Influence of Farmyard Manure and Urea Fertilizer on Phosphorus and Potassium Content in Grain and Straw of Maize (*Zea mays* L.) on a Sandy Loam Soil

A. Ibrahim[1], M. L. Bubarai[2], A. M. Tahir[3]

[1, 3]Department of Soil Science Modibbo Adama University of Technology, Yola

[2]Department of Soil Science, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad 211007, U.P., India

Abstract: ***A rain fed field experiment was conducted during the 2016 rainy season with the objective of investigating the influence of combined application of farmyard manure, FYM, and urea fertilizer on the phosphorus and potassium content in grain and straw of maize (Zea mays L.) on the sandy loam soils of Modibbo Adama University of Technology, Yola, Teaching and Research farm. The experiment was laid out based on randomized complete block design. Treatments applied consisted of five levels of farmyard manure at 0, 2.5, 5.0, 7.5 and 10tons ha^{-1} and five levels of urea fertilizer at 0, 50, 75, 100 and 125kg urea per hectare. Results obtained revealed that the interaction effects of farmyard manure and urea fertilizer significantly ($P\geq0.05$) influenced phosphorus and potassium content in maize grains and straw. Application of urea up to 75kg per hectare rate and beyond with up to 5.0t/ha FYM and above either solely or in combination produced positive responses. The result showed that 125 kg urea per hectare with 10t/ha FYM resulted in the highest content of phosphorus and potassium in both grains and straw. This tremendous effect indicate that increase in P and K contents were greater for treatment which received combination of FYM and urea than urea alone, and even far greater than treatment with FYM alone. At 100 kg urea per hectare in combination with the various levels of FYM the result revealed significant ($P\geq0.05$) effect which recorded higher grain P and K contents than combination of FYM with 125 kg urea per hectare.***

Keywords: FYM, Urea Fertilizer ,P , K and Maize grain

1. Introduction

Combined application of organic and inorganic fertilizers is an accepted strategy for soil fertility management. Manure is an excellent fertilizer containing nitrogen, phosphorus, potassium and other important plant nutrients in organic form. Its decomposition in soil adds organic matter to the soil which may improve the physical and chemical properties of soil (Tadesse *et al.,* 2013).) However, nutrient content of manure and its contribution to soil fertility varies depending on source, moisture content, storage, and handling methods (Hassanien *et al., 2017*). In general, the nutrients in manures are not water-soluble and are released to the plants slowly over a period of months or even years after decomposition. For this reason, manures are best applied in the dry season so the nutrients will be available in the rainy season. These manures stimulate the activities of beneficial soil microorganisms. Soil microbes play an important role in the decomposition of manure in soil and can provide all the secondary and micronutrients needed by plants for growth and development.

Synthetic fertilizers such as urea are water-soluble and easily ionisable, and can be taken up by plant roots almost immediately. In fact applying too much synthetic fertilizer can "burn" foliage and damage plants. Synthetic fertilizers give plants a quick boost but do little to stimulate soil life or improve soil sructure, or even improve soil's long-term fertility. Synthetic fertilizers are highly water-soluble and are available to plants even when the soil is cold and soil microbes are inactive.

Phosphorus stimulates root growth, helps the plant set buds and flowers, improves vitality and increases seed size. It does this by helping transfer energy from one part of the plant to another. To absorb phosphorus, most plants require a soil pH of 6.5 to 6.8. Organic matter and the activity of soil organisms also help increase the availability of phosphorus in the soil.

Potassium improves overall vigor of the plant. It helps the plants make carbohydrates and provides disease resistance. It also helps regulate metabolic activities. According to Prajapati and Modi (2012)., the exact function of K in plant growth has not been clearly defined. Potassium is associated with movement of water, nutrients, and carbohydrates in plant tissue. If K is deficient or not supplied in adequate amounts, growth is stunted and yields are reduced. Various research efforts have shown that potassium stimulates early growth, increases protein production, improves the efficiency of water use, vital for stand persistence, longevity, and winter hardiness of alfalfa, and improves resistance to diseases and insects.

