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Agro-Morphological Performance Evaluation of *Sorghum Bicolor* (L) Moench Under Integrated Management in Forestry Zone, Central African Republic

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Abstract

Agricultural intensification is a necessity to ensure food security. The objective of the study conducted under integrated management in the forest zone with the participation of members of an agro-pastoral group was to determine the system and identify the doses of fertilizers required for sorghum cultivation in the forest zone. For this purpose, an experimental set-up consisting of three distinct plots that constitute the integrated management types (flat land, open ridges and furrows, and closed ridges and furrows) was set up in a completely randomized block design with the use of mineral and organic fertilizers of different doses grouped into five treatments (T1, T2, T3, T4, and T5), of which T1 is the control and does not receive any fertilizer. These five treatments were randomized into three replicates, with one plot having fifteen subplots and forty-five subplots in total for the three plots. Fertilizers were applied using the micro-dose technique. The results obtained showed that the best grain yields of sorghum are obtained in T5 (Sorghum + N=18kg/ha + P= 37kg/ha + DAP=14kg/ha) on the ridges and open furrows with a production of 720 kg/ha and T5 on the flat land with the production of 710 kg/ha followed by T3 (Sorghum + N=60kg/ha + P= 36kg/ha) on the flat land with a production of 700 kg/ha It should be noted that the sorghum crop on the flat land showed a better agronomic performance and a better yield compared to the other plots. By default, ridges and open furrows could be considered. The results of the economic analyses show that the use of fertilizers does not give any benefit according to the treatments.

Keywords: Sorghum; Fertilizers; Yields; Forest; CAR

Introduction

Sorghum (*Sorghum bicolor* (L) Moench) is a cereal of African origin of confirmed importance. Indeed, sorghum, which is one of the only important agricultural species to have its origins on the African continent, occupies the 5th position of food grains in the world in terms of annual production quantities, coming after corn, rice, wheat and barley [1]. It is a major cereal in several tropical regions of the world [2]. Along with millet, it constitutes the main cereals grown in the semi-arid tropical regions of Africa and Asia [3]. Thanks to a large root system deeply rooted in the soil, sorghum is more tolerant of soil and climatic variations than traditional cereals such as rice and maize [4]. This makes this crop a crop of choice in regions where drought and

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poor soils are limiting factors [5]. Approximately 90% of the sorghum area and 70% of global production is in developing countries. African and Asian countries alone account for over 95% of total sorghum food use [2]. Sorghum is thus a staple food in Africa, South Asia and Central America.

In Africa, cereals are an important source of food [6]. The diet of sub-Saharan peoples is essentially based on cereals. Thus, sorghum ranks third after maize and rice. In the Sahel, it is in first place with millet. Together, these two crops occupy 50 to 70% of the land area. In the semi-arid Sudano-Sahelian zones of West and Central Africa, sorghum is the most important crop [7].

The Central African Republic is a landlocked country with significant agricultural resources. Arable land covers 15 million hectares, of which approximately 800,000 hectares are cultivated according to the 2017 survey results (only 10 percent of the country's arable land is farmed). The average size of the area per agricultural worker is 5.3 hectares. Economically, agriculture employs 75 percent of the working population and contributes 45 percent of PIB. Agriculture in the Central African Republic is mainly subsistence agriculture using rudimentary means. Food crops based on cassava, corn, rice, millet, sorghum, peanuts and sesame are predominant. Cotton and coffee are the main cash crops. Agricultural yields are still low due to the very limited use of fertilizers and quality seeds [8]. In the Central African Republic, sorghum is grown in the savannah zone and especially in the northern part of the country in connection with food habits. Although this resource is one of the neglected plants in CAR, maize is a cereal that is grown almost everywhere in the Central African Republic, but sorghum is not.

The great challenge for the countries of the world in general and for CAR in particular is to ensure food security for a growing population in the context of climate change. These climate changes are perceived by producers through several indicators such as increased temperatures, irregularity of rainfall, shifting of sowing dates, phenological disruption of plants, reduction of arable land, leading to a decrease in yield [9]. Indeed, according to [10], populations in the developing world, already vulnerable and exposed to food insecurity, are likely to be the most severely affected by climate change. Agriculture remains mostly rain-fed and therefore has little capacity to anticipate and curb the effects of climate fluctuations [11]; and is characterized by low use of organic matter and mineral fertilizers. In addition, the inherent low fertility of soils coupled with inappropriate agricultural practices are aggravating factors. In such a context, an intensification of production systems is necessary. This involves, among other things, the adoption of endogenous resilience strategies such as the use of improved varieties, new cropping techniques, crop rotations and crop diversification [9,12]. These strategies fit perfectly with integrated soil fertility management as defined by Vanlauwe et al. [13]. According to Katengeza et al. [14], the use of integrated soil fertility management technologies could protect producers from climate risks, reduce nutrient losses, and improve food security.

It is in this perspective that a study was conducted in the forest zone on the theme "Evaluation of agro-morphological performance *Sorghum bicolor* (L) moench in integrated management in the forest zone (commune of Pissa)" to see if sorghum can also be cultivated everywhere in order to solve the problem related to climate change, food insecurity and the fight against poverty in CAR.

The objective of the present study is to determine the adequate device and to identify the doses of fertilizers essential to the cultivation of sorghum in the forest zone.

Specifically, it will:

- Characterize the growth of sorghum according to the treatments and devices ;
- Evaluate yields according to treatments and systems ;
- Presenting and analyzing the results obtained in order to identify the system(s) and treatment(s) (fertilizer doses) that are profitable to grow in the zone.

Materials and Methods

Study environment

The study was conducted in the LOBAYE prefecture, sub-prefecture of M'BAÏKI, commune of PISSA located in the forest zone in southwestern CAR, 70 km from the capital. It has a Guinean-forest climate characterized by nine months of rainy season and three months of dry season with a rainfall ranging from 1600 to 1800 mm/year [15]. The average annual temperatures in this region are between 23 and 26° C while the maximum annual temperature is 29° C and the minimum is 18° C. The average relative humidity is 77%. The predominant vegetation is of the forest type. As a result of anthropic action (logging and field installations) savannah has been progressively established, colonized by Panicum maximum (Jacq.) R.Webster and Imperata cylindrica Raeusch. The soil is of medium desaturated ferralitic type (sandy-clay texture) [15]. Site experimental.

