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Effects Farming System On Soil PH, Soil Heavy Metals And Chemical Composition Of Pearl Millet (Pennisetum Glaucum) Seeds Farm In Kaura Namoda, Zamfara State, Nigeria.

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Abstract
The impact of organic and conventional farming practices at four planting fields was carried out to determine the effect on P^H, soil heavy metal and chemical composition of pearl millet seeds farmed in Kaura Namoda north – west, Nigeria. Conventional farming system plot shows higher soil P^H (4.60) compared to that of organic and control plots which were above 5.50. The result of chemical analysis of the seeds of peal millets show some significant variation in the composition of ash, protein and total carbohydrates ($P \leq 0.05$). Soil analysis of heavy metals, As, and other elements content of the four plots used for this study indicate that uncontrolled use of synthetic fertilizer may lead to soil contamination with heavy metals, phosphorus, nitrogen and iron containing compounds. The outcome of this study shows that the type of farming system may significantly ($p \leq 0.05$) affects the quality and safety of the agricultural soil. Farmers can adopt this data to improve on conventional and organic system for better quality and safety of food crops production to improve food security.

Keywords: *Conventional farming, organic farming, pearl millet, heavy metals and soil.*

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I. Introduction

The demand for food security in Nigeria and the desire to reduce labour and increase crop yield has become the motivation for the type of farming system to be adopted by most farming communities in Zamfara state. A farming system that work in harmony with nature with minimum or no damage to the natural environment is referred to as organic farming system (OFS). While the type of farming system that utilizes chemical inputs such as fertilizers, pesticides and herbicides in order to sustain and replenish soil nutrients is commonly referred to as conventional farming system (CFS). Organic farming system is fast replacing conventional farming system because of demands for organic food and growing environmental concerns. Studies have shown that organic farming system has the potentials to increase the level of soil nitrogen and prevents leaching of essential soil nutrients (Diepeningen., Vos, Korthals, Bruggen, 2006; Yung et al., 2008). In contrast, conventional farming system most often results in negative impacts such as, nutrient run off, soil erosion, loss of organic matter, impaired environment quality leading to pollution of underground waters by agricultural chemical inputs. Furthermore, Diepeningen *et al*., (2006) in another study reported that prolonged use of chemical fertilizers may persist in the soil with consequent effect on food chain.

Over the decades, chemicals and heavy metals contamination caused by anthropogenic activities has raised concern over public health and environment quality (Saadia Rashid Tariq Musharaf and, 2016; Sabry, 2015; Tariq et al., 2016). The health risk arising from heavy metal pollution have attracted global attention because of its role in the causation of disease to man. According to a study conducted by (Omolar TItilayo Aladesanmi, Jeremiah Gbenga Oroboade, Chisom Peter Obbisiogu, 2019), crop plants especially cereals is capable of accumulating high amount of heavy metal from the soil during conventional farming system. Similarly, (Sabry, 2015) reported that fertilizer can seriously deplete the nutritional content of food.

Pearl Millet is a vital staple crop in northern Nigeria particularly in semi-arid region of the north-west and north-east (Badau et al., 2002; Nkama, and Ikwelle, 1997). The states that farm Pearl millet in large quantities in northern Nigeria are Sokoto, Yobe, Jigawa, Taraba, Borno, Kano and Zamfara. Pearl millet thrives well in harsh climatic condition and support food security for millions in Nigeria.

Pearl millet is used for processing of intermediate food products such as tuwo, fura, and kunun- zaki, Cuscus, burabusko, thin and thick porridges, alcoholic, non-alcoholic beverages and some winning foods. Food processors and consumers need to understand what they consume when they adopt any farming system for the production of this important crop.

Studies and data provide information into the challenges and health implication on the farming system adopted by farmers in northern Nigeria (Badau et al., 2002). Furthermore, the economic and health benefits of adopting either conventional or organic farming has been a subject of discussion (Doanh et al., 2018; Sabry, 2015). Therefore the need to investigate the impact of OFS and CFS soil profile and chemical content of food crops is the focus of this research as an away safe guard public health, protect environment and improve food security.

The objective of this study therefore was to investigate the impact of organic and conventional farming practices on the quality and safety of agricultural soil and chemical composition of Pearl millet farmed in Kaura, Namoda, Zamfara state, Nigeria.

II. Methodology

Study Site

Kaura Namoda is located at Zamfara. North- West of Nigeria. The temperature ranges from 23^{o}C to 38^{o}C with annual rainfall characteristic of that of typical Sudan Sahel region. The soil use for cultivation of millet is mainly sandy loam texture with pH range of 4.0 to 6.5.