Moore *et al.* (2011) reported that nutrient uptake and subsequent nutrient content is affected by environmental conditions, management practices, the concentration of nutrients and the form in which nutrients are present in the soil. According to Adesoji *et al.* (2015), uptake of nutrients and their distribution to various parts of the maize plant varied primarily with factors like native soil fertility, applied chemical fertilizers, growth stage of the plant and environmental conditions.

The objective of this study is to investigate on the influence of combined application of farmyard manure, FYM and urea fertilizer on the phosphorus and potassium contents in the grain and straw of maize (Zea mays L.) on the sandy loam soils of Modibbo Adama University of Technology, Yola, Teaching and Research farm.

2. Materials and Methods

A rain fed field experiment was conducted during the 2016 rainy season with the objective of investigating the influence of combined application of farmyard manure and Urea fertilizer nitrogen on the phosphorus and potassium content in grain and straw of maize (Zea mays L.) on the sandy loam soils of Modibbo Adama University of Technology, Yola, Teaching and Research Farm located on Latitude 9^{o} 16' N and Longitude 12^{o} 35' E at 152m above sea level in the Northern Guinea Savannah agro-ecological zone. The location has an average annual rainfall of 700mm to 1000mm and temperature ranges from 15.2 – 39^{o}C. Temperature characteristics in Adamawa State are typical of the West African savanna climate. Temperature in this climatic region is high throughout the year because of high radiation, which is relatively evenly distributed throughout the year (Adebayo, 1999).

Laboratory analysis

Particle size distribution was determined by Bouyous hydrometer method (Gee and Or, 2002). Soil pH was measured electrometrically using glass electrode pH meter in a soil-water ratio of 1:2.5 (Hendershot *et al.,* 1993). Total nitrogen was determined by micro-Kjeldahl digestion technique method (Bremner, 1996). Exchangeable bases were determined by the neutral ammonium acetate procedure buffered at pH 7.0 (Thomas, 1982). Exchangeable acidity was obtained according to McLean (1982). Total carbon was analyzed by wet digestion (Nelson and Sommers, 1982). Phosphorous was determined by Bray ll method according to the procedure of Nelson and Sommers (1982). Cation Exchange Capacity was determined using neutral ammonium acetate leachate method (Summer and Miller, 1996).

3. Results and Discussion

Physical and Chemical Properties of the Experimental Soils

The result of the analysis of surface soil samples (0 – 20 cm) carried out prior to the experiment showed that the soils of the experimental site is sandy loam, classified as Typic-Haplustalf (Musa *et al., 2007*). The pH of the soil is near neutral with very low electrical conductivity, low N, P and K contents. It is quite apparent that the fertility status of the soil is low as reported for similar soils by several workers (Zhao *et al.*,2009; Tadesse *et al.*, 2013 and Hassanien *et al., 2017).* The low organic carbon content means low organic matter which might not be unconnected with the scanty vegetation cover and high rate of organic matter decomposition in the area due to high temperature. Marked response is therefore expected from the application of farmyard manure in combination with mineral fertilizer such as urea to improve and maintain the fertility of the soil as reported by Hassanien *et al.(2017).*

Phosphorus Content in Maize Grains

Results for the phosphorus content of maize grains as shown in Table 3 indicate that significant (p>0.05) effect on phosphorus content of grains due to combined application of FYM and urea. The result showed increase in grain P content with each increase in urea rate given a range of percent increase from 5% to 52%. At 100 and 125 kg urea per hectare the P content was 0.33% and 0.32% corresponding to about 57% and 52% increase over the control, respectively. This finding is in line with that of Moore *et al.* (2011) and Zhao *et al. (2009)* who reported increased yield and P and N contents of maize grains when P and N were applied although increase in grain P content was observed due to FYM application with only about 3.70% increase over control. The interaction results showed increases in grain P at higher urea and FYM rates even though significant effects due to combined application of urea an FYM were not observed. This result is in consonance with report of Ademiyan *et al. (2011).*

