RESEARCH ARTICLE

Effect of fertilization and weeding type on the cotton production in Benin

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Soil fertility and land degradation have become a major problem in agricultural production in general and specially in cotton production. This study aimed to evaluate the effects of fertilization and weeding-butting on cotton growth and production. Thus, it studied the effect of several fertilizers associated with weeding type on cotton production. The experimental design used was a split plot with two factors: Fertilization application at four levels (no fertilization, mineral fertilization, organic fertilization, organic and mineral fertilization) and the weeding type at two levels (weeding-butting and simple weeding). The data collected were: Height and collar diameter, number of bolls and cotton fiber. The results showed that organic and mineral fertilization followed by weeding-butting significantly ($P<0.05$) improved height growth of plant (128.28 cm), diameter at the collar of the plants (1.86 cm), the number of bolls (18.46) and cotton fiber yield (3.17 t/ha). Organic and mineral fertilization associated with weeding-butting could be recommended to farmers for soil fertility and cotton production improvement.

Key Words: *Soil fertility; Plant nutrition; Weeding-butting; Cotton production*

INTRODUCTION

Agricultural development is the fundamental sector for economic emergence and poverty alleviation in most countries of the world [1]. In African Franc Zone (AFZ) countries such as Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Cote d'Ivoire, Guinea, Mali, Niger, Senegal and Togo, it is the basis for development and it contributes significantly to the employment and income of rural populations [2]. However, since several years now, soil fertility in these cotton-growing areas has been declining, mainly due to the progressive decrease in organic matter levels and deficient mineral balances [3]. Low soil fertility is considered as one of the major constraints limiting the productivity of sub-saharan agriculture [4]. The solution to the declining productive capacity of the land necessarily involves investments in land fertility [5]. Soil fertility management involves the use of mineral fertilizers, organic fertilizers or a combination of both [3]. The valorization of crop residues can make a decisive contribution to ensuring the maintenance of cultivated soil fertility [6]. The sustainability of cropping systems relies on the rational management of soil fertility [7]. In Benin, the problem of declining soil fertility is a concern for both farmers and researchers [8]. One of the strategies to improve soil fertility, particularly ferralitic soils that are poor in nitrogen and phosphorus, is the use of organic fertilizers [9]. This practice contributes to the increase of the organic matter stock and to the increase of the cation exchange capacity and consequently the soil fertility level [10]. The application of organic fertilizers to cotton and soils has been shown to improve soil structure, increase soil water and nutrient holding capacity, stimulate microbial activity and increase crop yields [11,12]. The overall objective of the study presented in this paper is to evaluate the effects of fertilization and weeding-butting on cotton growth and production.

MATERIALS AND METHODS

Study areas

The present study was carried out in the municipality of Ketou (Figure 1). This municipality is located at the northern end of the plateau department, between latitudes 7°10' and 7°41'17" North and longitudes 2°24'24" and 2°47'40" East. The climate is tropical with a bimodal rainfall regime composed of two nuances: A long rainy season, a short dry season, a short rainy season and a long dry season. The average annual rainfall is about 1073 mm in 365 days [13]. The two maxima of this regime are centered on June and September.

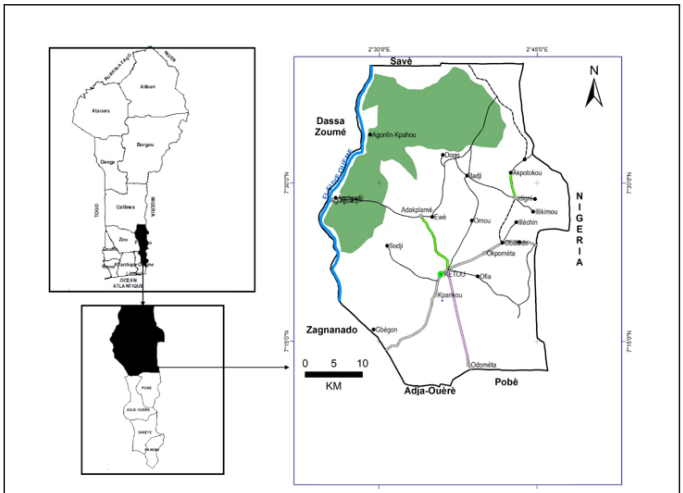

Figure 1) *Map of the study area.* **Note:** *( ): Region limit; ( ): District capital; ( ): Survey village: ( ): Village; ( ): RN3: ( ): RNIE4; ( ): Seasonal road; ( ): Secondary road; ( ): Track; ( ): Dogo forest; ( ): Ketou forest; ( ): Water course*

Material

The plant material used was the variety KET 782 of cotton adapted to the southern Benin zone. The types of fertilizers used were: poultry manure, NPKSB 14-18-18-6-1 and urea (46%).

