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RESEARCH ARTICLE OPEN ACCESS

REVIEW OF THE PERFORMANCE OF THE ASSOCIATION OF MINERAL FERTILIZER WITH ORGANIC SMOKE ON THE PRODUCTIVITY OF CORN CULTIVATION IN THE NGANDAJIKA/DRDCONGO REGION (CASES OF DAP, BAT-GUANO AND TITHONIA DIVERSIFOLIA)

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ABSTRACT

There is considerable agreement that neither type of fertilizer can be used without good agricultural production, and that organic matter and mineral fertilizers play their role (Dudal, 2002; FAO, 1999). A test was conducted in the Ngandajika region using a mineral fertilizer (DAP), a manure combining bat-guano and DAP, and a manure combining *Tithonia diversifolia* and DAP. The following results were recorded: Of two varieties, QPM3 yielded 3.87 Mg/Ha higher than Mus1 yielded 3.08 Mg/Ha. In the QPM3 variety, all fertilizations yielded significantly the same higher yield than the control, whereas in the Mus1, the combination of Bat-guano+DAP yielded 4.28 Mg/Ha significantly the same as the DAP with 3.97 Mg/Ha more than the combination of Tithonia diversifolia+DAP with 3.55 Mg/Ha by far greater than the control.

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INTRODUCTION

The combination of organic fertilizers and minerals, being the proven and successful approach in other parts of Sub-Saharan Africa, shows that the combination of two types of manure, well meets the fertility needs of most soils. It effectively contributes to the restoration of soil fertility (Citeau and al 2012; Kathuku and al 2011; Mafongoya and al 2007). This approach may well be tried in the Ngandajika region where organic matter has been a constraint (Anonyme, 2005; FAO/UNDP/USAID/BM, 1991). The two organic fertilizers (Bat-guano and *Tithonia diversifolia*) having given good results on the cultivation of maize, this test aims to compare the productivity of the Bat-guano+DAP associations) and Tithonia+DAP to that of mineral fertilizer (DAP). The objective of this study is to assess the impact of the associated manures (Bat-guano + DAP, *Tithonia diversifolia* + DAP) on the growth and yield of corn crop compared to the application of DAP alone. Since maize is a staple food in this region, and research is also focused on developing productive varieties, this trial also aims to compare a local variety with an exogenous variety, Mus1 to QPM3

Thus, this test uses the split-plot test device on which the varieties $QPM_{3\ (V1)\ and\ Mus1}$ (V_2) constitute the main factor and the 4 levels of fertilizer, the secondary factor as shown in Table 1. The experimental device of this test, as shown in Figure 1. has three blocks separated by 1.5 m, one from the other.Each block is subdivided into sixteen elementary plots of area of (4 m x 3 m)=12 m^2 separated by 0.5 m, one from the other, corresponding respectively to the varieties QPM3 and Mus1. This device extended over an area of 30 m by 27.5 m or 825 m^2 with the following treatments: (1) The unamended control plots are symbolized by Fo. (2) F1 plots that received DAP at a rate of 120 g per plot, i.e. 100 kg/ha; (3) F2 plots that received treatments with associated manure 1/2 (Tithonia + DAP) representing 6 kg of *Tithonia*+60 g of DAP per plot, i.e. the equivalent of 5 Mg of *Tithonia*/ha and 50 kg of DAP/ha; (4) F_3 groups the plots whose treatments were carried out with associated manure 1/2(Bat guano+DAP) representing per plot 6kg of bat-guano+60g of DAP, equivalent to 5 Mg of bat-guano/ha and 50kg of DAP/ha. All fertilizer doses contained 21.21kg N and 23.4kg phosphorus in 100kg DAP/ha, 370.605kg N and 464.7kg P/ha in 5 Mg bat-guano/ha and 50kg DAP/ha, 170.605kg N and 16.3 kg P/ha in 5 Mg *Tithonia*/ha and 50kg DAP/ha.