The site is located on the plot of the "Champ école paysan" grouping in the village of GBOLET, about 3 km before the town of Pissa from Bangui (Figure 1). It is a fallow dominated by *Imperata cylindrica* Raeusch, *Chromolaena odorata* and *Pueraria javanica*.

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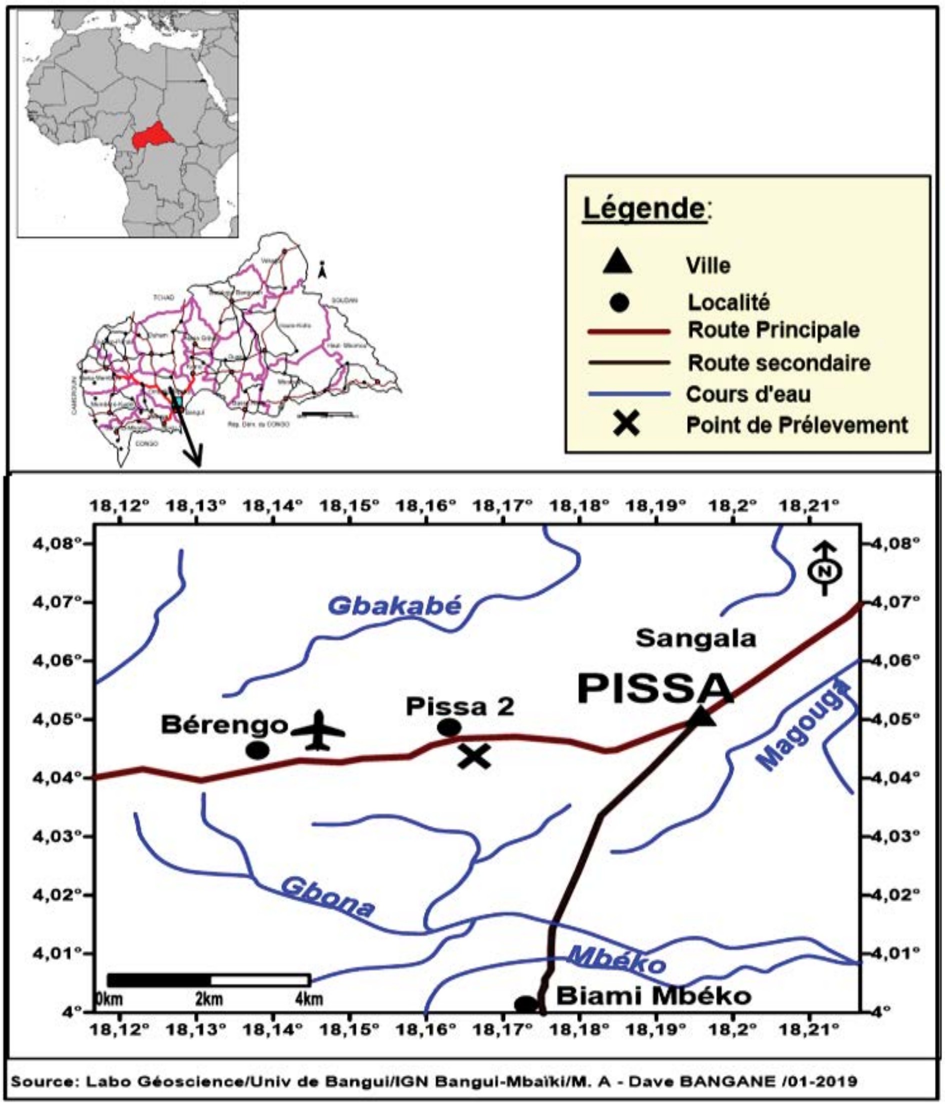

Figure 1: Location of the experimental site.

Geographical coordinates of the experimental site

- North Latitude: 04°04.267'.
- East Longitude: 018°12730'.
- Elevation or Altitude: 354m

Plant material

The study focused on a sorghum cultivar (*Sorghum bicolor* (L) Moench), the choice being justified by its importance in consumption and especially in production in several regions of CAR (Figure 2).

Fertilizers

Mineral fertilization

- The mineral fertilizers used are urea (CO(NH2)2 containing 46% N, triple super phosphate TSP (Ca(H2PO4)2 containing 46% P and DAP which contains 18% N and 46% P.
- **Urea with 46% Nitrogen** in granular form is not directly assimilated by plants in its ammoniacal form but hydrolyzed into ammonium or ammonia in two or three days in the soil before being used by the absorbent hairs of the roots.
- This element is involved in the process of vegetative or foliar development of the plant but is very volatile and also very soluble in water; hence the need to split its contribution during the crop cycle to avoid its loss.
- **Super Triple Phosphate (STP):** the element that acts in the formation of fruits.
- **DAP:** It is a binary fertilizer composed of nitrogen and phosphorus. It is solid in the form of compact granules

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Figure 2: Sorghum seed and plants.

which allows to answer quickly to the needs of the cultures from the beginning of the growth. It acts directly on the plant's roots to strengthen them and prevents ammonia poisoning, stimulates root growth and above all increases yields. It is a fertilizer that is used from the seed to help germination and is applied 5 cm beside the plant and 5 cm below it.

Organic fertilization

The use of organic fertilizers is one of the strategies to improve the fertility of soils (ferralitic) known for their poverty in nitrogen (N) and phosphorus (P) [16].

The organic matter (farm animal manure) for this study is cow dung which is used as organic fertilizer. This material provides nutrients, and organic carbon and this to improve the physical property of the soil such as water retention, microbial activity allowing to have a healthy soil [17]. On the other hand, manure also provides Nitrogen N and also contains other nutrient to improve the soil nutrient balance.

Table 1: Fertilizer doses applied in Kg/ha.

Traitments	Fertilizers used in (kg) per ha				
	N (Urée)	P_2O_5	K_2O	N (DAP)	Cow dung
T1	0	0	0	0	0
T2	30	18	0	0	0
T3	60	36	0	0	0
T4	30	18	0	0	5000
T5	18	37	0	14	0

Table 2: Fertilizer doses used in g per plant.