Conduct of the survey

The trial was conducted in a real environment at a volunteer farmer's place with a flat plot. Two factors were studied: The fertilization application and the weeding type. Thus, the experimental design was the split plot and the type of weeding was considered as the main factor. The fertilization application

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had four levels (no fertilizer, mineral fertilizer, organic fertilizer and organo-mineral fertilizer) and the weeding type had two levels (weeding-butting and simple weeding). Table 1 presents the amount of each type of fertilizer.

TABLE 1

The amount of each fertilizer type used

Type of fertilizer	NPKSB (Kg/ha)	Urea (Kg/ha)	Organic (Kg/ha)
Without fertilizer	0	0	0
Mineral fertilizer	200	50	0
Organic fertilizer	0	0	20,000
Organo-mineral fertilizer	200	50	20,000

The trial was set up on two large plots (weeding-butting plot and simple weeding plot) separated by a 2 m pathway. Each large plot had an area of 234 m^2 and was divided into twelve equal plot units (3 m × 3 m or 9 m^2). Within each large plot was randomized the modalities of the different types of fertilizers. Each fertilizer type was repeated three times within each large plot. The plot units were separated by 2 m rows. Seeding was done at a spacing of 0.80 m × 0.40 m, thinned out to two plants per cluster, i.e., a density of 62,500 plants per hectare. The fertilizers were brought in closed stakes followed by the realization of the weeding-butting. In the simple weeding plot, weeding was done before fertilizer was applied in closed paddocks. Mineral fertilizers were applied in closed stacks.

NPKSB was applied 15 days after sowing and urea 50 days after sowing. Organic fertilizer was applied at the same time as NPKSB, i.e., 15 days after sowing. The different types of weeding were done twice on each plot 15 and 50 days after sowing. Insecticide treatments were carried out on the cotton plant following the recommended treatment schedule.

The collection began 26 Days After Sowing (DAS). From each plot unit, 10 plants were randomly selected and marked. Growth (height and collar diameter) and production (number of bolls) data were collected from these 10 plants every 30 days, starting 26 DAS. The cotton fiber mass was taken after harvest.

The height and the diameter at the collar were measured. The height of the plants is taken from the collar to the end of the main stem. The number of bolls formed was also counted per plant. The cotton fiber was harvested when the bolls were completely opened on each unit plot. The harvest was weighed with an electronic scale and the yield was determined in tons per hectare. The cotton fiber yield was estimated using the following formula:

$$Yield = (N \times M)/n$$

Yield at tons per ha with N, the number of plants on a hectare. Here N is 62,500 considering a spacing of 80 cm between the lines and 40 cm between the paddocks and 2 plants per paddock and n is the number of plants harvested on the plot unit and M is the mass (tons) of cotton fiber harvested from n plants per plot unit.

Statistical analysis

The R software version 3.4.3 was used for the statistical analysis of the data. These are Analyses of Variance (ANOVA) at the 5% significance level. Finally, multiple comparisons of means were made using the Student Newman-Keuls test.

RESULTS AND DISCUSSION

Effect of fertilizer application and weeding type on cotton height growth

Table 2 presents the effect of fertilizer combined with the two weeding types on the height growth of the cotton plant. The results of this table reveal that the type of fertilizer, the type of weeding after fertilization and their interactions, significantly influenced ($p<0.001$) the height growth of cotton plant. It also revealed that the height of the cotton plant varied with time. Considering the plot that received weeding-butting after fertilization, it was found that organic and organo-mineral fertilization induced a better growth in height of the cotton plant and no significant difference existed between these two types of fertilization 86 days after sowing (131 and 128.26 cm in height). The same trend was observed on the plot that was simply weeded after fertilization. Thus, organo-mineral fertilization significantly improved the height growth of the cotton plant. Cotton plants that received mineral fertilization and those that received no fertilization on the two types of plots showed the lowest height growth with 94.26 and 97.53 cm respectively, 86 days after sowing.

