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RESEARCH ARTICLE

ASSESSMENT OF THE CHEMICAL PARAMETERS OF *JATROPHA* BIOMASS AND COMPOST IN THE SOUTHERN SUDANIAN ZONE OF BURKINA FASO

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ABSTRACT

In the context of agricultural land degradation in Burkina Faso, there is an increasing interest in *Jatrophacurcas* L. as potential source for crop production sustainability. In order to evaluate the chemical properties of *Jatropha* biomass and compost, trials were carried out in 2017 (May 2016-June 2017) in Torokoro and Tin locations with jatropha growing farmers in the south Sudanian zone of Burkina with annual average rainfall of 1200 mm. At each location, two (02) farmers were selected to conduct the trials (biomass collection and compost production). The trials were done in field with 2 and 6 years old *Jatropha* threes. The experimental design consisted of plots of 400 m^2 each containing 20 m of *Jatropha threes*. The results indicate very high level of C, P and K in both *Jatropha* Biomass and compost. *Jatropha* biomass and compost are high potential sources of organic matter and nutrients which can improve crop productivity in the Burkina Faso

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INTRODUCTION

In Burkina Faso, the promotion of *Jatropha* was the work of the projects. The plant was identified in 2004 by the Ministry of the Environment as a species that contribute to the recovery of degraded lands, and is the subject of an extensive awareness campaign for its promotion (MMCE, 2012). In view of its environmental and agronomic potential, *Jatropha* was integrated into several national and sub-regional programs to fight against desertification in the Sahel and in reforestation or delimitation of pastoral lands (Blin *et al.,* 2008, Bazongo, 2011). Planting j*atrophathrees* has many advantages. In fact, the plant is well adapted to arid zones and requires very low quantities of nutrients for it development (Bazongo, 2015).Furthermore, many studies indicated the positive impact of *jatropha* plantation on crop performance. However, up to date few data are available on the chemical properties of the biomass and compost derived from this plant (Assigbetse *et al.,* 2011). Also, information on the capacity to compost *Jatropha* biomass and the quality of the compost is isolated and highly variable which can leave doubt about the contribution of the plant to the improvement of soil fertility.

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The current study was initiated to increase the knowledges on *Jatropha* contribution to land productivity. The objective was to evaluate the value of the chemical parameters of *Jatropha* biomass and compost derived from farms field in the south-Sudanian zone of Burkina Faso.

Specifically we wanted to

- Evaluate the chemical properties of *jatropha* biomass and compost for nutrients content,
- Make recommendation for biomass or compost use for soil fertility improvement

We hypothesize that *Jatropha* biomass contains important nutrients for soil fertility improvement but nutrients contain is higher when the biomass is composted.

MATERIAL AND METHODS

Presentation of the study sites: The trials were carried out in rural area in the South Sudanian zone of Burkina Faso, in Torokoro and Tin locations. The coordinates of Torokoro and Tin locations are respectively 4 ° 20 'west longitude, 9 ° 59' north latitude and 297 m altitude and 11 ° 08 'north latitude, 04 ° 97' west longitude and 459 m altitude (Bazongo, 2011). The annual average rainfall in the area is around 1100 mm, with a

rainy season of 4 to 5 months. The 2 locations were selected because of previous extension actions with *Jatropha* by some promotors in these villages. Soils in Torokoro and Tin sites are tropical ferruginous soils poor in organic matter, N and P. Soils textures are sandy to sandy loam (Youl, 2009).

Plant material

Plant material, consisting of *Jatropha* plants aged 2 years and 6 years.

Methods

Data collection device: At each location two (02) farmers were selected to conduct the trials. The experimental design consisted of biomass collection plots of 400 m^2 (20m x 20m) containing 5 *Jatropha*plants each. In each farmer's field, three (03) collection plots were marked with sticks and secured during the whole process. For the 2 locations 12 collections plots were selected.

Jatropha biomass collection: All the biomass (leaves and branches) under Jatropha threes was collected every seven (07) days for twelve (12) weeks, ie 84 days from March to May, which corresponds to the period when the *Jatropha* plant loses it leaves.