Traitments	Fertilizers used in (g) per plant				
	N (Urée)	P_2O_5	K_2O	N (DAP)	Cow dung
T1	0	0	0	0	0
T2	2	1.25	0	0	0
T3	4	2.5	0	0	0
T4	2	1.25	0	0	160
T5	1.25	2.57	0	2	0

Table 3: Timing of fertilizer application.

T1	T 2	T 3	T 4	T 5
-	Total P at soil preparation	Total P at soil preparation	Cow dung and total P for soil preparation	2g of DAP per hill at planting (microdosing)
-	½ of N at one month after planting	½ of N at one month after planting	½ of N at one month after planting	1 g of urea per one week before flowering (microdosing)
-	½ of N at one week before flowering.	½ of N at one week before flowering.	½ of N at one week before flowering.	

NB:

1. *For T3 and T4, we want to understand if P should be plowed in (as a basal fertilizer)? P should be applied before the last soil preparation.*
2. *We want to know if zinc or iron sulfate will be applied as a basal fertilizer? Zinc or iron sulfate will be applied as a base fertilizer only in soils lacking (deficient) in zinc and iron.*

In this experiment, the fertilizer application technique used was to draw a hollow circle of 20 cm around the sorghum plant.

Methods

Experimental device

The experimental plot that served as the framework for the study was set up in collaboration with the farmers of GBOLET village in the commune of Pissa. The experimental set-up consists of three distinct plots that constitute the types of rainfall management.

On the flat land, the trial was conducted in completely randomized blocks. The crop plot is composed of three (3) blocks, one of which has five (5) elementary plots for a total of fifteen (15) elementary plots. The spacing between the elementary plots is 0.5 m and 1 m between the blocks, an

Figure 3: Installation of the trials with the input of the farmers.

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elementary plot is 3 m long and 2 m wide which gives an area of 6 m2 and the total area is 132 m2. The density on the elementary plot is 80 cm between the rows which leads to 3 rows and 40 cm on the row for a total of 7 rows.

Figure 4: Aspect de la parcelle à trois mois.

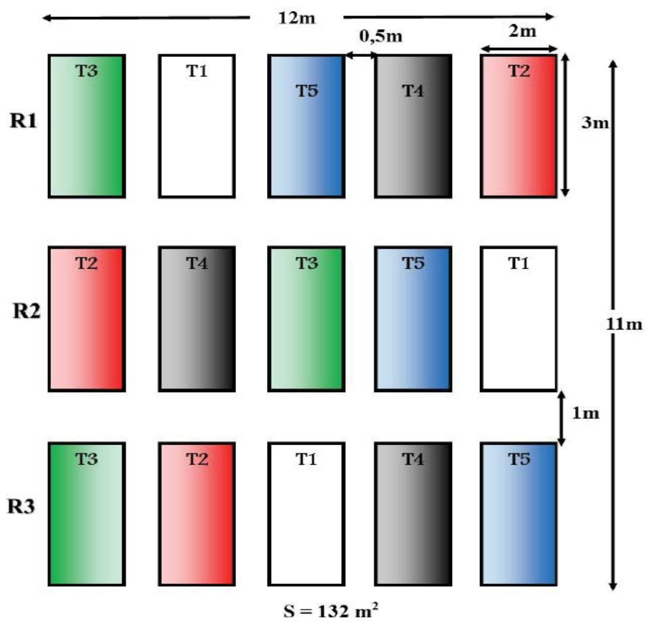

Figure 5: Experimental device on flat ground.

- **Type 2: Planting on open ridges with 60cm spacing between ridges and 40cm between hills on ridges**

The trial was conducted in completely randomized blocks. The crop plot is composed of three (3) blocks including one block with five (5) elementary plots for a total of fifteen (15) elementary plots and the elementary plots are ridges. The spacing between the ridges is 0.6 m and 2 m between the blocks, a ridge is 5 m long and 1.2 m wide which gives an area of 6 m2 and the total area is 142.8 m2. The density on a ridge is 75 cm between lines which gives 2 lines and 40 cm between hills on the ridges for a total of 11 hills.

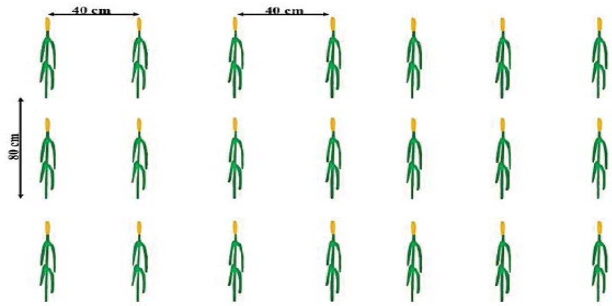

Figure 6: Density.

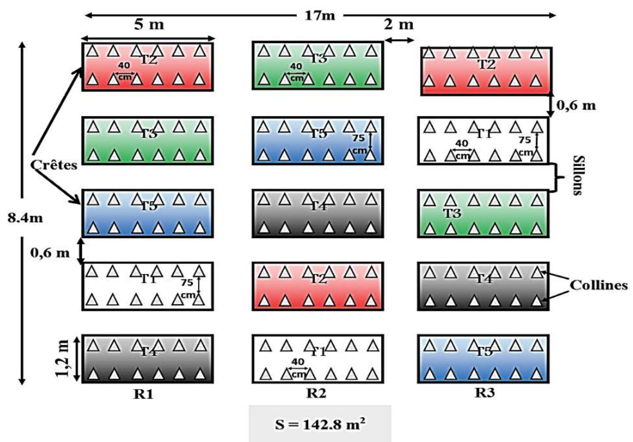

Figure 7: Experimental device on ridges and open furrows.

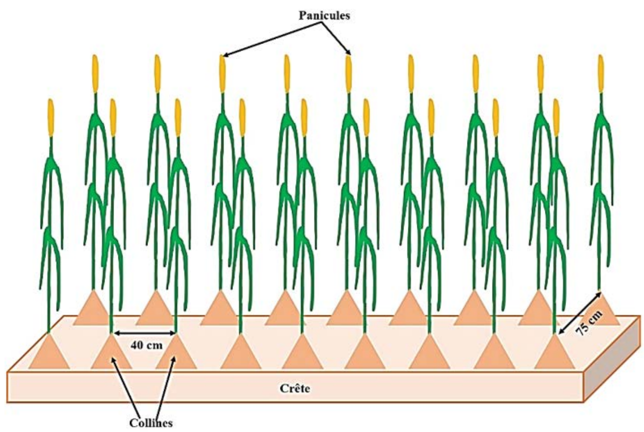

Figure 8: Density on the ridges.