TABLE 2

Effect of fertilizer application and weeding type on cotton height growth

Type of weeding after fertilization	Type of fertilization	26 DAS	56 DAS	86 DAS
Weeding-butting	Mineral	11.1 ± 0.5^{d}	46.1 ± 1.5^{e}	94.26 ± 2.4^{c}
	Organic	14.1 ± 0.8^{bc}	64.5 ± 2.5^{abc}	131.00 ± 2.9^{a}
	Organo-mineral	13.1 ± 0.6^{c}	58.5 ± 1.9^{cd}	128.26 ± 3.1^{a}
	No fertilization	13.6 ± 0.6^{c}	53.6 ± 2.8^{d}	105.70 ± 4.1^{bc}
Simple weeding	Mineral	15.9 ± 0.5^{ab}	61.1 ± 2.1^{bcd}	111.26 ± 2.8^{b}
	Organic	16.7 ± 0.6^{a}	68.7 ± 2.3^{ab}	125.76 ± 2.7^{a}
	Organo-mineral	17.7 ± 0.7^{a}	71.7 ± 2.6^{a}	125.73 ± 4.8^{a}
	No fertilization	17.9 ± 0.8^{a}	60.7 ± 3.2^{bcd}	97.53 ± 4.6^{c}
P type of weeding		2.09e-06***		
P fertilization		<2e-16***		
P type of weeding × fertilization		7.76e-05***		

Note: DAS: Days After Sowing; (***): Signiicantly diferent (P<0.05) according to Student Newman-Keuls test.

Effect of fertilizer application and weeding type on cotton collar diameter

Table 3 presents the effect of fertilization combined with two types of weeding on the collar diameter of the cotton plant. The results in this table show that the type of fertilization, the type of weeding after fertilization and their interactions significantly influenced (from $p<0.05$ to $p<0.001$) the collar diameter growth of the cotton plant. Regardless of the type of weeding, it was found that organic and organo-mineral fertilization induced the best growth in collar diameter of the cotton plant and no significant difference existed between these two types of fertilization 86 days after sowing. The weeding-butting after fertilization positively improves the growth of the collar diameter. Indeed, the largest collar diameter was obtained on the plot that received weeding-mounding after fertilization (1.86 cm, 86 days after sowing).

TABLE 3

Effect of fertilizer application and weeding type on cotton collar diameter

Type of weeding after fertilization	Type of fertilization	26 DAS	56 DAS	86 DAS
Weeding-butting	Mineral	0.18 ± 0.00^{b}	0.67 ± 0.02^{f}	1.20 ± 0.03^{b}
	Organic	0.23 ± 0.01^{a}	1.06 ± 0.04^{bc}	1.82 ± 0.05^{a}
	Organo-mineral	0.21 ± 0.00^{ab}	0.97 ± 0.03^{a}	1.86 ± 0.04^{a}
	No fertilization	0.21 ± 0.01^{ab}	0.74 ± 0.02^{f}	1.18 ± 0.03^{b}
Simple weeding	Mineral	0.21 ± 0.00^{ab}	0.90 ± 0.02^{of}	1.28 ± 0.04^{b}
	Organic	0.21 ± 0.01^{ab}	1.13 ± 0.03^{ab}	1.82 ± 0.05^{a}
	Organo-mineral	0.25 ± 0.01	1.18 ± 0.03^{a}	1.83 ± 0.05^{a}
	No fertilization	0.23 ± 0.01^{a}	0.84 ± 0.03^{e}	1.13 ± 0.04^{b}
P type of weeding		9.22e-05***		
P fertilization		<2e-16***		

P type of weeding × fertilization	0.0409*

Note: DAS: Days After Sowing; (*, ***): Signiicantly diferent (P<0.05) according to Student Newman-Keuls test.

Effect of fertilizer application and weeding type on the number of bolls released by cotton plants

Table 4 presents the effect of the studied factors on the number of bolls emitted by the cotton plants. The analysis reveals that fertilizers and weeding types have a significant effect (p<0.001) on the number of bolls produced by the cotton plants. Organic and organo-mineral fertilization induced the highest number of bolls in both plots. These two types of fertilization combined with weeding-butting after fertilization positively improve boll release. 86 DAS, organo-mineral fertilization combined with weeding-butting gave 18 bolls while organic fertilization combined with weeding-butting gave 14. Thus, both organo-mineral fertilization and weeding-butting improve the number of bolls emitted by the cotton plants.