Phosphorus Content in Maize Straw

The results in Table 4 show the phosphorus content of maize straw at harvest. Comparison among the urea means showed that urea application significantly (P>0.05) affected phosphorus content of straw. Percentage increase over control ranged from 25% at 75kg urea per hectare to 50% at 100 kg urea per hectare and 125 kg urea per hectare. The results suggest that urea rate of 100 kg urea per hectare is ideal for optimum P content in maize straw. Application of FYM was only significant (P>0.05) beyond 5.0 t/ha which gave higher increases in P content of straw when in combination with urea. It is therefore effective to apply higher levels of FYM so that the beneficial effects on soil structure will also show. The interaction results showed significant (P>0.05) effect with the highest interaction effect of 0.08 occurring at the combination of 100 kg urea per hectare with 7.5t/ha FYM, even though up to 125kg urea per hectare the effect is still significant. These results therefore further demonstrate the beneficial effect of the application of urea in combination with FYM.

Potassium Content in Maize Grains

Results presented in Table 5 show the K content of maize grains as affected by the application of urea and FYM. The results for the urea means reveal that the application of urea fertilizer significantly (P> 0.05) increased the K amount in grains, which increased from 2% to a little more than 3% corresponding to a percent increase over control ranging from 33% to about 55% at 50 kg urea per hectare to 125 kg urea per hectare, respectively. The result for FYM means showed that increase in K content of grains occurred at 7.5t/ha and 10t/ha FYM which however were not significant indicating that FYM alone had no significant effect on grain K content. The interaction result showed that combined application of N fertilizers with FYM significantly (P>0.05) increased the K content of grains. The highest values were observed with 125kg urea per hectare in combination with FYM at 7.5 and 10t/ha. These therefore indicate that sole application of FYM or urea will have no significant benefit.

Potassium Content in Maize Straw

Results in Table 6 reveal that application of urea in combination with FYM had significant (P>0.05) effect on the K content of maize straw. The result for the N means showed that increasing rates of urea fertilizer progressively increased the K content of maize straw. The highest value of 2.01% was obtained at 125kg urea per hectare followed by 1.84% at 100kg urea per hectare and 1.76% at 75kg urea per hectare. The response was low for 50kg urea per hectare when compared with control. This result therefore indicate that application of N enhanced K utilization by the maize plant because the percent increase over control increased from about 30% at 50kg per hectare urea to about 99% at 125kg per hectare urea. The result for the FYM means also show significant (P>0.05) effect on the K content of straw due to FYM application but the effect is however low compared to that due to the application of urea. Percent increases over the control ranged from 1% at 2.5t/ha FYM to about 25% at 10t/ha FYM with the highest mean value of 1.77%. Interaction results showed that combined application of N fertilizer along with FYM significantly (P>0.05) affected the K content of straw. The highest value of 2.13% was observed when 125 kg urea per hectare was combined with 10t/ha FYM indicating about 117% increases over the control. However, the results generally suggest that 75kg and 100kg urea per hectare in combination with 7.5t/ha FYM is adequate since the results showed good response to K content which is in conformity with the report by Zhao *et al (2009).*

4. Conclusion

This study was conducted with the objective of investigating the influence of combined application of farmyard manure, FYM, and urea fertilizer on the phosphorus and potassium content in grain and straw of maize (Zea mays L.) on the sandy loam soils of Modibbo Adama University of Technology, Yola, Teaching and Research farm. Results obtained demonstrated significantly beneficial effects of the combined application of farmyard manure and urea on the phosphorus and potassium contents of maize grain and straw. Significant responses due to application of 75kg and 100kg per hectare urea in combination with 5.0t/ha FYM and above were obtained. The result showed that 125kg per hectare urea with 10t/ha FYM resulted in the highest content of phosphorus and potassium in both grains and straw. This tremendous effect indicate that increase in P and K contents were greater for treatment which received combination of FYM and urea than urea alone, and even far greater than treatment with FYM alone. In conclusion therefore, combined application of 100kg per hectare urea with various levels of FYM is preferred for optimum phosphorus and potassium contents in maize grain and straw.

5. Conflict of Interest

Authors do hereby declare that there is no conflict of interest that would possibly arise.