Biomass composting: All biomass collected were composted using the compost pile system. The method consisted of combining *Jatropha* leaves with farm yard manure and make a pile directly on the ground followed by regular watering and covered with a black plastic film. The total volume of the pile was 1 m^3, i.e. 0.67 m^3 (2/3) of *J. curcas* L. biomass and 0.33 m3 (1/3) for cow dung. The reversal and watering were done once every week for 1 month.

Laboratory analyzes: The biomass samples were dried at room temperature for 21 days and then crushed and sieved at 2 mm. All the residues were dried, weighed, calcined and weighed again.

Organic carbon and nitrogen contain were determined by dry burning using a LECO FP 428 CHN elemental analyzer and phosphorus and total potassium levels were determined by colorimetry (Murphy and Riley, 1962). For the compost, the samples were weighed and oven at 65 ° C dried for 48 hours. Total carbon was determined using walky and black (1965). The organic matter content was estimated using the formula: %C x 1,724. The determination of chemical parameters such as pH and N were done on compost crush of *Jatropha*.

Temperature and moisture content: The compost pile temperature and humidity were measured during the composting and at each turnaround. The temperature was measured with a thermometer and the moisture measured using the "weight loss" method. The moisture content was calculated using the following formula: **100 x (wet weight - dry weight / wet weight).**

Data analysis: All data collected were recorded in Excel spreadsheet and analysis of variance done using XLSTAT version 2007 software. The averages were separated using the Newman-Keuls test at 5% confidence.

RESULTS

Chemical characteristics of leaf biomass: The results of Table I and II show some chemical characteristics of the leaves of *Jatrophacurcas*. For the 2 year's old threes, the results show significant difference between the 2 locations for total C (Table 1). Jatropha biomass total C is higher (7 to 10%) for Torokoro than for Tin location. No difference was found between the 2 locations for N total, P total and K total. Regardless of the age of the plants, there are significant differences between biomass carbon levels from the Torokoro site, andbiomass carbon levels from Tin. For the nitrogen, phosphorus and potassium levels, the analysis revealed no difference between the biomass from 2-year-old plants at the Torokoro site and that from the Tin plants.

Table I. Chemical characteristics of foliar biomass of *Jatrophacurcas*

Age of plants	Site	C (%)	total N (%)	total P (mg.kg^{-1})	total K (mg.kg^{-1})
2 years	Torokoro	57.96*b* ±1.09	2.38*a* ±0.46	1223.33*a* ±214.7	15057.50*a* ±707.27
	Tin	50.66*a* ±0.5	3.49*a* ±0.49	1212.50*a* ±86.17	15042.18*a* ±375,31
	Probability	0,041	0.105	0.219	0.146
	Signification	S	NS	NS	NS

The averages of the treatments were separated by the Newman-Keuls test at the 5% significance level to check for significant differences between the averages.

TableII. Chemical characteristics of foliar biomass of *Jatrophacurcas*

Age of plants	Sites	C (%)	total N (%)	total P (mg.kg^{-1})	total K (mg.kg^{-1})
6 years	Torokoro	62.36*a* ±0.72	2.78*a* ±0.29	1159.17*b*±87.43	16122.42*b* ±29.54
	Tin	51.61*b* ±1.03	3.15*a* ±0.37	1688.34*a*±324.82	21994.62*a* ±40,24
Probability		0.038	0.314	0.001	0.001
Signification		S	NS	HS	HS

The averages of the treatments were separated by the Newman-Keuls test at the 5% significance level to check for significant differences between the averages.

Table III. Compost characteristics of *Jatropha* residues

Parameters analyzed	**Periods (days)**	
	After 8 days	*After 30 days*
Temperature (°C)	67° C	39° C
pH	5.2	6.8
Carbone (C %)	54.52	30.55
Nitrogen (N %)	0.86	1.58
Ratio C/N	63	16

Significant differences were observed between biomass from 6-year-old plants at the Torokoro site and that of Tin plants for phosphorus and potassium levels (Table II). The biomass from 6-year-old *Jatrophacurcas* plantations contains the highest concentrations of P and K at the Tin site. These litters are characterized by high levels of phosphorus (1688.34 mg.kg-1) and potassium (21994.62 mg.kg-1) compared to those from plantations of *Jatrophacurcas* de Torokoro.

