ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 06, Issue, 01, pp. 6410-6416, January, 2016

International Journal of
DEVELOPMENT RESEARCH

Full Length Review Article

COMPARATIVE EFFECTS OF ORGANIC MANURE (TITHONIA DIVERSIFOLIA AND BAT-GUANO) ON THE CROP YIELD OF CORN (IN MONOCULTURE AND IN ASSOCIATION WITH COWPEA) IN NGANDAJIKA REGION IN CENTRAL DEMOCRATIC REPUBLIC OF CONGO

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ARTICLE INFO

Article History:

Received 17th October, 2015
Received in revised form
22nd November, 2015
Accepted 16th December, 2015
Published online 31st January, 2016

Key Words:

Comparative, Effects,
Tithonia diversifolia,
Bat-guano, Crop,
Yield, Corn, Monoculture,
Association, Cowpea,
Ngandajika, DRCongo.

ABSTRACT

Globally, agriculture is still facing the challenge of supplying humanity with food, every year millions of people are added to the billions to be fed. Food production faces increasing population, a deficit to cover the needs of the global population with food (Francis, 1986). The famine in some vast regions of the world and continues to make havoc in Sub-Saharan Africa and the DRC in particular, the scourge is increasingly felt. The spaces to produce the food are reduced with the erosive phenomenon and flooding caused by global warming. A strategy that seems to be effective is the high production in confined spaces (AAR 1985). The cultures association system which is the production system of small farmers and the majority of farmers in Sub-Saharan Africa is part of this logic. But this system is faced with the same constraints as the conventional system including the availability of organic fertilizer yet, input the most accessible agricultural producer in tropical regions. Tithonia diversifolia and guano-bat organic amendments can be found in the tropics, with the bat breeding techniques producing bat guano that have just been developed. Both fertilizers may well contribute to the development of agriculture, not only because of their richness in nutrients, but also their availability. A study was conducted in the region Gandajika by testing, both organic fertilizers in monoculture maize (QPM variety) and in association with cowpea. The following results were recorded:

- The yield of the culture of my ï s monoculture is statistically the m ê me that 'in combination with either or e b e 2,959T/ha against 2,250T/ha
- The bat-guano gave a performance ï my lev é é s more than that, with the registered e Tithonia as well as in monoculture or in association with the é b é In monoculture there. Bat-guano> Tithonia> T e moin is 4,187T/ha> 3,733T/ha> 0,957T/ha.

In association with cowpea: Bat-guano> Tithonia> indicator is 3,187T / ha> 2,767T / ha> 0,792T / ha These organic manure can be recommended to farmers in their production systems in tropical regions, especially those in the read Ngandajika region.

INTRODUCTION

The agricultural researchers as the rulers had to neglect the production system of small farmers that is widely used by the majority of farmers in the tropics. Believing that its contribution was less than that of conventional agriculture, the economy and trade in developing countries (Lynam and al., 1986). But the great challenge of our time, who still supply humanity with food, given that every year millions of human beings in addition to billions to be fed; increasing food production worldwide, is proving to be inadequate.

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Thus, food production faces increasing population, a deficit to cover the needs of the global population with food (Francis, 1986). Traditionally, increased food production comes from putting large areas under cultivation. However, we are currently witnessing the loss of large arable land in the world: - In some regions such as Africa south of the Sahara with the erosion phenomenon.

- In other parts of the world with the floods link to warming climate as huge areas are already used for the production of foods specially in Asia, America etc … It is how food production per capita of e cline in the world (Aziz, 1977).

A strategy that seems to be effective, is the high production on areas already highlighted (AAR, 1985). The crop association system which is the system of small farmers and the majority of farmers in Sub Saharan Africa is in this light. It is the way for the subsistence farmers in the tropics (Beets, 1982). It is as much confronted with the constraint of availability of organic fertilizers input though remaining the most accessible agricultural producer in tropical regions, its effects are beneficial to the physicochemical and biological properties of the soil. They would ensure more efficient use of mineral fertilizers modest (Jama B. and al., 2000; Uyo Ybesere EO and Elemo KA, 2000). If the organic material used is of good quality and contain quantities of nutrients. This technology would reap a huge success (Palm, 1995).

