Effects of Farmyard manure (FYM) and Zinc fertilizer rates on growth and yield of wheat (*Triticum aestivum* L.) Grown on Sandy-clay Loam of Maiduguri, Borno State.

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ABSTRACT

A study was carried out in Screen house in University of Maiduguri to study the effects of Farmyard manure (FYM) and Zinc fertilizer rates on wheat (*Triticum aestivum* L.) yield grown on sandy clay loam, from November 2019 to February, 2020 in CRD replicated 3 thrice. Ten (10) Kg soil was weighed into each pot, four rates of FYM; 0, 5, 10 and 15t/ha and three rates of Zn fertilizer; 0, 5 and 10 mg/kg treatment combinations with basal NPK fertilization were added to the appropriate pot. Soil, FYM and plant analyses for Zn concentrations were carried out for wheat grain, leaf and straw and their uptake. Agronomic data on wheat were collected. Result obtained showed improved wheat yield with the tallest plant produced by 0t/ha FYM + 5ppm Zn, while 5t/ha FYM + 5ppm Zn and 10t/ha FYM + 0 ppm Zn fertilizer rates gave the best yield for wheat grain and TDMW. It was concluded that application of FYM and Zn fertilizer had increased wheat grain and TDMW yield.

Keywords: farmyard manure, sandy-clay loam, wheat, yield

INTRODUCTION

Wheat (*Triticum aestivum* L.) is cultivated on more land mass than all cereals, approximately 220.4 million hectares (FAOSTAT, 2014). Wheat cultivated for its important grain and nutritive characteristics. It is utilized in bread, feed, confectionary production etc.

Wheat is grown in Nigeria for years (Ohiagu *et al*., 1987). Huge evidence exists showed that wheat is grown since 200BC (Olabanji *et al*., 2007). 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 (Curtis and Halford, 2014). Structure of wheat grain partitioned viz; bran (14-16%), embryo (2-3 %) and endosperm (81-84%) (Mousia *et al*., 2004).

Zinc (Zn) is among the 17 important nutrients elements required development and growth of wheat. Zn is essential in respiration and photosynthesis (Fu *et al*.,2016).

Zn deficiency occurred in humans and crops (Welch and Graham, 2004). Deficiency of Zn on soils/plants is a world problem in deficiency (Alloway, 2004).

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

(Reddy, 2005). 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 (Parshottam et al., 2018).

Shukla *et al*. (1978) reported the beneficial effect of farmyard manure on crop yield and the availability of zinc to plants. Gondek and Mazur (2005) 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 (Karki *et al*., 2005). Petal et al. (2008) observed the highest maize grain yield, Zn content and uptake with the combined application of five-ton FYM and 16 kg ZnSO4 ha^{-1} every year. Rupa *et al*. (2003) 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.).

METHODOLOGY

Pot Experiment

A pot experiment was done in Screened House Facility at the Faculty of Agriculture, University of Maiduguri from November 2019 to February, 2020. Ten (10 kg) of composite prepared soil was measured into all pots and the appropriate treatment applied. Wheat crop (LACRI WHIT 6 REYNA-28) obtained from Lake Chad Research Institute (LCRI) Maiduguri was used as the test crop. Nine (9) wheat seeds were sown and thinned to six (6) seedlings one week after germination which were allowed to grow to maturity. Weeds were removed by hand picking using hand when necessary to ensure that crops were kept weed free throughout the experiment.

FYM and Zn fertilizer application

Cow dung FYM was applied at four levels viz., 0, 5, 10 and 15 tonnes per hectare equivalent to 0, 25, 50, 75g FYM per 10 kg pot soil to appropriate treatment and thoroughly mixed with the soil two (2) weeks before sowing. Zinc fertilizer as $ZnSO_4.7H_2O$ at three levels 0, 5 and 10 mg/kg equivalent to 0, 10 and 20kg Zn/ha was also surface applied as solution to the appropriate pot. Basal NPK fertilizer was also surface applied to all pots at the rates of 50, 22.5 and 28.38 mg per kg N, P and K equivalent to100Kg N ha^{-1}, 45Kg P ha^{-1} and 57Kg Kha^{-1} respectively in the form of NH_4NO_3 and KH_2PO_4 at sowing. Equal quantity of water was supplied to each pot to maintain soil moisture at field capacity.

Treatment and experimental design

The pot experiment was carried out with four rates of cow dung FYM (0, 5, 10 and 15t/ha) and three levels of Zn (0, 5 and 10 ppm) giving a total of twelve (12) treatments which were replicated thrice giving a total number of 36 pots. The study was done in a CRD.