Table 1. Secondary factors representing the 4 fertilization levels

Facteur secondaire	Symbole	Dose/m²	Dose/Unité expérimentale
Témoin	F_0	0	0
EM(DAP)	F_1	10g	120g
Tithonia+ DAP/2	F_2	1Kg+5g	6Kg+60g
Bat-guano + DAP/2	F_3	1Kg+5g	6Kg+60g

B_1		B_2		B_3	
V_1	V_2	V_2	V_1	V_1	V_2
F_2	F_1	F_0	F_3	F_2	F_1
F_0	F_2	F_3	F_2	F_3	F_3
F_1	F_0	F_2	F_0	F_1	F_0
F_3	F_3	F_1	F_1	F_0	F_2
F_1	F_0	F_3	F_2	F_1	F_0
F_3	F_2	F_1	F_0	F_2	F_3
F_0	F_3	F_0	F_1	F_3	F_2
F_2	F_1	F_2	F_3	F_0	F_1

Figure 1: Schematic of the experimental device of the 3rd test third test

TECHNICAL ITINERARY: The organic matter (Bat-guano and *Tithonia diversifolia*) was buried on 30 September 2021 and the DAP was applied on 29 October 2021. Seedling was carried out on 14 October 2021 at a spacing of 75x50 (cm^2) at a rate of 3 to 4 grains per poquet. The empty replenishment was carried out on 21 October 2021. The 1st and 2nd weeds were carried out on 05 and 26 November 2021 respectively. While the ridging and demarcation were carried out on the same day as the 2nd weeding. Measurements of growth parameters (crown diameter, plant height, leaf area) and yield (number of ears per plant) were taken on 14 December 2021 and harvested on 20 March 2022. The other yield parameters (number of grains per ear, weight of thousand grains and yield Mg/ha) were measured on this harvest day. Precipitation and temperature conditions have prevailed throughout this growing season and are presented in section 7.5.

PRESENTATION AND DISCUSSION OF RESULTS

Effects of fertilizer applications on recovery and development parameters: Table 2 reports the effect of fertilizer applications on emergence rate, crown diameter, plant height, and leaf area.

The rate of release (T.L.): The difference between the two varieties is significant, with Mus1 showing statistically an average (87.8%) higher than QPM3 (81.1%). In the QPM3 variety, the difference between the manures is significant, the association (Tithonia-DAP) gives a rate of emergence (88.7%) statistically higher than the association (Bat guano-DAP) (82.7%), the DAP (79.2%) and the control (74.0%). In the variety Mus1, the difference between the manures is significant, all the manures used give a significantly the same rate of emergence, higher than that recorded with the control. F_1 (89.0%) = F_2 (88.3%) = F_3 (92.7%) ≥ F_0 (81.3%)

Diameter at collar (D.L.): The difference between the two varieties is not significant, the Mus1 shows statistically the same mean (2.88cm) while the QPM3 shows the mean value of (2.66cm). In the QPM3 variety, the difference between manures is significant, the combination (Bat guano-DAP) has a diameter at the collar (2.92cm) that is statistically greater than the DAP (2.62cm) and the combination (Tithonia-DAP) (2.61cm), and these have a significantly greater diameter than the control (2.28cm). In the variety Mus1, the difference between manures is significant in the following order: DAP (2.85cm) ≥ Tithonia-DAP (2.74cm) ≥ Bat guano-DAP (2.58) ≥ Control (2.16).

Plant height (H.L.): The difference between the varieties is significant, the QPM3 variety shows the height of plants (148cm) larger than the Mus1 (138.5cm). In the QPM3 variety, the difference between the manures is significant, the DAP (158.8 cm) and the association (Bat guano-DAP) (154.7 cm) have statistically the same height of plants. These two manures had significantly higher plant height than the combination (Tithonia-DAP) (144.7 cm). This association had a mean of this parameter significantly greater than the control (132.7 cm). In the variety Mus1, the difference between the manures is significant in the following order: DAP (152.2 cm) ≥ Bat-guano+DAP (143.2 cm) ≥ Tithonia+DAP (131.4 cm) = Control (127.2 cm).