Farmland Preparation

A farmland of half of an acre that has not been cultivated for 5 years was hired at the School of Agriculture technology site of Federal polytechnic, Kaura namoda main campus. It was cleared, ploughed and harrowed. The research was laid in a split-plot with four replications where Pearl millet cultivar was allocated to represent OFS, CFS as well as the control(CTRFS) (Bagchi et al., 2015)

Planting and Fertilizer Application

Sasakawa planting method was applied in planting the Millet seeds. The fertilizers was applied according to standard methods (Sareen, 2018).

Soil and seed plant Analysis for heavy metals.

Heavy metal determination was done using the (Ruiz-Huerta et al., 2022; Tessier, A., Campbell, PG., 2016). In brief, Soil samples were collected at the depth of about 15cm in all the locations from the farmland and was mixed properly to give a representative sample. It was then air dried and, sieved using a sieve size of 0.63mm mesh. Digestion of the soil samples was carried using strong solution of 1:3 (conc. HNO_3 and conc. HCl) at 170^{o}C for 30 minutes using a microwave accelerated reaction system. The samples were dissolved in deionized water and was filtered using no. 40 Whatman filter paper. The solution was brought to final volume of 100mL. Analysis of Cd, Cu, Pb, Cr Ni and Fe & Zn was carried out using Atomic Adsorption Spectrophotometer (AAS), while AS was analyzed by hydride generation with Perkin-Elmer AAnalyst 100. Calibration of the equipment was done using standard solution of known concentration of each of the mineral elements to be analyzed. Four replicates were used for each of the soil samples analyzed.

For chemical analysis and bioaccumulation study, Seeds were digested using open acid digestion with 4:1 concentration of HNO_3 and $HClO_4$ as described by (Ruiz-Huerta et al., 2022).

Physicochemical Analyses of soil.

Physicochemical analysis including pH, N, P. Fe and other elements were measured in triplicate using the method of Ruiz Huerta and others (2022).

Statistical Analysis

Minitab software version 17 was used for analysis of variance (ANOVA). Results were considered significant at $P \leq 0$ .05.

III. Result And Discussion

In this study we analyzed the impact of different farming system on chemical composition of pearl millet seeds, soil heavy metals and, Arsenic (As), and other chemical elements on soil (Table 1, 2 &3).

Chemical Composition of Pearl millet seeds

The result of chemical composition of Pearl millet (Table 1) shows that moisture content was between 10.03 to 11.09%, crude fibre was from 3.95 to 4.57 %, whereas the ash content was in the range of 1.38 to 1.90 %, that of protein was between 9.90 to 12.10 %, crude fat and total soluble carbohydrate were in the range of 4.2 to 4.50 % and 67.12 to 71.62 % respectively. The mean values of the chemical composition showed correlation ($\leq$ 0.05) with a previous study carried out on the physicochemical characteristics of pearl millet cultivated in North –west Nigeria by (Badau et al., 2002). The type of farming system did not significantly affect the moisture,

crude fibre, and crude fat composition of the seeds significantly ($p \leq 0.05$). However, there was significant difference in the ash, protein and carbohydrate contents of conventional farming system compared with the organic farming system and the control plot. This may be attributed to the type farming input that is characteristic of organic and conventional farming system. Although inorganic and organic fertilizers may produce quick and impressive result in farms, where growth and yield are desirable, it has been reported that overly fertilized soils are deficient in iron, zinc, Cu, and protein leading to fertilizer pollution (Sabry, 2015). In this study, the significant difference observed in the protein content of the conventional farming system may be a result of quick action of the fertilizers applied in which nitrates and ammonium radicals formed as a result inorganic fertilizer application influenced chemical composition of the seeds.

Table 1. Proximate Composition of Pearl millet grown under different farming Systems

Parameter	Moisture (%)	Crude Fibre (5%)	Ash (%)	Crude fat (%)	Protein (%)	Carbohydrate (%)
OFSPM	11.01^{a}	4.30^{a}	1.90^{a}	4.50^{a}	9.90^{b}	67.30^{c}
CFSPM	10.75^{a}	3.95^{a}	1.58^{b}	4.20^{b}	12.10^{a}	71.62^{a}
CTRFSPM	10.03^{a}	4.57^{a}	1.45^{c}	4.30^{bc}	11.70^{b}	67.95^{b}
BFPM	11.09^{a}	4.45^{a}	1.38^{c}	4.28^{c}	11.68^{b}	67.12^{b}

OFPM – Organic Farming Pearl millet seed
CFPM – Conventional farming Pearl millet seed
CTRFPM - Control farming Pearl millet seed
BFPM – before farming pearl millet seed
Result are Mean of three determination
Means within a column with different letters are statistically significantly different (≤ 0.05).

Impact of Farming system on soil P^{H}, heavy metals and Arsenic (As)

Table 2 shows the result of impact of farming system on P^{H}, mineral elements, heavy metals and arsenic (As) on soils.