Composite soil sample collected was analysed before the experiment for physico-chemical properties and DTPA extractable Zn. The texture distribution done by method of hydrometer as given by Bouyoucos, 1962. Soil sample pH done using soil-water (1:2.5) ratio and used for EC. Organic C. done method of Walkley and Black (1934) dichromate oxidation procedure (Nelson and Sommers, 1982). Basic cations of the soil was determined by using 1N NH_4OAc (pH7.0) saturation method (Chapman, 1965). Sodium and potassium were determined using flame photometric method while calcium (Ca) and Magnesium (Mg) were determined by titration method against EDTA using eriochrome black TEA indicator. Exchangeable acidity was extracted with 1N KCl and measured according to the procedure of Mclean (1982). Total nitrogen was determined by micro-Kjeldahl digestion method (Jackson, 1962). The analysis of FYM was done following the method of plant analysis by Marr and Cresser (1983). 0.2g of prepared cow dung FYM was weighed into a beaker and

2.5ml concentrated H_2SO_4 and HClO4 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.

Soil zinc was extracted using diethylene triamine penta acetic acid (DTPA); 10g of soil was shaken with 20ml of DTPA extractant (0.005M, DTPA and 0.01M $CaCl_2$+0.1M triethanol amine adjusted to pH 7.3)

Agronomic data collection

Plant height (cm)

At time of harvest, the plant height of wheat was measured using a graduated long tape from bottom to top of spike in centimetres and recorded. Four (4) plant stands were selected in each treatment at random for this purpose and the average was recorded.

Spike length (cm)

From the above four (4) randomly selected stands used for measuring plant height one spike length from each of the four (4) stands were measured using a graduated long tape from bottom of spike to upper tip of spike in centimetres and the average was recorded.

Number of spikelets per spike

From the four (4) randomly selected stands used for measuring plant height and spike length, number of spikelets from each four (4) selected stands was counted and their average was recorded from each experimental pot unit.

Total dry matter yield (g)

Wheat was harvested at physiological maturity when the colour of the crops turned to yellow and started to dry. This was done by cutting at 2cm above the soil surface by using a clean stainless steel scissors from each pot, oven dried at 65 0C for 24 hours, weighed on electrical balance M10001 model and was referred to as total dry matter yield (above ground total biomass) and recorded in g/pot.

Grain yield (g)

After weighing for the total dry matter, the spikes were cut off from the stems. The grains were separated manually from the spikes and weighed using electrical balance M10001 model and recorded in g/pot in each pot.

Straw yield (g)

The straw yield of wheat was calculated from the difference of total dry matter yield and respective grain yields and recorded in g/pot in each pot.

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.

Harvest index (%)

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

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.

RESULTS

Effect of FYM and Zn Fertilizer Rates on Wheat Plant Height, Spike Length, Total Dry Matter Weight, Grain Yield and Number of Spikelets per Spike

The result in Table **1** shows effect of FYM and Zn fertilizer rates on wheat plant height, spike length, total dry matter weight, grain yield and number of spikelets per spike. There was highly significant difference (P<0.01) between the treatments in relation to wheat plant height. The highest (80.51 cm) plant height was given by 0 t/ha FYM + 5 ppm Zn fertilizer rates while the lowest (72.87 cm) was given by 5t/ha FYM + 10 ppm Zn fertilizer rates which was similar to the control treatment. Treatments 5t/ha FYM + 10 ppm Zn, 10 t/ha FYM + 0 ppm Zn, 10t/ha FYM + 5ppm Zn, 10t/ha + 10 ppm Zn, 15t/ha + 0 ppm Zn, 15t/ha + 5ppm Zn and 15t/ha + 0 ppm Zn all varied significantly with the control.

Application of FYM and Zn fertilizer rates had no significant (P>0.05) difference on wheat spike length. Spike length ranged from 15.18 cm in treatment 15t/ha FYM + 5 ppm rates to 16.34 cm in treatment 0 t/ha FYM + 5 ppm Zn rates. 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. Number of spikelets per spike of wheat had shown significant (P<0.01) difference between control and all treatment rates. The lowest (49.25 cm) number of spikelets per spike was observed in control and highest (63.38 cm) in the treatment 5 t/ha FYM + 10 ppm Zn rates.

Table 1. Effect of FYM and Zn fertilizer rates on wheat plant height, spike length, total dry matter weight, grain yield and number of spikelets per spike.