The leaf surface (S.F.): The difference between the varieties is not significant, the QPM3 variety has a leaf area (444.3 cm^2) significantly the same as the Mus1 (442.5 cm^2). In the QPM3 variety, the difference between manures is significant, in the following order: Bat guano-DAP (542.2 cm^2)≥ DAP (457.0 cm^2) ≥ Tithonia-DAP (405.7 cm^2) ≥ Control (372.1 cm^2). In the variety Mus1, the difference between the manures is significant in the following order:

DAP (579.6cm2) ≥ Bat-guano-DAP combination (503.9cm^2) ≥ Tithonia-DAP (406.1cm^2) ≥ Control (280.3cm^2).

Effects of the application of fertilizers on the production parameters of maize: Table 7.3 presents the results obtained after application of fertilizers to corn production parameters, the number of cobs per plant (NPE), the number of grains per cob (NGE), the weight of a thousand grains and the yield per hectare (RDH)

Number of ears per plant (NEP): The difference between the varieties is not significant for the number of ears per plant, the two varieties have statistically the same number of ears per plant: 1.58 for QPM3 and 1.66 for Mus1. In both the QPM3 and Mus1 varieties, all manures tested, such as the control, had statistically the same number of ears per plant.

The number of grains per ear (NGE): The difference between the varieties is significant, the variety Mus1 has statistically the number of grains per ear (466,27) larger than the variety QPM3 (421,17). In the QPM3 variety, the difference between the manures used was significant: the DAP had statistically the number of grains per ear (439.21) greater than all other manures and the control, which had significantly the same number of grains per ear, the Tithonia-DAP combination (414.8) = Bat-guano-DAP (419.36) = Control (411.31)
In the variety Mus1, the difference between the manures is significant, according to this order, the combination of Bat guano-DAP statistically had a greater number of grains (498,40) than Tithonia-DAP (462,30)= at DAP (451,84)≥ at control (422,53)

Weight of thousand grains (1000P): The difference between the varieties is not significant, QPM3 (192g) has statistically the same weight of 1000grains as Mus (191g). In the QPM3 variety, the difference between the fumes is significant, the DAP (195.7 g) has the same weight of thousand grains as the Tithonia-DAP combination (195.0 g) and the guano-DAP bat (196.3 g), all these fumes have statistically the weight of thousand grains larger than the control (180.3 g). In the variety Mus1, the difference between the manures is significant, the DAP has significantly the same weight of thousand grains (195.0 g) as the combination bat guano-DAP (194.8 g), this weight is statistically greater than that of Tithonia-DAP (188.7 g) which is statistically greater than that of the control (185.3 g).

Yield (Mg/ha): The difference between the varieties is significant, the QPM3 variety has the yield (3.87Mg/ha) larger than the Mus1 variety (3.08Mg/ha). In the QPM3 variety, the difference between manures is significant in the following order: DAP (4.55 Mg/ha) has statistically the same yield as Tithonia-DAP (4.26 Mg/ha) and guano-DAP (4.34 Mg/ha), these mean yield values are significantly greater

Table 2. Results of the development of monoculture maize under fertilizer application

Varieties	Fertilizers	Scanned Settings															
		T.L. (%)				DC (cm)				H.P. (cm)				S.F.(cm^2)			
		VM	M/V	D	CV	VM	M/V	D	CV (%)	VM	M/V	D	CV	VM	M/V	D	CV
QPM3	F1	79.2b				2.64b		S	5.81	158.8a		S	27.21	457.0b		S	12.37
	F2	88.7a				2.61b	2.62a			144.7b	148am			405.7d	444.3		
	F3	82.7b	81.1bm	S	7.03	2.92a				154.7a				542.2a			
	F0	74.0c				2.28c				132.7c				372.1d			
MUS 1	F1	89.0a				2.85a		S	5.81	152.2a		S	22.18	579.6a		S	12.44
	F2	88.3a				2.74b				131.4c	138.5bm			406.1c			
	F3	92.7a	87.8am	S	7.03	2.58c	2.88a			143.2b				503.9b	442.5		
	F0	81.3b				2.16d				127.2c				280.3d			
Decision		S				NS				S				NS			
CV		7.03				5.81				27.21 (QPM3) 22.18 (MUS1)				12.37 (QPM3) 12.44 (MUS1)			

Caption: F1: DAP; F_2: ; F_3: ; F_0 : Witness; T.L: Collection rate (%); D.C. : Neck diameter (cm); H.P. : Height of the Plants (cm); S.F. : Foliar area (cm^2); VM: Measured value; M/V: Average per truth; D: Decision; CV: Coefficient of variation.

