Theme 2

Potential and feasibility of use of external input and improved soil and crop management to achieve the African Green Revolution

Promoting uses of indigenous phosphate rock for soil fertility recapitalization in the Sahel: State of the knowledge on the valorisation of the rock phosphate of Burkina Faso

Moussa Bonzi*, François Lompo and Michel P. Sedogo

Institute of the Environment and Agricultural Research (INERA), 04 P.O. BOX. 8645 OUAGADOUGOU 04, Tel., +226 50 34.02.70 / +226 50 34.40.12, +226 70253130; fax: +226 50 34.02.71, BURKINA FASO.
*Corresponding author: *mousbonz@yahoo.fr*

Abstract

The general deficiency of the tropical soils in phosphorus constitutes one of the main factors limiting the production in sub-Saharan Africa. The present work is to collect a knowledgments on the use of Burkina Rock phosphate in the recapitalization of soils fertility in order to increase agricultural production. The main research permitted to: (1) define the doses of rock phosphate to recommend by culture: 400 kg.ha^{-1} in first year and 100 kg ha^{-1} year^{-1} the years after or 200 kg ha^{-1} every year, for sorghum, maize, cotton, peanut and cowpea; 500 kg ha^{-1} in first year and 200 kg ha^{-1} year^{-1} the following years for the pluvial rice; 600 kg ha^{-1} in first year and 300 kg ha^{-1} year^{-1} the following years for the irrigated rice; (2) finalize a formula of partially solubilised rock phosphate whose is: 4,22N - 24,55P_2O_5 - 6,26S - 25,52CaO - 0,16MgO. This one is practically equivalent to TSP in term of production of cereals and better in term of nutrients content on soil and, is economically profitable; (3) improve phosphate rock solubility by add 80 Kg per tonne of organic residue at the beginning of composting organics residues. Mixed formula combining 75% rock phosphate to 25% TSP or 50% rock phosphate + 50% TSP associated to the rotation with cowpea increased sorghum production. Rock phosphate is efficient, in the struggle against the soils degradation and the recuperation of the degradated soils and in the stabilization of the productions for a lasting agriculture.

Keywords: *Burkina rock phosphate, mixed formula, rate, tropical soils*

Improving phosphorus availability in maize based systems in the West African moist savanna

Nwoke O.C.[a,]*, Abaidoo R.C.[a], Nziguheba G.[a], and Diels J.[b]

[a]Soil Research Laboratory, International Institute of Tropical Agriculture , IITA, Ibadan, Nigeria, c/o Lambourn & Co., Carolyn House, 26 Dingwall Road, Croydon CR9 3EE, UK. Telephone: +234-2-241-2626; Fax: +234-2-241-2221.
[b]Division of Soil and Water Management, Department of Land Management and Economics, K.U. Leuven, Kasteelpark Arenberg 20, 3001 Heverlee, Belgium.
*Corresponding author: *c.nwoke@cgiar.org*

Abstract

Management options to improve phosphorus (P) availability in the West African savanna include the application of organic residues, sole or with inorganic fertilisers. The quality and quantity of organic resources affect their contribution to nutrient availability. The quality of residues influences decomposition and nutrient release in the short term but its importance in the long term is unclear. A greenhouse study with six different soils assessed the residual effect of contrasting organic residues (maize stover, *Senna siamea*, *Mucuna pruriens*, *Leucaena leucocephala*, *Gliricidia sepium*, *Pueraria phaseoloides*, and *Lablab purpureus*) and triple super phosphate (TSP) on maize growth during four cropping cycles of 7 weeks. For the first cropping, the average shoot dry matter yield (DMY) obtained with residues of C:P ratio ≤200 was similar to the TSP treatment (about 14 g pot^{-1}), and higher than the yield obtained with maize stover (C:P ratio = 396). From the second cropping, the shoot DMY of the maize stover treatment (15 g pot^{-1}) was higher than those of the other treatments. Both high and low quality residues had similar effects on the cumulative DMY. Cumulative shoot P accumulation in the maize stover treatment (53 mg pot^{-1}) was significantly higher than the control (30 mg pot^{-1}), and also similar to those from high quality residue treatments. Significant interaction (P<0.05) between soil and organic resource for DMY occurred only during the first two croppings. This indicates that the effects of soil type and residue quality on nutrient availability dwindle in the long term.

Keywords: *Phosphorus accumulation, phosphorus availability, residual effect, residue quality and quantity, shoot dry matter.*

Reversal of productivity decline in agroecosystems with organic amendments of different stability

Kimetu JM[1], Lehmann J[1], Mugendi DN[2], Bationo A[3], Verchot L[4] and Pell A[5]

[1]Department of Crop and Soil Sciences, Cornell University, Ithaca, NY 14853 USA
[2]School of Environmental Studies and Human Sciences, Kenyatta University, P.O Box 43844-00100, Nairobi, Kenya
[3]African Network for Soil Biology and Fertility, TSBF-CIAT, P.O Box 30677-00100, Nairobi, Kenya
[4]World Agroforestry Centre (ICRAF), P.O Box 30677-00100, United Nations Avenue, Gigiri, Nairobi, Kenya
[5]Department of Animal Science, Cornell University, Ithaca, NY 14853 USA

Abstract

In tropical agroecosystems, productivity declines associated with SOM degradation can be reversed through organic inputs of diverse quality which also increase crop fertilizer use efficiency. To soils that had been under continuous cultivation for 5, 20, 35, 80 and 105 years, four OM sources; *Tithonia diversifolia*, Hemsley A. Gray, cattle manure, biochar and sawdust were incorporated at the rate of 6 tons C ha^{-1}, for 3 seasons over a 2-year period. Full fertilizer N, P and K rates (120, 100, 100 kg ha^{-1} respectively) were superimposed to the organic treatment plots. For soil with a long-term (105-year) cultivation history, full fertilization yielded a maximum of 3.0 t ha^{-1} of maize grain which more than doubled with the addition of Tithonia (6.7t ha^{-1} and 8.0t ha^{-1} in the first and second year respectively). For Tithonia and manure, there was an increase of 2.0 ± 0.6t ha^{-1} and 2.0 ± 0.3t ha^{-1} respectively above fertilized, no biomass treatment in soil with medium cultivation history (20 yrs). No immediate changes to maize yield were noted with application of highly recalcitrant OM (charcoal and saw dust) but in the second year, charcoal and sawdust addition yielded 2.9 t ha^{-1} and 1.7 t ha^{-1} respectively higher than control. Nutrient uptake by maize crop was significantly improved with the application of Tithonia and charcoal OM. Soil pH, CEC_{pot} and CEC_{eff} were improved with OM inputs. We demonstrate that improved SOM, especially in degraded soil, are an integral part of reversing soil productivity declines in tropical agroecosystems.

Keywords: *Chronosequence; degradation; fertilizer use efficiency; SOM*

Evaluation of shoot and root traits for identifying P-use efficient cowpea genotypes

Abaidoo[1,]* R. C., B.B. Singh[2], C. Nwoke[1], P. Pypers[3], J. Diels[4] and G.O. Kolawole[5]

[1]International Institute of Tropical Agriculture (IITA), c/o L.W. Lambourn & Co., Carolyn House, 26 Dingwall Road, Croydon CR9 3EE, England. [2]Dept. of Genetics and Plant Breeding, G.B. Pant University of Agriculture and Technology, Pantnagar 263145, Uttaranchal State, India. [3]Tropical Soil Biology and Fertility, Institute of CIAT, PO Box 30677, Nairobi, Kenya. [4]Division of Soil and Water Management, Department of Land Management and Economics, K.U. Leuven, Kasteelpark Arenberg 20, 3001, Heverlee, Belgium, [5]Department of Agronomy, Ladoke Akintola University of Technology, PMB 4000, Ogbomoso, Nigeria
*Corresponding author: *rabaidoo@cgiar.org*

Abstract

Cowpea is a pro-poor crop with a high potential in marginal environments in the dry savanna zones of West Africa. However, cowpea biomass and grain yields are constrained by low levels of available phosphorus (P) in the soil. Plant scientists and soil fertility experts have proposed the adoption of plant genotypes that are efficient in mobilizing less-available soil-P pools and demonstrate optimal response to P fertilizer application. This demands that appropriate plant traits are identified and used in breeding programs to achieve the desired results. Field trials were conducted at Kano and Shika in the Nigerian savanna in 2004 and 2005 to examine the variation in traits for P uptake and incorporation efficiency under different P regimes (0, 20, 40, and 60 kg ha^{-1}). At Ibadan, greenhouse pot experiment was conducted in 2005 with P applied as 0, 25, and 50 mg P kg^{-1} soil to examine variations in root traits for P uptake efficiency. Field experiments revealed large year and location effects. In both years, significant ($P \leq 0.05$) P rate, genotype, and P rate × genotype interaction effects were recorded for vesicular mycorrhizal fungal colonization of roots, tissue P concentration, grain yield, and total P in grain. In the greenhouse experiment, the application of P significantly influenced total biomass P and the root parameters measured. The studies revealed that P availability and cowpea genotype influence the suitability of percentage root colonization by mycorrhiza, root parameters, biomass P concentration, and grain yield as P-use efficiency traits.

Keywords: *Cowpea; P use efficiency traits; Soil P availability; West Africa*

Low Input Approaches for Soil Fertility Management in Semi-Arid Eastern Uganda

C.K. Kaizzi[1,*], J. Byalebeka[1], C.S. Wortmann[2] and M. Mamo[2]

[1]Kawanda Agricultural Research Institute (KARI), National Agricultural Research Organization (NARO), Box 7065 Kampala, Uganda;
[2]University of Nebraska Lincoln, IANR, Department of Agronomy and Horticulture, 154 Keim Hall, Lincoln, NE 68583-0915; *cwortmann@unlnotes.unl.edu*.
*Corresponding author: *kckaizzi@hotmail.com*

Abstract

Grain sorghum [*Sorghum bicolor* (L.) Moench] is an important food crop in semi-arid areas of sub-Saharan Africa. Crop yields are low and declining, partly due to low soil fertility. The aim of this research was to evaluate, with farmer participation, alternative low-input practices for soil fertility improvement in sorghum-based cropping systems. These were: use of herbaceous legumes in improved fallow; a grain legume in rotation with sorghum; use of farmyard manure; application of low levels of N and P fertilizers; and reduced tillage. Four studies, comprised of 142 on-farm trials, were conducted at three locations over three years in drought-prone parts of eastern Uganda. Mucuna (*Mucuna pruriens* (L.) DC.) on average produced 7 t ha^{-1} of above-ground dry matter containing 160 kg N ha^{-1} across the three locations. Application of 2.5 t ha^{-1} of manure and of 30 kg N plus 10 kg P ha^{-1} increased grain yield by 1.05 and 1.30 t ha^{-1}, respectively and a combination of 2.5 t ha^{-1} manure with 30 kg N ha^{-1} by 1.50 t ha^{-1} above the yield with no nutrients applied (1.1 t ha^{-1}). The increase in sorghum grain yield in response to 30 kg N ha^{-1} alone, to a mucuna fallow, and to a rotation with cowpea (*Vigna unguiculata* (L.) Walp.) was 1.15, 1.55 and 0.82 t ha^{-1}, respectively. These soil fertility management practices and reduced tillage, were found to be cost effective in increasing sorghum yield, hence on-farm profitability and food security for sorghum production systems can be improved by use of alternative low-input practices.

Keywords: *Low input, Mucuna pruriens, reduced tillage, resource poor, rotation, smallholder agriculture*

Integrated soil fertility management for increased maize production in the degraded farmlands of the Guinea Savanna Zone of Ghana using devil-bean (Crotalaria retusa) and fertilizer nitrogen

B. D. K. Ahiabor*, M. Fosu, E. Atsu, I. Tibo and I. Sumaila

[1]CSIR-Savanna Agricultural Research Institute, P. O. Box 52, Tamale, Ghana
*Correspondence author: *bahiabor@yahoo.com*

Abstract

The native N and P of soils of the Guinea Savannah Zone of northern Ghana are only about 20% and 10% of the crops' requirements, respectively and organic matter content is usually below 1%. Hence, cereal yields without soil amendments are usually below 500 kg ha^{-1}. Organic residue and mineral fertilizer combinations are necessary to increase nutrient use efficiency. Devil-bean is a very promising leguminous cover crop for this agro-ecology. The best time to intercrop devil-bean in maize, effect of P on the maize and the effect of incorporated devil-bean biomass on grain yield of N-fertilized maize were investigated. In 2003, devil-bean was drilled in maize at 1, 3 and 4 weeks after planting (WAP) the maize which received 0, 20 and 40 kg P ha^{-1}. Phosphorus enhanced maize growth and yield. The devil-bean biomass was incorporated into the soil in the 2004 growing season**.** Maize was planted, fertilized with 0, 20 and 40 kg N ha^{-1} and intercropped again with devil-bean as before. 40 kg N ha^{-1}-fertilized maize grown on incorporated devil-bean intercropped at 1 WAP in 2003 had the highest grain yield of 1.59 t ha^{-1}. In 2005, the devil-bean intercropped in the 2004 40 kg N ha^{-1}-maize at 3 WAP produced the highest biomass containing 42 to 88, 4 to 11 and 25 to 52 kg ha^{-1} of N, P, K, respectively. Maize grain yield significantly increased with incorporated biomass with the highest biomass producing the highest grain yield. The cumulative effect of the biomass applications was significant in this study.

Keywords: *Devil-bean biomass, fertilizer nitrogen, intercropping, maize production, soil fertility management*

Effect of Continuous Mineral and Organic Fertilizers Inputs and Plowing On Groundnut Yield and Soil Fertility in a Groundnut – Sorghum Rotation in Central Burkina Faso

Emmanuel Compaore[1], Philippe Cattan[2,3] and Jean-Baptiste S. Taonda[2]

[1]INERA, Station de Recherches Agricoles de Farako-Bâ, 01 B.P. 910 ; Bobo-Dioulasso 01, Burkina Faso, Tel: (226) 20 - 98 - 23 - 29; Fax: (226) 20 - 97 - 01 - 59; [2]INERA, Centre de Recherches Environnementales, Agricoles et de Formation de Kamboinsé, 01 B.P. 476 Ouagadougou 01, Burkina Faso; [3]CIRAD, station de Neufchateau-Sainte-Marie, 97130 Capesterre-Belle-Eau, France
Corresponding author: *ecompaorez@hotmail.com*

Abstract

Two field groundnut-sorghum experiments were conducted at Saria in the centre of Burkina in order to assess the effect of chemical and organic fertilizers on groundnut yield and its components and soil fertility on two ferruginous tropical soils of different texture. Groundnut haulm yield, pod yield, number of pods, percent pod two-seeded, percent pod rot, seed yield and 100 seeds weight as well as sorghum dry shoot and grain yields were measured during 8 years. Most of the different variables were affected by continuous cropping without fertilizer application on the two soils, in particular on the coarse one. The effect of a likely deficiency in some nutrients (P, K, and Ca) was observed. The mineral fertilizers allowed maintaining yield, but their supply was not able to replenish the nutrient uptake by plants. The effect of compost on the crop production was weak but enhanced during the years, 7 and 8. Tillage had also an effect on yield, but this effect was limited and varied with soil type. In the control, the initial status of organic matter reduced in five years and did not increase with the application of fertilizers and compost. In contrast the addition of fertilizers increased the content of total N and Bray-I P. Nitrogen, P, K and Ca balance was negative in almost all treatments without mineral fertilizers. The cultural techniques improved sorghum production, while groundnut responded better than sorghum on the soil eroded.

Keywords: *Groundnut-sorghum rotation; mineral and organic fertilizers; soil fertility; Yields.*

Targeting Resources within Heterogeneous and Diverse Farming Systems: Towards a 'Uniquely African Green Revolution'

P. Tittonell[1,2,*], B. Vanlauwe[2] and K.E. Giller[1]

[1]Plant Production Systems, Department of Plant Sciences, Wageningen University, P.O. Box 430, 6700 AK Wageningen, The Netherlands.
[2]Tropical Soil Biology and Fertility Institute of the International Centre for Tropical Agriculture (TSBF-CIAT), United Nations Avenue, P.O. Box 30677, Nairobi, Kenya.
*Corresponding author: *Pablo.tittonell@wur.nl; p.tittonell@cgiar.org*

Abstract

Smallholder farms in sub-Saharan Africa are diverse and heterogeneous, often operating in complex socio-ecological environments. Heterogeneity within farming systems is caused by spatial soil variability, which results from the interaction between inherent soil/landscape variability and human agency through management history of different fields. Technologies and resources designed to improve crop productivity often generate weak responses in the poorest fields of smallholder farms. Thus options for soil fertility improvement must be targeted strategically within heterogeneous farming systems to ensure their effectiveness and propensity to enhance the efficiency of resource (e.g. land, labour, nutrients) use at farm scale. Key issues in design of approaches for strategic targeting of resources include: 1. Inherent soil variability across agroecological gradients; 2. Social diversity, farmers' production orientations and livelihood strategies; 3. Farmer-induced gradients of soil fertility, their causes, and consequences for efficient allocation of scarce resources; 4. Competing objectives and trade-offs that farmers face between immediate production goals and long term sustainability; 5. The complexity of farmers own indicators of success. We used an analytical framework (NUANCES) in which systems analysis is aided by survey, experiments and simulation modeling to analyse farming futures in the highlands of East Africa. Our work contributes to the development of 'best-fit' or tailor-made technologies, using combinations of mineral fertilizers and organic matter management from N_2-fixing legumes and animal manures. Thus we hope to contribute to design of an 'uniquely African green revolution' called for by Kofi Annan, that fits technology interventions to diverse and heterogeneous smallholder systems of sub-Saharan Africa.

Keywords: *Agricultural inputs, Farm typology, Resource use efficiency, Soil fertility, Sub-Saharan Africa*

Effect of Organic Inputs and Mineral Fertilizer on Maize Yield in a Ferrasol and a Nitisol Soil in Central Kenya

M. Mucheru-Muna[1,*], D. Mugendi[1], B. Vanlauwe[2], R. Merckx[3], J. Mugwe[4], P. Pypers[2] and J. Kung'u[1]

[1]Department of Environmental Sciences. Kenyatta University, P.O. Box 43844, Nairobi, Kenya; [2]Tropical Soil Biology and Fertility, (TSBF) Institute of CIAT, P. O. Box 30677 Nairobi, Kenya; [3]K.U.Leuven, Faculty of Bioscience Engineering, Laboratory for Soil and Water Management, Kasteelpark Arenberg 20, 3001 Heverlee, Belgium; [4]Kenya Forestry Research Institute, P.O. Box 20412, Nairobi, Kenya.
*Corresponding author: *moniquechiku@yahoo.com,* Mobile: +254-733-915165

Abstract

Declining land productivity is a major problem facing smallholder farmers in Kenya today. This decline primarily results from a reduction in soil fertility caused by continuous cultivation without adequate addition of external nutrient inputs. Improved fertility management combining organic and inorganic nutrient inputs can enable efficient use efficiency of the inputs applied and increase overall system's productivity. Field trials were established at three sites in distinct agro-ecological zones of Central Kenya (one site at Machang'a and two at Mucwa with different soil fertility status) aiming to determine the effects of various organic sources (Tithonia, Lantana, Mucuna, Calliandra and manure) and combinations with mineral N fertilizer on maize grain yield of the inputs applied during four consecutive seasons. In Machang'a site, sole manure recorded the highest maize grain yield across the four seasons. In Mucwa poor site, sole tithonia gave the highest maize grain yield during the four seasons. Generally the maize grain yields were lower in the treatments with fertilizer alone compared to the treatments with organics across the three sites in the four seasons due to the poorly distributed rainfall. In Machang'a during the SR 2004 and SR 2005 seasons, the treatments with integration of organic and mineral fertilizer inputs were significantly higher than the sole organics, however in Mucwa good and bad sites, generally the treatments with sole organics did better than the ones with integration of mineral N fertilizer and organics with the exception of the mucuna treatment which did significantly better in the integration compared to the sole application.

Keywords: *Lantana, maize yields, manure, mineral fertilizer, tithonia*

The Potential of Reducing Nitrogen Fertilizer Rates Using a Soyabean-Sugarcane Production System in the South Eastern Lowveld of Zimbabwe

M.D. Shoko[1,]*, F. Tagwira[1] and M. Zhou[2]

[1]Faculty of Agriculture and Natural Resources, Africa University, Box 1320, Mutare, Zimbabwe.
[2]Department of Agronomy and Environment Management, Louisiana State University, Baton Rouge, Louisiana, USA.
*Corresponding author: *shokom@africau.ac.zw*

Abstract

Monoculture is common in sugarcane production throughout the world and leads to decline in yields and soil fertility and build up of pests and diseases. Legumes have been shown as potential crops that break the monoculture cycles in several crops. Farmers can reduce nitrogen fertilizer requirements to the subsequent sugarcane crop when soyabean [Glysine max (L.) Merr] is used as a fallow crop. Field studies were conducted from 2004 to 2005 on Nitrogen depleted sandy loam soils at the Zimbabwe Sugar Experiment Station in the South East Lowveld of Zimbabwe. The objectives of the study were to determine nitrogen fixed by soyabeans at various growth stages, determine nitrogen in the foliar of subsequent cane and estimate the artificial nitrogen fertilizer reduction. The treatments used were (i) vegetable soyabeans followed by cane topdressed with 80 and 120 kg nitrogen ha^{-1}, (ii) grain soyabean followed by cane topdressed with 80 and 120 kg nitrogen ha^{-1}, (iii) Monoculture cane topdressed with 120 kg nitrogen ha^{-1}. Both grain and vegetable soyabeans fixed more nitrogen at flowering stage, 128 and 118 kg nitrogen ha^{-1}, respectively. The results showed that farmers can save nitrogen fertilizer by using vegetable soyabeans. The nitrogen saved was estimated at 80 kg nitrogen ha^{-1} as shown by the number of tillers, biomass and nitrogen in leaves of cane.

Keywords: *Grain soybeans, nitrogen fertilizer, tillers, vegetable*

Residual Effects of Applied Phosphorus Fertilizer on Maize Grain Yield and Phosphorus Recovery from a Long-Term Trial in Western Kenya

H. Wangechi*, P. Pypers, and B. Vanlauwe

Tropical Soil Biology and Fertility institute of the International Centre for Tropical Agriculture (TSBF-CIAT), P.O. Box 30677 Nairobi, Kenya.
*Corresponding author: *h.wangechi@cgiar.org*

Abstract

Phosphorus (P) application is essential for crop production in the weathered, P-fixing soils of Western Kenya. It is hypothesized that a single large application can lift available P levels above a critical threshold, but further seasonal applications are requisite for sustaining yields. A field study was conducted in Siaya district to evaluate maize yield, P uptake, soil P balance and economic returns from P applied at different initial P rates, and further seasonal P additions. In the first season, triple super phosphate (TSP) was added at rates of (0, 15, 30, 50, 100, 150 and 250 kg P ha^{-1}, and maize yield and P uptake was assessed during 10 consecutive seasons. Additional treatments were included where an initial application of 100 kg P ha^{-1} was supplemented with seasonal additions of 7 kg P ha^{-1}, supplied as TSP, manure or *Tithonia*. Residual benefits of maize in terms of increased grain yields were high with cumulative yields ranging from 17.4 to 54.8 t ha^{-1} when P was applied at rates above 100 kg P ha^{-1}. Resin-extractable P increased significantly with initial P addition but decreased rapidly with time, particularly for treatments with one-time high dose P application. Economic evaluation of these technologies revealed that application of initial P as 100 kg P ha^{-1} with seasonal additions of 7 kg P ha^{-1} as TSP would give the best marginal returns to investment.

