Research Application Summary

Effects of farmyard manure and mineral fertilisers on maize yield and soil properties in two districts of Southern Rwanda

Munyabarenzi, I.[1], Mochoge, B.E.[1] & Nabahungu, L.[2]
[1]Department of Agricultural Resource Management, Kenyatta University, P. O. Box 43844 - 00100, Nairobi, Kenya
[2]Rwanda Agriculture Board (RAB), Rwanda
Corresponding author: munyainnocent@yahoo.fr

Abstract

Agriculture in Rwanda is characterised by low productivity due to decline in soil fertility. This is mainly attributed to the mining of nutrients due to continuous cropping without external addition of adequate nutrients coupled with small land sizes which promotes limited scope for crop rotation and inadequate land productivity. The adoption of ISFM technologies such as the combination of organic manure and mineral fertilisers is being taken as one of solutions to the situation. This study will investigate the effect of farmyard manure and mineral fertilisers on maize yield, determine crop nutrient uptake and use efficiency and bio-chemical soil properties. The study will be conducted in Huye and Kamonyi Districts in Southern Rwanda. The experiments will be conducted in the field. Mize will be planted in plots measuring 4.5 x4.5 m and spaced at 75 x 30 cm. The experiment will be a factorial in a randomised completely bloc design (RCBD) with two factors (nitrogen and phosphorus fertilisers) with 4 levels of N (0; 40, 80 and 120 kg/ha) and 3 levels of P (0; 25 and 50 kg/ha). Soil samples will be analysed for aggregate stability, soil P^H, soil organic carbon, available N, total N, Phosphorus, available Potassium, CEC and ECEC. After harvest, maize grains will be dried and weighed at 12.5% moisture content. Manure will be applied as blanket at 10 tons/ha to all treatments. The experiment will be replicated three times. Data will be subjected to analysis of variance using the general linear model of the SAS software. Treatment differences will be examined using Tukey-Kramer significant difference (HSD) test. Regression and correlation analyses between various variables will be done to draw key relationships.

Key words: Manure application, maize crop, nutrients use efficiency, NP fertilisers, soil bio- chemical properties

Résumé

L'agriculture au Rwanda est caractérisée par une faible productivité due à la baisse de fertilité des sols. Ceci est principalement attribué à l'extraction de nutriments à cause de

la monoculture sans apport extérieur de nutriments adéquats couplés avec de petites tailles de terre qui favorisent la portée limitée de la rotation des cultures et la productivité inadéquate des terres. L'adoption des technologies GIFS telles que la combinaison de la fumure organique et des engrais minéraux est considérée comme l'une des solutions au problème. Cette étude portera sur l'effet de fumier et d'engrais minéraux sur le rendement du maïs, déterminera l'absorption des nutriments culturaux et l'efficacité de leur utilisation et les propriétés bio-chimiques des sols. L'étude sera menée dans les districts de Huye et de Kamonyi dans le sud du Rwanda. Les expériences seront réalisées sur le terrain. Le mais sera planté dans les parcelles mesurant 4,5 x 4,5 m et espacées de 75 x 30 cm. L'expérience sera un factoriel dans une conception des blocs complètement randomisés à deux facteurs (les engrais azotés et les engrais phosphatés) avec 4 niveaux de N (0, 40, 80 et 120 kg / ha) et 3 niveaux de P (0, 25 et 50 kg / ha). Des échantillons de sol seront analysés pour déterminer la stabilité du sol, le pH du sol, le carbone organique du sol, l'azote disponible, l'azote total, le phosphore, le potassium disponible, la CEC et l'EAJE. Après la récolte, les grains de maïs seront séchés et pesés à la teneur en humidité de 12,5%. Le fumier sera appliqué comme couverture en 10 tonnes / ha à tous les traitements. L'expérience sera répétée trois fois. Les données seront soumises à une analyse de variance en utilisant le modèle linéaire général du logiciel SAS. Les différences de traitement seront examinées à l'aide du test de différence significative de Tukey-Kramer (HSD). Les analyses de régression et de corrélation entre les différentes variables seront faites pour tirer les relations clés.