Research in agriculture shows that this system has several advantages over conventional culture. It is insurance against the vagaries or the vagaries of weather, disease and pests. Planting more crops in the same field offers the opportunity to maximize moisture, maintain fertility and minimize erosion. These are the disadvantages of monoculture, but the benefits constituting the cultures association system. The Association system increases productivity as compared to the area by minimizing labor input or capital (Willey, 1979). The combination of cultures is a diverse system in time and space. Plant diversity results in the significant reduction of pests (Altieri and Letournea 1982; Cromartie, 1981 and Perrin, 1980). It also has an impact on the growth of weeds, of course, since the change of systems used throughout the world, the effects can not be predicted or generalized (Bantilan *et al*, 1974. Summer *et al*, 1981 and Egunjobi, 1984).

The present crop association system many advantages, it is used by good producers in tropical areas, but it also faces the same constraints as the conventional culture dominated by monoculture. Given the low availability of organic amendment, the Tithonia diversifolia offers some advantages that may well motivate its use in lieu of most organic fertilizers include: The use of compost and animal manure including inadequate 1st of materials required for their manufacture can stand as an obstacle. Where materials are available 1st; transportation can be a problem. As for green manure, the use of this technique faces its perception by farmers. How can we be content to lose a whole growing season to the cultivation of a plant species that we will not bury reap a product. Given all these constraints, then we can look at that Tithonia diversifolia:

- Besides the relatively high availability ed by their production around fields of biomass foliac é es, Tithonia diversifolia This is species that produces large quantities of leaves easily ed d ed modular in composition lignin phenols and nitrogen polyph é (Buresh and Tiam., 1998; Palm *et al*, 1997) and rich e l e nutritious ments (Jama B. and al., 2000; Nyasimi MA and al, 1997). It is easily propagated by seed and cuttings, it grows spontaneously in the hearts alento é ment houses and roads (THORsm Smestad B. and al, 2002).
- Doses of most of organic amendments varies from 10 to 40 t / ha, however Tithonia biomass can effectively ed are used at much lower doses gr â what their content relatively lev é é e e l macro- é ments: N and K P 5.5% 0.5% e are expressed in relation to the matter è che è re s. This largely explains their influence on the properties ve signifi ed t ed soil. Apart from their effects on property ri ty s physical, their contribution of nitrogen to the soil is not n e negligible, around 54 Kg / ha (Mr. Ngongo, 2000). Its leaves contain nitrogen levels comparable to those of most of these species è é are used in agroforestry for imp é improve the fertility of the soil. As for the contents of P and K, they are clearly sup é EXTERIORFEATURES to those contained in other species these è.
- Tithonia diversifolia is a local resource that can be used ê é ed a mani è re optimal for the agricultural development of é r é in our regions (Duncan, 1974).

Another organic fertilizing, with many virtues is the bat guano. It is used in agriculture for various purposes among others, the reconstitution of soil structure due to its high content of ca $^{++,}$ activation of compost. It is now the major source of imported organic nitrogen. It contains 15-20% nitrogen on a dry weight basis (Hadas *et al*., 1991). It contains 3% of phosphorus, 1% of potassium and other mineral elements (calcium, magnesium, manganese ...) (Nkongolo, 2011). The bat guano is an organic fertilizer, it is pure and natural, it protects plants against nutritional deficiency diseases, it also allows root development, rapid growth. It causes rapid flowering. It is an organic fertilizer with a high content of NPK of organic origin.

One application of low dose or amount can give a higher return than that produced by other organic materials Overdose of bat guano is not toxic to plants and does not pollute the soil, against an overdose of fertilizer has a toxicity risk (http: www. Danavive.fr / veg / nutrivégétal html). With all these features, the bat guano is an organic fertilizer that can contribute to the development of agriculture in the tropics. Its availability is a path constraint to be circumvented with the bat breeding techniques which have been developed. It is in light of all these considerations that we considered necessary in the context of our research: To compare the two manures Tithonia diversifolia and bat guano in both monoculture systems as organization that is used by tropical producers in Sub-Saharan Africa, particularly the DRC, with the variety of QPM.