Keywords: *P balance, P modeling, P recovery, P uptake*

Effect of Sources of Organic Inputs on Phosphorus Sorption and Chemical Properties of Some Acid Soils of Zambia

L.K. Phiri[1,*], C. Malama[2] and M. Mwale[1]

[1]Mt.Makulu Central Research Station, Private Bag 7 Chilanga, Zambia; [2]Misamfu Research Station, P.O. BOX 55 Kasama, Zambia (Deceased)
*Corresponding author: *phiriluckson@yahoo.com*

Abstract

Most acid soils in the high rainfall areas of Zambia, characterized as region III, are depleted of phosphorus (P) and have low base saturation, high exchangeable aluminium and extractable iron. Soil acidity and its associated low P are the major limitations to crop production in this region. The objective of this study was to evaluate the effect of sources of organic inputs on P sorption and chemical properties of benchmark acid soils of region III. The organic inputs were dried at 60° C and ground to pass through a 2 mm sieve before being added to the soil. Five-grams of ground tithonia diversifolia prunings, common bean, and maize residues were added to 95 g of each of the study soils. Distilled water was added to saturation and the moisture content was adjusted to field capacity every 4 days. The soils were incubated for 90 days at 25° C. During incubation the soils were mixed every sixth day to enhance uniform contact of organic inputs with the soil particles. At the end of incubation period, the soils were dried and retained for P sorption studies, and chemical analysis using established methods. The effect of each source of organic input on P sorption and exchangeable aluminium, calcium and magnesium was evaluated. The organic inputs that were most effective in decreasing P sorption and increasing soil pH and contributing nutrients such as nitrogen (N) and potassium (K) to the study soils are recommended to be integrated with mineral fertilizers to improve crop production of acid soils.

Keywords: *Exchangeable aluminium, organic input, P sorption, soil acidity, Tithonia diversifolia.*

Long-Term Effects of Organic and Inorganic Fertilizer Application on Phosphorus Availability in Semi-Arid Eastern Kenya

Muriuki[1] S.W., Mugendi[1] D.N.; B. Vanlauwe[2]; K.D. Shepherd[3]; G.P. Warren[4] and F.M. Kihanda[5]

[1]Department of Environmental Sciences, Kenyatta University, P.O. Box 43844, Nairobi, Kenya
[2]Tropical Soil Biology and Fertility-CIAT, P. O. Box 30677, Nairobi, Kenya
[3] World Agroforestry Center (ICRAF), P.O. Box 30677, Nairobi, Kenya
[4] University of Reading, United Kingdom
[5] Kenya Agricultural Research Institute (RRC Embu), P.O. Box 27, Embu, Kenya
*Corresponding author: *s.muriuki@cgiar.org*

Abstract

Decline in crop yields is a major problem facing smallholder farmers in semi-arid Kenya and the entire Sub-Saharan region. Particularly, many soils of semi-arid Eastern Kenya are characterized by phosphorus (P) and nitrogen (N) deficiencies due to low native nutrients reserves in soils. Inorganic fertilizers are unaffordable to most smallholder farmers at current producer prices, limiting their use on farms. While N can be replenished through biological fixation, there is no equivalent process for the introduction of P in soils. Consequently, phosphorus deficiency is now a major constraint to food production. Two long-term field experiments were established at Machang'a site to assess long-term effects of manure and inorganic P fertilizers on soil P availability. The first experiment began in 1989 and treatments were; control continuous manure at 5 and 10 t/ha/yr, residual manure at the same rates and NP fertilizer at 51 and 12 kg/ha/yr respectively. The second experiment began in 1994 and was planned to supplement the first experiment by giving information on the effects of a one time application of 250 kg/ha TSP on long-term P availability. Results indicated that repeated manure application at 10t/ha/yr significantly increased the level of plant available P and maintained the highest concentration of P fractions. Though inorganic fertilizers raised the level of bioavialable P fractions, this was comparatively low to manure effects. The residual value of a one time application of 250 kg/ha TSP was observed to maintain high soil P-test values for close to 10 years.

Keywords: *Fractionation, manure, nutrient deficiency, triple-super phosphate*

Selecting Indigenous P Solubilising Bacteria for Crop Improvement in Nutrient Deficient Acidic Soils of Southern Cameroon

H. Fankem[1,]*, D. Nwaga[2], M. Abba[2], A. Deubel[3], W. Merbach[3] and F-X Etoa[4]

[1]Department of Plant Biology, University of Douala. P.O. Box: 24157 Douala. Tel (237) 9983 89 69, Fax (237) 340 75 69, Cameroon; [2]Laboratory of Soil Microbiology, Biotechnology Centre, University of Yaoundé I. P.O. Box: 812 Yaoundé. Cameroon. E-mail: *dnwaga@yahoo.fr*
[3]Institute of Soil Science and Plant Nutrition, Martin-Luther University Halle-Wittenberg, Adam-Kuckhoff-Straße 17 b, D-06108 Halle/Saale, Germany; [4]Department of Biochemistry, University of Yaoundé I. P.O. Box: 812 Yaoundé, Cameroon.
*Corresponding author: *hfankem@yahoo.com*

Abstract

Phosphorus is one of the major limiting factors for crop production on many tropical and subtropical soils. The concentration of soluble phosphorus (P) in soil is usually very low. These low levels are due to high reactivity of soluble P with calcium, iron or aluminium that leads to P precipitation. Some soil micro-organisms are effective in releasing P from inorganic sources through solubilization and from organic pools by mineralization. About 187 isolates of P solubilizer's (PSM) were obtained from soil and root samples collected in four provinces situated in two out of the five agro-ecological zones of Cameroon, on young and old oil palm-trees rhizosphere selected for their economical importance in Cameroon. They were tested for purity on agar plates and their efficiency in mobilizing phosphorus from insoluble sources were evaluated in liquid media containing sparingly Ca-P, Al-P and Fe-P. As mechanisms of phosphate solubilization, it appeared that Ca-phosphate solubilization resulted from combined effects of pH decrease and carboxylic acids synthesis. However, the synthesis of carboxylic acids was found to be the main mechanism involved in the process of Al- and Fe-phosphates solubilization. Both were mobilized at pH 4 corresponding to their natural occurrence by citrate, malate, tartrate, on much lower level by gluconate and trans-aconitate. Green house trials using maize inoculated with pre-selected 10 PSM isolates showed a significant improvement of plant yield and phosphorus uptake from 49 to 200% according to isolates. Some of theses bacteria have been identified as *Pseudomonas fluorescens*, the plant growth promoter and soil borne disease biocontrol agent.

Keywords: *Plant yield, phosphorus uptake, phosphate solubilizing micro-organisms, organic acids.*

Greenhouse Evaluation of Agronomic Effectiveness of Unacidulated and Partially Acidulated Phosphate Rock from Kodjari: Effect of Crop Species and Mixed Crop on Plant P Nutrition

Emmanuel Compaore[1,3,*], Jean-Claude Fardeau[2] and Jean-Louis Morel[1]

[1]LSE/ENSAIA, BP 172, 54505 Vandoeuvre-lès-Nancy Cedex, France, Tel: 982329, Fax: 970159;
[2]Département Environnement et Agronomie, INRA, Route de Saint-Cyr, 78000 Versailles, France;
[3]Institut de l'Environnement et de Recherches Agricoles (INERA), Station de recherches de Farako-Bâ, 01 B.P. 910 Bobo-Dioulasso, Burkina Faso 01.
*Corresponding author: *ecompaorez@hotmail.com*

Abstract

Greenhouse study was conducted to determine the agronomic effectiveness of unacidulated (KPR) and partially acidulated (KAPR) Kodjari phosphate rock relative to Triple Superphosphate (TSP). The available phosphorus of a ferruginous soil (pH, 6.2) was labelled with a $^{32}PO_4^{3-}$ solution, and the soil was amended with 50 mg P kg^{-1} as ground KPR, KAPR and TSP. Two plants, maize and cowpea were grown alone or in association. After 60 days growth period, shoot yield, P uptake and real coefficient of P utilization (RCU %) were determined.Dry matter yields and P in dried tops increased by KAPR and TSP application however, with KPR, no significant difference with the control was recorded. Also in KPR treatment the dry matter yield and P uptake for maize and cowpea, grown in association decreased in all treatments. The agronomic effectiveness of KPR, KAPR and TSP in terms of RCU% was classed in this order: KPR < KAPR < TSP. The average values of RCU% in KPR treatments of pure or mixed culture were very low (0.3 %) indicating that KPR was not dissolved in the soil. In contrast they were high in KAPR and TSP treatments. In KPR treatments planted with maize alone or in association, RCU% values were higher than those measured with cowpea. This indicates that maize seemed to use KPR more efficiently than cowpea due to organic acids actions excreted by its roots and higher root densities. At last, the association did not increase significantly the use of KPR by plants.

Keywords: *Agronomic effectiveness, dissolution, mixed-cropping, plant species, phosphate rock,*

The Potential of Increased Soybean Production in Uasin Gishu District resulting from soil acidity amendment using Minjingu Phosphate Rock and agricultural lime

A.O. Nekesa[1], J. R. Okalebo[1], C. O. Othieno[1], M. Thuita[1], A. Bationo[2], B. Waswa[2]

[1]Moi University, Department of Soil Science, P.O. Box 1125-30100, Eldoret; [2]TSBF-CIAT, Nairobi, P.O. Box 30677, Nairobi.
Corresponding author: *amarishas@yahoo.com*

Abstract

In Kenya, soil acidity is a major contributor to declining soil fertility and 20% of the soils are acidic and are considered to be of low fertility. Most farmers are unaware of the benefits of liming acid soils and hence blame seed and fertilizers for low yields. A study was carried out during the 2005 LR and 2006 LR at Kuinet in Uasin Gishu District of the Rift Valley Province in Kenya to delineate the effects of Minjingu phosphate rock (MPR) and agricultural lime as liming materials on yields of soybeans intercropped with maize. The maize responded to application of soil amendment materials for the first season with the DAPL treatment giving the highest maize yields of 6.19 t ha^{-1} compared to the control which gave 1.36 t ha^{-1}. Soybean yields were disappointingly low in the first season with the DAPL treatment and control treatment giving yields of 0.32 t ha^{-1} and 0.14t ha^{-1}, respectively. This however changed significantly after the variety was changed in the second season, with yields going up to 0.68 t ha^{-1} for the TSPL treatment. From the study, it was concluded that there is potential for growing soybean in Uasin Gishu District of Kenya. However, a study and/or research is recommended to screen and identify a suitable variety for increased soybean yields in this District.

Keywords: *Declining soil fertility, soil acidity, liming, MPR, soybean yields*

Predicting phosphorus mineralization and maize yield in high P adsorption soils using plant quality indices.

A. Mukuralinda[1,*], J. S.Tenywa[2], L. Verchot[3] and J. Obua[2]

[1]Institut des Sciences Agronomiques du Rwanda (ISAR); [2]Makerere University. P.O. Box 7062, Kampala, Uganda; [3]World Agroforestry Centre (ICRAF), P.O. Box 30677, Nairobi, Kenya
*Corresponding author: *mukuratha@hotmail.com*

Abstract

Phosphorus has been found to be the most limiting nutrient for maize production on acid soils of sub-Sahara Africa, including high P–fixing soils of Rwanda. Using high rates of inorganic P fertilizers has been suggested as one of the strategies for managing high P-fixing soils, although it remains inaccessible to small scale farmers. The integration of inorganic and organic materials is an alternative option to improve P availability on these soils. Incubation and field studies were conducted with the objective of determining plant quality indices for predicting P mineralization and maize yield. Treatments compared were the control, limestone at 2.5 t ha^{-1} , TSP at 25 and 50 kg P ha^{-1}, leaf of *Calliandra*, *Tithonia* and *Tephrosia* each at 25 and 50 kg P ha^{-1} respectively, *Calliandra*, *Tithonia* and *Tephrosia* each combined with TSP at equivalent rate of 25 and 50 kg P ha^{-1} respectively. Application of *Tithonia* independently at high rate (50 kg P ha^{-1}) showed higher net P mineralization above 200 mg P kg^{-1}. Total plant phosphorus (TP), total plant carbon (TC), C: P and C: N ratios predicted P mineralization ranging from 64% to 84%. Total plant P showed the highest coefficient of regression. Plant quality indices such as TP, TC, N, C: N and C: P ratios predicted maize yields from 59% to 83%. These plant quality indices are the best tested predictors of P mineralization and maize yield, and therefore can efficiently be used to screen agroforestry species P sources.

Keywords: *Maize yields, plant quality indices and phosphorus mineralization*

Use of "Prep-Pac" Product to Improve Maize and Legume Yields, Legume Heights and Improved Farm Income in the Nutrients Depleted Soil of Western Kenya

E.C. Ruto[1], J.R. Okalebo[1,] C.O. Othieno[1], M.J. Kipsat[2] and A. Bationo[3]

[1]Department of Soil Science, Moi University, P.O. Box 1125, Eldoret, Kenya; [2]Department of Agricultural Resource Economics and Marketing, Moi University, P.O Box 1125, Eldoret, Kenya; [3]Afnet Programme, TSBF-CIAT, P.O. Box 30677, Nairobi, Kenya
Corresponding author: *emyruto@yahoo.com*

Abstract

Western Kenya region contains 40% of the country's population on only 15% of the country's land area, with population densities ranging from 500 to 1200 persons per km^2. This has resulted to reduced land sizes, continuous cropping with no addition of fertilizers due rising poverty levels, high rates of soil nutrients depletion and food insecurity. 'PREP-PAC' an integrated nutrient management package that targets the replenishment of 'lost' nutrients in the widespread low fertility patches, was felt to be a simple, effective and affordable package that can be adopted by resource poor farmers. PREP-PAC was tested on a small scale farm in Nyabeda, Siaya District western Kenya for three continuous seasons. The farm was characterized by low pH (5.35), low % carbon content (1.84), Olsen P (1.12 mg P/ka and low total nitrogen (0.27%) and classified as sandy clay loam (FAO classification). MBILI intercropping system involving seven legumes, intercropped with maize (Zea *mays*) was used. The treatments were arranged in a 7x2 factorial, in a randomized complete block design, each treatment replicated four times. PREP-PAC application significantly ($p<0.01$) increased legume and maize grain yields A significant increase ($p<0.01$) in legume heights five weeks after planting was reported. Economic analysis indicated a significant ($p<0.01$) increase improved farm income hence concluded that PREP-PAC can be utilized under MBILI intercropping system towards nutrient replenishment and food security in Western Kenya

Keywords: *Economic benefits, legume heights, maize and legume grain yields, MBILI inter cropping system, PREP-PAC*

Responses of indigenous legumes species to mineral P application for soil fertility restoration in smallholder farming systems of Zimbabwe

T.P. Tauro[1*], H. Nezomba[1], F. Mtambanengwe[1], and P. Mapfumo[1,2]

[1]Department of Soil Science and Agricultural Engineering, University of Zimbabwe, P.O Box MP167, Mount Pleasant, Harare, Zimbabwe; [2]Soil Fertility Consortium for Southern Africa (SOFECSA), CIMMYT, Southern Africa, P.O. Box MP 163, Mount Pleasant, Harare, Zimbabwe
*Corresponding email: *phirilani2@yahoo.co.uk*

Abstract

Developing alternative soil fertility management options for resource-constrained farmers is vital for increasing food security in many parts of Africa where soils are constrained by nitrogen (N) and phosphorus (P) deficiency. This study investigated the population dynamics and P response of indigenous legumes as organic nutrient sources in smallholder farming systems of Zimbabwe. Single super phosphate (SSP) was broadcast and incorporated to 20 cm depth at 26 kg P ha^{-1} before indigenous legume species mostly of the genera *Crotalaria*, *Indigofera* and *Tephrosia* were broadcast in mixtures on surface at 120 seeds m^{-2} $species^{-1}$ on disturbed soil. The study was conducted in 2005/06 rainfall season under low (450-650 mm yr^{-1}) to high (>800 mm yr^{-1}) rainfall conditions. Application of P had no significant (P>0.05) effect on legume species composition and establishment patterns but positively increased biomass by 20-60%. Instead, P increased and influenced the biomass and composition of non-legume species. Abundance of *Richardia scabra* was reduced by 20-38% while that of *Cynodon dactylon* increased with SSP application, leading to a significant (P<0.05) increase in overall non-legume biomass. Indigenous legumes derived 61–90% of their N from the atmosphere with amounts fixed ranging from 5–120 kg N ha^{-1} under semi-arid conditions to 78–267 kg N ha^{-1} under high rainfall. N-fixation of indigenous legumes increased by 32% and 18% under low and high rainfall respectively. P application moderately increased biomass productivity but resulted in substantial increase in nitrogen fixation rates. Further research is required to quantify potential P benefits to subsequent cereal crops.

Keywords: *Biomass productivity, N_2-fixation, Indigenous legumes establishment, Phosphorus management, Species dynamics*

Extractable Bray-1 Phosphorus and Crop Yields as influenced by Addition of Manure Integrated with Phosphatic Fertilizers of Various Solubilities in an Acid Soil

E.W. Gikonyo[1]*, A.R. Zaharah[2], M.M Hanafi[2] and A.R. Anuar[2]

[1]KARI-NARL, P.O Box 14733- 00800, Nairobi, Kenya; [2] Department of Land Management, Faculty of Agriculture, University Putra Malaysia 43400-UPM, Serdang, Selangor, Malaysia;
*Correspondence author: *estgikonyo@yahoo.com*

Abstract

Extractable soil phosphorus (P) varies with the solubility of phosphatic fertilizers. Extractable bray-1 P (B1P) and S*etaria anceps cv. kazungula* response to P in a treated acid soil were monitored. Soil treatments comprised; Triple super phosphate (TSP), Gafsa phosphate rock (GPR) or Christmas Island phosphate rock (CIPR) at 0 to 300 kg P ha^{-1} with or without manure. Monitoring was done bimonthly for 14 months and experimental design was randomised complete block with three replications. Results indicated that extractable Bray-1 P (B1P) in decreasing order was; TSP>GPR>CIPR, consistent with their solubities. An integration of manure and fertilizers resulted in much higher extractable B1P than sole fertilizers or manure. Over time, P availability decreased at a fast rate for the first six months and later was relatively constant. The DMY exhibited quadratic relationships with P rates. Maximum DMYs (6-11 t ha^{-1}) were attained at 150-200 kg P ha^{-1} and declined above that rate. Average setaria dry matter yields (DMY) were not significantly different (6.1 to 6.6 t ha^{-1}). Yields per harvest increased to a maximum (11 t ha^{-1}) at 2-6 months and then declined to 2-4 t ha^{-1} after one year. Cumulative yields (20 to 55 t ha^{-1}) were not significantly different for the various fertilizers. Manure-CIPR integration increased DMY but manure-GPR and manure-TSP depressed DMY. Yield depression was associated with high P causing nutrient imbalances in the soil. The study demonstrates the need for balanced fertilization, particularly in the use of high fertilizer levels as advocated in the Africa green revolution.

Keywords: *Manure, Phosphorus availability, Phosphatic fertilizers*

Soil Nutrients Transformations in a Tropical Oxisol: Effect of continuous land cultivation.

S. Ngoze[1*], S. Riha[1], J. Lehaman[2], A.N. Pell[3] and L. Verchot[4]

[1]Department of Earth and Atmospheric Sciences, Cornell University, Ithaca, NY 14853, USA; [2]Department of Crop and Soil Sciences, Cornell University, Ithaca, NY 14853, USA; [3]Department of Animal Sciences, Cornell University, Ithaca, NY 14853, USA; 4World Agroforestry Centre (ICRAF), P.O Box 30677-00100, United Nations Avenue, Gigiri, Nairobi, Kenya
[*]Corresponding author: *son2@cornell.edu*

Abstract

The long-term dynamics of emerging nitrogen (N) and phosphorus (P) constraints in degrading soil were investigated along a 100-year chronosequence in the agricultural highlands of western Kenya. Treatments included control (no P and N), N (0, 30, 60, 90 and 120 kg N ha^{-1}) and P (0, 25, 50, 75 and 100 kg P ha^{-1}). Mineral N, available P decreased, and P adsorption capacity increased with age since conversion. The long rain (LR) season control grain yield (GY) declined rapidly in the first 25 years of cultivation and then more gradually approached an equilibrium within a 60- to 100- year time period, at which point GY was only 16% of that of the young conversion GY (6.4 Mg ha^{-1}). Application of either N or P alone significantly increased GY in both the LR and short rain (SR) seasons. However, there was a much greater yield increment response to N and P when applied together (ranging from 1 Mg ha^{-1} to 3.8 Mg ha^{-1}), with the greatest responses on the oldest conversions. N was more limiting than P on the old conversions. This study clearly indicates that in the LR season N and P productivity responses are significantly affected by age of conversion due to differences in ISF. Land productivity recovery strategies need to consider ISF in determining N and P input requirements, as well as the synergistic effects of N and P if climate rather than fertility limited productivity levels are to be sustained.

Keywords: *Nitrogen, Phosphorus, western Kenya, soil degradation, conversion age*

Effect of Phosphorus Sources and Rates on Sugarcane Yield and Quality in Kibos, Nyando Sugar Zone

J. O. Omollo* and G. O. Abayo

Kenya Sugar Research Foundation (KESREF), P.O. Box 44 – 40100, Kisumu. KENYA, Tel: 0202047307.
*Corresponding author: *jacob.omollo@kesref.org*

Abstract

One of the causes for declined sugarcane yields is low soil nutrient levels especially the most limiting ones, Nitrogen (N) and Phosphorus (P). This is further aggravated by inadequate or lack of nutrient replenishment. The study conducted at KESREF-Kibos, experimental field on a *Eutric Vertisol* evaluated the effect of four P sources, single super phosphate (SSP), triple super phosphate (TSP), diammonium phosphate (DAP) and rock phosphate (RP) and four P levels (0, 17, 34 and 52kg P ha^{-1}) on yield and quality of sugarcane varieties KEN 82-808 and CO 421. P sources significantly influenced yield of variety CO421 at second ratoon harvest the trend being DAP>RP>TSP>SSP. Effect of P sources on quality was not significant. Application of P increased population of millable stalk and yield compared with the control (0kg P ha^{-1}) in both KEN 82-808 and CO 421. Highest yield was recorded when P applied was 34kg P ha^{-1} and lowest in control (0kg P ha^{-1}) the trend being 34>17>52>0kg P ha^{-1}. Effect of P rates on quality was not significant. It is concluded that fertilizer P sources can be applied to supply P. P plays a significant role on yield parameters than on quality parameters. The level 34kg P ha^{-1} (80kg P_2O_5 ha^{-1}) is appropriate to maintain the crop to second ratoon harvest for increase yield.

Keywords: *Phosphorus, Rates, Sources, Sugarcane, Yield*

Complementary Nutrient Effects of Organic and Inorganic Fertilizers on Maize Production in the Smallholder Farms of Meru South District, Kenya

Mutegi* E.M, JB Kung'u , Mucheru M and Mugendi D.N

Department of Environmental Science, Kenyatta University, P.O Box 43844, Nairobi Kenya.
Corresponding author: *mutegiedwin@yahoo.com*

Abstract

Low soil fertility is a major constraint to maize production in the smallholder farms of MeruSouth District. This is mainly attributed to the mining of nutrients due to cropping without external addition of adequate nutrients. Inorganic fertilizers are expensive hence unaffordable by most smallholder farmers. The use of organic matter to increase and maintain soil fertility is being considered as a solution to help the low-income smallholder farmers. A study was conducted in Mucwa location, Meru South District to determine the levels of complementarity between organic and inorganic amendments on maize yields. The experiment was set in a complete randomized block design (CRBD) with three replicates. The treatments were compared with the response obtained from control. The highest grain yields of 5.5 Mg ha^{-1} and 4.2 Mg ha^{-1} were realized from sole application of calliandra during the 2005 Short rains and 2006 Long rains cropping seasons. Results obtained indicated that the use of either organic or combined organic/inorganic N soil amendment appear to be superior to using inorganic amendment sources alone**.**

Keywords: *Maize, organic/inorganic soil amendments, soil fertility*

Soil Inorganic N dynamics and N uptake by maize following application of legumes, tithonia and manure and inorganic fertilizer in central Kenya

J. Mugwe[1],*, D. Mugendi[2], J. Kungu[2] M. Mucheru-Muna[2]

[1]Scientist, Kenya Forestry Research Institute (KEFRI), P.O. Box 20412-00200 Nairobi, Kenya; [2]Kenyatta University (KU), School of Environmental Studies and Human Sciences, Department of Environmental Sciences P.O Box 43844, Nairobi, Kenya.
*Corresponding author: *jaynemugwe@yahoo.com*

Abstract

In the smallholder farms of central Kenya, the rate of soil nitrogen (N) loss is higher than the rate of replenishment resulting in N deficiency. Farmers lack financial resources to replenish N through application of chemical fertilizers. This study evaluated the contribution of some organic materials solely applied or combined with inorganic fertilizer to soil inorganic N and uptake of N by maize. The experiment was a randomized complete block with 3 replicates that was established in 2000. Soils and maize samples were taken at 2, 4, 6, 8, 12, 16 and 20 weeks after planting maize (WAP) and analysed for inorganic N and nitrogen content, respectively. The amounts of soil inorganic N at 0-15 cm soil depth and amounts of N taken up by maize varied among the different sampling dates, treatments and between the seasons. The treatments that had sole tithonia, leucaena and calliandra applied recorded the highest amounts of soil inorganic N especially in 2004 LR when rainfall was poor. During 2002 LR, when rainfall was fairly distributed, soil inorganic N increased from 0 to 4 WAP and generally reduced from 6 weeks up-to 20 WAP. The increase in soil inorganic N at the start of the season was attributed to nitrogen flush (Birch effect) and rapid decomposition of the organic materials while the reduction that followed was attributed to uptake of N by maize coupled with leaching. The amount of soil inorganic N was found to be generally higher during 2004 LR (when rainfall was poor) than 2002 LR probably due to the restricted uptake of N by the maize crop during 2004.