- Type 3: Planting on linked ridges (micro basin) at a spacing of 60cm between ridges and 40cm between hills on ridges

For the third device, the trial is always conducted in completely randomized blocks. The plot of the culture is composed of three (3) blocks of which a block with five (5) elementary plots for a total of fifteen (15) elementary plots, the elementary plots are ridges and they are linked by forming a micro basin of 2 m in diameter in the middle with a depth of 0.5 m. The spacing between the ridges is 0.6 m, a ridge is 4m long and 1m wide which gives an area of 4 m2 for a total

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area of 200 m2. The density on a ridge is 75 cm between the lines which leads to 2 lines and 40 cm between the hills on the ridges for a total of 9 hills.

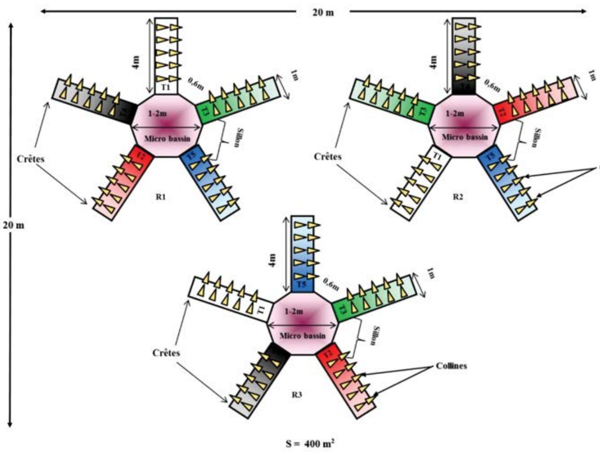

Figure 9: Crop management.

Crop management

Soil preparation, spacing, fertilizer rates, density, maintenance and harvesting are carried out according to technical itineraries (ITK). The preparation of the field started with the clearing of the existing vegetation, followed by a ploughing to prepare the seedbed.

Studied parameters

The descriptors developed by Harlan and De Wet [18] were used for the agro-morphological characterization of sorghum.

Sorghum : agro-morphological traits

Morphological traits (markers) are based on traits that can be visually observed and evaluated such as flower color, seed shape, growth habit, and pigmentation, and these markers do not require expensive technology.

Seedling stage

Anthocyanin coloration of sorghum seedlings from coleoptiles is examined at the seedling stage for varietal characterization.

5th leaf stage

At the 5th leaf stage, the genotype is characterized on the basis of two characters, the anthocyanin coloration of the leaf sheath and the color of the midrib of the 5th fully developed leaf.

Panicle emergence

Genotypes are characterized according to the time of panicle emergence (50% of plants with 50% flowering), the natural height of the plant to the base of the flag leaf, and the yellow coloration of the flag leaf from the midrib to the panicle emergence stage.

Flowering stage

Sorghum genotypes are classified into different groups based on anther length, dry anther color and flower with flower pedicel length. Based on the observed lemma formation on this trait, it is possible to broadly distinguish all genotypes into two categories: lemma present and absent.

Physiological maturity

Like the trait, glume color, branch panicle length, panicle density at maturity, panicle shape, panicle neck visible above the sheath, glume length, and grain threshing ability are recorded for characterization of genotypes at physiological maturity.

After threshing

Genotypes are classified according to caryopsis color, grain shape in dorsal view, seed mark grain size, endosperm grain texture (in longitudinal section), glassy albumen grain color, and grain luster.

Data analysis

Analyses were performed using R software (version 3.6.1), results are presented as mean ± SD descriptive statistics and the probability level of a significant difference is 0.05.

The GLM (Generalised Linear Model) was used to study the influence of the crop and treatment model on agronomic performance.

Pearson correlation tests were used to assess correlations between selected agronomic parameters.

Results

- **Growth parameters**

- **Sowing stage**

Anthocyanin coloration of coleoptiles at the seedling stage presented one week after sowing, is yellow-green in color, and is invariant for all devices and treatments.

- **Leaf stage (5th leaf)**

The 5th leaves appeared two (2) weeks after sowing, the color of the median sides is yellowish green and is invariable for all devices and treatments.

- **Panicle emergence**

Panicles emerged 50% late, at 99 days (3 months and one week) after seeding for all devices and treatments.

- **Height of the plant to the base of the flag leaf**

According to Figure 10 the plants in the micro-basins gave significantly lower heights (T1 = 2.4m; T2 = 2.7m; T3 = 2.6; T4 = 2.7m and T5 = 2m) compared to the other devices. But for T3 (TP = 3.2m and CSO = 3.3m), T4 (TP = 3m and CSO = 3.2m) and T5 (TP = 3.2m and CSO = 3m), with the exception of T2 (2.6m) where the flat ground is less

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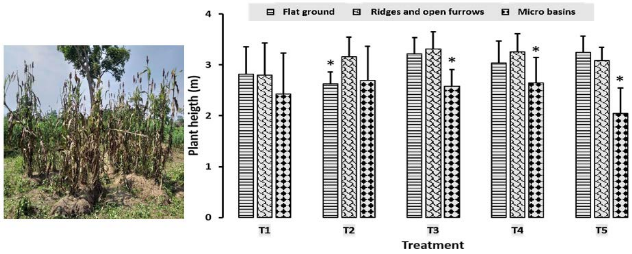

Figure 10 : Height of the plants.

advantageous in plant height performance. On T2, T3, T4 and T5 the difference observed from the statistical point of view is significant (P-value < 0.05).

- Length and width of the sheets

Leaf length as well as leaf width were taken 3 months after sowing i.e. one week before flowering. Treatments did not affect leaf size, except for the control (T1) where the plants in the micro-basins showed a lower leaf size i.e. leaf length and width (Figure 11 and 12). The difference observed statistically is significant (P-value < 0.05) on T1.