Table 3. Results of monoculture maize production under fertilizer application

Varieties	Fertilizers	Scanned Settings															
		NEP				NGE				P1000 (grams)				RDH (Mg/Ha)			
		VM	M/V	D	CV	VM	M/V	D	CV (%)	VM	M/V	D	CV	VM	M/V	D	CV
QPM3	F1	1.66a		NS	3.92	439.21a		S	7.24	195.7a		S		4.55a		s	
	F2	1.66a				414.8b	421.17bm			195.0a	192am			4.26a			18.31
	F3	1.66a	1.58am			419.36b				196.3a				4.34a	3.87am		
	F0	1.33a				411.31b				180.3b				1.32b			
MUS 1	F1	1.66a		NS	3.92	451.84b		S	7.24	195.0a		S		3.97a		s	18.31
	F2	2.00a				462.30a	466.27am			188.7b				3.55b			
	F3	1.66a	1.66am			498.40a				194.8a				4.28a			
	F0	1.33a				422.53c				185.3c	191.0am			0.92c	3.08bm		
Decision		NS				S				NS				S			
CV		3.92				7.24				5.72				18.31			

Caption: F1: DAP; F2: ; F3: ; F0 : Witness VM: Measured values; M/V: Average per variety; D: Decision; CV: Coefficient of variation NEP: Number of cobs per plant; NRE: Number of rows per cob; NGR: Number of seeds/row; P1000: Weight of 1000 seeds; RDH: Yield ton/ha

Table 4. Increased yield of corn compared to control with manure used

Varieties	Treatments	Yield in T/ha	Increase in yield compared to control (%)
QPM3	F_1	4.55	345
	F_2	4.26	323
	F_3	4.34	329
	F_0	1.32	-
Mus 1	F_1	3.97	432
	F_2	3.55	386
	F_3	4.28	465
	F_0	0.92	-

F1: DAP; F2:1/2 (Titho+DAP); F_3:1/2(BG+DAP); F_0 : Fertilizer-free control

Table 5. Cost incurred for used manures

Fertilizers with the variety QPM	Price per experimental unit(P) (FC)	Number of experimental units(N)	Total Cost (PXN) (FC)
T_0	-	-	-
T_1	2317.70	48	111250
T_2	2423.96	48	116350
T_3	1901.04	48	91250
Fertilizers with variety Mus	Price per experimental unit(P) (FC)	Number of experimental units(N)	Total Cost (PXN) (FC)
T_0		-	-
T_1	2317.70	48	111250
T_2	2423.96	48	116350
T_3	1901.04	48	91250

T_0= Control, T_1=1/2(Titho+DAP)=Association Titho+DAP, T_2=1/2(BNH+DAP)= Association Bat-guano+DAP, T_3=DAP

Table 6. Realizable revenue from the increase in production

Fertilizers with variety QPM3	Yield kg/ha	Increase in efficiency	Unit price FC/kg	Monetary value of surplus (FC)
T_0	1320	-	350	-
T_1	4260	2940	350	1029000
T_2	4340	3020	350	1057000
T_3	4550	3230	350	1130500
Fertilizer with variety Mus1	Yield kg/ha	Increase in efficiency	Unit price FC/Kg	Monetary value of the surplus
T_0	920	-	350	
T_1	3550	2630	350	920500
T_2	4280	3360	350	1176000
T_3	3970	3050	350	1067500

