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Effect of Farmyard Manure (FYM) and Zinc Fertilizer Application on Yield Parameters of Common Wheat (*Triticum aestivum* L.) Grown on Sandy-clay Loam of Borno State, Nigeria

A. M. Zubairu [a*], M. K. Sandabe [a], R. Abdullahi [a], M. T. Buba [b], A. Bunu [c] and Y. Zarami [d]

[a] Department of Soil Science, University of Maiduguri, Maiduguri, Nigeria.
[b] Department of Soil Science, Federal University, Dustin-ma, Nigeria.
[c] Department of Agricultural Technology, Ramat Polytechnic, Maiduguri, Nigeria.
[d] Research and Demonstration Farm, University of Maiduguri, Maiduguri, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Authors AMZ, MKS and RA designed and managed the experiment, analyses of the study and wrote the first draft of the manuscript. Authors MTB, AB and YZ managed and updated the literature searches. All authors read and approved the final manuscript

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**Corresponding author: E-mail: abbazubairu@gmail.com;*

ABSTRACT

A Screen House experiment was carried out in University of Maiduguri to study the effects of Farmyard Manure (FYM) and Zinc fertilizer rates on wheat (*Triticum aestivum* L.) grain yield, 1000 grain weight, total dry matter weigh and HI on Sandy Clay-loam soil with location; Latitude (11.923100 ^{O}N and 11.919042 ^{O}N) and Longitude (13.228927 ^{O}E and 13.221758 ^{O}E) of Jere Local Government Area, Borno state, Nigeria. The study was set out in CRD with 3 replications. Composite 10 kg soil was weighed into 36 pots and treatments applied. Reyna 28 wheat seed obtained from Lake Chad Research Institute (LCRI) Maiduguri was used for the pot experiment. Six (6) wheat seedlings were allowed to grow to maturity from each pot. The pots were kept clean from weeds. Results obtained showed improved wheat yield with 5t/ha FYM + 5ppm Zn and 10t/ha FYM + 0 ppm Zn fertilizer rates leading the best yield for wheat grain and TDMW. 1000 grain weight and harvest index were also significantly increased with FYM and Zn fertilizer application. It was concluded that application of FYM and Zn fertilizer had increased wheat grain and TDMW yield as well as 1000 grain weight and harvest index.

Keywords: Zinc; farmyard manure; wheat; grain yield; total dry matter weight.

1. INTRODUCTION

1.1 Background of the Study

Wheat (*Triticum aestivum* L.) is cultivated on more land mass than all cereals, approximately 220.4 million hectares [1]. Wheat cultivated for its important grain and nutritive characteristics. It is utilized in bread, feed, confectionary production etc. “Bread and bakery products obtained from wheat are considered worldwide an essential source of protein, dietary fiber, vitamins, micronutrients, and antioxidants” [2].

“The average production of wheat in Nigeria was about 81,904 metric tonnes while the average importation of wheat in the country was 2,193,566 metric tonnes within the same period” [3]. Huge evidence exists showed that wheat is grown since 200BC [4]. However, Nigeria’s wheat production remain low. More research is needed to tackle this low production. “Grain yield increase and quality are of paramount importance to geometrically increasing population” [5]. Structure of wheat grain partitioned viz; bran (14-16%), embryo (2-3 %) and endosperm (81-84%) [6].

Zinc (Zn) is among the 17 important nutrients elements required development and growth of wheat. Zn is essential in respiration and photosynthesis [7].

Zn deficiency occurred in humans and crops [8]. Deficiency of Zn on soils/plants is a world problem in deficiency [9].

“Application of Zinc containing fertilizers could be a viable option to satisfy the crop demand for Zn and also to increase grain Zn contents ultimately taken up by human beings. Application of organic amendments can influence Zn availability to crops through modification of various adsorption desorption process, chelation of Zn, cation exchange capacity, pH, soil structure and microbial transformation and increase or decrease the Zn availability to plants. Farmyard manure is a decomposed dung/ urine from livestocks plus their left over/faeces” [10]. “FYM is old manure in use by farmers for growing crops because of its early mineralization and availability of almost every nutrient required in plants” [11].