MATERIALS AND METHODS

Equipment

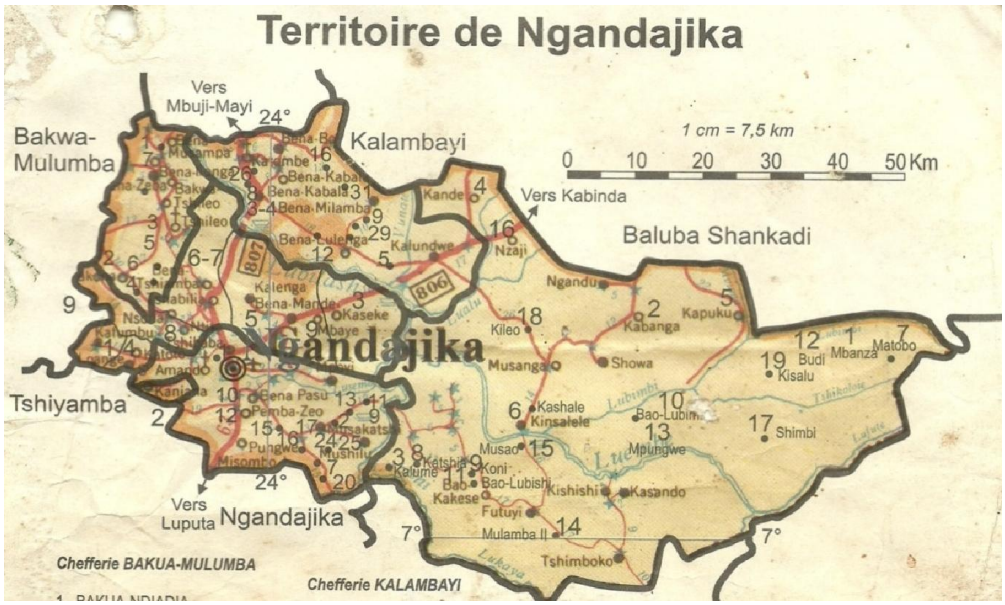
Study Milieu

It is on the site of the INERA station Ngandajika that this study was conducted. This station is located to 7 Km of the City of Ngandajika. Territory Ngandajika is 793 m above sea level, it is 6 ° 43'32,6 'south latitude and 23 ° 56'33,5' east longitude (Anonymous, 2003). It is an agricultural area par excellence Kasai-Oriental.

Soil Ngandajika

Ngandajika soils consisting of a collection of Sandy clay sediment that often rests on an ancient shallow lateritic slab (Bado 1993). They comprise a minor clay fraction does not seem consisting only of kaolinite (Anonymous, 1959). Ngandajika sols contain from 21 to 23% of fines (Fitting and Laudelout, 1959). These are deep soils with the profile with all

backgrounds and their subdivisions except for some places where there is a shallow water table



Climate Ngandajika

Climate Territory Ngandajika eastern tropical, AW4 according to the classification of Köppen. It is characterized by the alternation of two seasons: the rainy season and the dry season. The [1st] is divided into two, called the big rainy season from 31 to 31 December and Aôut the short rainy season called B season that runs from January 15 to May 15 Regarding the dry Saion, it goes from 31 December to 15 January, is the small season from May 15 to August 15, it was the long dry season. The annual precipitation in the period 1931-1970 are estimated at 1425.8 mm at Research Station INERA Ngandajika. The relative humidity was 72.6%. The annual air temperature ranges from 25 ° C in the north to 22.5 ° C in the South (Anonymous, 1998); an average of 23.3 ° C. The duration of sunshine is 2400 hours / year (Janssens, 1998) while on the ground, the temperature was 28.2 ° C in April and a minimum of 24.4 ° C in July, the month colder at the depth of 50 cm, this was observed in the period of 1959-1970.