Keywords: *Organic materials, Soil inorganic N, Uptake of N by maize*

Effect of manure application on soil nitrogen availability to intercropped sorghum and cowpea at three sites in eastern Kenya.

F.M. Kihanda[1], G.P. Warren[2], J.W. Irungu[1], and S.S. Atwal[2]

[1]Kenya Agricultural Research Institute (KARI), Embu Regional Research Centre, P.O. Box 27, Embu, Kenya; [2]Department of Soil Science, The University of Reading, P.O. Box 233, Reading, RG6 6DW, U.K.
Corresponding author: *kihandafm@yahoo.com*

Abstract

A trial was conducted where sorghum and cowpea were intercropped at three sites with different natural concentrations of soil phosphorus (1.0, 7.0 and 26.3 mg kg^{-1} Olsen-P) and with biannual cropping. There was a total of five field treatments namely goat manure applied at rates of 0, 5 and 10 t ha^{-1} annually for six years, and at 5 and 10 t ha^{-1} annually for four years followed by two years without manure. Continuous manuring at 10 t ha^{-1} created the same amount of soil N as 5 t ha^{-1} manure so the residual effects were the same for 5 and 10 t ha^{-1} manure and the effects were the same at all sites. In the season studied, between 1.8 and 4.1% of the native soil N was mineralized and taken up by the crops. 11% of the manure residual N (applied between two and six years previously and remaining in the soil) was taken up and this fraction was the same in all soils. Recently applied manure N contributed significantly more to crop N in the most nutrient-deficient soil. On the soils with Olsen-P ≥7 mg kg^{-1}, cowpeas obtained a significant extra 32 kg N ha^{-1}, attributed to biological N fixation (BNF). If Olsen-P was <6 mg kg^{-1}, BNF was negligible.

Keywords: *Intercropping, Manure, Nitrogen fixation, Phosphorus, Residual effect, Sorghum bicolor, Vigna unguiculata*

The Effects of Integration of Organic and Inorganic Sources of Nutrient on Maize Yield in Central Kenya

Kathuku[2] A.N., S. K. Kimani[2], J. R. Okalebo[1], C.O. Othieno[1], and B. Vanlauwe[3]

[1]Moi University, Department of Soil Science Box 1125, Eldoret, Kenya; [2]Kenya Agricultural Research Institute, National Agricultural Research Centre, Muguga, P.O. Box 30148, Nairobi, Kenya; [3]Tropical Soil Biology and Fertility Institute (TSBF)-CIAT, P.O. Box 30677, Nairobi, Kenya

Abstract

Low soil fertility is one of the major constraints to food production in the central highlands of Kenya. This phenomenon calls for intervention in order to fight food insecurity in this densely populated part of Kenya. Majority of the farmers use the old recommendations, which were general for central Kenya, while other meander in the maze of guessing depending on crop performance or availability of manures or fertilizers. To answer this noble call, an experiment was set up in two districts of Central Kenya; Kirinyaga (Mukanduini village) and Maragua (Kariti secondary school). The experiment was an RCBD design, which consisted of manure as single applications and manure in combination with varying and increasing rates of nitrogenous fertilizer and replicated three times. The results showed that application of manure alone at 5 t ha^{-1} was not sufficient enough for high crop performance although higher yields above the control were reflected but on addition of nitrogen higher yields were obtained even at the lowest rates of 20 kg N ha^{-1}. Nitrogen response curves showed that application of Manure 5 t ha^{-1} and N in form of calcium ammonium nitrate up to 40 N kg ha^{-1} is gives yield increases but in excess of that yields decreased. This indicated that the best quantity of nitrogen to add to manure 5 t ha^{-1} is 40 kg N ha^{-1}.

Keywords: *Maize yield, manure, N-fertilizer, N-response*

Nitrogen Use in Maize *(Zea Mays)* -Pigeonpea *(Cajanus cajans)* Intercrop in Semi- arid Conditions of Kenya

S. W. Wanderi*, M.W.K. Mburu, S.N. Silim, & F.Kihanda

Kenya Agricultural Research Institute P.O. Box 27, Embu
Corresponding author: *wanderi_susan@yahoo.com*

Abstract

A field experiment was conducted at Jomo Kenyatta University of Agriculture and Technology between 2001 and 2002 to determine nitrogen use in maize-pigeonpea intercrop system. The experiment was laid out as a randomized complete block design replicated four times. Treatments included two pigeonpea maturity types; two long duration (erect and semi-erect) and one medium duration type intercropped with maize (Katumani) or sole crop. Data on plant total nitrogen uptake, litter fall, N fixed and soil mineral N were determined. Results showed that intercropping increased maize grain concentration compared to sole maize, indication of nutritional quality improvement. Long duration cultivars had the highest plant N uptake and contributed high amount of N through litter fall and biological fixation compared to medium duration. Soil mineral N increased over time, probably due to soil N mineralization or pigeonpea N contribution through litter fall decomposition which ranged from 3.9-7.6 t/ha. N contribution through the litter fall was beneficial to subsequent maize crop, in plots previous intercropped with pigeonpea compared with continuous maize cropping. This study showed that late maturing pigeonpeas may play an important role in low input maize production systems primarily through N cycling, (probably through capture of deep soil N pool and litter) and through biological nitrogen fixation and this improves maize yield and quality.

Keywords: *Nitrogen uptake, N fixation, maize, pigeonpea, intercropping, residual effect, soil mineral N*

Natural and antropic determinant of carbon and nitrogen stocks in soils in agro-ecosystems of Burkina Faso

S. Youl[1,*], R.J. Manlay[2], D. Masse[3], V. Hien[4], C. Feller[5]

[1]IFDC-Ouaga 11 BP 82 CMS Ouagadougou 11, Burkina Faso; [2]DFRT/UR IRD 179 SeqBio, 648, rue Jean-François Breton BP 44494 - 34093 Montpellier Cedex 5, France; [3]IRD (Institut de Recherche pour le Développement), UR 179 SeqBio, 01 BP182 Ouagadougou Burkina Faso; [4]INERA-Kamboinsé 01 BP 476 Ouagadougou 01, Burkina Faso; [5]IRD (Institut de Recherche pour le Développement), BP 434 ,101 Antananarivo, Madagascar.
*Corresponding author: *syoul@ifdc.org*

Abstract

Two land management effects on C and N supplies and their dynamics was carried out in order to define plots C and N stocks models for a more complex modelling multi agents system (MAS). For that purpose 112 farmers plots judiciously selected were sampled in horizons 0-10 and 10-20 cm and analyzed. Moreover 26 pedological profiles were described and 12 of them sampled along the whole profile for C, N analysis to estimate C and N stocks and dynamics for deeper layers. Results show that apparent density (Da) is not significantly different in the two farming systems and cultivating does not affect this one. Da is not affected by the various land uses. Moreover Da in the two horizons 0-10 and 10-20 cm are significantly different. Fine elements content is not significantly different in the two farming systems. Soil is neither affected by the land uses, nor even by cultivating. On the other hand fine elements ratio varies significantly when moving from 0-10 cm horizon to the lower one 10-20cm. C and N stocks are mainly a function of fine elements content (clay + fine silt in %). Cultivating does not affect significantly stocks. The two farming systems show a significant difference of average stocks of C, N. These same stocks in the 0-10 cm horizon are higher than stocks of the 10-20 cm horizon. For all soil, all land uses confused, average C , N stocks for the 20 first centimetres respectively 14,12 t ha $^{-1}$ and 0,9 t ha $^{-1}$. The study suggests that management is the major determinant of C storage as well as soil texture (clay+ fine silt in %) and those act mainly on the first 10 centimetres soil. C and N contents and stocks beyond 20 cm are related to soil depth rather than land management.

Keywords: *carbon stock, soudano–guinean savanna, carbon sequestration, management mode, Burkina Faso.*

Effect of N and P Fertilization on Soyabean (Glycine Max (L) Merr) Growth in Acid Soil

M.C. Matokwe[1] and J. Nyamangara[2]

[1]Tobacco Research Board, P O Box 909, Harare, Zimbabwe; [2]Department of Soil Science & Agricultural Engineering, University of Zimbabwe, Harare, Zimbabwe
Corresponding author: *jnyamangara@agric.uz.ac.zw*

Abstract

Soybean (*Glycine max.* L. (Merr)) offers potential as a high protein substitute for human consumption and cash for smallholder farmers in sub Saharan Africa. Soil acidity and nutrient mining have been identified as the major constraints limiting crop production by smallholder farmers in SSA. A field trial was conducted over two seasons to determine the effect of rate of N and P fertilizer application on the growth of soybean under acid soil conditions. Four P rates (0, 7.5, 15 and 22.5 kg P ha^{-1}) were combined with two N application rates (0 and 30 kg N ha^{-1}) and 2 lime rates (0 and 1 500 kg ha^{-1}) on a sandy clay loam site previously under a grass fallow. Application of lime did not improve dry matter and grain yield ($p > 0.05$) of soybean. However, liming significantly ($p<0.05$) improved nodule number and nodule dry matter yield (ave. 56% and 81%, respectively). Phosphorus enhanced nodule development, while N suppressed (ave. 65%) the development and growth of nodules. It was concluded that the acidic soil conditions and low P had no effect on the soybean growth, but were not favorable for biological nitrogen fixation.

Key words: *Biological nitrogen fixation, lime, soil acidity, soybean*

N_2 fixation and P uptake of soybean at two low-P soils of southern Cameroon

M. Jemo[1,*], R. C. Abaidoo[2], C. Nolte[1], and W. J. Horst[3]

[1]International Institute of Tropical Agriculture, Humid Forest Ecoregional Centre (HFC) BP 2008 (Messa) Yaoundé, Cameroon.
[2]International Institute of Tropical Agriculture (IITA), Oyo Road, PMB 5320, Ibadan, Nigeria.
[3]Institute of Plant Nutrition, University of Hanover, Herrenhaeuser Strasse 2, 30419 Hanover, Germany.
*Corresponding author: *mjemo2001@yahoo.com*

Abstract

Genotypic differences in N_2 fixation and the efficient acquisition of phosphorus were evaluated among 12 soybean genotypes grown at two acid soils low in available P of southern Cameroon. Field assessments were carried out in 2001 and 2002 using three P sources: 0P kg P ha^{-1}, 90 kg P ha^{-1} as phosphate rock (PR), and 30 kg P ha^{-1} as triplesuperphosphate (TSP) and on a Typic Kandiudult (TK) and Rhodic Kandiudult (RK) soil. Shoot dry matter, nodule dry matter, ureide concentration, N_2 fixation, and P uptake were assessed at flowering and grain yield at the harvest maturity. Shoot dry matter, nodule dry matter, ureide concentration, N_2 fixation, P uptake and grain yield significantly varied with site and genotypes ($P < 0.05$). On TK soil, nodule dry matter ranged from 0.3 to 99.3 mg $plant^{-1}$ increased significantly with P application ($P < 0.05$). N_2 fixation measured using the ureide assay method ranged from 25.3 to 44.7 kg N ha^{-1} on TK and from 18 to 38 kg N ha^{-1} on RK soil. At low level of P availability, the grain yield of the soybean genotypes correlated significantly with shoot dry matter, and N_2 fixation, but loosely to nodule dry matter per plant. Two groups of soybean genotypes contrasting in N_2 fixation and P uptake at low available P soil were identified to further investigate the whole-plant mechanisms responsible for differences in P acquisition efficiency.

Keywords:: *N_2 fixation; P-uptake; soybean.*

Effects of leguminous plant residues and NPK fertilizer application on the performance of yam *(Dioscorea rotundata 'cv' ewuru)* in south western Nigeria

G.O. Kolawole

Department of Agronomy, Ladoke Akintola University of Technology (LAUTECH) PMB 4000, Ogbomoso, Oyo state, Nigeria; Phone number: (+234) 8037198801
Correspondence: *oladejokolawole@hotmail.com*

Abstract

The effects of cultivating and incorporating residues of previous *Pueraria phaseoloides* and *Glycine max*, with application of NPK fertilizer on performances of yam was evaluated at the Teaching and Research Farm, LAUTECH, Nigeria. There were nine treatments: incorporation of residues of the legumes (5 t DM ha^{-1}), application of the recommended NPK fertilizer rate for yam (90-50-75 kg NPK ha^{-1}) in the zone or 50% of the recommended rate (45-25-37.5 kg NPK ha^{-1}), alone and in combination with residues and a control without residues or fertilizer. The treatments were laid out as randomised complete block design replicated four times. Cultivation of previous legumes reduced soil nematode population (> 200%) compared with situation without legumes. Application of 50% of the recommended NPK rate with or without incorporation of residues slightly improved yam tuber yield. Fertilizer application enhanced Arbuscular mycorrhizal (AM) colonization of yam roots but, AM colonization was lower (about 50%) in plots where Pueraria residues was incorporated compared with other plots. Fertilizer application increased N concentration in yam leaves while P concentration was lowest in the control (0.152%) and highest in Pueraria residues+50% recommended NPK rate (0.21%) treatment. Combined application of plant residues with NPK fertilizer improved soil organic carbon, N, Ca, and Mg compared with application of NPK fertilizer. From these results, 50 percent of the recommended NPK rate for yam in the zone may be adequate and incorporation of residues with reduced NPK fertilizer application may be a sustainable soil fertility management option for continuous yam production.

Keywords: *Arbuscular mycorrhizal colonization, combined application of plant residues and mineral fertilizers, Dioscorea rotundata 'cv' ewuru, nematode population, southwestern Nigeria*

Influence of Agro-ecology on the Efficiency of Nitrogen Utilisation by Maize in Western Cameroon

Meppe[1*] P. F., F. Tchuente[2], P. Bilong[3], D.Nwaga[4]

[1]IRAD/DVI, Box 2067 Messa, Yaounde; [2]IRAD Soil Laboratory, Ekona, Cameroon; [3]Faculty of Sciences, Douala University; [4]Faculty of Sciences, Yaounde I University
*Corresponding author: *pacomep2000@yahoo.com*

Abstract

Field trials were conducted for two seasons to study the efficiency of fertilizer nitrogen utilisation by maize and reduce the cost of maize fertilisation in two agro-ecological zones of Western Cameroon. Treatments consisted of five rates of nitrogen, 0, 30, 60, 90 and 120 kg ha^{-1} as urea. Utilisation of applied N by maize for grain production was more efficient in the mid altitude zone than in the lowland area. Grain yield increase per unit of applied N was 6.2 kg in the lowland zone but could go as high as 30 kg in the mid altitude zone. Optimum fertilizer rates for maize production are 40 kg and 80 kg ha^{-1} respectively for the two agro-ecologies. Factors such as soil texture, low organic C content, lower solar radiation and substantial sub-soil NO_3-N accumulation may be responsible for lower N requirement for maize production in the lowland forest zone and consequently have an impact on the value of applied N fertilizer. Significant poor residual effects were recorded in the mid altitude zone. Therefore a full dose of the optimum rate is obligatory for each maize crop in that zone.

Keywords:, *Efficiency, maize, nitrogen, residual effect, Western Cameroon*

Enhancing productivity through the integration of grain legumes in maize cropping systems in Central Kenya

M. Mucheru-Muna[1,*], D. Mugendi[1], B. Vanlauwe[2], R. Merckx[3], J. Mugwe[4], P. Pypers[2] and J. Kung'u[1]

[1]Department of Environmental Sciences. Kenyatta University, P.O. Box 43844, Nairobi, Kenya; [2]Tropical Soil Biology and Fertility, (TSBF) Institute of CIAT, P. O. Box 30677 Nairobi, Kenya; [3]K.U.Leuven, Faculty of Bioscience Engineering, Laboratory for Soil and Water Management, Kasteelpark Arenberg 20, 3001 Heverlee, Belgium; [4]Kenya Forestry Research Institute, P.O. Box 20412, Nairobi, Kenya
*Corresponding author: *moniquechiku@yahoo.com,* Mobile: +254-733-915165

Abstract

Declining land productivity is a major problem facing smallholder farmers in Kenya today. This decline results from a reduction in soil fertility caused by continuous cultivation without adequate addition of external inputs. Improved agronomic measures integrating grain legumes into maize cropping systems can enhance nutrient use efficiency and overall system's productivity. Trials were established in two sites in Central Kenya (Mukuuni and Machang'a) to evaluate contribution of various legumes (beans, cowpea and groundnut) and plant spacing to overall productivity of the intercropping system. The conventional spacing (a legume row alternating a cereal row) was compared to MBILI spacing (two legume rows alternating two cereal rows), both with and without P. In Mukuuni (more fertile) neither legumes nor maize responded to P application, legume yield was increased by on average 40% and maize yields more than doubled by P application in Machang'a. At Mukuuni, groundnut produced poorly (<500 kg/ha); beans yielded slightly but significantly better than the other legumes. At Machang'a, highest legume yields were obtained with cowpea. At both sites, legume yields tended to be higher when planted at the traditional spacing, irrespective of legume species or P application; though not consistently significant in all seasons. Contrarily, at Machang'a, maize yields were generally highest when planted using MBILI spacing, provided P was applied. Without P application, higher yields were observed for maize in the traditional spacing, but only when intercropped with beans. Maize yields were significantly higher with traditional spacing when intercropped with groundnut, while in MBILI spacing; highest yields were observed for maize intercropped with beans.

Keywords: *Grain legumes, intercropping, MBILI spacing, P fertilizer, traditional spacing*

Effects of mineral substances on chemical composition and dry matter production of organs of cassava (Manihot esculenta)

V. D. Taffouo[1,*], E. Tsoata [2], M. Kenné[3], R. J. Priso[1], T. Fonkou[4] and A. Akoa[2]

[1]Department of Botany, Faculty of Science, University of Douala, P.O. Box 24157 Douala-Cameroon; [2]Department of plant Biology and physiology, Faculty of Science, University of Yaoundé I, P.O. Box 812 Yaoundé-Cameroon; [3]Department of Biology and Animal Physiology, Faculty of Science, University of Douala, P.O. Box 224157 Douala-Cameroon; [4]Department of Botany, Faculty of Science, University of Dschang, P.O. Box 377 Dschang-Cameroon.
[*]Corresponding author: *vtaffouo@yahoo.fr*

Abstract

In order to determine nutritional values of organs of cassava (*Manihot esculenta*) in rural area, effects of minerals substances on chemical composition and production of dry matter were evaluated. Plant where submitted to 4 levels of fertilisers' enrichments [manure potassic (K), phosphatic (P), phosphatic and potassic (PK) and nitrogenized, phosphated and potassic (NPK)]. Water, nitrogen, potassium, phosphorus, sodium, total proteins and total lipids contents were determined in different organs (leaves, shoots and tubers). After a 9 months growing period, results showed that nutritive solutions enriched with K, PK and NPK, significantly increased the organic compounds contents of the leaves ($P<0,05$). Furthermore, adding chemical fertilizers with high phosphorus content, significantly improved the lipids contents of the leaves (25%). Nutritive solutions enriched with NPK positively influenced the dry biomass produced in different organs of *Manihot esculenta*. Total proteins contents in the leaves and in the tubers produced in the medium enriched with NPK were higher (70 mg/g DM and 30 mg/g DM respectively) than those in the plants cultivated on the control media (17 mg/g DM and 9 mg/g DM respectively). The utilization of fertilizer in combination with NPK as a straightening manure would allow the improvement of the chemical composition and production of dry matter of the cassava in rural area.

Keywords: *Fertilizer, Manihot esculenta, nutritional value, rural area*

Nitrogen and carbon mineralization patterns of indigenous legumes as influenced by their chemical composition

Nezomba[1]* H., Tauro[1] T.P., Mtambanengwe[1] F., and Mapfumo[1, 2*] P.

[1]Department of Soil Science and Agricultural Engineering, University of Zimbabwe, P.O. Box MP 167, Mount Pleasant, Harare, Zimbabwe; [2]Soil Fertility Consortium for Southern Africa (SOFECSA), CIMMYT, Southern Africa, P.O. Box MP 163, Mount Pleasant, Harare, Zimbabwe
*Corresponding author: *hatienez@yahoo.co.uk*

Abstract

Nitrogen-fixing indigenous legumes can be harnessed to enhance soil fertility replenishment of smallholder farms. However, nutrient release from such organic materials is largely determined by the chemical composition. A study was conducted to determine the chemical quality of indigenous legumes mainly of the genera *Tephrosia, Crotalaria* and *Indigofera*, and their C and N mineralization using a leaching tube method under laboratory conditions. All the legumes had >2% N. With the exception of *Macrotyloma daltonii*, all the legume species had a lignin content of >15%. Total polyphenols ranged from 1-2.5% for all the legume species. Despite the relatively high lignin content, most of the legume species mineralized >70% of the added N within 155 days of incubation. *Eriosema ellepticum, Crotalaria pallida* and *Tephrosia longipezi* had mineralized >40% of the added N within 21 days of incubation. Mixed biomass from indigenous legume fallows (indifallows) cumulatively mineralized 69% of the added N compared with 54 and 42% for biomass generated in natural fallows and sunnhemp (*Crotalaria juncea*. L) fallows, respectively. *Crotalaria cylindrostachys* immobilized N throughout the incubation period despite the relatively high N (2.3%) and low polyphenol (1.8%) content. Cumulative evolved CO_2 was correlated to the initial legume N content (r^2=0.91). The results apparently suggest that indigenous legumes can potentially contribute to the N requirements of crops in smallholder farming areas. However, the major challenge lies in regulating the N mineralization to enhance crop uptake, given that most of the legume species had mineralized >50% of the added N within a month.

Keywords: *Indigenous legumes, N mineralization, lignin, smallholder, quality*

The Effect of Organic Based Nutrient Management Strategies on Soil Nutrient Availability and Maize Performance in Njoro, Kenya

J.J. Lelei[1,*], R.N. Onwonga[2] and B. Freyer[3]

[1]Department of Crops, Horticulture and Soil Sciences, Egerton University, P.O. Box 536, Njoro, Kenya, Tel - +254 722 305491; [2]Ministry of Agriculture, Cathedral Road, Kilimo House, P.O. Box 30028, Nairobi, Kenya; [3]Division of Organic Farming, University of Natural Resources and Applied Life Sciences (BOKU) , Gregor Mendel Strasse 33, A-1180 Vienna, Austria.
*Corresponding author: *joycendemo@yahoo.com*

Abstract

A field experiment based on the concept of organic nutrient management was conducted in Njoro, Kenya to test the effect of improved legume fallows; crotalaria (CR), lablab (LB) garden pea (GP) and natural fallow (NF, as control) on available soil N and P, and maize performance. The experimental design was a split plot fitted to a randomized complete block. The main plots were two cropping systems involving improved legume fallows and NF preceding (i) sole maize (M); NF-M, CR-M, LB-M and GP-M, and (ii) maize bean (M/B) intercrop; NF-M/B, CR-M/B, LB-M/B and GP-M/B. The sub-plots were two residue management types; residue incorporation and residue removal with manure (FYM) incorporated instead. Residue incorporation resulted into higher concentrations of N and P in soil than FYM in both cropping systems. Under sole maize, grain yield (t ha^{-1}) following LB (4.6) was significantly higher than after CR (3.5), GP (3.3) and NF (2.2). In the M/B intercrop, maize grain yield following LB (3.9) was significantly higher than after GP (2.4) and NF (2.8) with no significant differences in yields following CR (3.1) and LB (3.9). Maize dry matter (DM) yields followed a similar trend. Overall, maize grain and DM yields were higher in sole maize cropping system than in M/B intercrop but an additional 0.5-0.6 kg ha^{-1} of bean grain yield was realized in the latter cropping system. The improved fallow legumes enhanced soil productivity, besides the harvested seeds providing supplementary protein sources, with resultant higher yields of the succeeding crop.