6. Acknowledgements

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Table1: Physical and Chemical Properties of the Soils of the Experimental Site

Parameters	Values
Sand (%)	64.10
Silt (%)	21.11
Clay (%)	14.79
Textural Class	Sandy Loam
pH (water) 1:2.5 pH (KCl) 1:2.5 Electrical conductivity (mmhos/cm)	6.22 5.38 0.15
Organic carbon (g/kg)	1.42
Total nitrogen (g/kg)	0.09
Available phosphorus (mg/kg) Exchangeable Potassium (cmol/kg)	7.60 0.29
Exchangeable Calcium (cmol/kg)	4.27
Exchangeable Magnesium (cmol/kg)	1.19
Cation Exchange Capacity (meq/100g)	4.75

Table 2: Nutrients Content of Farmyard Manure

Parameters	Values (%)
Total N	0.91
Total P_2O_5	0.65
Total K_2O	1.15

Table 3: Phosphorus Content (%) in Maize Grains

	Farm Yard Manure Levels (t/ha)						% increase
Urea Levels (kg/ha)	0	2.5	5.0	7.5	10.0	Urea means	over control
0	0.21	0.20	0.21	0.22	0.20	0.21	00.00
50	0.20	0.22	0.23	0.23	0.23	0.22	4.76
75	0.27	0.25	0.25	0.29	0.31	0.27	28.57
100	0.33	0.32	0.33	0.34	0.34	0.33	57.14
125	0.34	0.34	0.32	0.31	0.31	0.32	52.38
FYM Means	0.27	0.27	0.27	0.28	0.28		
% increase over control		0.00	0.00	3.70	3.70		
	Urea	FYM	Urea x FYM				
SE	0.04	0.02	0.07				
LSD at 5%	0.10	NS	NS				

Table 4: Phosphorus Content (%) in Maize Straw

	Farm Yard Manure level (t/ha)						% increase
Urea Levels (kg/ha)	0	2.5	5.0	7.5	10.0	Urea means	over control
0	0.05	0.05	0.05	0.03	0.04	0.04	00.00
50	0.04	0.05	0.04	0.03	0.05	0.04	00.00
75	0.04	0.05	0.04	0.06	0.04	0.05	25.00
100	0.06	0.06	0.06	0.08	0.05	0.06	50.00
125	0.06	0.07	0.07	0.05	0.07	0.06	50.00
FYM Means	0.05	0.06	0.05	0.05	0.05		
% increase over control		20.00	0.00	0.00	0.00		
	Urea	FYM	Urea x FYM				
SE	0.01	0.01	0.02				
LSD at 5%	0.02	NS	0.05				

Table 5: Potassium Content (%) in Maize Grains

	Farm Yard Manure Levels (t/ha)						
Urea Levels (kg/ha)	0	2.5	5.0	7.5	10.0	Urea means	% increase over control
0	1.42	1.37	1.40	1.59	1.81	1.52	00.00
50	2.02	2.06	1.93	2.10	2.05	2.04	33.55
75	2.08	2.11	2.84	2.45	2.36	2.25	48.03
100	2.94	2.77	2.85	3.13	3.32	3.00	97.37
125	3.27	3.33	2.97	3.55	3.61	3.35	54.63
FYM Means	2.35	2.33	2.28	2.56	2.63		
% increase over control		-0.85	-2.98	8.94	11.91		

	Urea	FYM	Urea x FYM
SE	0.63	0.22	0.48
LSD at 5%	1.42	NS	1.11

Table 6: Potassium Content (%) in Maize Straw

	Farm Yard Manure Levels (t/ha)						
Urea Levels (kg/ha)	0	2.5	5.0	7.5	10.0	Urea means	% increase over control
0	0.98	1.00	1.00	1.00	1.04	1.01	00.00
50	1.22	1.22	1.30	1.35	1.48	1.31	29.70
75	1.41	1.46	1.77	2.10	2.07	1.76	74.26
100	1.63	1.62	1.74	2.08	2.11	1.84	82.18
125	1.84	1.92	2.06	2.11	2.13	2.01	99.01
FYM Means	1.42	1.44	1.57	1.73	1.77		
% increase over control		1.41	10.56	21.83	24.65		

	Urea	FYM	Urea x FYM
SE	0.21	0.06	0.35
LSD at 5%	0.47	0.13	0.76