

Impact of Crop Residue Burning on Soil Nutrient in Dawakin Kudu Local Government Area of Kano State, Nigeria

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ABSTRACT

Crop residue burning has been on the increase among rural farmers and this affects soil quality and the environment. This paper investigated the impact of crop residue burning on farmlands soil nutrients in Dawakin kudu Local Government Area, Kano state. 'Yar gaya, Kadawa, Tsakuwa, Yankatsari and Kantsi were chosen randomly as the study area. Soil samples were collected in two phases at depth of 1-10cm from five different farms site of sorghum. Phase 1, before crop residue burning, March 2019. Phase 2, after crop residue burning, November 2019. The samples were analyzed in the laboratory for soil nutrients. The results show that after crop residue burning there was an increase in phosphorus as the elements characteristics (mg/kg) from 8.31-12.33 (Yar gaya), 5.32-12.21 (Kadawa), 8.07-10.23 (Tsakuwa), 6.41-8.03 (Yankatsari), 9.31-11.06 (Kantsi), on sorghum farms. Also, Potassium (cmol/kg) increased on sorghum farm from 0.022-9.09 (Yar gaya), 0.04-5.03 (Kadawa), 0.05-6.02 (Tsakuwa), 0.05-0.08 (Yankatsari), 0.04-2.09 (Kantsi). While decreased in Nitrogen element which was obtained from 0.28-0.21 (Yar gaya), 0.63-0.21 (Kadawa), 0.29-0.23 (Tsakuwa), 0.54-0.22 (Yankatsari), 0.25-0.18 (Kantsi) on sorghum farm, mobility is the factor responsible for variation, where as nitrogen is mobile while phosphorus and potassium are immobile. The finding of the study reveals that crop residue burning increases the amount of phosphorus, and potassium, while it decreases the nitrogen content due to fire volatilization and particulate transfer, insufficient of any essential nutrients lead to poor crop production. Thus, crop residue burning has both positive and negative impacts on soil nutrients. The study recommends awareness campaign on consequences of residue burning and the economic importance of composting and recycling of residues. This should be done by training farmers on the adoption of conservation agriculture practices on effective and sustainable management of crop residue for sustainable agricultural practice and environment.

Keywords: Soil, Crops residue, Residue burning, Soil nutrients

1. INTRODUCTION

Soil is a key source of nutrients required by plants for growth. The three core nutrients are nitrogen (N), phosphorus (P) and potassium (K). Composed they make up the triangle known as NPK. Other important nutrients are calcium, magnesium and sulfur NLP (1992). Plants also need small quantities of iron, manganese, zinc, copper, boron and molybdenum, known as trace elements because only traces are needed by the plant (NLP 1992).

Nitrogen is an important element in plant growth. It is found in all plant cells, in plant proteins and hormones, and in chlorophyll. Atmospheric nitrogen is a source of soil nitrogen. Some plants such as legumes fix atmospheric nitrogen in their roots; otherwise, fertiliser factories use nitrogen from the air to make ammonium sulfate, ammonium nitrate and urea, Aczel (2019). When applied to soil, nitrogen is converted to mineral form, nitrate, so that plants can take it up. Phosphorus helps transfer energy from sunlight to plants,

stimulates early root and plant growth, and hastens maturity. All manures contain phosphorus; manure from grain-fed animals is a particularly rich source Aczel (2019). Potassium increases vigour and disease resistance of plants, helps form and move starches, sugars and oils in plants, and can improve fruit quality. Potassium is low or deficient on many of the sandier soils, Muriate of potash and sulfate of potash are the most common sources of potassium, (Aczel 2019).

Crop residue is what remains of a crop after its value edible, fiber or energy in biofuel crops has been harvested, in maize, the residue known as Stover consists of leaves, stems and husk; in sugar cane, the residue is made up of the leaves, wheat stubble, rice straw and in potatoes most of what grows above ground is considered residue (Meera, 2018). However, it would be a mistake to dismiss crop residue as waste, crop residues can be used for several purposes apart from others economic important of crop residue which includes organic soil amendment, fodder for livestock, domestic fuel, green manure and building materials, Residue also served as one of the most important factors for healthy and productive soil but when burned all those benefits lost plus others damage may be done (IARI, 2012).