Table 7. Economic profitability of associated manure on maize cultivation

Fertilizers with V.QPM3	Recipes on Increase/Product(R)	Expense for manure(D)	Rentabi.(R/D) Rate (RVC)
T_0	-	-	-
T_1	1029000	111250	9.25
T_2	1057000	116350	9.09
T_3	1305000	91250	14.30
Fertilizing with the variety Mus	Recipes on Increase/Product(R)	Expense for manure(D)	Rentabi. (R/D)
T_0	-	-	-
T_1	920500	111250	8.3
T_2	1176000	116350	10.11
T_3	1067500	91250	11.70

T_0= Control, T_1=1/2(Titho+DAP)=Association Titho+DAP, T_2=1/2 (Bg+ DAP)= Association Bat-guano+DAP, T_3=DAP

than the mean of the control (1.32 Mg/ha). In the variety Mus1, the difference between the manures is significant in the following order, the combination of bat guano-DAP has the yield (4.28 Mg/ha) statistically the same as the DAP (3.97 Mg/ha), which is significantly greater than that of Tithonia-DAP (3.55 Mg/ha). All these mean values are statistically larger than the control (0.92 Mg/ha). Table 7.4 below shows the increase in the yield of used manures compared with the control. The increase in the yield of used manures relative to that of the control ranges from 300 to about 350%, with the variety QPM3. It varies from 300 to about 500% with the variety Mus1. The DAP and the association (bat-guano+DAP) respectively lead, followed by the association (Titho+DAP) in both varieties. The cost of making bat guano available is higher than that of tithonia and mineral fertilizer (DAP). Tables 5, 6 and 7 respectively give the cost incurred to make available the various fillings used in this test, the revenue realizable on the production recorded with each fillings and finally the profitability obtained with these fillings.

The association of *Tithonia diversifolia* + DAP: In the light of the results obtained, which are shown in Table 7.7, it is apparent that the Association *Tithonia diversifolia* with mineral fertilizer (DAP) has a profitability of 9.25 with the variety QPM3 and 8.1 on the variety Mus1, i.e. 9 and 8 times that of the control respectively. The combined manure (Tithonia+ Mineral Fertilizer) is 8-9 times more profitable with both corn varieties than the non-use of fertilizer on this crop in this study area.

The association of Bat guano + DAP: Considering the results recorded in Table 7.7, in relation to the associated manure (Bat-guano + Mineral fertilizer), it should be noted that this treatment, under the conditions of the study medium on the two varieties of maize, shows a profitability of 9 to 10 times that of the control respectively. This integrated manure is thus more cost-effective than the lack of fertilizer on this crop in the study area.

The DAP: The results of Table 7.1 indicate that Mineral Fertilizer (DAP) has a profitability of 14.3 with the variety QPM3 and 11.7 with the variety Mus1 compared to the control.

DISCUSSION

Since the change in rainfall and recorded temperatures was in line with the climate context of the Ngandajika region, the volume and distribution of rainfall and temperatures were not a problem, maize cultivation developed normally. Corn crop requirements for temperature and rainfall were met for successful germination, emergence, flowering and fruiting, resulting in the conduct of this test and the following results:

By comparing the variety QPM3 with Mus1 at growth parameters for emergence rate and crown diameter, the variety Mus1 has higher averages than QPM3, presumably due to its adaptation in this region where it was obtained, this justifies the results recorded with the variety Mus1 against an exogenous variety undergoing adaptation in this medium.

While for plant height, the QPM3 variety has a higher height than the Mus1 variety, while for leaf area, they have the same mean. These recorded results are well related to the potential of the QPM3 variety on the one hand, and uncontrolled factors such as soil heterogeneity on the other hand. As regards the production parameters, the variety QPM3 has overall higher average values than the Mus1, a result which is explained by its higher productive potential than the other.