TABLE 4

Effect of the type of fertilization and type of weeding on the number of bolls emitted by the cotton plants

Type of weeding after fertilization	Type of fertilization	26 DAS	56 DAS	86 DAS
Weeding-butting	Mineral	1.93 ± 0.29^{cd}	9.46 ± 0.95^{bc}	14.70 ± 0.98^{bc}
	Organic	3.00 ± 0.39^{bcd}	11.10 ±1.05^{abc}	14.73 ± 0.99^{bc}
	Organo-mineral	3.2 ± 0.60^{bcd}	14.20 ±1.07^{a}	18.46 ± 1.10^{a}
	No fertilization	1.43 ± 0.26^{d}	8.06 ± 0.91^{c}	10.76 ± 0.86^{d}
Simple weeding	Mineral	3.00 ± 0.33^{bcd}	9.76 ± 0.82^{bc}	13.40 ± 0.81^{cd}
	Organic	6.20 ± 0.68^{a}	13.36 ± 1.32^{ab}	17.56 ±1.10^{ab}
	Organo-mineral	4.70 ± 0.68^{ab}	13.16 ± 1.05^{ab}	16.90 ±1.02^{abc}
	No fertilization	3.73 ± 0.84^{bc}	10.13 ± 0.89^{bc}	14.70 ± 0.93^{bc}
P type of weeding		0.000191***		
P fertilization		1.44e-09***		
P type of weeding × fertilization		0.001527**		

Note: DAS: Days After Sowing; (**, ***): Signiicantly diferent (P<0.05) according to Student Newman-Keuls test.

Effect of fertilizer application and weeding type on cotton fiber yield

Figure 2 presents the cotton fiber yield according fertilizer application and weeding type. The analysis of variance results showed that the type of weeding significantly influenced (p<0.05) the cotton fiber mass and fertilizer application had a very high influence (p<0.001) on this mass. Organo-mineral fertilization induced the highest cotton fiber yield on both types of weeding. In fact, organo-mineral fertilization combined with weeding resulted in the highest yield (3.17 t/ha), followed by organo-mineral fertilization combined with simple weeding (2.19 t/ha).

The results showed that cotton plants that received only mineral fertilization showed low growth in height, collar diameter and number of bolls (production parameters) followed by those that received no fertilization on both types of plots (simple weeding plot and weeding-butting plot). This result could be due to the low level of soil organic matter. The result corroborates the work of Dagbenonbakin et al., [3] who showed that based on crop behavior, there is a lack of response to mineral fertilizers when the level of soil organic matter is below 0.6%. In general, the best growth was obtained with organo-mineral fertilization on both types of weeding. These results can be explained by the balanced ratio between nutrients in the combination of the two fertilizers according to Kpera et al., [14]. Thus, this study confirms the results of Traore [15], who showed that organic matter plays a buffering role against soil acidification and allows for a better nutrient use efficiency of mineral fertilizers. However, weeding-butting impacted on the combination of organic and mineral fertilizers, which resulted in very good growth. This is explained by the fact that weeding-butting allowed the nutrients provided by the fertilizer combination to be maintained at the feet of the cotton plants.

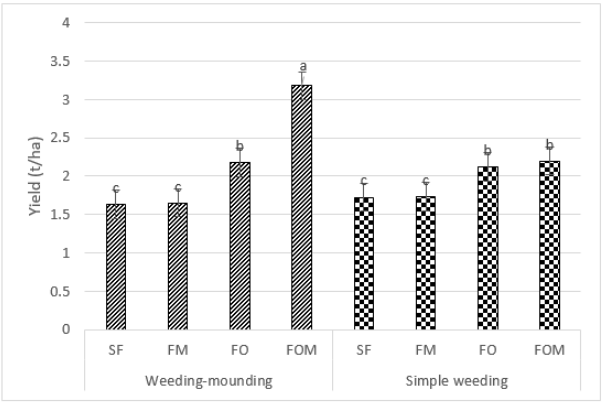

Figure 2) *Cotton fiber yield according fertilizer application and weeding type.* **Note:** *SF: Without fertilizer; FO: Organic fertilizer; FOM: Organo-mineral fertilizer; FM: Mineral fertilizer, vertical bars denote standard errors. Bars of the same types labelled with the same letter are not significantly different (P>0.05) according to Student Newman-Keuls test*

Organo-mineral fertilization combined with weeding-butting significantly improved cotton fiber yields. In the absence of organic matter, the yield is low despite the use of mineral fertilizers. Thus, this result shows that organic matter is crucial for the efficient use of mineral fertilizers. Amidou et al., [16] found a similar result for maize. Also, Dagbenonbakin et al., [3] had observed an improvement in cotton yield when compost or manure was combined with mineral fertilizers. This may be a result of the improved physical, chemical and biological properties following the application of these fertilizers that promoted nutrient use in the soil.