Crop residues are mostly used as livestock feed, soil mulching, bio-gas generation, bio-manure/compost, thatching for rural homes, bedding material for animals, mushroom cultivation, biomass energy production, and fuel for domestic and industrial use, among others (NPMCR, 2014). However, a large portion of crop residue is burnt on-farm primarily to clean the field for sowing the next crop. The on-farm burning of crop residues is intensifying in recent years due to a shortage of human labour, the high cost of removing the crop residue from the field and the mechanized harvesting of crops. The other additional factors behind the intentional burning of crop residues are pest and pasture management and soil fertility enhancement (Pathak *et. al*, 2011).

The benefit of retaining crop residue is far better than burning it. Crop residue can provide a protective layer for soil erosion by wind or water, can increase the organic matter and water holding capacity of the soil, and can provide feed and forage for earthworms and others organisms (Clark, 2015). The burning of crop residues is a short-term solution for much larger

and longer-term losses, while burning returns some nutrients to the soil and can even result in a burst of fertility in the short run, most of the organic material and nutrient content is lost under high temperatures (Clark, 2015). Even though there may be some short-term benefits to burning crop residue, there is a slow and steady reduction in soil health that will eventually result in reduced productivity that cannot be overcome with increased additions of mineral fertilizers (Clark, 2015).

Thus, insufficient of any essential nutrients lead to poor crops, even if India, China and USA are the top burners of residue, Africa is growing its burning (Clark, 2015). Hence Dawakin kudu local government area of Kano state is practicing burning of crop residue for the need of stoves for “gurasa production”.

The aim of the study is to assess the impact of crop residue burning on soil nutrients in Dawakin kudu Local Government Area. The specific objectives are:

- i. To identify some of the soil nutrients in the study area.
- ii. To determine the impact of crop residue burning on soil nutrients.

Though various studies in the literature have addressed this issue of burning of the crop stubbles, few attentions were paid specifically to the effects of crop residue burning and its implications on soil nutrient in Dawakin kudu Local Government Area of Kano State. Furthermore, there was limited research carried out on impact of crop residues burning on soil nutrients in study area. Also Dawakin kudu is an agrarian society where several tonnes of agricultural crop residues are misused, this affects the soil health, especially given the fact that the area is dominated by crop farmers. For these reasons, this study intends to fill the gap in knowledge by assessing the impact of crop residues burning on soil nutrients.

2. MATERIAL AND METHODS

2.1 Study Area

Dawakin Kudu is a Local Government Area in Kano State, Nigeria. Its headquarters are in the town of Dawakin Kudu. The inhabitants of Dawakin kudu are Hausa and are mostly Farmers. 'Yar gaya, Kadawa, Tsakuwa, Yankatsari and Kantsi were chosen randomly as the study area (Figure 1). Seasonal and Irrigation farming are widely practiced. The geographical location of Dawakin kudu is 11°