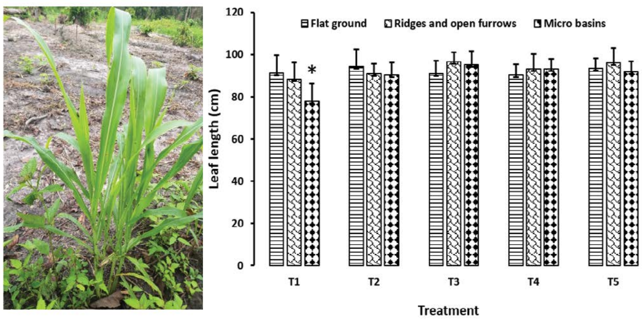

Figure 11: Leaf length.

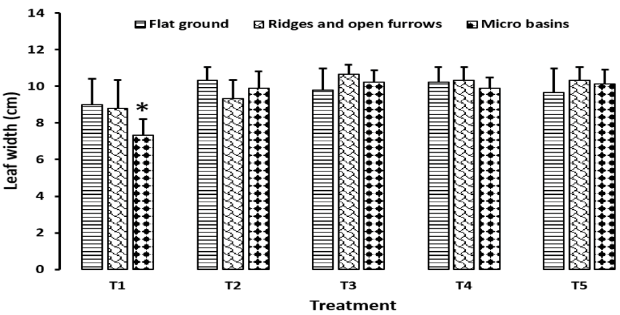

Figure 12: Width of the leaves.

- Number of nodes

On the ridges the plants had lower internodes than those grown on the flat land for T1 (14 and 12), T2 (16 and 13) and T5 (16 and 14). However, for T3 and T4 no difference was recorded for the three devices. Only the flat ground has a high number of internodes for T2 and T5, which have 16 internodes respectively (Figure 13). The results obtained show a statistically significant difference (P-value < 0.05).

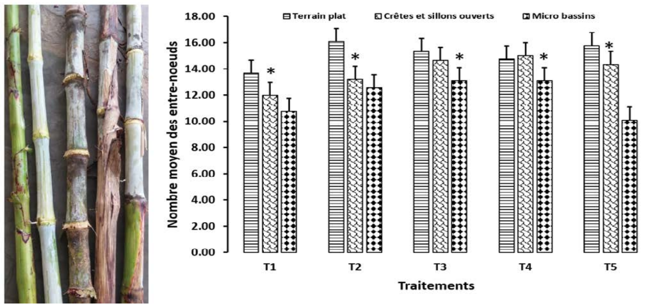

Figure 13: Number of nodes.

- Chlorophyll content

Chlorophyll content did not show significant differences between treatments and between soil types where sorghum was grown, with the exception of T5 (56.1%) where a higher chlorophyll content was recorded for plants on the flat soil (Figure 14).

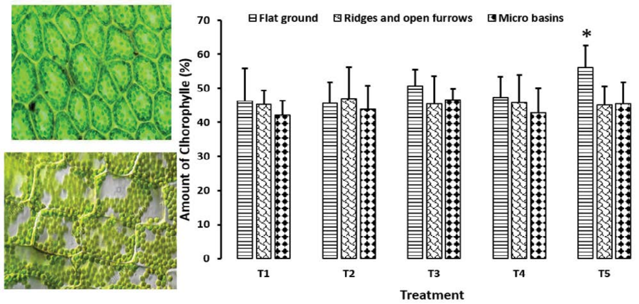

Figure 14: Chlorophyll content.

- Flower length (flower with pedicel)

According to Figure 15, flower length was lower in the microbasin-grown plants in the control (T1 = 5.2 cm) and in the treatments (T4 = 5 cm) and (T5 = 4.6 cm). No significant differences were recorded for T2 = 8 cm and T3 = 7.5 cm. The longest length was T4 = 9.4 cm on the open ridges and furrows.

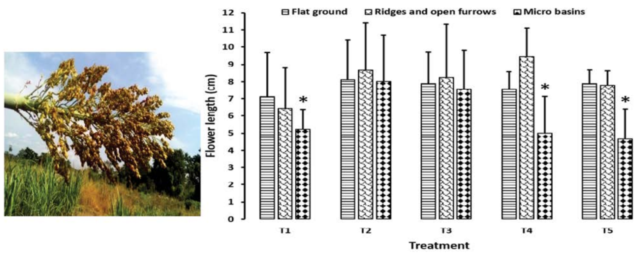

Figure 15: Length of the flower.

- Length of anthers

Sorghum plants grown in open ridges and furrows and in micro basins have smaller anthers compared to those grown in the field for T1 (2.3 mm; 1.6 mm and 1.4 mm), T2 (2 mm; 1.4 mm and 1.3 mm) and T3 (2.1 mm; 1.5 mm and 1.3

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mm). However, for T4 and T5, the micro-pool is the device where anther development is more inhibited (0.8 mm and 1.1 mm) while no significant difference was recorded for the flat ground and ridges (Figure 16).

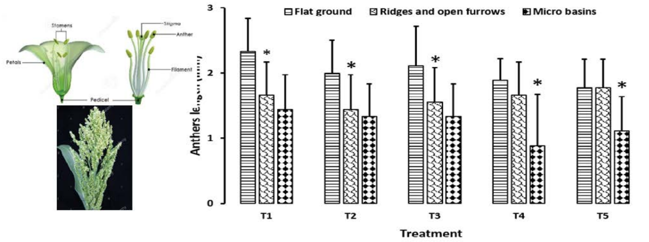

Figure 16: Length of anthers.

Agronomic parameters

- Fresh weight of the panicle

Panicle weight was taken after harvest (5 months after sowing). Figure 17 shows that panicle production was significantly lower in the micro basin compared to the other cropping systems. For T1 (86.6 g; 65 g and 53.3 g), T3 (94.8 g; 86.5g and 70.4 g), T4 (87.9 g; 84.5 g and 59.5 g) and T5 (102.2 g; 92.7 g and 61.4 g), this observed difference is significant. No difference was recorded on the ridges and micro basin for the T2 treatment (71.3 g and 74.2 g) and the flat ground was always superior (88.2 g).

