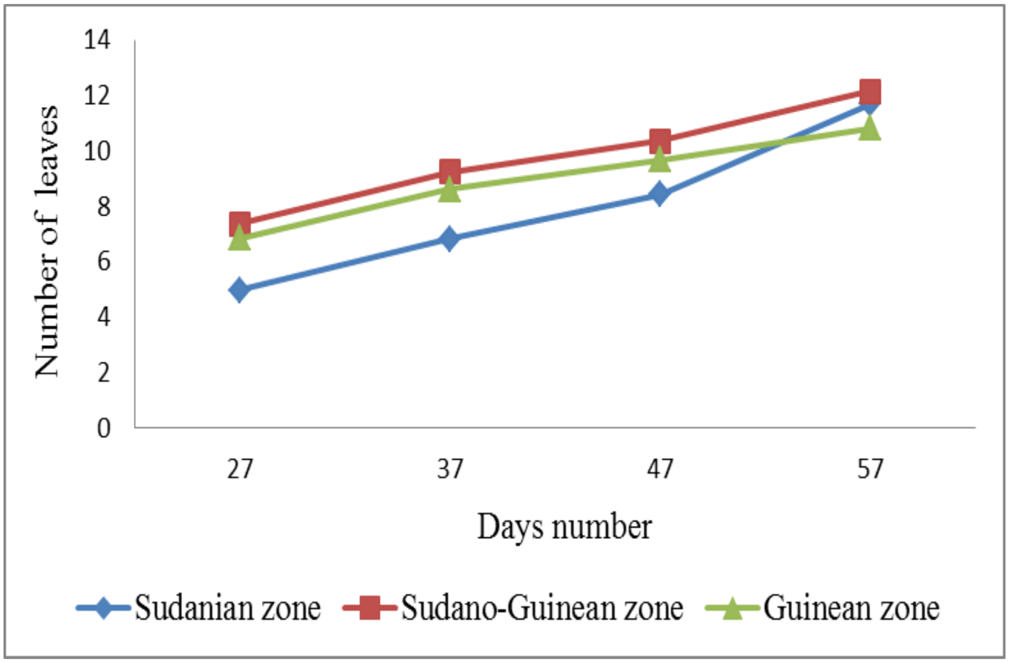


**Figure 6: *A. digitata* seedlings number of leaves variation per climatic zones**

## DISCUSSION

For this study three morphotypes were identified. The morphotype 1 consisted of seeds weight averagely heavy while the morphotypes 2 composed of seeds whose weight is less heavy. The morphotype 3 consisted of the seeds with heaviest weight. The seeds from Sudanian zone are dominant in morphotype 3. That result corroborates the findings of others that show the seeds from the Sudanian zone composed generally of heaviest seed weight (Assogbadjo et *al.*, 2005a, b). In Senegal, similar results were obtained by Mareme Niang et *al.*, (2015) on the morphological variations of baobab seeds. Those authors demonstrated that seeds from Sudanian zone have the heaviest weight compared to the Sahelian and Soudano- Sahelian zone. Ginwal et *al.*, (2005), attributed seeds variation weight observed among climatic zones to annual rainfall, temperature, type and nature of soil. According to Assogbadjo et *al* (2005), the variability of seed weight among climatic zones is due to the genetic diversity existing within baobab species. Results further reveal that the Sudanian zone characterized by heaviest seed weight had 94.44% of germination rate, the highest seedling height, high averagely number seed and diameter. The Sudano-Guinean zone consisted of the averagely heavy seeds had 91, 66% of germination rate, high seedling height, largest diameter and highest number of leaves. The Guinean zone composed of light seed weight had low germination rate (56, 1%), the low seedling height, diameter and number of leaves. This finding is in agreement with results obtained by Mareme Niang et *al.*, (2015) who stated that the height and seed weights have an effect on the baobab

  

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seeds germination. The study carried out on three species [(*Cleomeviscosa L., Digera muricata Forsk. and Ipomoea sindica Stapf*)] by Aziz & Shaukat (2010), revealed that seeds that have high height have a highest germination rate compared to seeds with averagely and small height. The similar results were seen by Aiken et Springuer, 1995 on *Andrepogon gerandii* Vitman and Shaukat et *al*., 1999 on *Acacia nilotica* (L.) Wild. Another study realized by Ahirwar, (2012) on effect of seeds weight and seeds height of *Alangium lamarckii Thw* showed that the germination rate of seeds of high, average and small height are 76%, 74% and 59% respectively. The opposite results were seen by Stamp, 1990 on *Medicago sativa L*., *Erodium brachycarpum* as well as the tasks conducted *by* Swaminatha & Srimathi, 1994 on *Acacia fistula L., Cassia hybrida L., Acacia holosericea L. and Acacia concinna L*. Those authors found that the light seed weight had the highest germination rate. This difference is explained by the fact that the seed germination rate is not only depended on height and seed weight but other factors such as types of soil, sunlight, conservation time of seeds and genetic variation among the individual and within the different population may influence the seeds germination. This study reveals that seed weight positively influences seedlings growth. According to Lusk, (1995), the positive effect of seeds weight on seedlings growth could be explained by the important availability of carbohydrate and other nutriments in the heavy seeds. Leshman et *al*., (2000) demonstrated that seeds of heavy weight have the best access to the nutritive elements because of the important availability of food store as reserves. For these reasons, the seedlings from heavy weight seeds resisted the stress such as drought (Leshman et *al*., 2000). The studies conducted by Gaëlle et *al*., (2006) revealed that seedlings from heavy weight seed have best access to sunlight and water acquisition than seedlings from light weight seeds because of rapid emergence of their root system. The plants from heavy weight seeds mobilized important amount of nutritive reserves during certain time and grew rapidly more than the plants from light weight seeds (Gaëlle et *al*., 2006). The smaller size observed in plants from Guinean zone seeds could be explained by an excessive humidity. While baobab plants grew in the less dry zone. Abundance of rainfall is not favorable so that the plants ensure the maximum of his functions in this zone. It supports previous findings observed by Derieux et *al*., (1989). This author demonstrated that photosynthesis which starts up in the cold conditions becomes very expensive in reserves.

## CONCLUSION

The study revealed that the seeds weight and seeds origin are the factors that influence seeds germination rate and baobab seedlings growth. The mastering of these factors will contribute to a selection of best seeds for the baobab domestication as well participating in the quick integration of biotechnologies in the program of plants performance improvement. The seeds weight and seeds origin are not the key determinants of seed germination and baobab seedlings growth other factors such as the sunlight, conservation time of seeds and genetic variation among the individual and within the different population are likely to influence the parameters studied. Moreover, further study should be done to explore determinant factors that were not included in the study area.

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