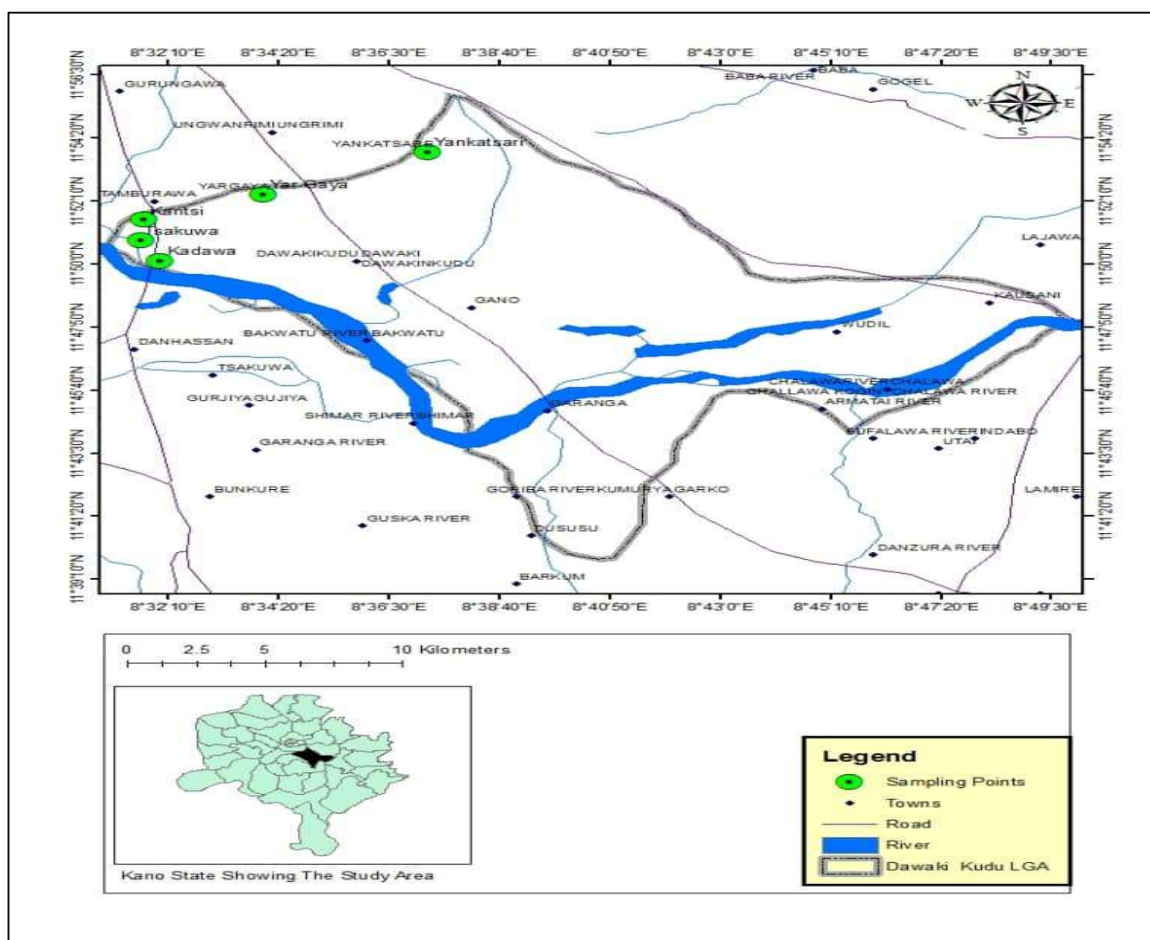


Figure 1: Map of Dawakin kudu local government, Kano State.

50 '05" N, 8° 35' 53" E, mean temperature ranges from 22°C to 29°C during the rainy season and 30°C to 37°C during the dry season. Rainfall is bimodal with the short rains between May to June and heavy rainfall between July and September. Mean annual rainfall ranges from 700mm to 1000mm. Dawakin kudu LGA has a population of 416,113 people of which 202,077 (48.6%) are males (NPC, 2006).

2.2 Types and Source of Data

Impact of crop residue burning on soil nutrients was sourced from a primary source used quantitative means of soil sample test.

Instruments for Data Collection

- i. Ruler
- ii. Clear bag
- iii. Hoe

Sampled was collected from sorghum farm plots before and after burning at depth of 1-10cm to assess the impact on nutrients.

Procedure for soil nutrient test: Different method of soil nutrients determination was used

to determine the impact of crop residue burning on soil nutrients, the methods used depended on the parameter. Kjeldahl distillation method (Kjeldahl & Mulvaney, 1982) was used for nitrogen (N) content, Ammonium acetate method (Thomas 1982) for Potassium (K), BRAY I method (Olsen and Sommers, 1982) for phosphorus (P) and Graduated cylinder method was used for determination of particle size.

Kjeldahl distillation method was used for the determination of nitrogen N: distillation was used to get the final burette reading, and calculated using the below formula:

$$\%N = 0.014 \times N \times VO \times 100 \times TV / A.D \times W.S \quad (1)$$

0.014 is the mill equivalent of nitrogen and is calculated as $14/1000 = 0.014$

N= is the normality of H₂so₄ used (0.025N)

VD= volume of digest made

TV= filter value after filtration

AD= aliquate taken during distillation

W.S= weight of the sample.

BRAY I method used for available phosphorus P: weigh 1g of soil sample and put into a centrifuging tube or 100ml plastic bottle, measure 7ml of p extract and pour it into the centrifuge, then filter the content using what man filter paper, measure 3 to 4ml of the filtrate and pour it into a 100ml volumetric flask, Add 10ml of distilled water, Add 4ml of reagent B(Reagent A+Ascorbic Acid), Prepare blank using the same procedure using 0.2, 0.4, 0.6 and 0.8N. Measure the absorbance using a spectrometer at 860nm wavelength.