Considering the different manures, it was observed that:

- The difference between manures is significant, the association (Tithonia-DAP) gives a rate of emergence (88.7%) statistically higher than the association (Bat guano-DAP) (82.7%), the DAP (79.2%) and the control (74.0%). This result is said to be due to the release of ammoniacal nitrogen from certain nitrogen-containing fertilizers such as bat guano, phosphate diammonium. Ammonia has a negative effect on germination and therefore on the rate of emergence. This result is similar to that recorded in the Mbujimayi trials in which the Guano bat was compared with mineral fertilizers and farm manure (Nkongolo, 2016).
- At the collar diameter level, the association (Bat guano-DAP) has the collar diameter (2.92cm) statistically larger than the DAP (2.64cm) and the association (Tithonia-DAP) (2.61cm) and these have it significantly larger than the control (2.28cm).
- Compared to the height of the plants, the difference between the manures is significant, the DAP (158.8 cm) and the association (Bat guano-DAP) (154.7 cm) have statistically the same height of the plants. These two manures had significantly greater plant height than the association (Tithonia-DAP) (144.7 cm). This association had a mean of this parameter significantly greater than the control (132.7 cm).
- For leaf area, the difference between manures is significant, in the following order: Bat guano-DAP (542.2 cm^2)≥DAP (457 cm^2)≥Tithonia-DAP (405.7 cm^2)≥Control (372.1 cm^2). These results are explained by the richness of the bat-guano and its rapid decomposition, like mineral fertilizers, which provide crops with nutrients and contribute to the loosening of the soil as organic matter. These results are similar to those recorded in Guinea in trials where the Guano bat was compared to mineral fertilizers. It was observed that the Guano bat yielded higher average vegetative parameters of corn cultivation than mineral fertilizers (Karimou 2012). While tithonia slowly releases nutrients that are made available to crops, it also loosens the soil as organic matter. The results recorded with *Tithonia diversifolia* in this study confirm those obtained by Ganunga, Chukwuka and Omotayo, according to which it has the potential to restore exhausted soils and it allows a good management of their physical, chemical and biological properties in comparison with the control (Ganunga et al., 2005; Chukwuka and Omotayo, 2009).

With regard to yield parameters (production), the variety QPM3 displays overall well its performance compared to the Mus1, its great potentialities would be the basis of these results:

- At the manure level, all those studied, as the control, have statistically the same number of ears per plant. The mean value of this parameter is 1.58 for the variety QPM3 and 1.66 for the variety Mus1, it is a varietal characteristic probably the same for several varieties.
- Compared to the number of grains per ear, the difference between the manures is significant, according to this order, the association Bat guano-DAP statistically has the number of grains larger (498,40) than the Tithonia-DAP (462,30)= at DAP (461,84)≥ at control (422,53).
- With respect to the weight of 1000 grains, the difference between the manures is significant, the DAP has significantly the same weight of thousand grains (195 g) as the combination bat guano-DAP (194.8 g), this weight is statistically greater than that of Tithonia-DAP (188.7 g) which is statistically greater than that of the control (185.3 g).
- With respect to yield, the difference between the manures is significant in the following order with the variety Mus1, the combination bat guano-DAP has the yield (4.28 Mg/ha) statistically the same as the DAP (3.97 Mg/ha), which is significantly greater than that of Tithonia-DAP (3.55 Mg/ha). All these mean values are statistically larger than the control (0.92 Mg/ha). Whereas with the variety QPM3, all these manures have statistically the same yield as follows: DAP (4.55Mg/ha)=auTithonia+DAP(4.26Mg/ha)=auBatguano+DAP(4.34Mg/h), this yield which is greater than that recorded for the control (1.32Mg/ha). All these results are explained by the fact that the bat-guano is a powerful natural fertilizer whose action is rapid, like the mineral fertilizers to which it can be substituted by virtue of its richness of nutrients. In addition, it can be used in small amounts to soil as several studies have established (Hadas A., Rosenberg R., 1992; Dutoit et al, 1992; Karimou, 2012; Anonymous, 2014a; Nkongolo, 2019).