Keywords: *Improved legume fallow; maize; Njoro; nutrient availability; organic based nutrient management*

Influence of Conventional and 'Mbili' (Maize-Legume) Intercropping Systems on Yield, Nutrient Uptake and Rooting Characteristics of Intercrops in Western Kenya

C. Kiraithe[1,*], J.R. Okalebo[2], C.O. Othieno[2]

[1]Kenya Forestry Research Institute, P.O. Box 1078-80200, Malindi, Kenya
[2]Moi University, Soil Science Department, P.O. Box 1125, Eldoret, Kenya
*Correspondence author: *mbinyu@yahoo.com*

Abstract

Variations in rooting and nutrient uptake are envisaged from the complex nature of spatial arrangements of intercrops. This study was undertaken to enhance the understanding of 'MBILI' (Managing Beneficial Intercrops within Legume Intercrops) over conventional intercropping system in relation to yield, nutrient uptake and rooting characteristics of intercrops. On-farm experiments were carried out in Bungoma and Siaya Districts of Western Kenya in a 2×2×2 factorial arranged as a randomized complete block design with four replicates. Two intercrops, groundnuts/beans with maize were planted within 'MBILI'/conventional at two nutrient levels 0 and 150 kg DAP ha^{-1} (27 kg N/ha; 30 kg P/ha). Yields, nutrient uptake and utilization of intercrops were measured while root sampling was done at legume flowering stage. Bungoma 2003 (long rains) had the highest groundnut yields, ranging from 430 to 893 kg ha^{-1} for the 'MBILI' control and 'MBILI' fertilized plots, respectively. Maize yields were relatively high in Siaya 2003 (long rains) than in other sites and seasons with 'MBILI' at 27 kg N/ha; 30 kg P/ha (within maize/groundnut intercrop) giving the highest yields 4,218 kg ha^{-1}. The N and P uptake in the legume and maize grains in all sites were significantly ($p<0.05$) affected by the nutrient level and row arrangement. Root density was higher and roots grew deeper in the 'MBILI' system than in the conventional system. Thus, roots in 'MBILI' system were able to access N at deeper layers and therefore reduce dependency on N_2 fixed leading to a greater overall resource capture.

Keywords: *Spatial arrangements yield, rooting characteristics.*

Interaction between Resource Quality, Aggregate Turnover, Carbon and Nitrogen Cycling in the Central Highlands of Kenya

A. Kavoo[1,3,*], B. Vanlauwe[1], J. Six[2], R. Gentile[2], D. Mugendi[3], G. Muluvi[3], H.K. Wangechi[1]

[1]Tropical Soil Biology and Fertility (TSBF-CIAT) P.O. Box 30677, Nairobi, Kenya; [2]Departments of Agronomy and Range Science, University of California, Davis, CA 95616, USA; [3]Kenyatta University, P.O. Box 43844, Nairobi, Kenya
*Correspondence author: *agneskavoo@yahoo.com*

Abstract

Combined use of organic (OR) and mineral sources (MR) of nutrients is accepted as one of the most appropriate ways to address the problems of declining soil fertility and poor crop yields facing small-scale farming in sub-Saharan Africa. A field study was conducted at Embu in Central Kenya to investigate the effect of OR and MR management on aggregate turnover, C sequestration and N stabilization. The study comprised of ORs of differing quality; *Tithonia diversifolia (*high quality), *Calliandra calothyrsus* (medium quality), *Zea mays* stover (medium quality), Grevillea sawdust (low quality) and farmyard manure applied at a rate of 4 ton C ha^{-1} with or without 120 kg N ha^{-1} mineral fertilizer. Soil organic matter (SOM) fractions from soils sampled from the top soil (0-15cm depth) at the establishment of the field trial in 2002 and before the long rains in 2005 were analyzed for C, N and C-13 signatures. In 2005, SOM fractions C and N quantity was higher for both the sole and combined application of tithonia, calliandra, stover and manure compared to the initial (2002) total soil C and N. High quality ORs had the highest SOM input compared to low quality ORs while medium quality ORs contributed most to the formation of stable macroaggregates and SOM accumulation. Therefore, both OR quality and MR should be considered when devising soil management options for soil fertility and crop production.

Keywords: *Aggregate turnover, crop production, mineral N fertilizer, organic resource quality, soil organic matter*

Grain Legume Rotation Benefits to Maize in the Northern Guinea Savanna of Nigeria: Fixed-Nitrogen vs other Rotation Effects

A.A. Yusuf[1,*], E.N.O. Iwuafor[1], R. Abaidoo[2], O.O. Olufajo[3] and N. Sanginga[4]

[1]Soil Science Department, Faculty of Agriculture/Institute for Agricultural Research, Ahmadu Bello University, P.M.B. 1044, Zaria, Nigeria. [2]International Institute of Tropical Agriculture (IITA), P.M.B. 5320, Ibadan, Nigeria. [3]Agronomy Department, Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. [4]Tropical Soil Biology and Fertility Institute of CIAT (TSBF-CIAT), P.O. Box 30677, Nairobi, Kenya.
*Corresponding author: *adamu_99@yahoo.co.uk*

Abstract

The yield increases often recorded in maize following grain legumes have been attributed to fixed-N and 'other rotation' effects. These effects have not been quantified in the legume/cereal rotation system of the Sub-Saharan West Africa. Field trials were conducted between 2003 and 2005 to separate the effects on maize following grain legumes in the northern Guineas savanna of Nigeria. Maize was grown on plots previously cultivated with two genotypes each of soybean (TGx 1448-2E and SAMSOY-2) and cowpea (IT 96D-724 and SAMPEA-7), maize, and natural fallow. The plots were split into four N fertilizer rates (0, 30, 60 and 90 kg N ha^{-1}) in a split plot design. The total effect was calculated as the yield of maize following a legume minus the yield following maize, both without added N and the rotation effect was calculated as the difference between rotations at the highest N fertilizer rate. The legume genotypes fixed between 16 and 50 kg N ha^{-1} of their total N and had an estimated net N balance ranging from -22 to 3 kg N ha^{-1}. On average, maize following legumes had higher grain yield of 1.2 and 1.3-fold compared with maize after fallow or maize after maize respectively. The results also indicated that the magnitude of the fixed-N and other rotation effects varied and were influenced by the contributions of the grain legumes to the soil N-balance. SAMPEA-7 had the lowest contribution to other rotation effects of 16% in 2004 while this increased to 45% in 2005.

Keywords: *N balance, N contribution, N_2-fixation, Northern Guinea Savanna, Rotation effects*

Use of Tithonia Biomass, Maize Residues and Inorganic Phosphate on Bean Yield and Soil Properties in Rwanda

L. N. Nabahungu[1,]*, J. G. Mowo[2], A. Uwiragiye[3] and E. Nsengumuremyi[2]

[1]ISAR-Rwanda, B.P 138 Butare, Rwanda; [2]African Highland Initiative Box 26416 Kampala, Uganda; [3]Kiruhura District, B.P 135, Butare
*Corresponding author: *nabahungu@yahoo.com*

Abstract

Lack of adequate nutrient supplies both organic and inorganic sources are the principal constraints to bean production in Rwanda. Experiments on two sites in Rubona,Butare, Rwanda were conducted to assess the effect of Tithonia diversifolia biomass and maize residues applied alone or in combination with Triple Super phosphate on the yield of climbing bean (Var. G2331) and soil chemical properties. The combination of Tithonia and Maize residues produced more yield in 2 sites respectively of 3.3 t ha $^{-1}$ and 1.6 t ha $^{-1}$. The Tithonia addition has followed with 2.9 tons ha $^{-1}$ and 1.7 tons ha $^{-1}$. The above treatments have also improved the soil chemical properties except Bray 1 P. The combination of Tithonia and TSP has been good to solve the P problem and increased soil pH at 0.2 to 0.5 and reduced exchangeable aluminium toxicity. The high performances of Tithonia application on yield confirm its capacity to increase yields than inorganic fertilizers at equal N, P and K rates.

Keywords: *Acidic soils, Aluminium toxicity, decomposition*

Effects of Leguminous and Non Leguminous Hedges in Management and Productivity of Arable Steep Lands of the Central Highlands of Kenya

James K. Mutegi[1],*, Louis V. Verchot[1], Daniel N. Mugendi[2] and James B. Kung'u[2]

[1]World Agroforestry Centre (ICRAF), United Nations Avenue Gigiri, P.O. Box 30677, Nairobi, Kenya;
[2]Department of Environmental Sciences, Kenyatta University, P.O Box 43844, Nairobi, Kenya.
*Corresponding author: *mutegijames@yahoo.com* or *mkinyua@cgiar.org*

Abstract

Moderate to steep landscapes and severe soil, water and nutrient losses characterize over 40% of arable land in the central highlands of Kenya. To study the effectiveness of biological methods in management and enhancement of productivity of these arable steep lands, we established contour double row hedges of sole calliandra, leucaena and napier and combination hedges of either calliandra or leucaena with napier. These hedges were established on slopes exceeding 5%, pruned regularly and the resulting biomass cut into fine pieces, which were then incorporated into the plots they served for a duration of 20 months. We observed significantly higher soil pH (P = 0.013), Ca (P = 0.001), Mg (P = 0.042) and C (P = 0.032) after 20 months of trial, relative to the initial conditions. The first season registered higher soil losses (P = 0.004) than the second season for hedge treatments and vice versa for the control. Twenty months old combination hedges of leguminous and napier improved soil fertility concurrently with soil conservation across all the slope categories examined. This was in contrast with other hedges which mainly had one of these benefits but not the two. We conclude that well spaced, managed and combined contour hedges of leguminous trees and napier have a potential for controlling soil and nutrient losses across a range of slope categories while simultaneously enhancing soil productivity.

Keywords: *Soil erosion, soil fertility, maize production*

The Effect of Farmyard Manure Amendment on Soil and Rice Production in the Office Du Niger Zone of Mali

M. Bagayoko

Institut d'Economie Rurale (IER), Regional Center of Agronomic Research of Niono BP 12, Fax: 223 235 21 36, Cell: 223 647 44 92
Corresponding address: *Minamba.Bagayoko@ier.ml*

Abstract

From 2001 to 2004, a study was conducted in the "Office du Niger" zone of Mali to determine the combined effects of farmyard manure and N and P fertilizer applications in rice production system. Twenty five treatments were set-up in a factorial arrangement with 5 levels of manure (0, 1, 2, 3, and 4 tons manure per ha), 5 levels of nitrogen (0, 30, 60, 90, and 120 kg N per ha) and replicated 4 times. With a basal application of 2 tons of manure per ha, rice paddy yield reached a maximum of 6.5 tons when N was applied at increasing rate up to 90 kg N ha-1. When organic manure was applied at a rate greater than 2 tons, rice paddy responded linearly up to 120 N and reached 7 to 7.8 tons per ha. Increasing rates of manure (1 to 4 tonnes per hectare) improved paddy yield but not the straw and the total biomass yields. Without manure, crop yields were levelled at 5.5 tons ha-1 with increasing rates of N. The results indicated that, annual application of low quality organic resources such as the farmyard manure can significantly improve soil physical and chemical properties and rice paddy yields. The results also suggest that with application of 3 to 4 tons of manure, nitrogen fertilizer rate can be reduced by 40 kg N per hectare.

Keywords: *Mali, manure, nitrogen, Office du Niger, rice yield response*

Residue quality does not influence long-term C and N stabilization

R. Gentile[1*], A Kavoo [2], P. Chivenge[1], B. Vanlauwe[2] and J. Six[1].

[1]Department of Plant Sciences, University of California, One Shields Avenue, Davis, CA 95616, USA; phone: +1 530 752 6309; fax: +1 530 752 4361; [2]Tropical Soil Biology and Fertility institute of CIAT (TSBF-CIAT), Nairobi
*Correspondence author: *rgentile@ucdavis.edu*

Abstract

To fully benefit from the Integrated Soil Fertility Management approach to combine organic and mineral inputs, the linkage between input quality and soil structural dynamics needs to be understood. Our objectives were 1) to determine how input quality and root growth control aggregation, and 2) to assess how these relationships influence C and N stabilization. We sampled two trials in Kenya located at Embu, a clay soil, and Machanga, a loamy sand. The trials were initiated in 2002 with different quality residue inputs (no input, high quality *Tithonia diversifolia*, medium quality *Calliandra calothyrsus*, and low quality maize stover), applied at a rate of 4 Mg C ha^{-1} alone and in combination with 120 kg N ha^{-1} mineral fertilizer. Maize was grown in the plots each season, and a section of the plots was left uncropped. Soil samples (0-15 cm) were collected in March 2005 to assess aggregation and C and N stabilization. Residue additions increased macroaggregation at Embu, and cropping increased aggregation at Machanga. At Embu adding organic residue, regardless of the quality, and cropping significantly increased total soil C and N. This increase was also observed in the macroaggregate and microaggregate-within-macroaggregate fractions. Input treatments had little effect on C and N concentrations at Machanga. Nitrogen fertilizer additions did not significantly alter C or N contents at either site. We conclude that residue quality does not effect the long-term stabilization of soil organic C and N, only increased residue quantities lead to a long-term stabilization.

Keywords: *aggregation, fertilizer, residue quality, roots, soil organic matter*

Contribution of cowpea, pigeonpea and greengram rotation to nitrogen requirement of maize on a Ferralsol in Tanga – Tanzania

A.E.T. Marandu[1]*, J.P. Mrema[2], E. Semu[2] and A.S. Nyaki[1]

[1]Mlingano Agricultural Research Institute P.O.Box 5088 Tanga –Tanzania
[2]Department of Soil Science, Sokoine University of Agriculture. P.O.Box 3008 Morogoro Tanzania
*Correspondence: *atanasiom@yahoo.co.uk* Tel. + 255-27-47647, Mobile: 255754530805

Abstract

A glasshouse incubation of soil from field experiment where cowpea, pigeonpea and greengram were grown in rotation with maize was carried out at Mlingano Agricultural Research Institute. The objective was to study the N mineralization of the soil and its potential to supply N to the maize crop following legumes rotation. The experiment comprised of eight treatments which included the three legumes in rotation with maize, with maize stover removed or retained on the plots and continuous maize with the stover removed or retained. The maize was grown during long rains and the legumes during short rain seasons. Soil sampling for the incubation was carried out before maize planting from treatment plots at 0- 20 cm depth and sieved through a 6mm screen while fresh, then 250g sub samples were incubated in 500ml wide mouth volumetric flasks at 60% field capacity for 42 days. Destructive samplings were done at 14-day intervals and analysed for mineral N. Much of the mineralization occurred between 0 – 14th day. Seventy one percent of the mineralized N was obtained during this period when maize plants N demand is low. It was concluded that although substantial quantities of N are released through mineralization in this cropping system, the released N is not in synchrony with maize plants demand. Supplementation with mineral N fertilizer applied as top dressing is therefore necessary.

Keywords: *Legume for increasing maize yields, residues, maize stover, nitrate leaching, nitrogen mineralization*

Residual Benefits of two Cowpea Genotypes and Natural Fallow to Subsequent Maize in the Northern Guinea Savanna of Nigeria

E.N.O. Iwuafor[1], A.A. Yusuf[1,*], R. C. Abaidoo[2], O.O. Olufajo[3] and N. Sanginga[4]

[1]Soil Science Department, Faculty of Agriculture/Institute for Agricultural Research, Ahmadu Bello University, P.M.B. 1044, Zaria, Nigeria. [2]International Institute of Tropical Agriculture (IITA), P.M.B. 5320, Ibadan, Nigeria. [3]Agronomy Department, Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria. [4]Tropical Soil Biology and Fertility Institute of CIAT (TSBF-CIAT), P.O. Box 30677, Nairobi, Kenya.
*Corresponding author: *adamu_99@yahoo.co.uk* , Tel. 234 80 35 78 72 91

Abstract

Increased yields of maize grown after cowpea than maize has been attributed to enhanced N-availability and other rotation effects. Improvement in soil chemical properties has been indicated to be one of the most important rotation effects. Soil properties and grain yield were evaluated where different crop rotations were used. Two promiscuous improved cowpea lines (IT 96D-724 and SAMPEA-7), natural fallow and a hybrid maize (Oba Super 2) grown in 2003 were followed by a test crop of maize in 2004 with and without nitrogen (N) fertilizer (0 and 90 kg N ha^{-1}). Rotation and N fertilizer had significant ($P<0.05$) influence on the organic carbon and total N contents and unfertilized continuous maize resulted in the lowest values. Soil total N of maize plot following SAMPEA-7 was slightly higher (0.920 g kg^{-1}) than that following IT 96D-724 (0.870 g kg^{-1}). Cropping systems had no significant ($P > 0.05$) effect on soil pH, while the main effect of fertilizer on exchangeable cations was highly significant with rotation systems involving cowpea having lower values than continuous maize. Fertilization significantly affected exchangeable Ca and K concentrations only. The average increase of both cowpea cultivars were 50% higher than that of maize-maize and 22% higher than that of the fallow-maize system. Lack of interaction between rotation and fertilizer N effects indicates that the changes in the soil properties may explain the yield difference between cowpea rotations and continuous maize. The study showed that crop rotation increases maize yield even in the absence of inorganic fertilizer.

Keywords*: Crop rotation, exchangeable bases, organic carbon, soil pH, total nitrogen*

Seedbed types and Integrated Nutrient Management Options for Cowpea Production in the Southern Rangelands of Semi-Arid Eastern Kenya

C.M. Githunguri*, A.O. Esilaba, L.M. Kimotho, and L.M. Mutuku

Kenya Agricultural Research Institute (KARI) – Katumani, P.O. Box 340, Machakos.
*Corresponding author: *cgithunguri@kari.org; cmgithunguri@yahoo.com*

Abstract

The Southern Rangelands of Kenya are difficult environments prone to frequent droughts. The effect of the flat (farmer practice), tied-ridging and contour furrows seedbed types and integrated nutrient management practices on the performance of rainfed cowpeas was studied on-farm at the southern rangelands of Kenya during the 2006 short rains season. The treatments without fertilizer in combination with the flat seedbed had significantly higher number of pods than the tied-ridging and contour furrows seedbed types. The tied-ridging seedbed produced the highest number of branches while the flat and contour furrow seedbeds produced the highest pods and grain yields. The tied-ridging in combination with 10t ha^{-1} manure produced significantly higher number of pods, branches, pods and grain yields than both flat and contour furrows seedbeds. Under the 10t ha^{-1} farmyard manure + 20kg N ha^{-1} + 20kg P ha^{-1} soil fertility option the flat seedbed produced the highest number of pods and the contour furrows the highest number of branches, pods and grains yields. The flat, tied-ridging and contour furrows seedbeds in combination with 5t/ha manure produced the highest number of pods, pod and grain yields while the contour furrows produced the highest number of branches. Under 5t ha^{-1} manure + 20kg N ha^{-1} + 20kg P ha^{-1} the flat seedbed produced the highest pod and grain yields. The tied-ridging seedbed in combination with farmyard manure enhanced cowpea performance and grain yield even though performance was best under the flat seedbed on incorporation of inorganic fertilizers to manure.

Keywords: *Cowpeas, drought, integrated nutrient management, seedbed types, soil fertility*

Effect of soil acidity on nodulation and yield of selected soybean cultivars commonly grown in southern Africa

C. Musharo and J. Nyamangara*

Department of Soil Science and Agricultural Engineering, University of Zimbabwe, P.O. Box MP 167, Mt Pleasant. Harare. Zimbabwe
*Corresponding author: *jnyamangara@agric.uz.ac.zw*

Abstract

The inclusion of soybean (*Glycine max. (Merr)*) in the cropping systems of smallholder farmers in sub Saharan Africa (SSA) can improve soil N status and the diet of most households which have been affected by the HIV/AIDS pandemic. The selection of soybean cultivars tolerant to soil acidity can sustain productivity in the smallholder areas where most soils are acid is and lime is not readily available. A 2-season study was conducted to assess the tolerance of selected soybean cultivars to soil acidity (pH = 4.6) under field conditions. A split plot design with lime as the main factor and soybean cultivar as sub factor was used with 4 replications. Safari and Magoye showed highest tolerance to acidity in terms of nodule number and weight in the first season. Grain yield in acid soil was similar across cultivars implying that the varieties whose nodulation was affected by acidity later recovered possibly due to N mineralization from the soil. Liming significantly ($p<0.05$) increased grain yield of Safari (ave. 18.2%) and Magoye (ave. 23.2%). It was concluded nodulation was sensitive to soil acidity and any tolerance mechanism of soybean would involve this stage of plant growth. In low N and acid soils typical of smallholder areas of Zimbabwe, where N fixation in critical in the supply of plant N, selection of relatively acid tolerant cultivars such as Safari and Magoye would ensure economical grain production.

Keywords: C*ultivars, lime, soil acidity tolerance, soybean,*

Genetic Diversity of *Bradyrhizobia* Nodulating Promiscuous Soybean Varieties in Soils amended with Phosphorus and Lime in Two Contrasting Sites in Kenya

V.W. Wasike[1,2,3], B. Vanlauwe[2], F. Wachira[4], N.W. Mungai[3] L.M. Mumera[3] and D. Lesueur[2].

[1]Kenya Agricultural Research Institute (KARI), Kaptagat Road, Loresho. P.O. Box 57811-00200, Nairobi, Phone: +254 722 850805, Kenya; [2]Tropical Soil Biology and Fertility Institute of the International Centre for Tropical Agriculture (TSBF-CIAT), United Nations Avenue, P.O. Box 30677, Nairobi, Kenya; [3]Department of Crops Horticulture and Soils, Egerton University, P.O Box 536, Njoro, Kenya; [4]Department of Biochemistry and Molecular Biology, Egerton University, P.O Box 536, Njoro, Kenya.
*Corresponding author: *vwasike@cgiar.org;*

Abstract

Research was carried out to determine genetic diversity of indigenous *Bradyrhizobia* strains nodulating seven introduced promiscuous soyabean varieties grown in two sites differing in rainfall and soil chemical characteristics in Kenya. Genetic diversity was assayed using the Polymerase Chain Reaction-Restriction Fragment Length Polymorphism (PCR-RFLP) markers by amplifying the 16S-23S rDNA intergenic spacer (IGS) region. The differences in fingerprints served as the basis of grouping the strains into IGS groups. Results indicated that strains nodulating promiscuous soyabean varieties in Kenya can be grouped in 18 different polymorphic intergenic spacer groups. The three most predominant IGS groups were I, III, II, IV and VI which constituted 43.4%, 24.2%, 8.4% 7.7% and 7.3% respectively of all the analyzed nodules from the two sites while IGS group VII, IX, X, XI, XII, XIV, XVI, XVII, XVIII constituted less than 1%. The polymorphism identified in *Bradyrhizobia* populations from the two sites represent a valuable genetic resource that has potential utility in the selection of more competitive strains for use in inoculants.

Keywords: *Agro-ecological zone, Bradyrhizobia, promiscuous soyabean,* PCR-RFLP

In-vitro selection of soybean accessions for germination induction and reduced attachment of *Striga hermonthica (Del.)* Benth on associated maize

J.A.Odhiambo[1,*], B.Vanlauwe[2], I.M Tabu[1], F. Kanampiu[3] and Z. Khan[4]

[1]Department of Crops, Horticulture and Soils, Egerton University, P.O. Box 536, Egerton, Kenya; [2]Tropical Soil Biology and Fertility institute of the International Centre for Tropical Agriculture (TSBF-CIAT), P.O. Box 30677-00100, Nairobi, Kenya; [3]CIMMYT, P.O. Box 1041-00621, Nairobi, village market, Kenya ; [4]ICIPE, Mbita point, P.O.Box 30, Mbita, Kenya.
*Corresponding author: *otishanan@yahoo.com*, Cell phone: +254 0722-957041

Abstract

Production of maize in Western Kenya is adversely affected by *Striga hermonthica*. Integrating of legumes as intercrops is one of the ways of reducing density of *S. hermonthica* in soil and improving the livelihood of subsistence farming communities. Legume species and varieties however vary in their ability to stimulate suicidal germination of *S. hermonthica* seeds of same or different populations. A study was conducted to select soybean (*Glycine max*) accessions with ability to stimulate germination of *S. hermonthica* seeds from Western Kenya. The cut-root technique was used to screen 32 soybean accessions with *Desmodium*, *Mucuna* and maize varieties Nyamula, KSTP92, and WH502 as checks. Fourteen soybean accessions (selected from through the cut-root experiment), *Desmodium* and *Mucuna* were grown in association with maize variety WH502 in pots inoculated with *Striga* seeds. There was a significant variation among soybean accessions in inducing germination of *Striga*. The relative germination of *Striga* seeds by soybean accessions ranged from 8% to 66% compared to 70% for synthetic germination stimulant Nijmegen 1®. Accessions TGX1448-2E, TGX1740-2F, Tgm1576, TGX1876-4E, TGX1831-32E, TGX 1871-12E, Tgm944, Tgm1419, Tgm1039 and Namsoy4m had the highest relative germination percentage. Most accessions that stimulated high germination of *Striga* seeds increased the *Striga* attachment by 6% to 95%. There was a negative correlation (R=0.7) between maize shoot dry weight and intercrop shoot dry weight. Accessions TGX1831-32E, Tgm944, Tgm1419 and Namsoy4m had high stimulation but low attachment hence making them potentially important trap crops.