Calculation of phosphorus P.

$$P(\text{mg/kg}): \text{Absorbance/slope} * \text{VE} \quad (2)$$

Where VE = volume of digest which is 100ml

Ammonium acetate method used for determination of Potassium K: Measure 5.0g of soil sample using an analytical balance; transfer the measured soil into a 100ml plastic bottle. Add 50ml of Ammonium acetate into the plastic bottle and shake the mixture for about

30minute; filter the mixture using whatman filter paper. Use a flame photometer to measure the absorbance of the potassium.

3. RESULT AND DISCUSSION

The result in (table 1) shows that short-term crop residue burning have complex impact on soil nutrients and organic matter, it increases and decreases some nutrients, soil nitrogen decrease after burning while phosphorus (P) and potassium (K) increases. **Total Nitrogen (TN):** The result in (plate 1) shows that the percentage value of total Nitrogen (TN) at depth of 1-10cm on sorghum farm before and after burning are 0.28-0.21, 0.63-0.21, 0.29-0.23, 0.54-0.22, 0.25-0.18. N% with before burning residue having the highest percentage respectively. This is because a lot of soil nitrogen is lost by fire through volatilization and particulate transfer to the atmosphere during burning. This is in line with a findings of the study carried out by Baird *et. al*, (1999) where it was found that fire contributing to the loss of nitrogen by volatilization and particulate

Table 1: Impact of Crop Residue Burning On Some Soil Nutrient (NPK) and Organic Matter.

Site	Soil Depth	Condition	N%	O.M%	K cmol/kg	P Mg/kg
Sorghum farm A	1-10cm	Unburned	0.27	0.57	0.02	7.96
	1-10cm	Burned	0.20	0.58	7.52	12.33
Sorghum farm B	1-10cm	Unburned	0.29	0.55	0.04	5.32
	1-10cm	Burned	0.23	0.58	5.03	12.21
Sorghum farm C	1-10cm	Unburned	0.25	0.54	0.05	8.07
	1-10cm	Burned	0.18	0.57	6.02	10.23
Sorghum farm D	1-10cm	Unburned	0.31	0.56	0.05	6.41
	1-10cm	Burned	0.24	0.58	0.08	8.03
Sorghum farm E	1-10cm	Unburned	0.27	0.52	0.04	9.31
	1-10cm	Burned	0.21	0.55	2.09	11.06

Source: soil lab, soil science department, BUK.

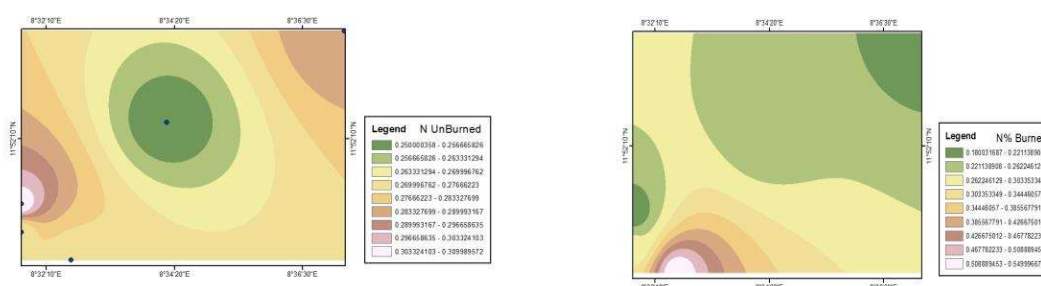


Plate 1: Unburned and burned sample soil on nitrogen

transfer to the atmosphere, especially in the site of the most recent fire, but the result disagreed with the finding of Edem and Alphonsus (2013) who observed increased in total nitrogen in burnt soil in continuous cropped arable experimental plots.

Phosphorus (P): The results of the study revealed that phosphorus P in sorghum farms at

was found an increase in available P was higher immediately after burning than after one year of cropping relative to the unburned forest vegetation. It's also in line with findings of Van *et. al*, (1995) and that of Kopecky *et. al*, (2012) where it was found an additional increase of ash after burned and that also increases available P. each ton of wood ash could substitute for 13 to 14 kg of phosphate.

