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Research Application Summary

Comparative effect of farmyard manure, cowpea residues and NPK Fertilizer on maize grain yield in Morogoro

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Abstract

Optimal combinations of organic and inorganic fertilizers can give rise to increased maize yields in nutrient depleted soils. In this study, we assessed the effectiveness of cowpea residues and combinations of inorganic fertilizers on maize yield. Integration of 40 kg/ha N, 10 kg/ha P and 50 kg/ha K and organic fertilizers improved maize yields significantly. In areas where cowpea is produced in reasonable quantities, its residues can be used to improved maize yields.

Key words: Inorganic fertilizers, maize yield, organic fertilizers, soil fertility

Résumé

Les combinaisons optimales d'engrais organiques et inorganiques peuvent donner lieu à une augmentation des rendements du maïs en éléments nutritifs des sols appauvris. Dans cette étude, nous avons évalué l'efficacité des résidus de niébé et de combinaisons d'engrais minéraux sur le rendement du maïs. L'intégration de 40 kg / ha N, 10 kg / ha de P et 50 kg / ha K et les engrais organiques améliorent les rendements du maïs de façon significative. Dans les régions où le niébé est produit en quantités raisonnables, les résidus peuvent être utilisés pour améliorer les rendements du mais.

Mots clés: Les engrais minéraux, le rendement du maïs, les engrais organiques, la fertilité des sols

Background

Low soil fertility associated with inadequate and inefficient use of fertilizers is one of the most important causal factors of low maize yield in Tanzania. Maize productivity could be improved by adequate supply of nutrients particularly nitrogen, phosphorus and potassium through fertilizers application. The use of mineral fertilizes by small - scale farmers is still limited by their high prices and availability. Therefore more strategies using farmer-available resources are needed to increase yield. These may include incorporation into soil of farmyard manure (FYM), green manure (GM) and crop residues of high quality. Therefore the study aimed to assess the effectiveness of cowpea residues as

source of nutrient for maize, compare NPK and organic fertilizers on maize yield and determine the best combination rate of inorganic N and organic fertilizer to increase maize yield.

Literature Summary

A judicious combination of mineral fertilizers with organic materials was reported to reduce fertilizer requirement, increase soil fertility and then crop production (Roy *et al*., 2006). Such integrated applications are not only complementary but also synergistic as organic inputs have beneficial effects beyond their nutrient content. Through their contribution to the buildup of organic matter (Horst and Hardter, 2006) organic materials improves soil moisture storage, decrease soil erosion and then minimize leaching losses of nutrients especially N, contribute to P availability, and stimulate soil biological activities (Roy *et al*., 2006). Ademiluyi and Omotoso (2007) reported that about 84 and 78% of maize grain yield was produced in 2003 and 2004 in degraded soil incorporated with tithonia biomass in Nigeria. The incorporation of alfalfa and red clover residues contributed 65 to 71% of the total N content to a succeeding maize crop (equivalent of 90 to 125 kg Nha^{-1}) from inorganic fertilizer. Dakora *et al.* (1987) reported that net N returns to soil from cowpea residues was 150 kg ha^{-1} and the benefit of N from cowpea to maize in the rotation was equivalent to 60kgha^{-1} of N fertilizer based on grain and dry matter yields. Kaboneka (1993) reported that 30%N, 30%P, and nearly 50% K are provided by crop residues and manure in the United States.

Study Description

A field experiment was conducted from November 2009 to February 2010 at Sokoine University of Agriculture Farm (SUA-Farm) situated at longitude 37^{0}39'E and latitude 6^{0} 50'S and at the altitude of 526m a.s.l. The area has a bimodal rainfall pattern with a long rainy season from March to June and the short rainy season from November to January.