[12] reported that farmyard “manure determines many soil properties such as nutrients availability, aggregate stability, aeration, and favorable water uptake and retention characteristics.” [13] “Observed the use of Farmyard manure also increased the concentration of nitrogen and Zn. The application of 120 kg N + 10 tones FYM + 5 kilograms of Zn per hectare increased plant Zn uptake, stover and grain yields” [14]. Sole Zn fertilizer application without organic amendment of Zn can render Zn to be fixed and is therefore not utilized by the crop [15]. [16] “Observed the highest maize grain yield, Zn content and uptake with the combined application of five ton FYM and 16 kg $ZnSO_4$ ha^{-1} every year.” [17] Reported that wheat crop also enhanced Zn utilization with FYM application.

The incorporation of farmyard manure into arable soil is an age-old practice and universally accepted. This study was necessitated in order to test the application of FYM and Zinc fertilizer rates on yield of wheat *(Triticum aestivum* L.).

2. METHODOLOGY

The experiment was carried out in Screened House Facility, Faculty of Agriculture, University of Maiduguri in cool season of 2019 in a Completely Randomized Design (CRD). Composite 10 kg soil was weighed into 36 pots and treatments applied. Reyna 28 wheat seed obtained from Lake Chad Research Institute (LCRI) Maiduguri was used for the pot experiment. Six (6) wheat seedlings were allowed to grow to maturity from each pot. The pots were kept clean from weeds.

Two weeks before sowing, to appropriate pots, farmyard manure (FYM) was applied at 0, 5, 10 and 15 t/ha equivalent to 0, 25, 50, 75g FYM per 10 kg pot. To appropriate pot, zinc sulphate ($ZnSO_4.7H_2O$) fertilizer was applied at three levels 0, 5 and 10 mg/kg equivalent to 0, 10 and 20kg Zn/ha as solution. NPK fertilizer at the rates of 50, 22.5 and 28.38 mg per kg N, P and K (100Kg N, 45Kg P and 57Kg K) ha^{-1} as NH_4NO_3 and KH_2PO_4 were applied to all pots. Moisture in the pots were maintained thoroughly.

The sample soil was analysed for chemical and physical properties. Texture distribution was done following hydrometer method of [18] Soil pH and EC were determined with soil-water ratio of 1:2.5. OC determined by [19] dichromate oxidation procedure [20] method. "Exchangeable cations determined by saturation using 1N NH_4OAc (pH7.0) method" [21]. "Flame photometre method was used to determine Na and K. Ca and Mg were determined by titration method against EDTA using eriochrome black TEA indicator. Exchangeable acidity was done following the procedure of extraction with 1N KCl and measured according to the procedure of" [22]. "Total nitrogen was determined by micro-Kjeldahl digestion method of "[23], "while available phosphorus was determined using Bray II method as described by" [24]." FYM was analysed following the method of plant analysis given by" [25]. "0.2g of prepared cow dung FYM was weighed into a beaker and 2.5ml concentrated H_2SO_4 and $HClO_4$ acid and placed on a hot plate and heated at 180-200 ^0C until a clear digest is obtained. NPK and Zn was then determined from the digest. Diethylene triamine penta acetic acid (DTPA) was used to extract soil Zn" [26] and then determined using VGP 210 atomic absorption spectrophotometre.

2.1 Total Dry Matter Yield (g)

At physiological maturity, wheat was harvested when the colour of the crop turned into yellow. Wheat was cut at 2cm using clean stainless steel scissors from each pot, inserted into envelope, dried at 65 ^0C in an oven for 24 hours. Electrical balance M10001 model was used to weigh and recorded as total dry matter yield (g/pot).

2.2 Grain Yield (g)

Grains were separated manually from each treatment and weighed using same electrical balance and recorded (g/pot).

2.3 1000 Grain Weight (g)

After harvest, 100 grains were collected from each treatment and weighed using laboratory electrical balance. This was multiplied by 10 to obtain 1000-grain weight in grams.

2.4 Harvest Index (%)

The harvest index was calculated by dividing the total grain weight by the total biomass for each treatment and expressed in percentage.