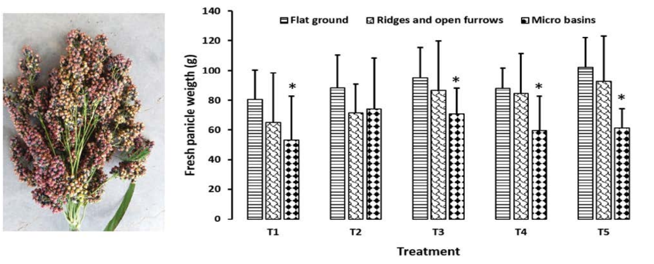

Figure 17: Fresh weight of the panicle.

- Dry weight of the panicle

The dry weight was taken after 72 hours of oven drying at 50° Celsius. According to Figure 18 the dry weight of panicles is significantly lower in the micro basin compared to the other growing devices. The best weight is T3 and T5 from the flat soil (90.1 g and 89 g) as well as T5 from the ridges (83 g).

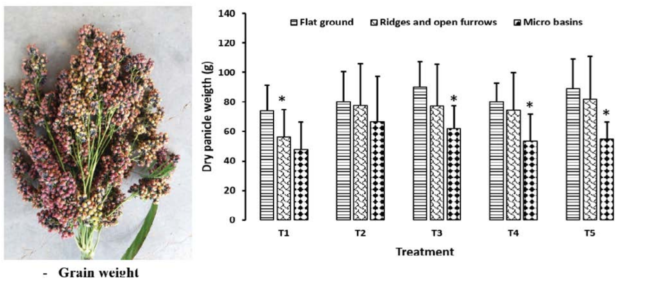

Figure 18: Dry weight of the panicle.

Weight was taken after threshing, as for panicle production, seed weight is significantly lower in the micro basin compared to the other cultivation devices for T1, T3, T4 and T5. No differences were recorded across sites for T2. The best weight was T3 (71 g) and T5 (71.3 g) on the flat soil and T5 (72.3g) in the micro basin (Figure 19).

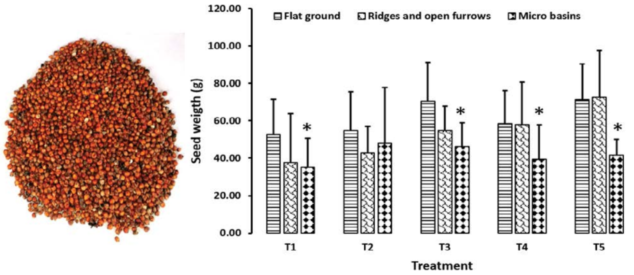

Figure 19: Seed weight.

• Correlation between some parameters

According to Table 7 a weak correlation was recorded between panicle weight and leaf length (R2 = 0.5), and also between panicle weight and leaf width (R2 = 0.49). These results show that panicle weight does not depend on either leaf length or width. But a strong correlation was recorded between panicle weight and [stem circumference (R2 = 0.77), plant height (R2 = 0.73), chlorophyll content (R2 = 0.71), anther length (R2 = 0.9), and panicle length (R2 = 0.83)]. These results show that panicle weight depends on stem circumference, plant height, chlorophyll content, anther length, and panicle length. The more important they are the more the weight increases.

Between seed weight and leaf length (R2 = 0.5), and between seed weight and leaf width (R2 = 0.49) the correlation was also weak so seed weight does not depend on leaf length and width. However, a strong correlation was recorded between seed weight and stem circumference (R2 = 0.69), plant height (R2 = 0.66), chlorophyll content (R2 = 0.66), anther length (R2 = 0.6), and panicle length (R2 = 0.7). These results show a relationship with respect to changes in seed weight and these parameters.

For chlorophyll content, a strong correlation was observed with panicle length (R2 = 0.6) and also with seed weight (R2 = 0.66). This explains that variations in chlorophyll content are somewhat dependent on panicle length and chlorophyll content.

Invariant parameters

The results also showed that some parameters are invariant regardless of the types of devices and treatments. The yellow coloration of the flag leaf of the midrib and the lemma is an example. The anthocyanic coloration of the stigma is yellow, that of the glume red gray at physiological maturity. The density of the panicles at maturity (compactness of the head of

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the ear) was compact, after harvesting and drying in the oven, the seeds are freely beatable. For the color of the caryopsis, it is grayish orange color, the shape of the grain in dorsal view is elliptical and in profile view is narrow elliptical. The texture of the grain of the endosperm (in longitudinal section) is farinaceous and the color of the grain of the vitreous albumen is greyish yellow.

Yield per hectare

The yield of threshed grains obtained per hectare is low on the micro basin, on the ridges and open furrows. Only T5 had a better yield compared to the other treatments. On the flat land, T3 and T5 gave better yields compared to the other treatments (Table 5).

Simplified operating account for each treatment (For 1ha)

The results of the operating accounts obtained following the adoption of the different types of treatments are presented in Table VI. The values are functions of the income generated by a crop cycle. The analyses indicate that the application of fertilizer increased the yield but did not yield a profit because of the cost of fertilizer.

Discussion

The integrated management study of sorghum (Sorghum bicolor (L) Moench) in the forest zone of the CAR, in collaboration with the farmers of an Agropastoral group, is carried out on the basis of three types of soil devices, fertilizers applied at different doses and evaluated using 32 descriptors for the agro-morphological characterization It was found that there is a variability between the different parameters evaluated according to the treatments and devices tested. This proves a variability between the parameters that allow to distinguish the treatments and devices at the morphological and agronomic level.

The analysis of variations with a significant difference (P-value < 0.05) for the height growth parameter shows that the plants of the bound ridges (micro basin) have low heights, this would be explained by the fact that the micro basin retains a lot of water and increases soil moisture. Stagnant water prevents the growth in height of the plants and also slows down their development. [19] who worked on "excess water and development of cereal yield" as well as [20] on "straw cereals, excess water" obtained results that support those obtained in the case of this study. Seed emergence, tillering and the number and fertility of ears can be more or less affected with sometimes important consequences on cereal yield. [21] showed that soil water saturation reduces root growth and affects overall yield. Germon et al. [22] and Roger [23] in their respective studies on soil and climate change and soil management, have shown that the fermentation of organic matter in anoxic environment produces methane and carbon dioxide which contribute to the greenhouse effect. Cellier et al. [24] and Renault et al. [25] have shown that the nitrogen cycle is also disturbed, saturation favors denitrification. For the other devices, the analysis shows that T3 of the open ridges and furrows presents a better performance with an average height of 3.3m followed respectively by T3 (3.2m) of the flat terrain, T4 (3.2m) of the open ridges and furrows and T5 (3.2m) of the flat terrain and also T4 of the open ridges and furrows. The variations observed between the average height growth can be explained by the combined contribution of mineral fertilizers nitrogen, phosphorus and organic matter (cow dung) which favors the growth in height compared to the treatment (T1) which did not benefit from fertilizers.