Keywords: *Maize, soybean, Striga hermonthica, suicidal germination*

Assessment of Soil Management Practices In East African Highland Cooking Banana *(Musa Spp. AAA-EA)* Systems in Uganda

L.W.I. Wairegi[1,3,*], P.J.A. van Asten[1], C. Kiwanuka[2], M. Tenywa[3] and M. Bekunda[3]

[1]International Institute of Tropical Agriculture, P.O. Box 7878, Kampala, Uganda Tel: +256 41 223445, Cell: +256 752793041, Fax: +256 223459; [2]Agricultural Productivity Enhancement Program, P.O. Box 7856, Kampala, Uganda; [3]Makerere University, Faculty of Agriculture, P.O. Box 7062, Kampala, Uganda
*Corresponding author email: *wairegi@iita-uganda.org, wanjawairegi@yahoo.com*

Abstract

Banana is the most important food crop in Uganda. However, there has been a decline in production, attributed to declining soil fertility, drought, pests and diseases and crop management factors. This study tries to quantify the contribution of these factors to yield loss in order to identify opportunities to improve production. The on-farm study was carried out in 179 plots in central, south, southwest and east Uganda. About half were 'demonstration' plots from a USAID-funded project, while the rest were 'control' plots, representing farmer practices. Control plots received manure (48% of the plots) and mulch (22 %) applications, whereas demonstration plots received manure (46%), mulch (64%) and inorganic fertilizer (100%, with N, P, K averaging 52, 5, 59 kg $ha^{-1}yr^{-1}$). Weevil corm damage and nematode-induced root necrosis was slight and averaged 3% and 8% respectively for both plots types. Demonstration plots had higher yields (47%) compared to control plots. The increase ranged from 12.3 (Mpigi, central) to 4.3 t $ha^{-1}yr^{-1}$ (Luwero, central). Farm gate bunch prices declined from 0.17 to 0.07 USD kg^{-1}, when moving from central Uganda to southwest Uganda. Minimum yield increase to off-set increased costs of the demonstration plots (i.e. fertilizer, mulch) ranged from 1.4 (Mukono, central) to 4.7 t $ha^{-1}yr^{-1}$ (Bushenyi, south-west). Benefit cost ratio of the demo plot technologies ranged from 8.0 (Wakiso, central) to 1.1 (Bushenyi). The study concludes that there is scope for increased input use in banana systems in Uganda, but that regional variations in crop response and input/output prices have to be taken into account.

Keywords: *Highland bananas, nutrient inputs, mulch, market price fluctuations*

The potential of Ipomoea stenosiphon as a soil fertility ameliorant in the semi-arid tropics

T. Mombeyarara[1,*], H. K Murwira[1] and P Mapfumo[2]

[1]Tropical Soil Biology and Fertility Institute of CIAT, P O Box MP228, Mount Pleasant, Harare, Zimbabwe.
[2]Department of Soil Science and Agricultural Engineering, University of Zimbabwe, Box MP167, Mt Pleasant, Harare, Zimbabwe
*Corresponding author: *t.mombeyarara@cgiar.org*

Abstract

There is potential for smallholder farmers in Zimbabwe to use locally available plant resources to improve soil fertility and crop production. The challenge is to identify species with high nutrient concentrations and large amounts of above ground biomass. Such a potential species is *Ipomoea stenosiphon* (Hall) A. Meeuse, a plant species indigenous to Zimbabwe, Malawi, Mozambique and Zambia, and is currently being used by farmers in Zimbabwe. The aim of this study was to determine its productivity and variation in shoot nutrient concentrations on different soil types, its N mineralization potential and effect on maize productivity. *I. stenosiphon* grown on clayey soils had significantly higher shoot macro-nutrient concentrations than when grown on sandy soils (N: 43 vs. 11 g N kg^{-1} soil, P 4.6 vs. 2.5 g kg^{-1} soil, K 4 vs. 1.5%). Laboratory incubation of *I. stenosiphon* shoot biomass showed greater ($P<0.05$) N mineralization than many other agroforestry species although it was inferior to *Leucaena leucocephala* and *Acacia angustissima* because of their higher N content of 3.2% and 3.03% respectively, compared to 2.3% for *I. stenosiphon*. Field evaluation as an organic nutrient source in semi-arid areas of Zimbabwe showed an increase in maize grain yields of 111% and 161% at two study sites after applying *I. stenosiphon* biomass at 75 kg N ha^{-1}. These yields showed an average N fertilizer (ammonium nitrate) equivalency of 83%. The study showed the high capacity for acquisition of soil nutrients in *I. stenosiphon* biomass, with corresponding high levels of mineralization and crop production.

Keywords: *Biomass transfer, fertiliser equivalence, Ipomoea stenosiphon, nitrogen mineralization.*

Innovations in Cassava Production for Food Security and Forest Conservation in Western Côte D'ivoire

A. Amandine[1,2,*], K. Inza[1,2], A. Bertin[1,2], A. Désiré[2,3], T. Andres[1], C. Gueladio[1]

[1]Swiss Centre for Scientific Research in Côte d'Ivoire; [2]University of Cocody, Abidjan, Côte d'Ivoire; [3]National Centre for Agronomical Research, Côte d'Ivoire, 01 B.P. 1303 Abidjan 01; Tel: (225)23 47 27 90; Fax: (225)23 45 12 11.
*Corresponding author: *amandine.ayemou@csrs.ci, amandine.sopie@gmail.com*

Abstract

To support food security and reduce human pressure over the Taï National Park, Côte d'Ivoire, we introduced two improved cassava varieties, innovative farming techniques and processing technologies at the western fringe of the park in 2004. The strategy was to: i) increase cassava productivity on reduced surfaces; ii) limit conflicts for access to arable land; iii) increase the added value of cassava; iv) and form a new generation of producers. After the multiplication of introduced germplasm using mini-cuttings technique with three groups of producers, communal fields were established thanks to multiple stem harvestings. After these two community-based multiplication steps, farmers transferred the improved varieties to their individual fields and average yield was estimated at 20 t/ha. The experience resulted in a massive and rapid distribution of improved varieties in the Taï region. Indeed, trained farmers were hired by neighbouring villages to replicate the experience, without any incentive, and two years later, more than a dozen of villages planted improved varieties. Parallel to this, two women were trained in "attieke" production and entrusted with transferring this skill to peers. "Attieke", cassava semolina obtained after fermentation is a widely consumed and commercialised food in Côte d'Ivoire. This training was particularly relevant for Taï, where "attieke" is often not available because of poor production standards. The induced diversified source of income may reduce poaching and land-use conflicts, but this remains to be evaluated in a sound fashion.

Keywords: *Cassava, farming innovations, food security, improved varieties, Côte d'Ivoire*

Integrated Soil Fertility Management Involving Promiscuous Dual-purpose Soybean and Upland NERICA Enhanced Rice Productivity in the Savannas

S.O. Oikeh[1,]*, P. Houngnandan[2], I. Rahimou[2], A. Toure[1], A. Niang[1], R. Abaidoo[3], A. Inoussa[1]

[1]Africa Rice Center (WARDA), Cotonou, 01 BP 2031, Benin, Phone: +229 21 350188; Fax: +229 21350556; [2]Faculté des Sciences Agronomiques (FSA), Université d'Abomey-Calavi (UAC), 01 BP 526 Recette Principale, Cotonou, Benin; [3]International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, C/o L.W Lambourn & Co., Carolyn House, 26 Dingwall Road, Croydon CR93 EE, England
*Correspondance author email: *s.oikeh@cgiar.org*

Abstract

Use of integrated soil fertility management (ISFM) involving an appropriate dual-purpose, nitrogen-fixing grain legume, limited chemical fertilizer, and resilient rice variety may restore soil fertility and enhance rice productivity in fragile upland rice ecosystems. A two-year on-farm study was carried out at Eglime in the southern (SGS) and Oake in the northern Guinea savannas (NGS) of Benin Republic to evaluate the contribution of dual-purpose soybean varieties (Glycine max) to grain yield of upland NERICA rice fertilized with low N level. In 2005, four dual-purpose, promiscuous soybean varieties (cv. TGX 1440-IE; TGX 1448-2E; TGX 1019-2EB; and TGX 1844-18E), a popular improved soybean variety (cv. Jupiter) and local rice (control) were sown in 10 farmers' fields. In 2006, drought-tolerant upland interspecific rice (NERICA 1) was sown in all the plots and received only 15 kg N ha-1. Soybean grain yield and grain N uptake were similar in both savannas, but nodule production, shoot dry matter and shoot-N were higher by at least 40% in NGS than in SGS. Soybean cv. TGX 1440-1E (late-maturing) ranked the highest in nodule number, dry matter, and shoot- and grain-N accumulation in NGS, while TGX 1448-2E (medium-maturing) was superior to other varieties in the NGS. Grain yield of NERICA 1 rice following one-year rotation with soybean cv. TGX 1440-1E was 150% greater than yield obtained from farmer's control of two-year continuous rice cropping without nitrogen. Results indicate that integrating an appropriate dual-purpose soybean in an ISFM package can enhance rice productivity in resource limited smallholder production systems.

Keywords: *Crop rotation; ISFM; NERICA rice; Promiscuous soybean; Savannas*

Effect of Al toxicity and liming acid soils on the growth of selected maize cultivars grown on sandy soils in Southern Africa

Chipo Musharo and Justice Nyamangara[1]

Department of Soil Science and Agricultural Engineering, University of Zimbabwe, P.O. Box MP 167, Mount Pleasant, Harare, Zimbabwe.
[1]Corresponding author: *jnyamangara@agric.uz.ac.zw*

Abstract

The majority of smallholder farmers who cultivate acidic soils in sub Saharan Africa (SSA) have limited or no access to lime. Differential tolerance to acidity by crop species can be exploited to sustain crop production without liming where production would be uneconomic. A study was conducted under greenhouse (nutrient solutions) and field conditions (Domboshawa Training Centre and Chendambuya smallholder area, Zimbabwe) from August 2002 to June 2004 to evaluate the effects of soil acidity on the growth of eight maize cultivars commonly grown in Southern Africa. There were significant ($p<0.001$) cultivar tolerance by Al toxicity in terms of total root length (TRL), relative root length (RRE), and shoot and root dry matter weight. In terms of Al tolerance indices (ATI), cultivars DK 8031 and SC517 were the most and least tolerant varieties, respectively. Liming significantly increased grain and stover yield at one of the three sites in all cultivars except PAN 413. At the other two sites, liming depressed grain and stover yield in both seasons. It was concluded root growth parameters can be used screen maize cultivars commonly grown in Southern Africa for tolerance to soil acidity. Response of maize to liming seems to depend on exchangeable soil Ca-to-Mg ratio with positive with positive responses being recorded where the ratio in low, i.e. low Ca content. More studies are required to determine thresholds limits where Ca fertilisation is necessary.

Keywords: *Ca-to-Mg ratio, maize, soil acidity tolerance, cultivar*

An African Green Revolution requires a secure source of Phosphorus: Alternative sources and improved management options of P

Alhaji S. Jeng

Bioforsk Soil & Environment Division, Fredrik A Dahls vei 20, N-1432 Aas, Norway
Corresponding author: *Alhaji.Jeng@bioforsk.no*

Abstract

An African green revolution cannot succeed without a secured supply of mineral fertilizers. This is particularly true of phosphorus, one of the key essential macronutrients. In most tropical soils, P is one of the main limiting plant nutrients and its deficiency is a major constraint for better crop production. This is mainly attributable to: (i) the low total P content in soil, (ii) the relative unavailability of inherent soil P for plant uptake, and lastly, (iii) the relative speed at which applied soluble sources of P such as inorganic P fertilizers and manures become fixed or changed to unavailable forms. It is clear that mining P minerals and spreading P fertilizers over the landscape is not sustainable in the long run. Cultural practices which can secure P sources and which conserve P should be made use of. Some of the measures necessary to adequately address the P problem can be listed as nutrient cycling through the recycling of crop residues, green manures, animal manures, domestic and industrial wastes, the integration into the cropping system of P-mobilizing plant species which show the ability to improve P uptake even from less labile P forms and store P in the aboveground biomass even in excess of their needs, and, biological means making use of mycorrhiza to help extract fixed P from deep soils under low pH conditions. African Green Revolution must put a lot of emphasis on integrated soil fertility management (ISFM), which combines the use of plant residues and inorganic P fertilizers exploiting their high potential for increasing crop production and ensuring sustainability. Increased production and productivity should never be based on addressing the constraints surrounding inorganic (mineral) fertilizers alone.

Keywords: *Integrated soil fertility management (ISFM), Phosphorus, P-mobilizing*

Use of phosphate rocks to alleviate phosphorus deficiency

Peter W Sale

Department of Agricultural Sciences, La Trobe University, Vic. 3086 Australia
Corresponding author: *P.Sale@latrobe.edu.au*

Abstract
Research in Australia has added to our understanding of the role that phosphate rocks (PRs) may play in managing phosphorus deficiency. This understanding indicates that a range of interacting factors determine whether a particular PR will be an agronomically-effective P source, compared with traditional water soluble P fertilizer, in a specific farming system. The factors include the nature of the PR itself, together with climate, soil, plant and management considerations. The key issue is whether the rate of P release from the dissolving PR particle is sufficient to enable the food plants to take up the dissolved P fast enough to grow satisfactorily in the P-deficient soil, and produce adequate yields. Assessing this suite of interacting factors, along with economic and supply chain issues, is necessary to determine how effective a locally-available PR might be in the farming system.

Keywords: *Agronomic efficiency, Farming systems, Phosphate rocks*

Effect of long term application of organic and inorganic resources on soil properties and maize yield at Kabete, Kenya

Waswa BS[1,]*, Bationo A[1], Mugendi D[2], Okeyo JM[1], Kimetu J[3]

[1]Tropical Soil Biology and Fertility Institute of CIAT (TSBF-CIAT), Nairobi; [2]School of Environmental Studies and Human Sciences, Department of Environmental Sciences, Kenyatta University. [3]Department of Crop and Soil Sciences, Cornell University, Ithaca, NY 14853 USA
Corresponding author: *b.waswa@cgiar.org*

Abstract

An experiment was established during the short rain season 1999 to assess the fertilizer equivalencies of organic and inorganic nutrient sources. Three organic resources, *Tithonia diversifolia* (tithonia), *Calliandra calothrysus* (calliandra) and *Senna spectabilis* (senna) were applied singly or in combination with inorganic fertilizer in the form of urea to supply an equivalent of 60 kg N ha^{-1}. The above treatments were compared to an N fertilizer response curve involving application of urea at the rate of 0, 30, 60 and 100 kg N ha^{-1}. Results from this trial consistently showed higher maize grain yields in the treatments receiving combinations of organic and inorganic nutrient sources compared to the sole and control treatments. On average, Tithonia plus 30 kg N ha^{-1} gave the highest grain and biomass yields. This trend could be attributed to improved synchrony in nutrient release and uptake by the crop. The organic resource gave a fertilizer equivalency of 130, 72 and 68% for tithonia, callianddra and senna respectively. Analysis on whole soil showed minimal changes in the whole soil carbon and nitrogen. However, higher proportions of C and N were observed in the aggregate size fractions. An analysis on the carbon-13 signature of the soil fractions testified that the application of the C3 organic resources was responsible for this shift in the SOM composition observed in at site.

Keywords: *Carbon-13, fertilizer equivalency, soil organic matter*

Rotational effects of cowpea genotypes and P fertilization on the yield of sorghum on P-deficient soils of Sudan and Sahel savannas of West Africa.

Saidou[1] A.K., R.C. Abaidoo[1]*, E.N.O. Iwuafor[2], N. Sanginga[3], B.B. Singh[1], and G.O. Kolawole[4]

[1]International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria; [2]Ahmadu Bello University, Samaru, Zaria, Nigeria; [3]Tropical Soil Biology and Fertility (TSBF) Institute of CIAT, Nairobi, Kenya; [4]Department of Agronomy, Ladoke Akintola University of Technology, Nigeria
*Corresponding author: *rabaidoo@cgiar.org*

Abstract

Adoption of cereal/legume rotation is a sustainable strategy for increasing cereal yields and improving soil fertility by subsistence farmers in West Africa, but little progress has been made on how different crop varieties and previous P fertilization will influence such a system. Field experiments were established at Minjibir (Sudan savanna, Nigeria) and Toumnia (Sahel savanna, Niger Republic) to assess the effects of cultivation of fifteen cowpea genotypes to which rock phosphate (RP) and SSP fertilizers were previously applied, on subsequent sorghum. Phosphorus fertilizers, (0, 90 kg P ha^{-1} as RP and 30 kg P ha^{-1} as SSP) were the main factors and cowpea genotypes were the sub factors arranged in a randomized strip plot design replicated three times. Grain yields of rotation sorghum were significantly higher than those of continuous sorghum. Cowpea genotypes exhibited variations in their effects on grain yields of subsequent sorghum. For example, at Minjibir mean grain yield of rotation sorghum with cowpea IT 98K-476-8 (2843 kg ha^{-1}) was 54% higher than that of continuous sorghum (1295 kg ha^{-1}). Previously applied P fertilizers significantly affected grain yield of sorghum in the order SSP > RP > 0P; this effect was more pronounced at Toumnia than Minjibir. Soil available P varied with cowpea genotypes and P fertilizer application and it was highest in plots that received RP, followed by SSP and least under 0P treatment. Generally, AMF colonization of roots of rotation sorghum was higher than that of continuous sorghum.

Keywords: *Cowpea/sorghum rotation, P fertilization, grain yield, Arbuscular Mycorrhizal Fungi (AMF), Sudan and Sahel savanna*

Evaluation of shoot and root traits for identifying P-use efficient soybean genotypes

Abaidoo R.C[1*]., C. Nwoke[1], P. Pypers[2], J. Diels[3] and G.O. Kolawole[4]

[1]International Institute of Tropical Agriculture (IITA), c/o L.W. Lambourn & Co., Carolyn House, 26 Dingwall Road, Croydon CR9 3EE, England. [2]Tropical Soil Biology and Fertility, Institute of CIAT, PO Box 30677, Nairobi, Kenya. [3]Division of Soil and Water Management, Department of Land Management and Economics, K.U. Leuven, Kasteelpark Arenberg 20, 3001, Heverlee, Belgium, [4]Department of Agronomy, Ladoke Akintola University of Technology, PMB 4000, Ogbomoso, Nigeria.

*Corresponding author: *rabaidoo@cgiar.org*

Abstract

Soybean production and utilization have increased tremendously in Nigeria over the last 20 years due to the adoption of new varieties that have superior agronomic traits compared to traditional genotypes. The soils for soybean production are inherently low in available-P and grain yield returns to external P application are generally low. To overcome P deficiency and its effect on crop productivity, the planting of varieties that are more efficient at acquiring P from low and sparingly soluble soil-P pools has been proposed. Field trials were conducted at Mokwa and Shika in the Nigerian savanna in 2004 and 2005 with eight soybean genotypes, previously selected for high grain yields. The purpose of the trials was to examine the variation in traits for P uptake and incorporation efficiency of the soybean genotypes under different P regimes (0, 20, 40, and 60 kg ha^{-1}). At Ibadan, greenhouse pot experiment was conducted in 2005, with P applied as 0, 25, and 50 mg P kg^{-1} soil, to examine the variations in root-based P uptake efficiency traits in these genotypes. Significant P and genotype effects were recorded for grain yield and total P in grain at both locations in both years. Phosphorus incorporation efficiency was significantly influenced by P rate, genotype, and plant phenological growth stageat both locations in both years. Application of P to greenhouse-grown soybean genotypes influenced root length significantly. The study revealed that soybean genotypes may use different shoot and root traits for enhanced P-use efficiency in tropical soils.

Keywords: *Nigerian savanna; P use efficiency traits; Soil P availability; Soybean*

Diagnosis of Soil and Plant Nutrient Constraints in Smallscale Groundnut *(Arachis Hyopeae)* Production Systems of Western Kenya Using Infrared Spectroscopy

S.I. Muhati*, K.C. Gachene, G. Kironchi

University of Nairobi Department of Land Agricultural Resource Management and Technology (LARMAT)

*Corresponding author: *s.ichami@cgiar.org*

Abstract

Soil fertility is a major biophysical problem that has led to problems of food insecurity, ecosystem degradation and poverty. Nutrient depletion and groundnut rosette epidemics have attributed to a decline in groundnut yields by 25% in the past decade in SSA. One of the major constraints to properly assessing current status, trends and processes of soil nutrient is the high level of costs involved when using conventional soil analytical methods. Previous studies have demonstrated that infrared spectroscopy may permit rapid and cost effective analysis of tropical soils that could provide new opportunities for farmers to diagnose and manage soil/plant constraints. An integrated management approaches that link diagnosis of nutrient deficiencies and crop diseases epidemics using infrared spectroscopy is quite important since, small-scale farmers have abandoned conventional methods all together and work on trial and error methods. This has led to escalating levels of inappropriate nutrient management strategies and options in small-scale groundnut production systems, exacerbating food insecurity. This study tested the potential of infrared spectroscopy for predicting and mapping soil/plant nutrient constraints in the small-scale groundnut production systems of western Kenya. Stable calibration models were developed for several key soil properties in the near and mid infrared spectral regions. Principle component (PCA) was used to assess the influence of soil properties and derive soil fertility indicators (SFIs) that were developed from principle component scores. Significant correlations were observed between the Soil organic carbon and SFI 1. The soil fertility indicators was successfully calibrated to soil reflectance measured in the laboratory with cross validated R^2 values of 0.89 and 0.79 for mid and near infrared respectively which permitted developing of soil fertility scores for assessing soil fertility status.

Keywords: *Arachis Hyopea,* groundnut yield, infrared spectroscopy, soil fertility indicators

Variation in Agronomic Attributes between Old and Modern Mexican Hybrids of Maize in Water and Nitrogen Unfavorable Environments

K.C. Serrem[1*], C. Lopez-Castaneda[2], Kohashi-Shibata[2]

[1]Soil Science Department, Moi University, P.O. Box 1125, Eldoret; [2]Programa en Gentica, Instituto de Recursos Genticos y Productividad, Colegio de Postgraduados. Km 36.5 Carr. Mexico-Texcoco, Montecillo, Municipio de Texcoco, Mexico
*Corresponding author: *cserrem@yahoo.com*

Abstract

Field worked was conducted to study the response of modern (MH) and old (OH) hybrids, and a variety of landraces (L) under irrigation (I) and drought (D) conditions with two levels of nitrogen (160 kg N ha^{-1} and 80 kg N ha^{-1}). Drought decreased grain yield (GY), final biomass (FBM), grains per ear row (GPER) and individual grain weight (IGW) by 24%, 18%, 7% and 6% and plant height (PH), and length (CL) and diameter of cob (CD) by and 51 cm and 0.5 and 0.2 cm respectively. Low nitrogen reduced FBM by 6% and PH by 11 cm, silking date and anthesis – silking interval were delayed by two days (24 ^{0}Cd) under drought. MH had greater GY than OH and L in average of drought and nitrogen treatments. GY ($r = 0.07$, $P < 0.05$) and FBM ($4 = 0.68$, $P < 0.05$) were positive and significantly correlated with year of hybrid release in average of drought and nitrogen treatments, and genotypes (excluding L genetic materials); a gain of 57 kg ha^{-1} for grain yield and 128 kg ha^{-1} $year^{-1}$ for biomass was determined. On the other hand, anthesis – silking interval was negative and significantly associated with year of hybrid release ($r = -0.76$, $P < 0.05$). This study reveals that greater biomass and a shorter anthesis – silking interval may be the key issues to improve grain yield of maize for water and nitrogen limited environments.