Evaluation of the quality of compost J. *curcas* L: The results in Table III indicate the chemical characteristics of compost from *Jatrophacurcas*. In general, after 30 days of composting, the results obtained varied significantly. The temperature has dropped to 39 ° C and the pH is close to neutral (6.8). C / N ratio down (19.33); which means that the amount of carbon has decreased while that of nitrogen is slightly higher. These results show that at 30 days the rate of Organic C 30.55% is close to the values of a good compost. On the other hand, observe an increase in the nitrogen content of the 8th to the 30th days respectively from 0.86% to 1.58%.

DISCUSSION

Chemical parameters of foliar biomass of *Jatrophacurcas:* The results showed that the chemical composition of the biomass is different depending on the site. In fact, regardless of the age of *jatropha* threes, the total carbon content differed significantly between Torokoro and Tin. The difference can be explained by the quality of the soils which has probability affected the overall quantities of nutrients in the biomass. However the quantity of carbon in *Jatropha* biomass is high compared to other type of residues. These results are similar to those reported by Sanou (2010) and Bazongo (2011) who indicated that the litter of *Jatrophacurcas* is characterized by high levels of organic C. According to Soulama, (2008), *Jatropha* leaves can contain 49.1% of organic carbon. Like the work of Gobat et al. (2010) and those of Girard et al. (2011) and Patricio et al. (2012), our results showed that the biomass from plantation of *Jatrophacurcas* of Tin contains low levels of carbon. *Jatropha* plantations can be used to provide important quantities of organic matter to the soil, which is good for land productivity (Vauramo and Setälä, 2011, Zhang *et al.,* 2013). *Jatropha* biomass can be considered a slow release source of organic matter (Dieye, 2016). From the results it appeared that the level of nitrogen is comparable for all the sites and ages. But the N contain of the biomass is very interesting and can help to support productivity of the lands in Burkina Faso. In fact, N is one of the most limiting nutrient in the soil in Burkina and Jatropha biomass application can help to improve it contain in the soil. The results showed also very high level of P and K in *Jatropha*biomass for both locations and plant ages. The green manure can therefore reduce loss of nutrients from soil and give sustainable nutrient supply for long period as compared to chemical fertilizer the challenge (Leye et al. 2009).

Quality of compost from *Jatropha:* Since composting is both a microbiological and thermal phenomena, temperature (67 ° C) increase noticed in our results, is therefore due to the gradual release of energy (partial oxidation) during fermentation. . The compost pile pH at 30 days is close to neutral. Using such compost will help to increase soil pH in acidic soils of Burkina. According to Ouédraogo (2012), the compost pH can rise up to 8 during the composting process (Ouédraogo, 2012). The C / N ratio of the compost (16) is indicating a very good compost which can easily release nutrients when applied in the soil. The quantity of Nitrogen in Jatropha compost is lower compared to the contain in the green manure. However, the C/N ratio is much better for the compost than for the biomass. The latest indicates that nutrient release from the compost will be higher than from the biomass. Our results are supported by Soulama (2008) and Kaboré (2014), who indicated that C / N ratio is higher for *Jatrophacurcas biomass*. Pfeiffer *et al.,* 2013, Dieye, 2016 reported also that *Jatrophacurcas* litters are slow-decay litters with high C / N ratios. Results obtained from our trials showed similar quality of compost compared to the compost obtained from other crop residues.

Conclusion

The objective of this study was to evaluate the chemical properties of *Jatropha* biomass and compost in farmers' field in the South Sudanian zone of Burkina Faso. From the results we can conclude the following:

- The quantity and quality of *Jatropha* biomass depends on the soil on which the crop is grown
- *jatropha* biomass contains very high level of C, N, P and K and the quantities of these nutrients in the biomass is independent of the age of the trees
- The pH of *Jatropha* compost is close to neutral which can help to improve soil fertility in Burkina
- The C/N ration of Jatropha compost shows an easily releasable material

From our results, it is possible to imagine that *Jatropha* biomass and compost are likely to improve soil properties. But compost application has potential to better supply to the soil in short time nutrients from the biomass. In perspective, this study should be extended to the evaluation of the effect of *Jatropha* biomass and compost application on soil properties and crops productivity.

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