Relief and v e g e tation Ngandajika

The relief of Ngandajika is dominated by plains, with the exception of a few mountains and plateaus. The relief of Ngandajika as its climate, gives this area of good agricultural potential. Ngandajika this vegetation type wooded grassland (Rushirumukirwa et al. 1989; Anonymous, 1998). Like other woodlands, there are gallery forests along rivers and streams. This savanna is dominated mainly by species such as Imperata cylindrica, on heavy soils and Hyparrhenya dissoluta, Digitaria brazzol, Triumfetta mustersu, Eriosema griseu, Sensitive Plant sporadically some species of the family of legumes such as Mucuna sp. Stylosanthes sp. , Met in the shallows. Overall, this is dominated by savanna grasses that cover more than 70% per m [2.]

Biological material

The biological material used in this experiment consisted of seed - corn (Zea mays) QPM variety from INERA / Ngandajika. It is a variety of the growing cycle of 100 days, which blooms to 59 days. The seed is white. This variety is resistant to streak, mildew and lodging. It has the yield of 3 4 tons / ha. Its cultivation area is: Le Bas Congo, Kasai Occidental, Kasai Oriental and North Katanga. It is suitable for medium and low altitude ecologies. Cowpea (Vigna unguiculata) Variety Diamond from INERA / growing cycle of 65 days Ngandajika blooms around the 45 [th] day, and has a resistance to bacterial blight. It gives a yield of 1000-1200 kg / ha in a controlled environment and 700 kg / ha in a real environment, the provinces of Bas Congo and Kasai Oriental and Occidental are its cultivation area.

Methods

Device expe rimental

The experimental design was completely randomized blocks with three simple treatments in three replicates. The treatments were as follows:
To = Witness received no fertilizer
T1 = Treatment that received fertilizer Tithonia diversifolia at a rate of 0.5kg / m
T2 = Treatment that received bat guano fertilizer at a rate of 0.5kg / m.
a dose tested Tithonia and bat guano was 5t / ha of organic manure.

Driving test

The plot of this experimental field has been plowed by tractor INERA. Harrowing and scalping were performed manually with hoes. The demarcation of the land was held February 5, 2013 and burial of organic fertilizers was made the same day. It's February 12, 2013 as seeding was conducted and the empty relining was carried out on February 19, 2013. The two weedings were held March 6, 2013 and March 28, 2013.

Observations

To assess the effects of organic manure on the monoculture of corn as its association with cowpea, we performed the measurements of the growth parameters such as the diameter of the collar, the height of plants and length of the leaves.

Table 1. The results of soil samples analyzes before and at the end of the trial in 2013

Features / Treatments	pH		Nitrogen%		Phosphorus%		Potassium%		Calcium%		Magnesium%		Carbon%	
	Beginning	End	Beginning	End	Beginning	End	Beginning	End	Beginning	End	Beginning	End	Beginning	End
T_0	5.26	5.37	0.21	0.16	0,046	0,023	0.44	0.27	0.27	0.18	0.011	0.009	2.08	1.87
T_1	5.24	5.04	0.21	0.29	0,046	0.054	0.44	0.52	0.27	0.43	0.011	0.014	2.10	2.13
T_2	5.24	5.17	0.21	0.39	0,046	0,061	0.44	0.61	0.27	0.40	0.011	0,021	2.08	2.14

T_o = treatment without fertilization, T_1 = Treatment with manure Tithonia, T_2 = Processing with manure Bat-guano.

Table 2. Change of some soil properties Percentage in different plots after the test

Features / Treatments	pH	Nitrogen	Phosphorus	Potassium	Calcium	Magnesium	Carbon
T_0	2.09	-23.80	-50	-38.6	-33.3	- 18.18	-10.09
T_1	-3.01	38.09	17.39	18.18	59,25	27.27	1.42
T_2	-1.3	85.71	32.60	38.63	48,14	90.9	2.88

Table 3. Growth parameters in monoculture and in association with cowpea

Fertilizers	Monoculture			In association with cowpea		
	DC (cm)	HP (in cm)	LF (in cm)	DC (cm)	HP (in cm)	LF (in cm)
Tithonia	1,100A	108,67C	57,773BC	1,167A	118,67A	62,633BC
Bat guano undissolved	1,300A	132,00AB	73,60A	1,200A	111,67B	60,33C
Witness	1,067A	105,00C	55,067C	1.0 667A	105,67B	60,133C
Average range	1,156A	114,56A	62,133A	1,144A	113,67B	61,033B
Decision	NS	S	S	NS	S	S
CV (%)	27.42	8.98	10,95	6.98	4.31	4.61