Effect of farming system on soil P^{H}

The soil P^{H} of the different farming system plots were 5.50 (SOFS), 4.60 (SCFS), 5.40 (SCTRSF) and 5.24 (SBFS). The P^{H} of the Soils were moderately acidic except for the soil from conventional farming plot which was significantly different (≤ 0.05) compared to soils from other plots. The difference may be attributed to the presence of nitrogen containing fertilizers applied. Studies showed that nitrogenous fertilizers used in conventional farming system leads to acidity (Ma,, Brussaard, , 1990; Tee, Dudas, Pawluk S. and Harapiak, 1987) .It has also been reported that continuous application of sulphate containing fertilizers without the addition of lime may reduce the soil P^{H} to below 4.0 to level that may not be suitable for crop yield (Yung et al., 2008).

Effect of Farming System on heavy metals and Arsenic (As) and other nutrients.

Concentration of heavy metals and arsenic, phosphorus (P), nitrogen (N) and iron (Fe) on the soils were determined because of the roles they play in plant growth, and public health safety. The level of Phosphorus (P) was in the range of 1.190 to 2.750 (mg/kg), while that of N was 2.862 to 5549 (mg/Kg) and Fe concentration was 0.074 to 1.080 (mg/Kg). Phosphorus, nitrogen and iron play significant roles in crop production since all plants need salts of these elements for successful growth (Sabry, 2015). The content of soil P, N and Fe of organic farming soils were significantly different from that of conventional farming system. This may be attributed to the application of the type of fertilizers characteristic of the farming system adopted.

Table 2 shows that the concentration of cadmium Cd) was in the range of 0.132 to 0.818 (mg/Kg), Chromium (Cr), 2.553 to 3.306 (mg/ Kg), for Copper (Cu) 2.226 to 3.407 (mg/ Kg), arsenic (As) concentration range from 0.130 to 0.227 (mg/ Kg), for Nickel (Ni) 0.046 to 0.107 (mg/Kg), for lead (Pb), 1.030 to 1.658 (mg/kg) , for Zinc (Zn), 0.010 to 0.037 (mg/Kg). The concentration of soil heavy metal (Cd, As, Pb and Zn) on the soil before and after application of conventional and organic system shows some significant variation ($p \leq 0.05$). However, the variation in the concentration soil heavy metals and that of nutrient chemicals were generally below the limit established by European Union's

Table 2 Effect of Farming system on soil heavy metals, arsenic (As)

Parameters(mg/Kg)	P^{H}	Cd	Cr	Cu	P	N	Fe	As	Ni	Pb	Zn
SOFS	5.50^{a} (1.33)	0.278^{a} (6.48)	0.276^{a} (1.44)	2.630^{a} (1.35)	3.670^{b} (18.35)	2.75^{a} (3.6)	2.226^{b} (1.35)	0.019^{a} (1.52)	0.82^{c} (3.0)	0.40^{c} (0.8)	1.963^{b} (0.84)

SCFS	4.60[b] (1.22)	0.130[b] (1.52)	0.143[a] (1.88)	3.306[a] (0.40)	5.549[a] (22.66)	2.47[a] (1.3)	3.407a (0.33)	0.096[b] (11.43)	1.13[a] (1.7)	0.52[b] (2.2)	2.044[a] (2.23)
SCTRF S	5.40[a] (1.34)	0.223[a] (1.35)	0.206[a] (1.96)	2.627[a] (0.48)	3.207[c] (14.21)	1.50[b] (1.7)	3.243[a] (0.40)	0.04[a] (0.2)	1.08[a] (2.0)	0.75[a] (2.2)	1.030[b] (2.23)
SBSF	5.24[a] (2.33)	0.129[a] (2.45)	0.198[b] (1.34)	2.553[a] (0.45)	2.862[c] (21.55)	1.19[b] (1.4)	0.938[b] (0.5)	0.025[a] (0.15)	0.48[b] (2.3)	0.41[c] (2.2)	0.203[c] (2.33)

are Mean of three determination

Means within a column with different letters are statistically significantly different (≤ 0.05) Numbers inside parenthesis represent RSD values (n = 3)

SOFS – Soil on Organic farming system

SCFS – Soil on conventional farming system

SCTRFS – Soil on control farming system

SBSF – Soil before planting

IV. Conclusion

This study provide information on the impact of farming system on chemical composition pearl millets seeds and soil heavy metals profile. The type of farming system significantly affect the agricultural condition of soil $P^{H,}$ and heavy metals concentration. Although the organic farming system has less concentration of heavy metals and other chemical element. *The outcome of this study shows that the type of farming system may significantly ($p \leq 0.05$) affects the quality and safety of the agricultural soil.* Farmers within Kaura Namoda can adopt this data to monitor organic and conventional farming system to improve public health and food security.

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