Yield variability was observed between treatments in accordance with the devices. These results corroborate with those of Nana [26] who had observed high variability in maize and sorghum yields among producers. Low yield levels were observed based on farmer practices. The nature of soil fertility may be one of the causes. The work of Ouattara et al. [27]; Sawadogo et al. [28]; Koulibaly et al. [29]; Ouédraogo et al. [30] and Ouattara et al. [31] have shown that yields are low when there is no fertilizer input. The results obtained in this study confirmed the impact of fertilization on sorghum productivity.

The micro-dose of mineral fertilizer resulted in improved grain yields and vegetative growth of sorghum across treatments and systems. Saba et al. [32] and Sissoko et al. [31] in a similar approach with the application of 2g NPK per packet on sorghum managed to improve production. As the trials were set up in a forest zone and during the rainy season, the improvement in crop water nutrition due to soil moisture are significant assets [31] have also indicated that improved mineral nutrition through fertilizer nutrients contributes to yield improvement.

Other studies have noted the impact of micro dose in improving yields Saba et al. [32]; Sissoko et al. [33]; Demisie et al. [34]. Also, results from several authors reported by Aune et al. [35] justified the positive effect of micro dose on millet and sorghum yield. Sissoko et al. [33] had also demonstrated that variables such as fertilizer microdosing, improved varieties, organic manure, water and soil conservation techniques were positive determinants in millet and sorghum production.

The correlations found between panicle weight, stem circumference, plant height, chlorophyll content, anther length and panicle length show a co-evolution between certain parameters under agroclimatic conditions of growth and production at the physiological level. The work of Hema et al. [36] in a similar approach confirms these results. Zongo [37] and Mbazumutima [38], following the same logic, also observed a positive correlation between plant size and panicle

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length on the one hand, and between the size and number of internodes on the other.

Conclusion

Agricultural yield is one of the main objectives in agricultural production, experimentation and varietal selection. The CAR is an agricultural country whose economic and social development is mainly based on agriculture, which contributes significantly to the fight against poverty and food security. Despite its importance, this sector remains less developed.

The results of this study showed that the best sorghum grain yields are those of T5 (Sorghum + N=18kg/ha + P= 37kg/ha + DAP=14kg/ha) on ridges and open furrows with a production of 720 kg/ha and T5 on flat land with the production of 710 kg/ha followed by T3 (Sorghum + N=60kg/ha + P= 36kg/ha) on flat land with a production of 700 kg/ha. The profitability of sorghum cultivation in the forest zone is better if the joint use of organo-mineral fertilizers is considered, however, the pedoclimatic conditions are fundamental for sorghum production.

It is certain that fertilizer use has positively affected the production potential of sorghum but does not generate any benefits according to economic analyses. This is due to the high cost of inputs. In the traditional sorghum growing areas, mainly in the central part of the Central African Republic, farmers generally use the after-effects of fertilizers applied to the cotton crop.

Constraints related to soil fertility management practices remain a major constraint for agricultural production in CAR with few exit solutions. However, the application of recommended fertilizers, or the association of sorghum cultivation with legumes would be a possible solution for improving sorghum yields in forest areas.

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References

1. Chantereau J, Cruz JF, Ratnadass A, et al. Presses Agronomiques de Gembloux, Quae, CTA, Gembloux (2013): 244
2. FAO. Food Agriculture Organization (2010).
3. Abu Assar AH, Uptmoor R, Abdelmula AA, et al. Assessment of sorghum genetic resources for genetic diversity and drought tolerance using molecular markers and agro-morphological traits. U K J Agric Sci 17 (2009): 1-22.
4. Chantereau J.et Nicou R. Le sorgho. Paris, Maisonneuve et Larose, Collection le Technicien de l'agriculture tropicale (1991): 159.
5. Koffi K, Germain C, Akanvou L, et al. Diversité morphologique du sorgho (Sorghum bicolor L. Moench) cultivé au Nord de la Côte d'Ivoire. Revue Ivoirienne des Sciences et Technologie 17 (2011): 125-142.
6. Falalou H, Gérard Z, Sita G. Réponse physiologique du niébé (Vigna unguiculata L. Walp) au déficit hydrique s'exerçant au cours de deux stades de développement, début floraison et début formation des gousses. Mémoire DEA. Uni. De Ouaga (2000): 62.
7. FAO. L'irrigation en Afrique en chiffres – Enquête AQUASTAT (2005): 1.
8. FAO. Rapport spécial mission / PAM d'évaluation des récoltes et de la sécurité alimentaire en République Centrafricaine (2017).
9. Bougma LA, Ouédraogo MH, Sawadogo N, et al. Perceptions paysannes de l'impact du changement climatique sur le mil dans les zones sahéliennes et soudano- sahélienne du Burkina Faso. Afrique SCIENCE 14 (2018): 264 - 275.
10. Nelson GC, Rosegrant MW, Koo J, et al. Changement Climatique : Impact sur l'Agriculture et Coûts de l'Adaptation. Institut International de Recherche sur les Politiques Alimentaires IFPRI: Washington D.C (2009).
11. Sultan B, Roudier P, Traoré S. Les impacts du changement climatique sur les rendements agricoles en Afrique de l'Ouest. In Les Sociétés Rurales Face aux Changements Climatiques Et Environnementaux en Afrique de l'Ouest, Sultan B, Lalou R, Sanni AM, Oumarou A, Soumaré MA (Eds). Marseille, IRD (2015): 209-225.
12. Doumbia S, Dembélé SG, Sissoko F, et al. Evaluation de la fertilité des sols et les rendements de cotonnier, maïs et sorgho à Gliricidia sepium (Jacq.) Kunth ex. Walp. Int J Biol Chem Sci 14 (2020): 2583-2598.
13. Vanlauwe B, Bationo A, Chianu J, et al. Integrated soil fertility management: Operational definition and consequences for implementation and dissemination. OutlookAgric 39 (2010): 17-24.
14. Katengeza SP, Holdena ST, Fisher M. Use of Integrated Soil Fertility Management Technologies in Malawi: Impact of Dry Spells Exposure. Ecol Econ 156 (2019): 134-152.
15. Atlas. https://data.unhcr.org/en/documents/details/81993 (2008).
16. Koné Y, Wamffler B, Beliere JF. Perception des acteurs sur la gestion de la fertilité des sols dans la zone de savane au Niger (2009): 270.
17. Hauser S, Wairegi L, Asadu CL, et al. Guide de culture du manioc. Consortium africain pour la santé des sols,