Table 4. Production parameters in monoculture and in association with cowpea

Fertilizers	Monoculture				In association with cowpea			
	No. of rows / ear	No. of seeds / row	100 seed weight	RTDt / ha	No. of rows / ear	No. of seeds / row	100 seed weight	RTD t / ha
Tithonia	12, 667A	24, 667A	199, 00B	3.7 33B	13, 333A	29, 667AB	207, 33A	2, 767B
Bat guano undissolved	14,667A	32, 667A	196,33B	4, 187A	13, 333A	30,667A	218, 33A	3, 187A
Witness	13,333A	25, 333A	135,67D	0, 957D	13,333A	20, 667D	127,00B	0, 7920
Average range	13, 556A	27, 556A	177,00B	2,959A	13,333A	27, 00A	184, 22a	2, 2500A
Decision	NS	NS	S	S	NS	S	S	S
CV (%)	9.76	21,12	3.38	3.36	8.22	6.45	8.46	6.46

We made measurements on production following parameters: The number of rows per ear, number of seeds per row, weight 1000graines and yield (tonnes / ha)

Statistical analysis

In order to compare the effects of two fertilizers in monoculture as in combination, the data were subjected to analysis of variance (ANOVA) using the 8.0 software Statix. The test of Least Significant Difference (LSD) was used for comparison of averages probability threshold of 5%

RESULTS AND DISCUSSION

Sampling and soil analysis

Before the burial of organic manure, was taken to collect a soil sample per plot to a depth of 20cm and O-composite samples per treatment were made. Some analyzes were performed to determine certain soil characteristics such as pH, organic carbon, total nitrogen, exchangeable bases (Ca, Mg, K) and available phosphorus. These analyzes were performed at the Research Centre for Geological and Mining and Kinshasa Regional Centre for Nuclear Studies in Kinshasa

Effect of different treatments on some properties of the soil

Changes to the characteristics of the soil between the beginning and the end of the study were calculated using the following formula:

Where X_1 = parameter value considered at the beginning of the test
X_2 = Parameter value considered at the end of the test

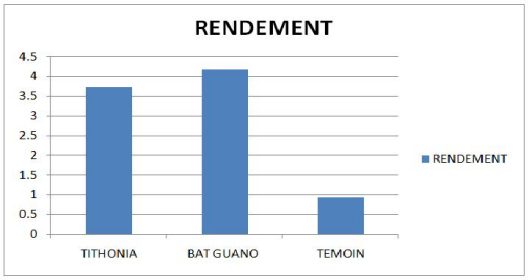
Table 2 shows the rate of change of various characteristics of the ground in connection with the treatments, at the end of the experiment. Compared to baseline values given in the table no.1, the general trend on the no2 table is the increase for most parameters, except pH and settings for the treatment TB of values, where a decrease is observed.

Effects of organic manure on maize cultivation in monoculture and in association with cowpea

Statistically, the average with the same letter are not different at the 5% level by LSD tests and TUKEY. In the same column, the values followed by the same letter are not significantly different at the 5% level according to the LSD and TUKEY test.

Effect of treatments on yield of maize cultivation

Chart 1. Performance of the variety of production but qpm3 monoculture related in fertilizer



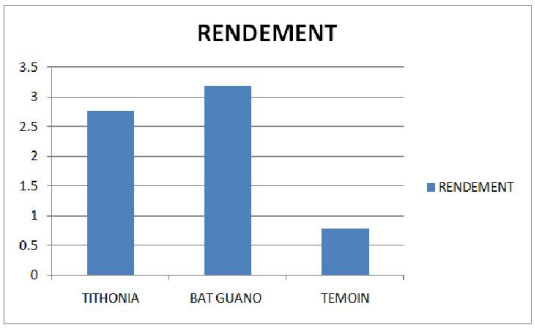


Chart 2. Performance of production variety of qpm3 but in association with respect to fertilizers