Treatment	Plant height (cm)	Spike length (cm)	TDMW (g)	Grain yield (g)	Straw yield (g)	No. of spikelets /spike
Control	73.38^{d}	15.68^{ab}	39.00^{e}	16.60^{g}	23.90^{e}	49.25^{h}
0t/ha FYM + 5 ppm Zn	80.51^{a}	16.34^{a}	49.50^{bc}	19.40^{d-f}	30.10^{bc}	53.38^{g}
0t/ha FYM + 10 ppm Zn	77.190^{bc}	16.09^{a}	50.67^{b}	21.10^{bc}	29.57^{bc}	56.75^{ef}
5t/ha FYM + 0ppm Zn	75.19^{cd}	15.68^{ab}	45.00^{d}	18.10^{f}	27.87^{cd}	60.13^{bcd}
5t/ha FYM + 5 ppm Zn	80.27^{ab}	15.81^{ab}	53.00^{ab}	23.40^{a}	29.60^{bc}	60.90^{abc}
5t/ha FYM + 10 ppm Zn	72.87^{d}	15.96^{ab}	45.67^{cd}	19.45^{d-f}	27.57^{cd}	63.38^{a}
10t/ha FYM + 0 ppm Zn	79.51^{ab}	15.81^{ab}	55.00^{a}	19.67^{c-e}	36.47^{a}	62.50^{ab}
10t/ha FYM + 5 ppm Zn	77.94^{ac}	16.02^{ab}	44.33^{d}	16.07^{g}	29.93^{bc}	59.04^{cde}
10t/ha FYM + 10 ppm Zn	78.85^{ab}	15.99^{ab}	46.67^{cd}	20.75^{cd}	25.92^{de}	56.13^{fg}
15t/ha FYM + 0 ppm Zn	77.83^{ac}	16.30^{a}	50.67^{b}	19.20^{ef}	31.47^{b}	53.25^{g}
15t/ha FYM + 5 ppm Zn	77.34^{bc}	15.18^{b}	52.00^{ab}	22.30^{ab}	29.70^{bc}	58.13^{cdef}
15t/ha FYM + 10 ppm Zn	77.55^{ac}	15.77^{ab}	46.67^{cd}	20.60^{cde}	26.07^{de}	57.77^{def}
SE±	1.0760	0.3105	1.3463	0.4931	1.0143	0.9976

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

Effect of FYM and Zn Fertilizer Rates on Wheat 1000 Grain Weight and Harvest Index

Table **2** presents the effect of FYM and Zn fertilizer rates on wheat 1000 grain weight and harvest index. 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.

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.

Table 2: Effect of FYM and Zn fertilizer rates on 1000 grain weight and harvest index of wheat

Treatment	1000 grain weight (g)	Harvest index (%)
Control	32.00[e]	42.33[ab]
0t/ha FYM + 5 ppm Zn	33.00[cde]	39.67[bcd]
0t/ha FYM + 10 ppm Zn	35.67[abc]	41.33[abc]
5t/ha FYM + 0ppm Zn	31.67[e]	40.33[bc]
5t/ha FYM + 5 ppm Zn	36.67[a]	44.33[a]
5t/ha FYM + 10 ppm Zn	32.67[de]	42.67[ab]
10t/ha FYM + 0 ppm Zn	32.00[e]	35.67[e]
10t/ha FYM + 5 ppm Zn	35.33[abcd]	36.33[de]
10t/ha FYM + 10 ppm Zn	36.33[ab]	44.67[a]
15t/ha FYM + 0 ppm Zn	35.00[abcd]	38.00[cde]
15t/ha FYM + 5 ppm Zn	33.67[bcde]	43.00[ab]
15t/ha FYM + 10 ppm Zn	33.67[bcde]	44.00[a]
SE±	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

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

Wheat plant height, straw and grain yield were significantly affected (P<0.05) with different treatments of both FYM and Zn rates. The results are same with findings of Asad and Rafique (2000) 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 (Daramola *et al*., 2004). Ebaid (2000) also reported significant increase in wheat grain when the rate of FYM increased from 20 to 30 t ha-1. Dixit and Gupta (2000) have confirmed improvement in crop heights with the use of organic materials that could be attributed to improvement in soil characteristics, vigorous root growth and optimum nutrient uptake including Zn. Tallest plant were produced by 0t/ha FYM + 5ppm Zn, while 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. Sushila and Girri (2000) found that incorporation of FYM at the 10 t ha-1 produced tallest wheat plants as compared to control treatments. Singh et al. (2012) found that increasing levels of zinc increased wheat and maize yields. In general higher yield components were observed with both FYM and Zn fertilizer which corroborate with the findings of Kanchikerimath and Singh (2001) who reported that organic manure supplemented with mineral fertilizers enhanced the crop yields. The favorable effect of applied Zn is because of its stimulatory effect on most of the physiological and metabolic process of plants (Mandal *et al*., 2009).

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 Khan *et al*., 2009 observed that considerable increase in 1000-grain weight of wheat by addition of Zn fertilizer and same was found by Butt *et al*. (1995) and Khan et al. (2009). Similar findings were also reported by Abbas et al. (2009) 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*. (2018) with FYM and Zn fertilizer effects on wheat crop.

Investigating the relationship between wheat leaf Zn content and straw and grain Zn uptake with wheat grain yield revealed that leaf Zn content and wheat straw and grain Zn uptake had contributed to wheat grain yield in this study which were positively correlated.

CONCLUSION

It was concluded that application of FYM and Zn fertilizer had increased wheat grain and TDMW yield. 5t/ha FYM + 5ppm Zn and 10t/ha FYM + 0 ppm Zn fertilizer rates gave the best yield for wheat grain and TDMW.

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