CONCLUSION

In conclusion, the study show that the application of organo-mineral fertilizers combined with the weeding-butting allows to improve the growth of the cotton plant and increase the yield of cotton fiber. The exclusive use of mineral fertilizers without any restitution contributes to the reduction of the organic matter rate in the soil. Based on the results obtained, organo-mineral fertilization with weeding-butting appears to be suitable for ensuring better productivity and the maintenance of soil fertility. This study confirms that organic matter plays an important role against soil acidification and contributes to a better nutrient use efficiency of mineral fertilizers. Thus, it shows that organic matter is crucial for the efficient use of mineral fertilizers.

REFERENCES

1. Godoy CD, Dewbre J. Importance economique de l'agriculture dans la lutte contre la pauvreté. 2010.
2. Matthess A, van Den AE, Chougourou D, et al. Le coton au Benin : Competitivite et durabilite de cinq systèmes culturaux cotonniers dans le cadre de la filiere. 2005.
3. Dagbenonbakin GD, Chougourou CD, Adjovi NR, et al. Effets agronomiques du compost et du N14P23K14S5B1 sur la production et les caracteristiques du rendement de coton-graine au nord benin. Bull Rech Agron Bénin. 2012:36-45.
4. Bationo A. Constraints and new opportunities for achieving a green revolution in sub-saharan africa through integrated sSoil fertility management. 2009.
5. Kante S. Gestion de la fertilite des sols par classe d'exploitation au mali-sud. Wageningen Uni Res. 2001.
6. Malhi SS, Lemke R, Wang ZH, et al. Tillage, nitrogen and crop residue effects on crop yield, nutrient uptake, soil quality, and greenhouse gas emissions. Soil Till Res. 2006;90(1-2):171-183.
7. Igue AM, Agossou V, Ogouvide FT, et al. Influence des systemes d'exploitation agricole sur l'intensité de la dégradation des terres dans le

departement des collines au benin. Bull Rech Agron Benin. 2008;61:39-51.

8. Saidou A, Kossou D, Azontonde A, et al. Effet de la nature de la jachere sur la colonisation de la culture subsequente par les champignons endomycorhiziens: Cas du systeme 'jachere'manioc sur sols ferrugineux tropicaux du Benin. Int J Biol Chem Sci. 2009;3(3).
9. Kone B, Sylvester O, Diatta S, et al. Response of interspecific and sativa upland rices to mali phosphate rock and soluble phosphate fertilizer. Arch Acker Pflanzenbau Bodenkd. 2011;57(4):421-434.
10. Weber J, Karczewska A, Drozd J, et al. Agricultural and ecological aspects of a sandy soil as affected by the application of municipal solid waste composts. Soil Biol Biochem. 2007;39(6):1294-1302.
11. Kowaljow E, Mazzarino MJ. Soil restoration in semiarid patagonia: Chemical and biological response to different compost quality. Soil Biol Biochem. 2007;39(7):1580-1588.
12. Amadji GL, Saidou A, Chitou L, et al. Recycling of organic residues in compost to improve coastal sandy soil properties and cabbage shoot yield in Benin. Int J Biol Chem Sci. 2009;3(2):58.
13. Sandra BO, Bagan GC, Fandohan AB, et al. Impacts du labour conventionnel sur le rendement cotonnier dans la commune de Ketou, Benin. Revue Marocaine des Sciences Agronomiques et Veterinaires. 2021;9(1).
14. Kpera A, Gandonou CB, Aboh AB, et al. Effet de differentes doses de bouse de vache, d'urine humaine et de leur combinaison sur la croissance vegetative et le poids des fruits de l'ananas (*Ananas comosus* (L.) Merr.) au Sud Benin. J Appl Biosci. 2017;110:10761-10775.
15. Traore M. Impact des pratiques agricoles (rotation, fertilisation et labour) sur la dynamique de la microfaune et la macrofaune du sol sous culture de sorgho et de niebe au centre ouest du burkina faso. 2012.
16. Amidou M, Djenontin AJ, Wennink B, et al. Valorisation des residus de recolte dans l'exploitation agricole au nord du Bénin: Utilisation du fumier produit dans le parc de stabulation des bœufs. Bull Rech Agron Benin. 2005;47:19-25.