Interpretation of Results

Analysis of variance (ANOVA) shows clearly that there is no significant difference between treatments for the diameter parameter monoculture collar as in combination. As against the height of plants and length of leaves, there is a significant difference between treatments with bat guano that comes first, followed by the Tithonia and finally the witness has an average lower in monoculture: Bat -guano> Tithonia ≥Témoin. Tandisqu 'corn in association with cowpea, for both parameters (the height of plants and length of leaves), Tithonia comes first, followed by the last bat-guano witness who has a low average: Tithonia> Bat -guano ≥Témoin Compared to production parameters, monoculture, there is no significant difference between treatments for the number of seeds per row and the number of rows per ear, however there is a significant difference between treatments for weight 1000 seeds and the yield (t / ha). For the weight of 1000 seeds, Tithonia comes first, followed by the bat-guano and the witness comes in 3rd position with a lower average compared to the other: Tithonia ≥ Bat-guano> Witness. To yield (t / ha), the bat-guano that comes first followed by the Tithonia and control which has an average lower by two others: Bat-guano> Tithonia> Witness.

In association maize with cowpea, there is no significant difference between treatments for the number of rows per ear while for the other parameters, the difference is significant between treatments

- Compared to the number of seeds per row é e: The bat-guano comes t ê you followed the Tithonia and finally moin t é, then: Bat-guano> Tithonia> T e moin.
- The weight of 1000 seeds: The bat-guano comes t ê you followed the Tithonia and finally moin ty, we have: Bat-guano ≥ Tithonia> T e moin.
- Compared to performance: The bat-guano comes ê t i ff you by Tithonia which is also followed by moin t é, Bat-guano> Tithonia> T e moin.

DISCUSSION

There is no significant difference between treatments collar diameter, this would be due to the fact that this character would not be influenced by manure as would other plants growth parameters. The height of plants and length translate well improved physicochemical properties of the soil caused by organic manures under study.

The bat-guano is in a form where it quickly releases nutrients while tithonia takes a little longer to decompose and release nutrients. This would explain the high average recorded with this manure compared to tithonia for several parameters such as monoculture in association whether growth parameters or production. Regarding the effects of fertilizers on certain soil characteristics, including lower pH and parameter values to the control treatment (To): It has been observed that farming of tropical soils, especially the lead to ferrasol decreasing pH (Lumpungu, 2011). Naturally, there has indeed declining levels of soil nutrient depletion of it if we do not restore him what crops exported (Falisse A., J. Lambert, 1995). Both fertilizers used to improve the content of soil nutrients, which explains the increase in the yield of maize cultivation and maintenance of soil fertility resulting in positive values in Table 2.

Conclusion

The study is entitled "Comparative effects of organic manure (Tithonia diversifolia and Bat-guano) Performance of the corn crop (monoculture and in association with cowpea) Ngandajika in the region of central DRC" She had the objective to compare the effect of two organic fertilizers on maize in monoculture and in association with cowpea. This study gives the following results: The Tithonia diversifolia as bat guano increases the yield of maize (QPM variety) in monoculture and in association with cowpea The increase is of the order of 390.07% with Tithonia and 437.51% with the bat guano from control in monoculture. It is 349.36% and 402.39 with Tithonia% with bat guano from control corn in association with cowpea. Under the conditions of this test, the bat-guano has great potential on the performance of the corn.

This is of great importance for producers in this study area where inorganic fertilizers are not always at their fingertips, they have a particular interest in what their local resources are in a good value for agricultural development in this environment. With the bat breeding, a possible solution opens to the availability of bat guano which was a constraint to the use of this fertilizer. Tithonia diversifolia can further be available with its easy cultivation around fields to use. The results also show that these fertilizers (Tithonia diversifolia and the bat-guano) improve soil fertility in particular the content of exchangeable bases. These fertilizers and significantly increase the yields of monoculture maize cultivation as in association with cowpea. They maintain the fertility of soil during its operations that can happen even if no inorganic fertilizer use at low doses. This is of great importance for producers of tropical environments that have an interest in using these fertilizers can be the basis of agricultural development in this region.

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