The increase in yield relative to the control ranges from 300 to about 350%, with DAP being the top performer in the QPM3 variety. In the variety Mus1, this parameter varies from 350 to 450%, it is the association Bat guano +DAP which gives the greatest value. This performance is due to the above-mentioned characteristics of bat-guano and DAP. However, the yield increase compared to the control of the combination or combination of organic fertilizers with minerals recorded in West Africa is in the range of 200-300% (Fairhurst, 2015; Vanlauwe et al, 2001) compared to that recorded in this study. Even more so, the adoption of integrated development in East and West Africa has produced increases in yield of 50-150% or more. This results in a benefit/cost ratio of around 6 for maize (Bationo and Waswa, 2011; Mokwunye and Bationo, 2011; Igue et al., 2016). The result of this test thus conforms to the results recorded in East and West Africa, which it confirms. However, this result can be explained by the context of each study (organic matter used, soil and climate) that differs from region to region. In addition, organic manure alone is insufficient to compensate for low nutrient levels in tropical soils. Indeed, it would appear useful for organic manures to be combined with minerals which have the advantage of making the nutrients directly available to the crop. Thus, to meet the need to maintain soil fertility and the sustainability of certain crop systems, one of the proposed pathways is to combine different types of organic matter with mineral fertilizers as indicated in all these trials (Muna-Mucheru et al. 2007, Uyo Ybesere and Elemo 2000; Vanlauwe et al. 2010). As regards the profitability, the DAP gives overall higher profitability than its associations to organic manures, this is due to the cost incurred for the availability of these organic materials. However, given all the advantages they offer and their availability, it is appropriate that all the provisions be adopted to minimize their cost (the cost of organic materials) in order to increase their profitability.

CONCLUSION

The 2021 growing season was undisturbed, with rainfall and temperatures conforming to the climate context of this region. Corn cultivation developed normally in relation to climate change and the trial was conducted without difficulty. The objective was to assess the impact of the combination of manure (Bat-guano+DAP) and (Tithonia+DAP) on the growth and yield of corn, in comparison with DAP. To assess this impact (effects), measurements were made in relation to crop growth on parameters, crown diameter, plant height, and leaf area. With regard to production, measurements were made on the following parameters: number of ears per plant, number of seeds per ear, weight of thousand seeds and yield.

Thus, from the comparison of two varieties, it has been observed that Mus1 has higher mean growth parameter values than QPM3 while QPM3 has higher production parameters than Mus1. At the level of manuring, the results recorded lead to the following findings:

- Mineral manure (DAP) gives overall the highest average than other manures for the three growth parameters, it is followed by associated manure (Bat-guano+DAP), then comes manure (Tithonia+DAP) and finally the control
- Compared with the production parameters, the mineral manure and the associated manure (Bat-guano+DAP) give significantly the same mean values, which are higher than those of the 2nd associated manure (Tithonia+DAP) and those of this manure higher than the control.

As regards the increase in yield relative to the control, the DAP induces it of the order of 350% greater than that of the associated manures (Bat-guano+DAP) and (Tithonia+DAP) which is generally around 300% on the cultivation of maize with the variety QPM3. While with the Mus1, the association (Bat-guano+DAP) comes first (450%), followed by DAP (400%) and finally (Tithonia+DAP) (350%). As for profitability, the associated manures have a profitability of 8 to 10 times compared to that of mineral fertilizer which is of the order of 11 to 14 times that of the control. However, they have the advantage of increasing soil fertility more than mineral fertilizer. They are thus of interest to producers. Mineral manure increases corn productivity more than associated manure. However, these associated manures increase yield (production) more than the control, although in a lower proportion than mineral fertilizer (DAP), they do constitute a solution to the decrease in soil fertility in the Ngandajika region, offering the advantage of increasing soil fertility, and consequently agricultural production, which can thus contribute to the improvement of food security. This test clearly shows the performance of these two associated manures with respect to the mineral manure. Associated manure (Bat-guano+DAP) is more similar to mineral manure and can be substituted for mineral manure, since Bat-guano has the virtues of an amendment affecting the other characteristics of the soil, including the water retention capacity it increases. Organic fertilizers (Bat-guano, *Tithonia diversifolia*) and their associations with DAP, can thus be considered as efficient fertilizing resources, accessible to low-income producers increasing not only agricultural production, but also fertility in sustainable soil management.

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