2.5 Statistical Analysis

"Data obtained from the pot experiment were statistically analyzed according to the technique of analysis of variance (ANOVA) for the Completely Randomized Design (CRD) using Statistix computer software package. The treatment means were compared using Duncan Multiple Range Test (DMRT) at 1 and 5 % level of significance as described by" [27].

3. RESULT AND DISCUSSION

3.1 Characteristics of the Experimental Soil and Cow Dung Farmyard Manure Used

Physico-chemical characteristics of the soil and Cow dung FYM are shown in Tables 1 and 2. The textural class of the soil was Sandy clay loam with sand, silt and clay content of 582, 114 and 304 gkg^{-1} soil (Table 1). The pH of the soil was 7.20 (slightly alkaline) with electrical conductivity (EC) of 0.02 mmhos/cm (non-saline). Phosphorus (16.10 mgkg-1), organic carbon (12.99 gkg-1), potassium (0.50 Cmol(+)/kg and sodium (0.48 cmol(+)/kg soil) were all moderate. Base saturation was 94.86% and calcium was 24.4 cmol(+)/kg read as very high. Cation Exchange Capacity (CEC) was 38.78 Cmol(+)/kg soil which was high, total

nitrogen was 0.76% interpreted as very low and moderate DTPA extractable zinc with value 1.12 $mgkg^{-1}$. Cow dung FYM contain N, P, K and Zn were 3.22, 0.38, 0.43 % and 1.84 μgg^{-1} as presented in Table 2.

3.2 Effect of FYM and Zn Fertilizer Rates on Wheat Total Dry Matter Weight, Grain Yield, 1000 Grain Weight and Harvest Index

The result in Table 3 shows effect of FYM and Zn fertilizer rates on wheat total dry matter weight, grain yield, 1000 grain weight and harvest index.

Total dry matter weight (TDMW) had shown significant (P<0.01) difference with the varying rates of FYM and Zn fertilizers. It ranged from 39.00g (control) to 55.50g (10t /ha FYM + 0 ppm Zn fertilizer rates).

Wheat grain yield differed significantly (P<0.01) between the treatments. The highest wheat grain yield (23.40g) was observed at 5t/ha FYM + 5ppm Zn and the lowest (16.07g) at 10 t/ha FYM + 5 ppm Zn rates. Wheat straw yield also varied significantly (P<0.01) with FYM and Zn fertilizer rates. The highest (36.47g) straw yield was given by 10 t/ha FYM + 0 ppm Zn rates and the lowest (23.90 g) by the control.

Significant (P<0.01) difference was observed between 1000 wheat grain weight in control and the following treatments: 0 t/ha FYM + 10 ppm Zn, 5 t/ha FYM + 5 ppm Zn, 10 t/ha FYM + 5 ppm Zn, 10 t/ha FYM + 10 ppm Zn and 15 t/ha FYM + 0 ppm Zn rates with values of 35.67, 36.67, 35.33, 36.33 and 35.00 g respectively. The highest (36.67 g) mean wheat 1000 grain weight was observed with application of 5 t/ha FYM + 5 ppm Zn and the lowest (31.67 g) with 5 t /ha FYM + 0 ppm Zn.

Table 1. Physico-chemical properties of the soil sample used

Characteristic	Value
pH 1:2.5 (H_2O)	7.20
EC (mmhos/cm)	0.02
Organic carbon (g/kg)	12.99
% N	0.76
C:N ratio	17.09
Available P (mg/kg)	16.10
Available Zn (mg/kg)	1.12
Exchangeable cations (Cmol/kg)	
Ca	24.40
Mg	13.40
K	0.50
Na	0.48
Exchange acidity (H +Al)	2.10
CEC	38.78
ECEC	40.88
Base saturation (%)	94.86
Particle size distribution (g/kg)	
Sand	582
Silt	114
Clay	304
Textural class	Sandy clay loam

Table 2. Characteristics of cow dung farmyard manure used

Nutrient	Content
N (%)	3.22
P (%)	0.38
K (%)	0.43
Zn (µg/g)	1.84

Table 3. Effect of FYM and Zn fertilizer rates on wheat total dry matter weight, grain yield, 1000 grain weight and harvest index