Keywords: *Drought, genetic variation, hybrid, silking*

Within-farm variability in soil fertility management in smallholder farms of Kirege location, Central Highlands of Kenya

Muthamia* J.M., Mugendi D. N. and Kung'u J. B.

Department of Environmental Sciences, Kenyatta University, P.O. Box 43844 Nairobi, Kenya
*Corresponding author: *muthamiajoses@yahoo.com*

Abstract

Smallholder farms in Central Highlands of Kenya exhibits a high degree of heterogeneity, determined by complex set of socio-economic and biophysical factors. The farms consist of multiple plots managed differently in terms of allocation of crops, nutrient inputs and labour resources; making within-farm soil fertility gradients caused by management strategies a common feature. In most cases nutrient inputs are preferentially allocated to home fields whilst outfields are neglected. A monitoring study involving nutrient inputs, flows and balances was conducted in Kirege Location, where 9 case study farms were used. The study was to compare the intensity of soil fertility management between home fields and outfields. It also compared soil fertility management practices between three different resources endowment classes to reveal important differences in patterns of fertility management. The farms were visited to record movement of nutrients-containing materials using a monitoring protocol covering household, crops, livestock, soil and socio-economic aspects of the farm. Data obtained was analyzed using IMPACT program version 2.0 to obtain total nutrient inputs and balances at field and farm levels and statistical analysis done using GenStat discovery edition 2. Results revealed that mean N inputs over all resource endowment classes decreased with distance to the homestead (from 94 to 22.9 kgha-1), as did Olsen-P (from 54.6 to 15.6 kgha-1) and K (from 193 to 34 kgha-1). Due to this heterogeneity in smallholder farms, there is a need for a more targeted approach to soil fertility intervention that differentiates between farm fields, agro-ecological zone and resource endowment status.

Keywords: *Nutrient inputs; soil fertility gradients; home fields; outfields; heterogeneity*

Interactive effects of different nutrient resources and soil moisture on the growth of maize (Zea mays l.) in a semi-arid area in Zimbabwe

J. Nyamangara* and I. Nyagumbo

Department of Soil Science & Agricultural Engineering, University of Zimbabwe, P.O. Box MP167, Mount Pleasant, Harare, Zimbabwe.
*Corresponding author: *jnyamangara@agric.uz.ac.zw*

Abstract

A two-year (2005/6 and 2006/7) study was conducted in semi-arid central Zimbabwe to determine the effect of combining selected nutrient resources with moisture conservation on maize (*Zea mays* L.) growth. The nutrient resources were: 240 kg ha^{-1} PKS fertiliser; 18 t ha^{-1} manure; 10 t ha^{-1} manure + 240 kg ha^{-1} (14% P 13% K 5% S) fertiliser; 35 t ha^{-1} leaf litter; 52 t ha^{-1} anthill soil; and a 0 kg ha^{-1} control. Mineral N was applied to fertiliser only and fertiliser + manure treatments at 60 kg ha^{-1}. A split-plot design was used with nutrient resource as the main plot and tillage practice as the subplot, and five farmers' fields were used as replicates. In 2005/6 addition of different nutrient resources under conventional tillage increased grain yield (12.5% m.c.) by 102-450 %. Grain yield was lowest in the control (551 kg ha^{-1}) and highest in the manure plus fertiliser treatment (3032 kg ha^{-1}). For each treatment, introduction of tied ridging further increased grain yield by 27% (fertiliser only) to 96% (leaf litter) indicating the importance of integrating nutrient and water management in semi-arid areas where moisture stress is frequent. In the tied ridging treatment in 2005/6, yield was lowest in the control treatment (997 kg ha^{-1}) and highest in the manure plus fertiliser treatment (4167 kg ha^{-1}). Similar trends were recorded in 2006/7. Farmers can effectively optimise maize yields by practising moisture conservation practices for which simple tools and modest labour resources are required as additional inputs.

Keywords: *Moisture conservation; nutrient resource; post-emergence tied ridges, conventional tillage*

Performance of Improved Cowpea Varieties in the ASALs of Eastern Kenya under Integrated Soil Fertility Management

Kimiti[1*] J.M., B. Vanlauwe[2], D.W. Odee[1] and N.M. Gitonga[3]

[1]Kenya Forestry Research Institute (KEFRI), P.O Box 20412-00200 Nairobi, Kenya, Tel. +254-721-473341; [2]Tropical Soil Biology and Fertility Institute of the International Center for Tropical Agriculture (TSBF-CIAT), Nairobi, Kenya; [3]Kenyatta University, Plant and Microbial Sciences Department, P.O Box 43844 Nairobi
*Corresponding author: *jmkimiti@yahoo.com*

Abstract

A study was carried out in the Arid and semi-arid lands (ASALs) of Kenya to investigate the effect of integrated soil fertility management (ISFM) on growth and yield of nine improved cowpea varieties. The study was implemented at two sites, Kavuthu 1223 m.a.s.l. and Ndunguni 1082 m.a.s.l., with contrasting rainfall amounts. Treatments applied included a control, manure at 2.5 t/ha, TSP at 15 kg/ha and a combination of manure and TSP at the single rates. Nodule numbers and weights, biomass production at 50% flowering and at maturity, and seed yields were recorded in the long and the short rains of 2006. The data collected was analysed using GenStat Discovery Edition 1, GenStat Procedure Library Release PL12.2. Results obtained showed that nodule numbers, biomass production and seed yields were in overall higher in the short rain season than in the long rains. For example in the long rains nodule numbers, root weight, and shoot biomass ranged between 1 to 26; 33 kg/ha to 142 kg/ha, and 616 to 2557 respectively compared to the short rains where same parameters ranged between 1 to 69; 58 kg/ha to 338 kg/ha, and 700 kg/ha to 3499 kg/ha respectively. Variety performance and treatment effects varied with season and site. However the results further indicated that shoot biomass production and seed yield were enhanced by a combination of manure and TSP especially in the drier site, Ndunguni. The results indicated that there is need to add inputs to enhance cowpea production in the ASALs of eastern Kenya.

Keywords: *Arid and semi-arid lands (ASALs), Biomass production, Cowpea, Integrated soil fertility management (ISFM),*

Using forage legumes to improve soil fertility for enhanced grassland productivity of semi-arid rangelands of Kajiado District, Kenya

Macharia[1*] P.N., Gachene[2] C.K.K. and J.G. Mureithi[3]

[1]KARI-Kenya Soil Survey, P.O. Box 14733-00800, Nairobi, Tel: 254-20-4443376 Fax: 254-20-4443376; [2]University of Nairobi, Kabete Campus, P.O. Box 30197-00100, Nairobi; [3]KARI Headquarters, P.O. Box 57811-00200, Nairobi
*Corresponding author: *kss@iconnect.co.ke*

Abstract

A two phase study was conducted in the semi-arid rangelands of Kajiado District, Kenya with an aim of studying the effect of forage legumes on soil fertility improvement and grassland productivity of natural pastures. During legume evaluation phase, *Neonotonia wightii* (Glycine), *Macroptilium atropurpureum* (Siratro), *Lablab purpureus* cv. Rongai (Dolichos), *Mucuna pruriens* (Velvet bean) and *Stylosanthes scabra* var. Seca (Stylo) were screened for adaptability and growth performance. Results of soil analysis showed that soil pH, organic carbon, nitrogen and potassium significantly increased after two years of study, due to the large amounts of organic residues produced by the legumes (particularly the perennials). However, calcium significantly decreased while phosphorus had a non-significant decrease from the soil. After integration of Glycine, Siratro and Stylo into natural pastures during the second phase of the study, the crude protein content of grasses intercropped with legumes increased from 7.1% to 14.3, 11.9 and 10.2%, respectively. Grasses intercropped with legumes also had higher digestibility contents than grasses in monoculture stands. The study concluded that addition of organic residues by the introduced forage legumes improved the soil fertility status and in addition, livestock fed on fodder from grass/legume mixed pastures and the manure they produced may be of higher quality than those fed on natural pastures alone.

Keywords: *Forage legumes; Grass/Legume intercrops; Grassland productivity; Semi-arid rangelands; Soil fertility*

Incorporating green manure in the subsoil markedly increases cereal grain yields

P. Sale*, C. Tang and J.Gill

Department of Agricultural Sciences, La Trobe University, Vic. 3086 Australia
*Corresponding author: *P.Sale@latrobe.edu.au*

Abstract

Field experiments were undertaken over two years to determine whether the incorporation of organic amendments in dense, clay subsoil, that previously had been hostile to plant root growth, might improve wheat yields. The two organic amendment treatments involved adding 20 t/ha of pellets of green lucerne shoots *(Medicago sativa)* and dried poultry manure, both having high N concentrations (~3% N). Other treatments included the deep incorporation of fertilizer N and P (100 kg MAP/ha), coarse sand (20 t/ha), and gypsum (10 t/ha), and deep ripping alone. All materials were incorporated to a depth of 30-40 cm beneath a friable sandy loam topsoil in May 2005, in a paddock near Ballan, in south west Victoria, Australia. A crop of red winter wheat, cv Amarok, was sown in June 2005, using commercial farming practices, and harvested in January 2006. The key finding was that the organic amendments resulted in marked yield responses, with wheat grain yields increasing from 7 t/ha in control plots up to 13 t/ha in the organic amendment plots. These yield responses exceeded smaller responses to the inorganic amendments. The large responses to deep organic amendments are attributed to the stimulation of root growth in the subsoil, which increased the supply of deep soil water and nitrogen to the crop, during the grain filling period. This delayed the senescence of flag leaves which are the major organs supplying photosynthate to developing wheat grain. The results are consistent with other research in Australia that has found that increases in rainfall productivity (yield/ mm rainfall) can occur if the wheat crop is able to access additional plant-available water in deep subsoil layers during in the grain filling phase of crop growth.

Keywords: *Green manure, soil water, productivity*

Multi-functional properties of mycorrhizal fungi for crop production: The case study of banana development and drought tolerance

Nwaga D.[1*], Tenkouano A.[2], Tomekpe K.[3], Fogain R.[2], Tsané G.[1,2], Kinfack D. M.[1,3] and Yombo O.[1]

[1]Biotechnology Centre & Plant Biology Department, University of Yaoundé I
P.O. Box 812, Yaoundé, Cameroon, Tél: (237) 9993.18.71, Fax: (237) 2223.74.29; [2]International Institute of Tropical Agriculture (IITA), Humid Forest Ecoregional Center, B.P. 2008 Messa, Yaoundé, Cameroon; [3]Centre Africain de Recherche sur le Bananier et Plantain (CARBAP), Njombé, Cameroon
*Corresponding author: *dnwaga@yahoo.fr*

Abstract

This work discusses the potentials of arbuscular mycorrhizal fungi (AM fungi) for nutrients uptake and for drought tolerance of banana/plantain. They may stimulate plant beneficial properties: flowering, development and crops yields in African soils. When their activity is low, inoculation with selected strains could be use for restoration. Banana/plantain need water and is very sensitive to drought stress and diseases. The potential benefit of banana-AM fungi symbiosis was tested after 90, 60 and 30% soil field capacity during 40 days. Under nursery conditions, plant growth, leaf surface and dry weight are significantly stimulated by mycorrhiza on oxisol and andosol. AM fungi inoculation provided 30% more water to banana after 40 days of stress, water use efficiency were correlated with drought tolerance. AM fungi inoculated micro propagated banana provide bigger bunch than non inoculated ones under farm conditions in an oxisol. How can we develop this approach in banana production system? The cost/benefit ratio of inoculation should be determined to envisage its incorporation into nursery. The use of mycorrhizal fungi for a sustainable agricultural production in Africa is needed.

Keywords: *Arbuscular mycorrhizal fungi, banana/plantain, drought, water use efficiency.*

Potential for Reuse of Human Urine in Peri-Urban Farming

Semalulu[1,]*, O., M. Azuba[2], Makhosi[1] and S. Lwasa[2]

[1]NARL-National Agricultural Research Laboratories, P.O. Box 7065, Kampala, Uganda. Tel.: (256) 41 567696/567649, Fax: (256) 41 567649; [2]Kampala City Council District Urban Agric. Office, P.O. Box 7010, Kampala, Uganda.
*Corresponding author: *landuse@infocom.co.ug*

Abstract

The possibility of recycling human urine for maize and vegetable growing was assessed on-farm, in a peri-urban Kyanja parish, Kampala District, Uganda. The objectives were to demonstrate to farmers and other stakeholders, the potential for using urine and develop guidelines for use of urine in farming. Field plots measuring 1.5x6m were established on 20 farmers' fields and planted with maize (*Zea mays* L.), *Nakati* (*Solanum aethiopicum*), Kale (*Brassica oleracea* L.) and Spinach (*Spinacia Oleracea* L.). Urine was applied at 10% (0.5:5 urine to water), 20% and 30%. Each concentration was applied weekly, bi-weekly and monthly. Urine:water mixtures (20L) were applied to each bed while the control received water only. Urine application significantly increased maize height and fresh yield; 30% urine weekly application gave highest benefits. Weekly application of 10% urine increased *Nakati* yield from 8.3 to 22.2 kg/plot, within 2 months and yielded nearly the same biomass as that treated to 20% urine weekly. Weekly application of 20% urine increased yield of Kale from 2.4 to 5.5 kg/plot, and spinach from 6.6 to 17.1 kg/plot within 2 months. These represented the highest, most economical biomass yields compared to other treatments. Weekly application outperformed bi-weekly, and least on once a month. From these findings we propose the following guidelines: Maize, apply 30% urine weekly for 8 weeks. *Nakati*, apply 10% urine weekly for 8 weeks. Kale, apply 20% urine weekly. Spinach, apply 20% urine weekly. Since Kale and Spinach can grow for about 1yr, prolong urine application for continued harvesting.

Keywords: *Ecological Sanitation; Closing the loop; Nutrient recycling; Urban Agriculture; Food security*

Evaluation of Human Urine as a Source of Nitrogen in the Co-Composting of Pine Bark and Lawn Clippings

Fatunbi* A.O and P.N.S Mnkeni

University of Fort Hare, Faculty of Science and Agriculture, Agronomy Department, PB X1314, Alice 5700, Eastern Cape, South Africa; Phone +27 406022025, Fax +27 406531730 Mobile +27 721138000.
*Corresponding author: *afatunbi@ufh.ac.za*

Abstract

The introduction of urine diversion toilets in South Africa has created opportunities for the recycling of human urine in agriculture. One of such possibilities is the use of human urine as a source of nitrogen during the composting of organic wastes. This study evaluated the possibility of (i) replacing urea fertilizer with human urine as a source of N in the co-composting of pine bark and lawn clippings; and (ii) minimizing the possible N loss during composting by encouraging struvite ($MgNH_4PO_4.6H_2O$) precipitation with the addition of magnesium oxide (MgO) + single super phosphate (SSP) fertilizer or rock phosphate (RP) to the composting mixtures. Results showed that composting progressed faster where urine rather than urea was used as the source of nitrogen, as reflected by early attainment of peak thermophillic temperatures (65^0C). The faster composting of the urine based composts translated into a 22% greater degree of degradation relative to the urea enriched compost. After 84 days of composting, inorganic N (NO_3 + NH_4) was 45% higher in the urine treated compost than the urea treated materials possibly as a result of the greater degradation observed in urine enriched compost mixtures. Struvite crystals were observed in the MgO, SSP, RP and urine treated composts but the elemental composition of the struvite crystals varied with the composting mixtures. However, none of the precipitated struvite crystals contained ammonium but potassium suggesting that the precipitated struvites were not effective in the conservation of nitrogen in the composting mixtures.

Keywords: *Pine bark, Human urine, Composting, Inorganic N and Struvite*

Phenotypic Characterization of Local Maize Landraces for Drought Tolerance in Kenya

I.M. Tabu*, S.W. Munyiri and R.S. Pathak

[1]Department of Crop, Horticulture and Soils, Egerton University, Kenya, Box 536, Egerton, Njoro, Kenya
*Corresponding author: *immtabu@yahoo.com,* Fax 254-51-62145

Abstract

Maize is one of the most important staple food crops in Kenya. Drought is one of the main problems contributing to the low crop yield. Improved crop genotypes have been developed but farmers continue to grow the local landraces. An experiment was conducted to identify the local landraces suited for the dry areas and determine their phenotypic characteristics as a step towards yield improvement. The experiment was conducted at the Kenya Agricultural Research Institute (KARI), Masongaleni farm Kibwezi, located at an elevation of 650 metres above sea level, altitude 2^0 21.6' S and longitude 38^0 7.3' E, and agro-ecological zone VI about 400mm of rainfall per annum. Sixty four landraces were evaluated in a lattice design experiment under irrigation with moisture stress at flowering. The genotypes varied significantly in the days to tasselling, days to silking (ASI) and yield. Some local landraces had the low ASI (1-5 days) compared to those from the highlands with ASI of upto 16 days. Maize yield varied from 8 ton/ha to 1 ton/ha. Stress at reproductive stage reduced maize yield by upto 82%, with genotypes having lowest ASI recording the lowest yield loss. The controls (Katumani Composite B and Dryland composite) had losses of 62% and 68% when subjected to moisture stress at flowering. The results led to the conclusion that local landraces hold potential for improving maize for drought tolerance.

Keywords: *Drought, flowering, maize landraces, yield*

Performance of Cotton-Maize Cropping System as Affected by Ploughing Frequency and Soil Fertility Management in Burkina Faso

K. Ouattara[1,2], G. Nyberg[2], B. Ouattara[1], M.P. Sédogo[1], A. Malmer[2]

[1]Institute of Environment and Agricultural Research (INERA), 04 BP 8645 Ouagadougou 04, Burkina Faso [2]Department of Forest Ecology and Management, Swedish University of Agricultural Sciences (SLU), SE-901 83, Umea, Sweden, Tel: +46 (0)73 734 9172,
*Corresponding author: *korodjouma.ouattara@sek.slu.se* or
korodjouma_ouattara@hotmail.com

Abstract

On-farm experiments were conducted on two soil types (Lixisol and Luvisol) in the western cotton area of Burkina Faso with the objective to develop sustainable water and soil fertility management techniques that improve cotton-maize productivity. The hypothesis that organic and mineral fertilizers in addition to reduced ploughing frequency may improve cotton (*Gossypium hirsutum*) and maize (*Zea mays L.)* productions was tested. The treatments were combination of two tillage regimes (annual ploughing, AP and ploughing/scarification, RT) with and without compost application and mineral fertilizer inputs. The treatment annual ploughing with compost addition (AP+Co) had the highest soil water content (WC) on both the Lixisol and the Luvisol. The cotton yield increase of 46% and 36% on reduced tillage plot with compost additions (RT+Co) compared to the control in the Lixisol, and the Luvisol respectively. In the Lixisol the highest maize grain yield was recorded in the annual ploughing plot with the additional amount of nitrogen equivalent to the compost nitrogen content. Reduced tillage together with compost additions had the highest maize yield in the Luvisol. These results confirmed the hypothesis that reduced tillage with organic and mineral fertilization improved cotton and maize productions.

Keywords: *Burkina Faso, compost, cotton-maize, ploughing frequency, soil water content, yield*

Decomposition of Genetically Engineered Maize Residue under Field Conditions

C. K. Daudu*, P. N. S. Mnkeni and P. Muchaonyerwa

Department of Agronomy, University of Fort Hare, P. M. B. X1314, Alice 5700, South Africa, Phone: +27 (0) 40-602-2136, Fax : +27 (0) 40-653-1730, Mobile: +27 (0)739483529
*Corresponding author: *christogonus@gmail.com*

Abstract

Crop plants genetically modified (GM) for resistance to pests represents a tool to decrease the amount of chemical pesticides used in agriculture. Genetic modification of crops for a specific purpose could result in an additional unintended effect on plant structure and function, which may have ecological implications. We assessed crop effects of Bt maize modified to produce the Bt endotoxin on decomposition using Bt and non Bt maize as a standard exogenous material using 2-mm mesh fibreglass litter-bags, under field conditions over a sixteen week period. Treatments were two maize varieties (transgenic Bt-maize DKC 78-15B and corresponding near isogenic maize CRN 3505) x four maize residues (stem and leaves from transgenic Bt-maize MON810 each and the corresponding near isogenic maize CRN 3549) with six harvest periods in a completely randomized design. Percent ash free dry mass loss increased over time and varied with litter type and source. Biomass decomposition was faster with leaves than stems for both residue types. There were slight differences between mass losses from both litter types when grown under genetically and non-gentically modified maize. Decomposition rates and the half-life values (t_{50}), the time it takes for loss of 50% of the amount of the organic material to occur, was estimated from best-fit models. The residues were also assessed with respect to selected chemical and resource quality characteristics. Knowledge of these processes is essential to the understanding and development of post harvest soil management strategies for genetically modified crops.

Keywords: *Genetically modified maize, decomposition, model, soil.*

Field inoculation of woody legumes with microsymbionts (rhizobia and mycorrhiza fungal): an evaluation of successes and failures in Africa.

D. Lesueur[1,*], X. Poshiwa[2], R. Duponnois[3], D. Odee[4], A. Sarr[1], K. Ingleby[5], N. Chikumba[2], B. Sougoufara[6], C. Plenchette[7], D. Diouf[8] and J. Wilson[5]

[1]Forest Dept of CIRAD, UPR « Ecosystems of Plantations », Tropical Soil Biology and Fertility of Soils Institute of CIAT, Nairobi, Kenya. [2]Grassland Research Station, P Bag 3701, Maroundera, Zimbabwe. [3]Institut de Recherche pour le Développement, UR 040 « Symbioses Méditerranéennes et Tropicales », Laboratoire Commun de Microbiologie (UCAD, IRD, ISRA), Dakar, Senegal. [4]Kenyan Forestry Research Institute, Biotechnology Institute, Nairobi, Kenya. [5]Centre for Ecology and Hydrology, Edinburgh EH26 0QB, UK. [6]Direction des Eaux ET Forêts, Chasse ET Conservation des Sols, Dakar, Sénégal. [7]Institut National de Recherche Agronomique, UR 1066 « Malherbologie et Agronomie », Dijon, France. [8]Université Cheikh Anta Diop, Dept de Biologie Végétale, Laboratoire Commun de Microbiologie (UCAD, IRD, ISRA), Dakar, Senegal.
*Corresponding author: *didier.lesueur@cirad.fr* and *d.lesueur@cgiar.org*

Abstract

In the past, much work has been done in Africa on the isolation of rhizobial strains nodulating legumes. Practical demonstrations of the value of rhizobial inoculation are rare, because most work has been done under controlled, rather than field conditions. In the present study, we describe results obtained in the field (research station and farms) on the utilization of selected microsymbionts (Rhizobium and mycorrhiza fungal) for inoculating tree legumes and improving their growth and biological nitrogen fixation in Africa. The synergic effect of the dual inoculation has been clearly demonstrated with *Acacia mangium* and *Calliandra calothyrsus* in irrigated perimeters in Senegal. On the other hand in Kenya, the impact of the dual inoculation on the forage production by *Calliandra calothyrsus* in several sites has not been clearly demonstrated in the field (3 sites). But meanwhile, the same inoculum tested with the same *Calliandra calothyrsus* provenances in Zimbabwe has significantly improved in the field (2 sites) the biomass yield produced by the trees. With African Acacias, the lack of rain in dry lands prevented a positive effect of inoculation on the growth of seedlings planted in the field after four months of growth in nursery. The inoculation of mature trees of *A. senegal* in the field has been effective and has significantly improved the yield of gum-arabic. Through our work, we have obtained information and results on the limitations of field rhizobial inoculation for improving tree growth for forage, firewood and litter production and in some cases soil fertility as well.