Mots clés: Epandage du fumier, cultures de maïs, efficacité d'utilisation des nutriments, engrais NP, propriétés bio-chimiques du sol

Background

Rwanda is a landlocked country with a total area of 26,33km^2. According to the estimates of the 2002 national population census, Rwanda has 10 million people. This population is projected to rise to 15 million by the year 2020. With 310 inhabitants per Km^2, Rwanda has one of the highest population densities in Africa. Majority live in rural areas. Rwanda's climate is conditioned by landscape. In the low altitude west, it is warmer with less precipitation. Annual rainfall in this region ranges between 900 and 1,600mm (MINAGRI, 2004). The Southern Province of Rwanda (1500 to 2800 m above sea level), temperature varies between 11^{o}C and 28^{o}C; annual rainfall

ranges between 1000mm and 1500mm (www.minaloc.gov.rw). The region is generally densely populated, thus, declining land productivity is a major problem facing the smallholder farmers. Agriculture represents one-third of Rwanda's gross domestic product and employs 80% of its workforce (MINECOFIN, 2002). Therefore, agriculture in Rwanda is characterised by low agricultural productivity due to soil fertility decline. Increased use of both organic and inorganic fertiliser and other agro–inputs is necessary to ensure food security in Rwanda. However, the use of fertilisers to increase crop yields is currently limited. Although the current use of inorganic fertilisers in the country which is 12 kg/ha/year (MINAGRI 2007) is slightly above the average for the sub-Saharan African (9kg/ha/year), this is far below the target of the Abuja fertiliser declaration of 50 kg/ha/year by 2015 (Sangina and Woomer, 2009). Maize (*Zea mays* L.) is one of the important food crops in Rwanda. It ranks second after sorghum among cereals and third among all crops. It covers 10% of the total cultivated land after beans (25%) and bananas (22%). It is produced on approximately 100,000 ha with a grain yield of 1.2 t/ha. It is currently grown in all Rwandan agro-ecologies that include semi-arid mid-altitudes (900-1450m asl), moist mid-altitudes (1450-1700m asl) and highlands (>1700m asl) (ISAR, 2009). The main challenges in mid-altitudes are: frequent drought, low-fertility especially low nitrogen, the maize streak virus (MSV) and turcicum leaf blight (TLB) () diseases, accessibility to improved varieties and quality seed (www.isar.rw). However, the Government of Rwanda and partners are putting efforts towards development of the maize research program. Maize is among crops selected for the Crop Intensification Program (CIP), which among others is meant to make it easier to access inputs, add value to the crops and earn smallholder famers more profits. The aim of the present study will be to determine the effects of farmyard manure and mineral fertilisers on maize yield and soil bio-chemical properties.

Literature Summary

One of the major problems affecting food production in Africa is the rapid depletion of nutrients in smallholder farms (Badiane and Delgado, 1995). Soil nutrient replenishment is therefore a prerequisite for halting soil fertility decline. This may be accomplished through the application of mineral and organic fertilisers. Animal manures are valuable sources of nutrients and the yield-increasing effect of manure is well established (Leonard, 1986). Organic matter in the soil improves soil physical conditions by improving soil structure, increases water –holding

capacity, and improves soil structure and aeration, as well as regulating the soil temperature (Gachene and Gathiru, 2003). Organic matter contains varying amounts of plants nutrients, especially nitrogen, phosphorus and potassium, which are slowly released into the soil for plant uptake (Gachene and Gathiru, 2003). Chemical fertilisers are used in modern agriculture to correct known plant nutrient deficiencies; to provide high levels of nutrition, which aid plants in withstanding stress conditions; to maintain optimum soil fertility conditions; and to improve crop quality. Adequate fertilisation programmes supply the amounts of plant nutrients needed to sustain maximum net returns (Leonard, 1986). The broad aim of ISFM is to utilise available organic and inorganic sources of nutrients in a judicious and efficient manner. Based on the evaluation of soil quality indicators, Dutta *et al*. (2003) reported that the use of organic fertilisers together with chemical fertilisers, compared to the addition of organic fertilisers alone, had a higher positive effect on microbial biomass and hence soil health. Sutanto *et al*. (1993) in their studies on acid soils for sustainable food crop production noted that farmyard manure and mineral fertiliser produced excellent responses. Boateng and Oppong (1995) studied the effect of farmyard manure and method of land clearing on soil properties on maize yield and reported that plots treated with poultry manure and NPK (20-20-0) gave the best yield results.