Treatment	TDMW (g)	Grain yield (g)	1000 grain weight (g)	Harvest index (%)
Control	39.00^{e}	16.60^{g}	32.00^{e}	42.33^{ab}
0t/ha FYM + 5 ppm Zn	49.50^{bc}	19.40^{d-f}	33.00^{cde}	39.67^{bcd}
0t/ha FYM + 10 ppm Zn	50.67^{b}	21.10^{bc}	35.67^{abc}	41.33^{abc}
5t/ha FYM + 0ppm Zn	45.00^{d}	18.10^{f}	31.67^{e}	40.33^{bc}
5t/ha FYM + 5 ppm Zn	53.00^{ab}	23.40^{a}	36.67^{a}	44.33^{a}
5t/ha FYM + 10 ppm Zn	45.67^{cd}	19.45^{d-f}	32.67^{de}	42.67^{ab}
10t/ha FYM + 0 ppm Zn	55.00^{a}	19.67^{c-e}	32.00^{e}	35.67^{e}
10t/ha FYM + 5 ppm Zn	44.33^{d}	16.07^{g}	35.33^{abcd}	36.33^{de}
10t/ha FYM + 10 ppm Zn	46.67^{cd}	20.75^{cd}	36.33^{ab}	44.67^{a}
15t/ha FYM + 0 ppm Zn	50.67^{b}	19.20^{ef}	35.00^{abcd}	38.00^{cde}
15t/ha FYM + 5 ppm Zn	52.00^{ab}	22.30^{ab}	33.67^{bcde}	43.00^{ab}
15t/ha FYM + 10 ppm Zn	46.67^{cd}	20.60^{cde}	33.67^{bcde}	44.00^{a}
SE±	1.3463	0.4931	0.9954	1.2360

Means following same letter(s) within a column are not significantly different at 0.05 level of probability according to DMRT

Harvest index (HI) of wheat significantly ($P<0.01$) differed between control and some treatments. Higher HI was observed with 10 t /ha FYM + 10 ppm Zn and the lowest with 10 t /ha FYM + 0 ppm Zn rates with values of 44.67 and 35.67 % respectively.

3.3 Effect of FYM and Zn Fertilizer Rates on Yield Components of Wheat

Wheat grain yield were significantly affected ($P<0.05$) with different treatments of both FYM and Zn rates. [28] found similar results who stated that application of zinc fertilizer increased wheat grain yield, dry matter and straw yield significantly in comparison to zero treatment. Attainment of higher yield is the ultimate goal of fertilizer use in crop production [29]. Ebaid [30] also reported significant increase in wheat grain when the rate of FYM increased from 20 to 30 t ha^{-1}. 5t/ha FYM + 5ppm Zn and 10t/ha FYM + 0 ppm Zn fertilizer rates gave the best yield for wheat grain and TDMW. This fertilizer rates not only improved wheat grain yield but could also provide long term effects on nutrients availability.

It was reported that increasing levels of zinc increased wheat and maize yields [31]. Both FYM and Zn fertilizers increased wheat grain yield and TDMW as similar to findings of Kanchikerimath and Singh [32] who reported that organic manure supplemented with mineral fertilizers enhanced the crop yields. Application of FYM and Zn fertilizer rates have shown significant results on 1000 wheat grain weight and HI. Higher 1000 grain weight was recorded with the combination of 5t/ha FYM + 5ppm Zn fertilizer rates. Findings by [33] observed that considerable increase in 1000-grain weight of wheat by addition of Zn fertilizer and same was found by [34] and [33]. Similar findings were also reported by [35] who stated that application of Zn had a significant effect on the growth/ yield of wheat. FYM and Zn fertilizer rates significantly improved harvest index of wheat grain. 10 t/ha FYM + 10 ppm Zn was found to be optimally higher among the treatments. Similar result was obtained by Firdous et al. [36] with FYM and Zn fertilizer effects on wheat crop.

4. CONCLUSION

FYM and Zn fertilizers had positively contributed to wheat grain. Application of 5t/ha FYM + 5ppm Zn and 10t/ha FYM + 0 ppm Zn fertilizer rates gave the best yield for wheat grain and TDMW while 10t/ha FYM + 10ppm Zn gave the highest HI result.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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