Keywords: *Mycorrhiza; Native and Exotic Tree legumes; Nodulation; Rhizobia; Symbiotic N_2 fixation;*

An evaluation of Lucerne varieties suitable for different agro ecological zones in Kenya

B.A. Lukuyu[1],*, J.N. Methu[4], D. Mwangi[3], J. Kirui[2], S.W. Mwendia[1], J. Wamalwa[1], A. Kavatha[2], G.N. Ngae[1] and G.N. Mbure[1]

[1]Kenya Agricultural Research Institute, Muguga South, P.O. Box 30148-00100, Nairobi, Kenya; [2]Land O' Lakes Kenya Office, P.O Box 45006-00100 Nairobi, Kenya; [3]Kenya Agricultural Research Institute, PO Box 57811 -00200, Nairobi, Kenya; [4]Land O' Lakes Regional Office, P.O Box 45006-00100 Nairobi, Kenya
*Corresponding author- e mail: *b.lukuyu@cgiar.org;* Mobile: 0722820758

Abstract

In order to choose suitable varieties with high yield and good quality for cultivation, 8 Lucerne varieties, including seven foreign ones (WL 625 HQ, KKS 9595, WL 414, Robusta, KKS 3864, SA Standard, WL 525 HQ) and a local check Hunter River were studied on farm in seven different agro ecological zones (AEZ) in the long and short rain seasons 2006 using a randomized block design with two replications. Each plot was cut two times in both seasons to evaluate herbage production of the tested varieties. Results showed that dry matter yield (DM) from varieties were significantly different between sites in both short ($P<0.05$) and long ($P<0.001$) rains seasons. Robusta and WL 525 HQ yielded significantly ($P<0.05$) more DM yield compared to the local check Hunter river in both wet mid and highland zones while SA Standard yielded significantly ($P<0.001$) more DM in both mid and high dry land zones across all seasons. There was a significant AEZ x Variety interaction on leaf: stem ratio in both short ($P<0.001$) and long ($P<0.05$) rains seasons. In both rain seasons, WL 414, WL 625 HQ and KKS 3864 had significantly ($P<0.05$) higher leaf: stem ratio in that order to the local check Hunter river across all zones. Similarly, in both rain seasons, age at harvested significantly affected DM yield ($P<0.05$) and leaf: stem ratio ($P<0.005$) of all varieties across all zones.

Keywords: *DM yield, leaf, harvesting age, lucerne, stem ratio*

Effect of Indigenous Cyanobacteria Strains on Plant Growth and Nitrogen Content of Degraded Soils of the Eastern Cape Province in South Africa

M.P. Maqubela*, P.N.S. Mnkeni and P. Muchaonyerwa

Department of Agronomy, University of Fort Hare, Private Bag X1314, Alice 5700, South Africa, Tel: 040 6022139, Fax: 040 6021730,
*Corresponding author email: *Mfundomaqubela@hotmail.com*

Abstract

Some cyanobacteria strains could be an economically attractive, ecologically sound alternative to chemical fertilizers because of their ability to fix nitrogen. As a result of lack of information on these effects in South Africa, a glasshouse study was conducted to evaluate the nitrogen fixation benefits of cyanobacteria strains 3g and 7e, indigenous to South Africa, and 9v from Tanzania, in a split split-plot design. Suspensions of cyanobacteria were uniformly applied to potted soils with or without maize seeds planted. After 6 weeks, the maize biomass was harvested and the top 15 mm of the soils mixed, before a second maize crop was grown for six weeks. Inoculation with strains 3g, 7e and 9v resulted in maize dry matter increases of 9.7, 9.1, and 10.4%, respectively, in the Fort Hare soil and 17.3, 22.3, 18.04%, respectively, in the Hertzog soil, at the first harvest. At the second harvest, the dry matter increases were 8.7, 10.3, and 24.07%, in the Fort Hare soil and 12.9, 14.8, and 19.01% in the Hertzog soil. Tissue N and N uptake also increased significantly with inoculation in both soils at both harvests. Soil nitrate N was higher where soils were inoculated and not cropped than cropped control in the first harvest. After the second harvest, soil ammonium N was highest in the 7e treatment for the Fort Hare soil, when cropped twice, and for Hertzog soil cropped once, relative to the control. The study suggested that cyanobacteria strains 3g and 7e have potential benefits in maize growth and for soil N improvement.

Keywords: *Cyanobacteria; dry matter; nitrogen fixation, soil N improvement, tissue N*

Arbuscular Mycorrhizal Dependency of Nine Different Tissue Cultured Banana Cultivars

R.M. Mwashasha[1],*, E.M. Kahangi[1], L.K. Rutto[1], D. Odee[2], B. Vanlauwe[3], J.M. Jefwa[4]

[1]Jomo Kenyatta University of Agriculture and Technology, Nairobi, Kenya; [2]Kenya Forestry Research Institute; [3]Tropical Soil Biology and Fertility (TSBF-CIAT), Nairobi, Kenya. [4]National Museums of Kenya
*Corresponding author: *mwajita@yahoo.com*

Abstract

The effect of four arbuscular mycorrhizal fungi (AMF) on growth and nutrition of nine different most popular commercial tissue cultured banana cultivars in Kenya and Uganda was investigated under greenhouse conditions. The banana plantlets at weaning stage were inoculated with one of the four AMF (i.e. *Glomus etunicatum, Glomus intraradices, Glomus mosseae* and *Gigaspora albida*) and a control (without AMF). Three sequential harvests were done at 8, 18 and 22 weeks after inoculation. At each harvest, plant height, fresh weight of shoots and roots, leaf surface area and shoot dry weight were measured. Fresh roots were processed to assess mycorrhizal colonization. Relative mycorrhizal dependency (RMD) of the various cultivars was calculated. The oven-dried shoots were analyzed for macronutrients. Inoculation with *Glomus* species resulted in significantly higher growth parameters compared to controls and *Gi. albida* in all the nine tested banana cultivars. Shoot nitrogen, phosphorus and potassium was also significantly higher in *Glomus* species inoculated plants than the *Gi. albida* and the non-inoculated plants. These results indicate that *Glomus* species can be used to enhance growth and nutritional status of bananas.

Keywords: *Arbuscular mycorrhizal fungi (AMF), banana cultivars, colonization, mycorrhizal dependency, nutrient content.*

Multi-functional properties of mycorrhizal fungi: field results from inoculation response and perspectives for crop production

D. Nwaga[1],*, A. Tenkouano[2], K. Tomekpe[3], R. Fogain[2], G. Tsané [1,2], D. M. Kinfack[1,3] and O. Yombo[1]

[1]Biotechnology Centre & Plant Biology Department, University of Yaoundé, P.O. Box 812, Yaoundé, Cameroon; Tél: (237) 99931871, Fax: (237) 22237429; [2]International Institute of Tropical Agriculture (IITA), Humid Forest Ecoregional Center, B.P. 2008 Messa , Yaoundé, Cameroon; [3]Centre Africain de Recherche sur le Bananier et Plantain (CARBAP), Njombé, Cameroon;
*Corresponding author: *dnwaga@yahoo.fr*

Abstract

The main objective of this work is to show multi-functional properties of microbial resources for crop production. Beneficial organisms such as arbuscular mycorrhizal fungi (AM fungi) may be very useful for a sustainable agricultural production in African countries were soil fertility and drought are serious limiting factors. AM fungi can stimulate plant functioning: nutrient uptake, tolerance to drought, soil acidity, disease and pest; contributing to improving crops yields in African soils. In conditions where their activity is low, inoculation with selected strains could be use for restoration. This work reviewed some results obtained after experimentation using some crops under diverse agro-ecological zones of Cameroon. A workshop was done to explain the use of this technology. Inoculation of AM fungi may increase yield from 50% to 200% depending on crops and environmental factors. Legumes, vegetables, fruit trees showed higher response to inoculation compared with cereals. The benefit of banana-AM fungi symbiosis was tested for growth and drought tolerance. The results showed that plant growth, leaf surface and dry weight are significantly stimulated by mycorrhiza. AM fungi inoculation provided 30% more water to banana after 40 days of stress, water use efficiency and phosphatases activities were correlated with drought tolerance. AMF inoculated banana provided more suckers and bigger banana bunch than others. To develop this approach, the cost/benefit ratio of inoculation should be determined to envisage its incorporation into nursery. The use of mycorrhiza to overcome constraints which are limiting factors for a sustainable agricultural production in Africa is needed.

Keywords: *Arbuscular mycorrhizal fungi, inoculation, multi-functions, water use efficiency.*

Arbuscular Mycorrhizal Fungi (AMF) in the rhizosphere of bananas in farming systems of Central Kenya

J.M. Jefwa[1,5], L. Ruto[2], A. Elsen[3], E. Kahangi[2], P. van Asten[3], T. Losenge[4], M. Mwajita[2], and B. Vanlauwe[1], N. Sanginga[5]

[1]The National Museums of Kenya, Herbarium Department, [2]Jomo Kenyatta University of Agriculture and Technology, [3]Katholeike University Leuven, [4]International Institute of Tropical Agriculture, [5]Tropical Soil Biology and Fertility Institute of the International Centre for Tropical Agriculture (TSBF-CIAT), United Nations Avenue, P.O. Box 30677, Nairobi, Kenya.
Corresponding author: *j.jefwa@cgiar.org*

Abstract

Arburscular Mycorrhizae are beneficial to banana. Indigenous AMF have evolved with the crop and are more adapted to prevailing soil environmental conditions. They may therefore enhance establishment, survival and subsequent productivity. There is no information on AMF associated with banana systems. A survey was undertaken in central Kenya to establish AMF in the rhizosphere of bananas. AMF spores were morphologically identified and counted from field soils and trap cultures. Sorghum, soybean, cooking (Kibuzi) and a desert (Giant Cavendish) banana cultivar were used as trap plants. A total of 22 AMF species were present comprising of 12 *Glomus* spp., 7 *Acaulospora* spp., 2 *Scutellospora* spp. and 1 *Gigaspora* sp. Banana cultivars significantly (p= 0.002) affected spore abundance, with slight variations noted in the probability of occurrence of AMF. Except for Grand naine, Chinese dwarf and Lacatan, all TC cultivars had high species richness and diversity. Two local cooking cultivars had the highest species diversity (Shannon index). Soybean had higher species richness than sorghum and the two banana cultivars. A proportion of 80% of AMF species from rhizosphere of banana systems associated with other hosts with only two *Glomus* spp. specifically associated with two banana cultivars. Spore abundance was highest in sorghum > soybean > Kibuzi >Giant Cavendish. Shannon diversity index was highest for soybean > Giant Cavendish > sorghum >Kibuzi. *Acaulospora* species accounted for 65.4% of the total spore abundance while only 18.1% represented the two most abundant Glomus spp.

Keywords: *Arbuscular mycorrhizae banana systems, rhizosphere*

Exploring the Potential of Beneficial Soil Fungi to enhance Productivity in Agricultural Systems

S. Okoth[1,*], M.J. Jefwa[2,5], N. Karanja[1], J. Kahindi[3], E. Muya[4], P. Okoth[5], P. Wachira[1]

[1]University of Nairobi, [2]The National Museums of Kenya, Herbarium Department, [3]The United States International University, P.O Box 45166, Nairobi, Kenya. [4]Kenya Agricultural Research Institute, [5]Tropical Soil Biology and Fertility (TSBF) Institute of CIAT, P.O Box 30777, Nairobi.
*Corresponding author: *dorisokoth@yahoo.com*

Abstract

Soil microorganisms are crucial to maintenance of soil function. They play key roles in structure formation, nutrient cycling, nutrient uptake and root health. *Trichorderma sp.* and Arbuscular Mycorrhizal Fungi (AMF) are soil beneficial fungi. *Trcichorderma* improves soil health through suppression of soil borne plant diseases by producing antifungal antibiotic, produce growth promoting hormones which enhance root and plant development and induce resistance in plants. Several species are used commercially as bio-control agents against plant pathogenic fungi. AMF play a major role in nutrient uptake, contribute to soil aggregate formation, control of pests and pathogens and maintain plant species diversity. A study was undertaken by the GEF project on sustainable management of Belowground Biodiversity (BGBD) to evaluate impact of land use gradients on the beneficial fungi. Eleven *Trichorderma* species were isolated, including the commercially utilized *Trichorderma harzianum.* Soil type, LUT's and soil management practice influenced the distribution and abundance of *Trichoderma* spp. Napier induced high abundance and richness of *Trichoderma* and can be used in crop rotations or in combinations with other crops to naturally maintain high levels of the fungus in the soils. Twenty two AMF species were identified with Acaulosporaceae and Glomaceae most dominant. Spore abundance was highest in cropping systems and colonization low, an indication of disturbance while species diversity was highest on LUT's without crops and low in cropped systems. Since fertilizer is not an option in agricultural systems in Africa, the benefits of these organisms documented can be enhanced and utilized to improve fertilizer use efficiency.

Keywords: *Abundance, land use, management, Mycorrhizae, Trichorderma*

Effects of selected soil chemical and biological properties on maize yield in biomass transfer agroforestry systems

A. Mukuralinda[1,]*, J. S. Tenywa[2], J. Obua[2] and L. Verchot[3]

[1]Institut des Sciences Agronomiques du Rwanda (ISAR); [2]Makerere University. P.O. Box 7062, Kampala, Uganda; [3]World Agroforestry Centre (ICRAF), P.O. Box 30677, Nairobi, Kenya.
*Corresponding author: *mukuratha@hotmail.com*

Abstract

Effects of *Calliandra calothyrsus*, *Tithonia diversifolia* and *Tephrosia vogelii* green manure applied independently or combined with triple super phosphate (TSP) and limestone on soil chemical and biological properties that influence maize yield were evaluated on an Ultisol of Rubona, Rwanda. Treatments compared were the control, limestone at 2.5 t ha^{-1}, TSP at 25 kg P ha^{-1} and 50 kg P ha^{-1}, leaf of *Calliandra*, *Tithonia* and *Tephrosia* each at 25 kg P ha^{-1} and 50 kg P ha^{-1} respectively, *Calliandra*, *Tithonia* and *Tephrosia* each combined with TSP at equivalent rate of 25 kg P ha^{-1} and 50 kg P ha^{-1} respectively. Leaf biomass, TSP and limestone were applied four consecutive seasons Limestone led to significant increases in soil pH followed by *Tithonia* combined with TSP at 50 kg P ha^{-1}. All treatments reduced significantly exchangeable acidity and aluminium compared to the control. A combination of organic materials with TSP at 50 kg P ha^{-1} improved soil organic carbon, microbial biomass carbon (MBC) and phosphorus (MBP).The same treatments contributed in inorganic P fractions increases from 3.6 to 109.5% than green manure applied independently. Only the combination of *Tithonia* with TSP increased inorganic P fractions by 1.6% to 52.2% compared to TSP alone. The combination of green manure treatments with TSP in the proportion of 25% significantly increased grain yield from 24 to 508%. Inorganic P fractions, soil carbon, MBC and MBP values were strongly correlated with maize yield, confirming the crucial role of these soil properties in improving maize yield.

Keywords: *Biomass transfer, maize yield and soil chemical and biological properties*

Decomposition and nutrient release from mixed plant litters of contrasting quality in an agroforestry parkland in the south-Sudanese zone of West Africa

Gnankambary Z.[1,3]*, Bayala J.[2], Malmer A.[3], Nyberg G.[3], Hien V.[1]

[1]Department of Natural Resource Management, Institute for Environment and Agricultural Research (INERA), 04 BP 8645 Ouagadougou 04, Burkina Faso. [2]Department of Forest Productions, Institute for Environment and Agricultural Research (INERA), 04 BP 8645 Ouagadougou 04, Burkina Faso. [3]Department of Forest Ecology and Management, Swedish University of Agricultural Sciences, SE-901 83, Umeå, Sweden.
* Corresponding author: email: *zacharia.gnankambary@sek.slu.se; gnank_zach@hotmail.com*

Abstract

We investigated under field and laboratory conditions the decomposition and nutrient release from mixed leaf litters of *Faidherbia albida* and *Vitellaria paradoxa* in the south-Sudanese zone of West Africa. Litterbags containing *F. albida* and *V. paradoxa* litters in varying proportions were placed on the soil surface and buried in plots receiving the following treatments: no fertilizer (control); nitrogen; phosphorus as Triple Superphosphate (TSP); and phosphorus as rock phosphate from Burkina Faso (BP). At each litterbags collection date, the undecomposed litter from each species was separated, and its remaining mass, nitrogen, phosphorus and potassium contents were determined. *F. albida* decomposed faster (k-values ranged from 0.031 to 0.131 week^{-1}) than *V. paradoxa* (k-values ranged from 0.015 to 0.086 week^{-1}) and released more nutrient than *V. paradoxa*. Mixing litters accelerated the decomposition rate of *V. paradoxa*, but did not affect the decomposition rate of *F. albida*. Decomposition was faster in the N and TSP plots than in the control and BP plots, and buried litter decomposed more rapidly than surface litter. In the early stages of decomposition, nitrogen was immobilized by *V. paradoxa* litter, but only in the control and N plots. Also under laboratory conditions, *F. albida* litter decomposed more rapidly than *V. paradoxa* litter as the microbial specific growth rate were 0.135 h^{-1} and 0.069 h^{-1}, respectively. Results indicated that leaf litter from indigenous tree species can be used to optimize nutrient supply for crops, and that mixing litters of contrasting qualities is a promising management option for regulating their decomposition rates.

Keywords: *Faidherbia albida*; *litter decomposition; microbial respiration; mineral fertilizers; Vitellaria paradoxa*

Enhancing productivity of crops through sustainable management and conservation of plant-pollinator biodiversity and pollination services

T. Munyuli[1,*], P. Nyeko [2], S. Potts [3] and O. Totland [4]

[1]Makerere University institute of environment and natural resources, P. O. Box 7062 Kampala, Uganda; [2]Faculty of Forestry, Makerere University, Kampala, Uganda; [3]Centre for Agri-Environment Research Policy, Faculty of Agriculture, University of Reading, UK; [4]Norwegian University of Life Sciences, Norway,
*Corresponding author: *munyulitheodore@yahoo.co.uk*

Abstract

Pollinators are well known to provide key ecosystem services to both natural and agro-ecosystems. Pollination is essential for the maintenance of diversity in wild flowers, and is indirectly responsible for the persistence of other guilds that depend upon floral resources, such as herbivores and seedeaters. Animal pollinators are thought to contribute between 15% and 30% of global food production and bees are recognised to be the most important pollinating taxon. The majority of agricultural crops in eastern and central Africa depend on pollinator populations from adjacent semi-natural and natural habitats for their productivity (yield increase). However, the value of pollinators is unknown in eastern and central Africa. A study was undertaken to improve our understanding of the habitat characteristics that moderate the value of plant-pollinator communities, especially in agricultural landscapes. The study aimed mainly at assessing the economic value of pollination services .This paper present results for data collected so far for 2 years in Uganda. Several pollen vectors were inventoried and were found to play a significant role in increasing yield of cash crops and of vegetables/fruits. Pollination services are crucial for sustaining livelihoods and improve human life in Africa. Pollination service is a critical service. Promoting green revolution in Africa will also imply the conservation of these vital ecosystem services

Keywords: *Plant-pollinator biodiversity, income increase, livelihood improvement, pollination services conservation, green revolution achievement*

Effects of Conservation Tillage, Crop Residue and Cropping Systems on Soil Organic Matter Dynamics and Maize-Legume Production: A Case Study of Teso District

Anyanzwa[1*] H., R.O. Okalebo[1], A. Bationo[2], B.S. Waswa[2], J. Kihara[2]

[1]Department of soil Science, Moi University, P.O BOX 1125, Eldoret Kenya; [2]Tropical Soil Biology and Fertility Institute of CIAT (TSBF-CIAT), P. O. Box 30677-00100, Nairobi, Kenya
*Corresponding author: *hellenanyz@yahoo.com*

Abstract

Tillage intensity reduction and use of cropping systems which maximize residue addition to the soil have been efficient agricultural practices to maintain or increase soil organic matter which has declined to very low levels. In this study, effects of conservation tillage, crop residue and cropping systems on the dynamics of SOM and overall maize-legume production were investigated in Western Kenya. The experiment was a split- split plot design with 3 replicates with crop residue management as main plots and cropping systems as sub-plots. Nitrogen was applied in each treatment at 4 rates (0, 30, 60, and 90 kg N ha^{-1}). Phosphorus was applied at 60 kg P/ha in all plots except 2 intercrop plots and control plot. The farm was characterized by low carbon content of 0.83% and total N of 0.08% with the soil classified as loamy sand. Data analyses were done using SAS. Inorganic fertilizer (N and P) showed significant effects on yields with plots receiving 60 kg P ha^{-1} + 60 kg N ha^{-1} giving higher yields of 5.5 t ha^{-1} compared to control plots whose yields were as low as 1.8 t ha^{-1}. There was a slight increase in SOM content in the third season in crop residue plots. Long-term studies are needed to show the effects of crop residue, cropping systems and nutrient input on sustainability of SOM and crop productivity.

Keywords: *Conservation tillage, Crop-residue, Intercropping, maize yields, SOM,*

Challenges for replenishing soil fertility in depleted fields: evidence from long-term trials in Zimbabwe

S. Zingore[a,]*, E.N. Masvaya[b], J. Nyamangara[b], R.J. Delve[a] and K.E. Giller[c]

[a]Tropical Soil Biology and Fertility Institute of CIAT, P.O. Box MP228, Mt Pleasant, Harare, Zimbabwe,Phone: +265 1 707278, [b]Department of Soil Science and Agricultural Engineering, P.O. Box MP167, Mt Pleasant, Harare, Zimbabwe, [c]Plant Production Systems, Department of Plant Sciences, Wageningen University, P.O. Box 430, 6700 AK Wageningen, The Netherlands
*Corresponding author: *s.zingore@cgiar.org*

Abstract

Gradients of decreasing soil fertility with increasing distance from homesteads commonly occur on smallholder farms in sub-Saharan Africa due to differential resource management. A study was conducted for five seasons (2002-2006) on fields closest to homesteads (homefields) and outlying fields (outfields) of two smallholder farms on a sandy and clayey soils to assess maize yields after applying 100 kg N ha-1 yr-1 with different rates of P (0, 30, 50 kg ha-1 yr-1) from single super phosphate (SSP) or cattle manure. In the first four experimental seasons, maize yields in homefield control plots were greater than in the outfields of farms on a granitic sandy and a red-clay soil. Application of large amounts of manure (~17 t manure ha-1 yr-1) for three seasons was necessary to significantly increase maize yields on the sandy outfields. There were no significant grain yield responses to addition of fertilizer N and SSP in the outfields over the first four seasons. In the fifth season, Ca and micronutrients (Zn, Mn, B) were added to assess of the potential to increase maize yields in these fields by targeted micronutrient fertilizer application, but their effects were masked by poor rainfall. A cost-benefit analysis revealed that more than five years were required for farmers to off-set the costs of replenishing soil fertility in degraded fields by applying large amounts of manure.

Keywords: *Manure, micronutrients, soil fertility gradients*

Breeding Common Bean for Tolerance to Low Fertility Acid Soils in East and Central Africa

P.M. Kimani[1], Lubanga Lunze[2], Gideon Rachier[3] and Vicky Ruganzu[4]

[1]CIAT Regional Program on Beans in East and Central Africa, Dept of Plant Science and Crop Protection, University of Nairobi, P. O Box 29053 Nairobi, Kenya; [2]INERA, Mulungu Research Station, B.P 496, Bukavu, DR Congo; [3]Kenya Agricultural Research Institute P.O Box 169 Kakamega, Kenya; [4]Institut de Sciences Agronomiques du Rwanda, B.P 259, Butare, Rwanda

Abstract

Bean production in eastern Africa is severely constrained by low soil phosphorus, nitrogen and acidity. Resource-poor smallholder farmers cannot afford and rarely apply fertilizers and other soil amendments to their bean crops. A strategy based on the identification of genotypes adapted to soils with inadequate nutrient supply and low pH associated nutritional disorders as a component of integrated soil management is now considered as the most appropriate approach to improving bean productivity in this region. More than 1337 bean genotypes were screened at nine sites in Kenya, Rwanda, DR Congo and Uganda to: (i) Identify lines tolerant to low soil nitrogen, phosphorus and aluminium and manganese toxicity; (ii) Conduct participatory evaluation with farmers to identify lines that combine tolerance to low soil fertility stress factors with marketable grain types. Soil analyses showed that all test sites had acid soils (pH 4 to 4.8) with low levels of available N, P, organic matter and moderate to high levels of aluminium saturation (40-60%). More than 50 bean lines tolerant to low soil nitrogen and phosphorus, and Al/Mn toxicity were validated with farmers in Uganda, Tanzania, Kenya, Madagascar, DR Congo and Rwanda. Genetic analyses showed that tolerance to low soil P and N was largely additive. Ten bean lines tolerant to low soil nitrogen, acid soil complex and five tolerant to low P have been released in six countries. Wider dissemination of low soil fertility tolerant lines has the potential of increasing productivity and profitability under low input bean production system.