Top soil samples (0-20cm depth) were taken and the initial soil nutrient status determined. Chemicals analysis was done for the organic materials before their application. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replicates. Amount of organic material applied was based on total N content. Ten treatments were applied. These included sole application of cowpea residues (CR) and farmyard manure (FYM) at the rate of 60N kg ha^{-1} and the recommended NPK(60N,20P,50K) rate. In addition, there was combination of organic material and inorganic fertilizer (20N, 40N, 60N kg ha^{-1} added with 5P, 10P and 15P kg ha^{-1}). All treatments except

the control received 50kg $ha^{-1}$of K in addition to that supplied by organic materials. Two weeks before sowing, organic fertilizers were uniformly spread on the soil and ploughed under using hand hoes. Inorganic P and K were applied at sowing; inorganic N was applied in two splits for the NPK treatment, one third at sowing time, two thirds five weeks after sowing.

At 50% silking stage, ear leaves were sampled from the crop and analyzed for N, P, K and S contents. Maize was harvested at 99 days after sowing and sun dried to 11.5% moisture content. All data were statistically analyzed using coStat software. Treatment means were compared using the Duncan's Multiple Range Test. Correlation between maize yield and N, P and K concentration in maize leaves was done using SPSS programme.

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N and P concentration in maize leaves was highly significant ($P<0.001$) for all treatments except the treatment of 20N + 5P +50K. Potassium (K) and sulphur (S) concentration were none significant.

Table 1. Maize yield as influenced by cowpea residues, farmyard manure, inorganic fertilizers and their combinations.

Treatments	Grain yield per plant (g)	Grain yield (t ha^{-1})	Dry matter yield (t ha^{-1})	Harvest index
T1	102.28b	4.67c	9.64 c	0.52a
T2	139.92a	6.19a	13.35a	0.49a
T3	129.82a	5.51ab	12.54ab	0.47a
T4	138.85a	6.04a	13.37a	0.47a
T5	123.05	5.12bc	11.35abc	0.46a
T6	127.48a	5.20bc	10.94bc	0.52a
T7	134.38 a	5.51ab	11.61ab	0.49a
T8	139.88a	6.03a	12.42ab	0.49a
T9	141.58a	5.83ab	11.81ab	0.50a
T10	139.52a	6.06a	12.63ab	0.50a
Mean	131.68	5.65	11.96	0.49
CV (%)	7.53	7.53	8.9	7.94

Means followed by the same letter in a column are not significantly different $P < 0.05$ by Duncan Multiple Range Test

T1:control; T2:Recommended NPK(60N,20P,50K); T3: (60N,30P,77K) from FYM; T4: (60N,3P,80K) from CR; T5: (20N,5P,54K)10N from urea, 10N from FYM, 5P from FYM and TSP; T6: (20N,5P,55K)10N from urea, 10N from CR, 5P from CR and TSP;T7: (40N,10P, 58K) 20N from urea, 20N from FYM,10P from FYM and TSP;T8: (40N,10P, 60K) 20N from urea, 20N from CR, 10P from CR and TSP; T9: (60N,15P, 63K) 30N from urea,30N from FYM, 15P from FYM and TSP; T10: (60N, 15P, 65K) 30N from urea, 30N from CR, 15P from CR and TSP. Notice: K is from both organic material and inorganic fertilizers.

All treatments gave significantly ($P < 0.05$) higher maize grain and dry matter yield than the control except the 20N+ 5P +(54K/55K) treatment. Grain maize yield ranged from 4.67 to 6.06 t/ha whereas dry matter ranged from 9.64 to 13.37 t/ha. Combination of organic and inorganic fertilizer at 40 N and 60N with P and K gave comparable yield with sole application of inorganic and organic fertilizer. Control plots gave the lowest maize yield. A high positive correlation was found between maize grain yield and N, P, K concentration ($R=0.86$) as well as between maize dry matter yield ($R= 0.71$).

Recommendation

The combination of organic materials and inorganic fertilizer at the rate of 40N, 10P and 50K kg ha^{-1} could be used to improve maize yield with reduced fertilizers. In high production area, cowpea residues could be used as source of N to increase maize yield.

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