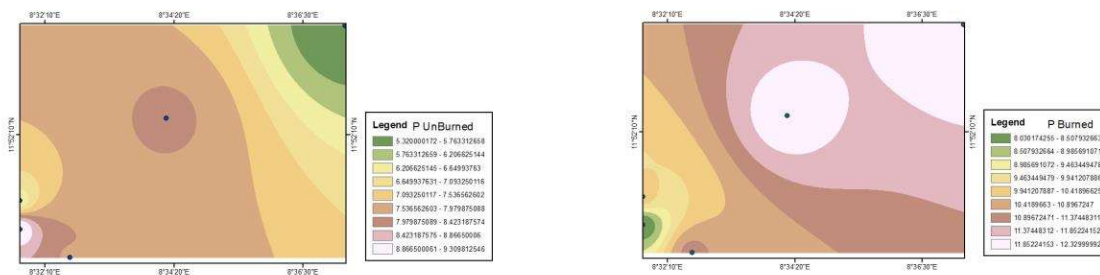


Plate 2: Unburned and burned sample soil on phosphorus

depths 1-10cm has increased after burning. This may be attributed to phosphorus being classified as an immobile element in the soil so that it does not move down to the soil profile (Hungerford *et. al*, 1990). Result in (plate 2) revealed that available phosphorus P on sorghum sampled farm at the depth of 1-10cm ranged between 8.31-12.33, 5.32-12.21, 8.07-10.23, 6.41-8.03, 9.31-11.06 P mg/kg with after burning soil record the highest value than before burning.

The result of this study is inconsistent with the findings of Tabi, FO., Mvondo, ZA., Boukong, AD., Mvondo, RJ., Nkoum, G. (2013) where it

Potassium (K): The result in (plate 3) revealed that potassium K ranged between 0.022-9.09, 0.04-5.03, 0.05-6.02, 0.05-0.08, 0.04-2.09 cmol/kg in sorghum farm before and after burn with after burned recording the highest value than unburned at the 1-10cm soil depth. This agreed with the findings of Richard (2001) which finds that crop residue burning increases the short term availability of soil nutrients (phosphorous (P) and potassium (K)) and reduces soil acidity, ultimately lead to a loss of other nutrients (nitrogen (N) and sulfur (S) and organic matter. These findings show that nutrients are dynamic to burning.

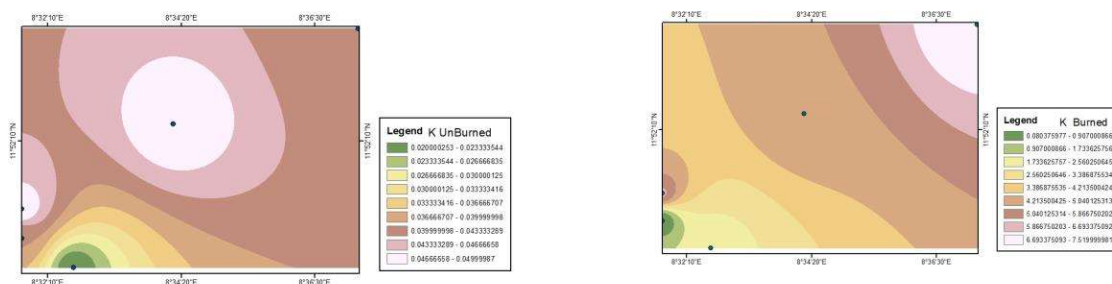


Plate 3: Unburned and burned sample soil on potassium

4 CONCLUSION

Crop residue burning have both positive and negative effect to farmers and the environment, increases soil fertility, and reduces grass seedlings in farms which aid greatly in perpetuation of tradition. But has long-term effects on the environment. Therefore, crop residue management is needed among farmers as a result of the compound function of the main nutrient. Absence of one leads to deprived crop production. It can be concluded that no law on crop residues burning in the area, which make the act unguarded, that contributed greatly to increases of burning, not lack of awareness. Controlling crop residue burning maintains variation of core element nutrients in the area. Similar study needs to be carryout on other important nutrients; calcium, magnesium and sulfur.2. Awareness campaign on consequences of residue burning and the economic importance of composting and recycling of residues. This should be done by training farmers' on the adoption of conservation agriculture practices on effective and sustainable management of crop residue for sustainable agricultural practice and environment.3. Government and community leaders should set Laws that will ban and curb the intentional burning of crop residues. And this should be through incentives and punishment.

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Appendix:

- Farm A = Yar Gaya
Farm B = Kadawa
Farm C = Tsakuwa
Farm D = Yankatsari
Farm E = Kantsi