KOSH-KOMBA E, et al., Int J Plant Anim Environ Sci 2025
DOI:10.26502/ijpaes.4490181

Nairobi. Consortium Africain Pour la Santé des Sols Article (2014): 45.

18. Harlan JR, de Wet JMJ. A Simplified Classification of Cultivated Sorghum. Crop Sciences 12 (1972): 172-176.
19. Masse J, Capy Y. Excès d'eau et élaboration du rendement des céréales. Perspectives Agricoles 126 (1988): 37-47.
20. Arvalis. Les fiches accidents: céréales à paille, excès d'eau. Texte intégral sur le site d'Arvalis (2014).
21. Rebière B. Effet d'un excès d'eau sur la croissance d'une culture de blé d'hiver. Identification d'une variable de stress et analyse de la réponse de la culture. Thèse Univ. de Strasbourg (1996): 234.
22. Germon JC, Cellier P, Gabrielle B, et al. Sol et changement climatique. In: Le Sol. Dossier INRA, Paris (2009): 42-47.
23. Roger P, Le Mer J. Les sols: source et puits de carbone. Étude et gestion des sols 10 (2003): 331-345. Texte intégral sur le site de l'AFES.
24. Cellier P, Germon JC, Hénault C, et al. Les émissions d'ammoniac (NH3) et d'oxydes d'azote (NOx et NO2) par les sols cultivés : mécanismes de production et quantification des flux. In: Maîtrise de l'azote dans les agrosystèmes. INRA, Paris, Les colloques, n°83 (1996): 25-37.
25. Renault P, Sierra J, Stengel P. Transfert d'oxygène et anoxie dans les sols agrégés: contribution à l'étude de la dénitrification. Agronomie 14 (1994): 395-409.
26. Nana G. Analyse de la variabilité spatiale des rendements du maïs (Zea mays L.) et du sorgho [Sorghum bicolor (L). moench] dans la province du Tuy, Burkina Faso. Mémoire d'Ingénieur du Développement Rural, option : Agronomie. Institut du Développement Rural Université Polytechnique de Bobo Dioulasso, Burkina Faso (2016): 69.
27. Ouattara B, Ouattara K, Serpentié G, et al. Intensity cultivation induced effects on soil organic carbon dynamic in the western cotton area of Burkina Faso. Nutr Cycl Agroecosyst 76 (2006): 331-339.
28. Sawadogo H, Bock L, Lacroix D, et al. Restauration des potentialités de sols dégradés à l'aide du zaï et du compost dans le Yatenga(Burkina Faso). Biotechnol. Agron. Soc. Environ 12 (2008): 279-290.
29. Koulibaly B, Traoré O, Dakuo D, et al. Effet de la gestion des résidus de récolte sur les rendements etles bilans culturaux d'une rotation cotton- maïs-sorgho au Burkina Faso. Tropicultura 28 (2010): 184-189.
30. Ouédraogo J, Ouédraogo E, Nacro HB. Effet de l'interaction entre des modes de gestion de fertilité et la macrofaune sur la productivité du niébé et du sorgho en zone nord soudanienne du Burkina Faso. Int J Biol Chem Sci 8 (2014): 104-114.
31. Ouattara B, Somda BB, Sermé I, et al. Improving Agronomic Efficiency of Mineral Fertilizers through Microdose on Sorghum in the Sub-arid Zone of Burkina Faso. In Improving the Profitability, Sustainability and Efficiency of Nutrients Through Site Specific Fertilizer Recommendations in West Africa Agro-Ecosystems (Volume1), Bationo A, Ngaradoum D, Youl S, Lompo F, Fening JO (Eds). Springer 1 (2018): 241-252.
32. Saba F, Taonda SJB, Sermé I, et al. Effets de la microdose sur la production du niébé, du mil et du sorgho en fonction la toposéquence. Int J Biol Chem Sci 11 (2017): 2082-2092.
33. Sissoko P, Berti F, Gry S, et al. Effets de l'adoption de la technique du microdosage d'engrais sur la disponibilité et l'accessibilité céréalière des exploitations agricoles à base de mil et de sorgho au Mali. Agron. Afr 30 (2018): 193-204.
34. Demisie W. Fertilizer microdosing technology in sorghum, millet and maize production at small-scale level in Africa: a review. Int J Adv Sci Res Dev 05 (2018): 39-49.
35. Aune JB, Coulibaly A, Giller KE. Precision farming for increased land and labour productivity in semi-arid West Africa. A review. Agron Sustain Dev 37 (2017): 1-10.
36. Hema T. Evaluation des caractéristiques morphologiques d'hybrides de sorgho guinea (Sorghum bicolor L. Moench). Mémoire d'Ingénieur du Développement Rural, option agronomie, UPB/IDR (2005): 66.
37. Zongo JD. Ressources génétiques des sorghos [Sorghum bicolor (L) Moench] du Burkina Faso: Evaluation agromorphologique et génétique. Thèse de doct., Univ. d'Abidjan (1991): 175.
38. Mbazumutima L. Evaluation agro-morphologique des sorghos de la région climatique sud-soudanienne du Burkina Faso. Mémoire de fin d'étude d'ingénieurs du Développement Rural, IDR, UPB, Burkina Faso (2000): 68.

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