Study Description

The field experiment will be conducted in Huye and Kamonyi Districts, in the southern midlands of Rwanda. The study will investigate the effect of farmyard manure and mineral fertilisers on maize yield, determine the crop nutrient uptake and nutrient use efficiency and evaluate changes on bio-chemical soil properties. Maize (var.ZM 607) will be planted in plots measuring 4.5 x 4.5 m with a spacing of 75 x 30 cm. The experiment will be factorial arranged as randomised completely block design (RCBD) with two factors (nitrogen and phosphorus fertilisers) and four levels i.e 0; 40, 80 and 120 kg/ha for N and 3 levels for P (0; 25 and 50 kg/ha). Manure will be applied as blanket at 10 tons/ha to all treatments. The experiment will be replicated three times. P fertiliser and manure will be applied at planting while N fertiliser will be top-dressed three and six weeks after emergence. Weeding will be done two times during the growth period and diseases will be controlled if need arises. Before the beginning and at the end of the experiment, soil will be sampled for bio-chemical properties analyses. From each plot, a composite sample of four topsoil samples (0 - 20 cm) will be taken using a soil auger, based on the Y-sampling frame. Maize

grains will be dried after harvest and be weighed to 12.5% moisture content. Data will be subjected to analysis of variance using the general linear model of the SAS software. Treatment differences will be examined using Tukey-Kramer significant difference (HSD) test. Regression and correlation analyses between various variables will be done to draw key relationships.

Research Application

This study will provide information on response of NP fertilisers and manure on maize yield and soil bio-chemical properties. By complementing cattle manure and mineral fertilisers, soil productivity and smallholder farmers' livelihoods can be improved through higher yields of maize and thus income. Lastly, the study will result into useful information to guide extension services.

Acknowledgement

This study is funded by AGRA.

References

Badiane, O. and Delgado, C. L. 1995. A 2020 vision for food, agriculture and the environment, Discussion Paper 4. International Food Policy Research Institute,Washington, DC.

Boateng, J. K and Oppong, J. 1995. Proceedings of Seminar on organic and sedentary agriculture held at the Science and Technology Policy Research Institute (C.S.I.R) Accra. 1-3 Nov, pp 85.

Gachene, G. K. K. and Kimaru, G. 2003. Soil fertility and land productivity, Nairobi, Kenya.

Dutta, S., Pal, R., Chakeraborty, A. and Chakrabarti, K. 2003. Influence of integrated plant nutrient phosphorus and sugarcane and sugar yields. *Field Crop Research* 77:43 – 49.

Institut des Sciences Agronomiques du Rwanda (ISAR). 2009. Maize Program Rwanda.

Leonard, D. 1986. Soil, Crop, and Fertiliser Use: A Field Manual for Development Workers. Under contract with Peace Corps. 4th edition revised and expanded. United State Peace Corps. Information collection and exchange. Reprint R0008.

MINALOC,. 2007. Administrative entities, www.minaloc.gov.rw

Ministry of Agriculture and Animal Resources (MINAGRI). 2004, National Agriculture policy. Rwanda.

Ministry of Finance and Economic planning (MINECOFIN). 2002. Rwanda Vision 2020. Kigali Rwanda.

Sangina, N. and Woomer, P.L. 2009. Integrated Soil Fertility Management in Africa: Principles, Practices and

Developmental Process. Tropical Soil Biology and Fertility Institute of the International Center for Tropical Agiculture. Nairobi, Kenya. 263pp.

Sutanto, R., Suproyo, A. and Mass, A. 1993. The management of upland acids Soils for Sustainable food crop production in Indonesia. *Soil Management Abstracts* 5 (3): 1576.

Rwanda Agriculture research Institute,. 2009. Research programs, www.isar.rw