Keywords: *Common bean, genotypes, selection, soil fertility, tolerance*

Soil fertility variability in relation to the yields of maize and soybean under intensifying cropping systems in the tropical savannas of north-eastern Nigeria

Joshua Dankasa Kwari*[a], Alpha Yaya Kamara[b], Lucky Omoigui[b]

[a]Department of Soil Science, University of Maiduguri, Nigeria; [b]International Institute of Tropical Agriculture, Ibadan, Nigeria
*Corresponding author: *jdkwari@yahoo.co.uk* Telephone (GSM): 08059727113.

Abstract

In north-east Nigeria, there are two types of fields (compound and bush) which are variable in soil fertility. This variability is either induced by management practices or by differences in texture. This influences the efficiency of resource use to increase crop yields on the fields. To address field soil fertility variability, some soil fertility parameters in 0-15 cm depth soil samples from farmer's compound (64) and bush (73) fields in southern Guinea (SGS) northern Guinea (NGS) and Sudan savanna (SS) zones were related to soybean and maize yields. Sand and silt contents significantly influenced soybean and maize yields in compound fields in SGS and NGS, respectively. Clay content had significant effect on soybean yield in compound fields in SGS and bush fields in NGS. Soil pH (range 5.23-8.03) and total N (range 0.14-4.90 g kg^{-1}) significantly influenced soybean yields in bush fields in SGS and NGS, respectively. Organic C (range 2.2-23.6 g kg^{-1}) significantly influenced soybean yields in bush fields in SGS and maize yields in fields in SS. Available P (range 0.30-11.30 mg kg^{-1}) and exchangeable K (range 0.15-1.79Cmol kg^{-1}) were important variables for soybean yields in compound fields in SGS and bush fields in NGS and for maize yields in bush fields in SS. Soil pH, organic carbon and available P were identified as critical in some of the fields. Addition of organic inputs, rotation of maize and soybean varieties tolerant to striga and drought stresses and application of N and P fertilizers but targeted to specific field situations are recommended.

Keywords*: Available phosphorus, Bush fields, Compound fields, Organic carbon, Soil fertility*

Survival and Soil Nutrient Changes during Five Years Growth of Sixteen *Faidherbia albida* Provenances in Semi Arid Baringo District, Kenya.

O.G. Dangasuk[1*] , J. R. Okalebo[2] and S. Gudu[1]

[1]Departments of Biological Sciences, Moi University, P. O. Box 1125, ELDORET, Kenya.
[2]Department of Soil Science, Moi University, P. O. Box 1125, ELDORET, Kenya.
*Corresponding author: *georgedangasuk@yahoo.com*

Abstract

Sixteen provenances of *Faidherbia albida* were planted in a randomized complete block design (RCBD) with five replications in April 1997 at Noiweit in semi arid Baringo District of Kenya. The objectives were (1) to investigate the pattern of genetic variation and performance among the16 provenances to determine their suitability for introduction in this environment, and (2) to assess the soil fertility development under *Faidherbia albida*. Assessments of growth variables and soil properties were done in October 1997 (six months after planting) and March 2002 (five years after planting). There were significant differences ($P < 0.05$) in height and diameter growth among provenances at six months but not five years. Survival percentage was higher among the Eastern and Southern African provenances, while four of the five West African provenances had 0% survival at five years. Soil data showed significant increase ($P < 0.05$) in soil pH, organic C, total N, available Olsen P and exchangeable (Na and K); a significant decrease ($P < 0.05$) in exchangeable (Ca and Mg); and no significant difference ($P > 0.05$) in exchangeable Al in five years.

Keywords: *Arid and semi arid lands, diameter and height, genetic variation, provenances, soil fertility*

Influence of Land Use and Cropping Systems on the Soil Monosaccharides Content: Induced Effects on Soil Aggregation in the Western Cotton Area of Burkina Faso

B. Ouattara[1,*], K. Ouattara[1], G. Piombo[2], A. Assa[3], P. M. Sédogo[1], A. Bationo[4]

[1]Institut de l'Environnement et de Recherches Agricoles (INERA), 04 BP 8645 Ouagadougou 04, Burkina Faso; [2]Centre International de Recherche pour le Développement (CIRAD), Montpellier/ France; [3]Université de Cocody, UFR/SVT; Abidjan, Côte d'Ivoire; [4]The Tropical Soil Biology and Fertility Institute of CIAT (TSBF/CIAT), P. O. Box 30677, Nairobi, Kenya.
*Corresponding author email: *badiori.ouattara@coraf.org*

Abstract

Soil organic carbon (SOC) and more precisely its labile pools play a pivotal role in the sustainable soil fertility management of poorly-ranged swelling clays soils in sub-Saharan Africa. The role of soil monosaccharides was assessed, based on a large typology of land use intensity. Thus 33 plots were sampled at a depth soil of 0-15 cm, considering field-fallow successions and tillage intensity. Six monomeric sugars (arabinose, xylose, glucose, galactose, glucosamine, mannose) accounting for 12 to 15% of SOC content has been extracted. The soil total sugars contents are significantly reduced by crop setting. But this depletion is more affecting hexose monomeric sugars (glucose and mannose), in particular that of microbial origin (mannose). The first ten cropping years after old fallow lands induces a loss of 63 % in mannose contents while annual ploughings practice in continuous cropping system leads to the greatest depletion (80%). As soon as the cropped plots are reconverted into fallow lands the soil monosaccharides contents record a renewed growth and rapidly get closer to the equilibrium level observed in the old fallow lands. Like soil polysaccharides contents, the amounts of soil water stable aggregates get lower as function of tillage intensity. But the total soil sugars explain only 13% of soil aggregation variability against 25% induced by galactose + mannose. Therefore, the soil monosaccharides from microbial neo synthesis could be considered as early indicators of SOC content depletion and key elements for soil aggregation.

Keywords: *Cultivation intensity; fallow, monosaccharides, water stable aggregates*

Cation flux in incubated plant residues and its effect on pH and plant residue alkalinity

G.M. Sakala[1,2,*], D.L. Rowell[2] and C.J. Pilbeam[3]

[1]Zambia Agriculture Research Institute, Mount Makulu Research Station, Private Bag 7, Chilanga, Zambia; Tel: 00 260 1 278380, Mobile: 00 260 95995264; [2]The University of Reading, Department of Soil Science, Whiteknights, P.O. Box 233, Reading RG6 6DW, UK; Fax: 00 44 118 9316660, e-mail: *d.l.rowell@reading.ac.uk*. [3]Cranfield University School of Management, Cranfield, Bedford MK43 0AL.
*Correspondence author: *godfreysakala@yahoo.co.uk*

Abstract

Plant residues offer a viable alternative to the costly and non-readily available commercial lime in addressing the constraint of soil acidity among the rural small-holders. The liming potential of the residues, attributable to excess cations over inorganic anions, exists in either available or non-available forms. This study investigates cation flux and its effect on pH and plant residue alkalinity of four plant residues, maize (*Zea mays),* soyabeans (*Glycine max),* leucaena (*L. leucocephala*) and gliricidia (*G. sepium*) upon incubation for 100 days with and without application of lime in an acidic Zambian Ferralsol. Initial characterization of base cation content ranged from 239-879 (Ca^{2+}), 188-458 (Mg^{2+}) and 298-477 $mmol_c\ kg^{-1}$ plant material (K^+). Of these between 26-60, 62-92 and 76-96% in that order were water soluble. On incubation up to 70 % Ca^{2+} and at least 80% Mg^{2+} and K^+ added in the residues were initially present eventually increasing to 84 and 95% respectively. Potential alkalinity were 373 (maize) 1264 (Soyabeans), 794 (leucaena) and 1024 (gliricidia) $mmol_c\ kg^{-1}$. Of this between 42% (gliricidia) and 52% (leucaena) constituted available alkalinity. Exchangeable aluminium was absent or appeared in insignificantly very low amounts towards the end of the incubation while base cations were fixed. There was initial dependence of pH on both total cation concentration and residue alkalinity but this relationship was later lost suggesting incomplete activation of the non-available fraction of the potential alkalinity. Nitrogen mineralization affected both cation flux and residue alkalinity. This study highlights the importance of residues on amelioration of major cation deficiencies and aluminium phytotoxicity.

Keywords: *Cation flux, nitrogen mineralization, plant alkalinity, soil acidity, Zambia*

Integrated Striga Management in Kenya

Canon E.N. Savala[1,*], George D. Odhiambo[2] and Paul L. Woomer[1]

[1]Forum for Organic Resource Management and Agricultural Technologies, P.O. Box 79, The Village Market, Nairobi, Kenya. Email: *format@wananchi.com* and
[2]Maseno University, P.O. 333, Maseno, Kenya. Email: *gdodhis@yahoo.co.uk*
Corresponding author: *format@wananchi.com*

Abstract

Striga hermonthica is a serious pest of cereal crops in west Kenya. It has infested about 217,000 ha of maize cropland resulting in 182,000 t of maize grain loss per year worth about $29 million. A two-year pilot project was developed by the African Agricultural Technology Foundation and six non-governmental organization partners to explore opportunities for better striga management. Three approaches and five management options were evaluated over two years; 1) striga tolerance (KSTP 94 and WH 502), 2) legume suppression (Push Pull and MBILI) and 3) imazapyr seed dressing of herbicide resistant maize (*Ua Kayongo*). *Ua Kayongo* resulted in the greatest maize yield (2.60 t grain ha^{-1}) largest returns ($371 $season^{-1}$) and reduced striga expression (0.5 striga stems $plant^{-1}$). In contrast, the striga susceptible hybrid (H513) control produced 1.58 t grain ha^{-1}, returns of $228 $season^{-1}$ and was infested by 2.6 striga stems $plant^{-1}$. The other striga managements were also effective, producing between 2.10 and 2.46 t grain ha^{-1} and infested by 0.5 to 1.4 striga stems $plant^{-1}$. In addition, *Ua Kayongo* was field tested on over 13,000 farms during two years and farmers' impressions of the variety were extremely favorable. Clearly, imazapyr seed treatment is a breakthrough technology in striga control but its combination with other, more agro-ecological management approaches, particularly suppression by intercropped field legumes is necessary. Moreover, it is unlikely that commercialization of *Ua Kayongo* seed alone is sufficient to reach a full cross-section of striga's impoverished victims, suggesting that additional incentives triggering farmer collective action are required before this technology can achieve its full impact.

Keywords: *East Africa, imazapyr-resistance, maize, plant parasite, Ua Kayongo*

Evaluation of Site Adaptability, Biomass Productivity and Quality of Selected Improved Fallow Species in a Ferralic Arenosol at the Coastal Region in Kenya

Kiraithe Christine*, Balozi Kirongo, Welimo Martin

Kenya Forestry Research Institute, Gede Regional Research Centre, P.O. BOX 1078- 80200, Malindi, Kenya
*Corresponding author: *mbinyu@yahoo.com*

Abstract

Inherent low soil fertility, continuous cultivation without nutrient inputs, nutrient losses through leaching, unsustainable farming methods of slash and burn leading to nutrient losses are some of the major causes of low crop yields at the Coastal region. Short term-improved fallow technology has been successfully associated with soil fertility improvement and increase in crop yields in several parts of Kenya but has not been adequately evaluated at the Coastal Kenya to give firm recommendations. An on-farm experiment was established in Malindi District as a RCBD with eight treatments replicated thrice in 2006. Six species were evaluated at two intervals: six and twelve months after planting (MAP) for their site adaptability, biomass productivity, nutrient accumulation and leaf quality. The overall objective was aimed at identifying potential leguminous fallow spp. for transfer at the Coastal region. Mucuna pruriens gave significantly ($p<0.05$) higher foliage biomass yield of 2.3 t/ha and 22.9 t/ha at 6 and 12 MAP respectively. All species tested except S. sesban had Nitrogen > 2.5 % with Phosphorus and Potassium contents being low in all species. Lignin contents were < 15 % except in Tephrosia spp. while all species tested had low polyphenol contents of < 4% at 6 MAP. Results indicate that Mucuna pruriens, Tephrosia candida and Tephrosia vogelii are potential species for the Coastal region and their production can be enhanced in order to have recyclable amounts of nutrients that can be used to ameliorate the inherent low fertility soils at the Coast and subsequently enhance crop yields.

Keywords: *Biomass quality, Coastal region, improved fallows*

Land and Water Management Research and Development in Arid and Semi-Arid Lands of Kenya

J.K. Itabari[1,]*, K. Kwena[1], A.O. Esilaba[2], A. N. Kathuku[2], L. Mohammad[1], N. Mangale[1] and P. Kathuli[1]

[1]Katumani Research Centre, Kenya Agricultural Research Institute, P. O. Box 340 Machakos, Kenya; [2]Desert Margins Programme, Kenya Agricultural Research Institute, P. O. Box 57811-00200, Nairobi, Kenya.
*Corresponding author: *itabarijustus@yahoo.co.uk,* Tel: +2540723389521

Abstract

Increasing demographic pressure in the arid and semi-arid lands (ASALs) in Kenya has resulted in the use of non-sustainable farming practices and subsequent environmental degradation, characterized by declining soil fertility, widespread land degradation and loss of biomass and biodiversity. Rainfall in these areas is low, unreliable and erratic and these drylands are prone to prolonged and recurrent droughts. As a result, crop production is low and insufficient to meet the food demands of the increasing population. Food insecurity is a major threat to the livelihoods of the resource poor smallholder subsistence farmers in these areas. Due to the limited possibilities of increasing the area under cultivation, the solution to meeting the demand for food and surplus for sale by the rapidly increasing population lies in increasing productivity through development of simple, effective and sustainable integrated soil fertility and water management technologies. Consequently, a lot of research work aimed at developing appropriate soil and water management technologies for these areas has been undertaken by research and development organizations in Kenya. This paper reviews, summarizes and highlights the major findings of research on options for improving soil fertility and for conserving soil and water in the ASALs. Socioeconomic factors are considered as well as their interaction with intervention measures such as tillage, water harvesting, soil conservation, integrated nutrient management, soil and water and crop management. The knowledge gaps in the various technological options tested are identified and future research needs are suggested.

Keywords: *Arid and semi-arid lands, Kenya, land and water management, soil fertility*

Water Harvesting And Integrated Nutrient Management Options For Maize-Cowpea Production In Semi-Arid Eastern Kenya.

J.M. Miriti[1],*, A.O. Esilaba[2], P. Wakaba[1], A. Bationo[3], H. Cheruiyot[2] and A.N. Kathuku[1]

[1]Muguga ARC, Kenya Agricultural Research Institute, P.O. Box 30148-00100, Nairobi. [2]Desert Margins Programme, Kenya Agricultural Research Institute, P.O. Box 57811-00200, Nairobi. [3]Tropical Soil Biology and Fertility (TSBF) Institute of CIAT, P.O. Box 30677-00100, Nairobi, Kenya.
*Corresponding author: *jmmiriti@yahoo.co.uk*

Abstract

Field experiments were conducted for four years at Emali, Makueni District in Kenya to compare the effect of tied ridging and integrated nutrient management practices on the yield of rainfed maize (Zea mays L.) and cowpeas (Vigna unguiculata L.). The main treatments were tied ridging and flat bed (traditional farmers' practice) as main plots. Farmyard manure (FYM) at 0 and 5 t ha-1 in a factorial combination with nitrogen (N) fertilizer at 0, 40, 80 and 120 kg N ha-1 ,phosphorus (P) fertilizer at 0 and 40 kg P2O5 ha-1 and crop management were the subplots in a split plot in a Randomised Complete Block Design (RCBD). The results show that tied-ridging significantly ($P<0.05$) increased maize grain yields by 12% when compared to flat tillage. Maize grain and stover yields were significantly increased by 79% and 61%, respectively, when manure was applied. Cowpea grain yields in tied-ridging were 25% more than in flat tillage treatments and the highest cowpea grain yield was1354 kg ha-1. Intercropping maize and cowpea lowered maize grain yield by more than 50% and 11% without and with nitrogen at 40 kg N ha-1, respectively and also reduced cowpea grain yields. However, crop rotation increased the yields of both maize and cowpea. Combining tied ridges with manure and inorganic fertilizers increased crop yields when compared to when either of them is used separately. Thus, integration of in situ water management with integrated nutrient management has a potential in increasing food production in arid and semi-arid areas of Kenya.

Keywords: *Integrated nutrient management, Kenya, Semi-arid lands, Soil fertility, Water harvesting*

Biophysical characterization of Oasis soils for efficient use of external inputs in Marsabit District: Their potentials and limitations

E.M. Muya[1,*], J.K. Lelon[2], M.G. Shibia[3], A.O. Esilaba[4], M. Okoti[3], G. N. Gachini[1] and A.L. Chek[1]

[1]Kenya Agricultural Research Institute, National Agricultural Research Laboratories, P.O. Box 14733, Nairobi; [2]Kenya Forestry Research Institute, P.O. Box 20412, Nairobi; [3]Kenya Agricultural Research Institute, National Arid Lands Research Centre, P.O. Box 147, Marsabit; [4]Kenya Agricultural Research Institute, Desert Margins Programme (DMP), P.O. Box 57811, Nairobi.
*Corresponding author: *edwardmuya@yahoo.com or kss@iconnect.co.ke*

Abstract

The biophysical site characterization was carried for irrigated oasis farming in Kalacha, where production has declined to an extent that farmers abandoned their farms and opted for forage production. The objective for carrying out the characterization work was to identify technologies and locally available resources not only for efficient utilization of limited water and nutrient, but also to reverse the declining soil quality for long-term production. The land attributes used in differentiating the soils into mapping units were geomorphology, nutrient availability, salinity and sodicity hazards, infiltration rate and drainage conditions for various crops. Productivity index for each soil mapping unit was determined by the regressed relationships between crop production and the soil quality indicators. Between Unit PIL1 was classified as Calcic Solonetz well drained, with productivity index of 22%. The most limiting factors were found to be nitrogen and high sodium concentrations. Unit PIL2 comprised well drained, stratified Salic Fluvisols, with productivity index of 26%. The most limiting factors were low nitrogen level, high sodium and salt concentrations. Unit PIL3 had excessively calcareous, moderately drained and strongly stratified soils, classified as Calcaric Fluvisols with productivity index of 21%. The major limitation was nitrogen. Unit PIL4 comprised firm soils, overlying cemented sub-soils with high carbonate concentration, classified as Calcic Solonchaks, with imperfect to poor drainage conditions, and having productivity index of 12%. The major limitations were poor drainage, high sodium concentration and low fertility status. The soil productivity can be improved by prescribing the required inputs to address the specified limitations.

Keywords: *Land characteristics, oasis soils, productivity index, water and nutrient use*

Analysis of Spatial Variation of Soil Fertility Gradients in Smallholdings in Tropical Africa Using Geostatistical Techniques: Case Studies from Vihiga and Siaya Districts of Western Kenya

J.M. Okeyo[1]*, C.A. Shisanya[2], W.N. Wamicha[3], and K.D. Shepherd[4]

[1]Tropical Soil Biology and Fertility Institute of the International Centre for Tropical Agriculture (TSBF-CIAT); [2]Kenyatta University, Department of Geography; P.O. Box 43844-00100, Nairobi; [3]Kenyatta University, Department of Environmental Science, P.O. Box 43844-00100, Nairobi; [4]World Agroforestry Center (ICRAF), United Nations Avenue, P.O. Box 30677, Nairobi, Kenya.
*Corresponding author: *j.okeyo@cgiar.org*

Abstract

Adoption of soil fertility management technologies in Western Kenya has been minimal at best, and one of the main reasons given is the highly heterogeneous (biophysical and socio-economic) conditions within which smallholder farmers operate. A study was carried out to quantify the variability of soil fertility at different spatial scales and formulate domains for better targeting of soil fertility management recommendations. Farms were selected using hierarchical Y-frame sampling design and all fields within each farm characterized. Top soil samples were collected at a depth of 0-20 cm and the sampling points georeferenced using a global positioning system (GPS). Geostatistical techniques of semivariography were used to explore the spatial structure of soil fertility gradients. Mixed effects modeling was used to confirm relationships, while accounting for spatial correlation structures, and understanding the variance of predicted soil organic C at different spatial scales. Predicted soil organic C was found to be spatially correlated and the spatial structure was modeled using experimental semivariograms fitted with spherical and exponential models. On average, all the variogram models gave a nugget/sill ratio of between 0.5-0.6, indicating moderate spatial correlation. The high nugget variances shown by most of the fitted models indicate high micro-scale variations. Analysis of estimated variance components showed that field (residual) effects accounted for the greatest percentage (62.5%) of the variation associated with random effects. Future soil fertility management strategies in western Kenya in particular and tropical Africa at large should account for the large spatial variability of soil within smallholder farms.

Keywords: *Semivariograms, Soil fertility, Soil Organic Carbon, Spatial variability, Western Kenya*

Spatial patterns of soil properties as influenced by soil fertility management in small-scale maize farms in Njoro, Kenya

Nancy W. Mungai[1,]*, A. Bationo[2] and B. Waswa[2]

[1]Department of Crop and Soil Sciences, Egerton University, P.O. Box 536 Njoro, Kenya,
Tel: 254-720-390893, Fax: 254-51-2217745,
[2]Tropical Soil Biology and Fertility Institute of CIAT, P.O. Box 30677, Nairobi, Kenya.
*Correspondence author email: *mungain03@yahoo.com*

Abstract

Soil testing by small–scale farmers in rural Kenya is relatively uncommon for several reasons key among them is lack of information on the possible benefits and limited access to testing laboratories. However, most of the farmers are aware of soil fertility variations within their farms which influence their management decisions. The purpose of this study was to assess spatial variation in soil quality as influenced by slope and soil management. Soil sampling was done in 37 small – scale farms in Njoro division of Nakuru district at 0-20 cm depth in March 2006. Sixty five percent of the farmers used inorganic fertilizers predominately DAP, 15 % used only farmyard manure, 15% used both organic and inorganic fertilizer, while only 6% did not use any soil fertility amendments. Most of the farms had a pH ($CaCl_2$) of less than 5.2, Twenty seven percent of the farms had a pH lower than 4.0. Organic C ranged from 1.6 to 5.8%, with a median value of 2.6%. Most of the farms were P deficient with a $NaHCO_3$ extractable P of less than 15 mg kg^{-1}. All farms had sufficient amounts of extractable K. Total N ranged from 0.12 to 0.33% with 76% of the farms with low N content (< 0.2%). Farms amended with farmyard manure had higher organic C and total N levels in Kikapu with correspondingly lower C: N ratios. Overall most of the farms were acidic and of low soil fertility. Farmers were advised to apply lime and manure. Interestingly none of the farmers had heard of liming.

Keywords: *DAP, farmyard manure, nutrient levels, slope, soil test*

Using spatial analysis for targeting research and scaling-up opportunities

Delve, R.J.[1,*], Sonder, K.[2], Farrow, A.[3], and Njuki, J.[4]

[1]Tropical Soil Biology and Fertility Institute of CIAT, Box MP228, Mt Pleasant, Harare, Zimbabwe.
[2]IITA, PMB 5320, Ibadan, Nigeria; [3]CIAT, PO Box 6247, Kampala, Uganda; [4]CIAT, Box MP228, Mt Pleasant, Harare, Zimbabwe.
*Corresponding author: *r.delve@cgiar.org*

Abstract

Geographical Information Systems (GIS) maps showing the prevalence and/or location of a certain feature, e.g. poverty rates, soil type, or rainfall distribution are common and these have evolved to predict/target where a similar environment or production system might occur, e.g. Homologue, Floramap. This paper reports the use of GIS to characterize the sub-Saharan African Challenge Program's southern Africa Pilot Learning site (PLS), and to identify project research sites that represent the variability across the PLS (250,000 km^2 across north-eastern Zimbabwe, central Mozambique and central Malawi). Initial variables were agro-ecosystem potential, population density, livestock density, time to input/output markets and poverty index. Time to markets was calculated using a model that takes into account road location and quality, as well as land cover classes and constraints to movement, like slope. By further classifying the variables into low, medium and high, a domain development matrix was developed that reflected the projects objectives. Selection of sites for the 2007-8 season and for implementation of the research programme were based on these derived development domains. This paper will present the results a participatory diagnosis process that integrated the socio-economic variables into delineation of the development domains. A scaling-up approach which uses this methodology to target research and extension approaches across the PLS and into the wider geographical region will be presented. Linking this approach to other tools, like the use of Near Infra-Red Spectroscopy for analysis of soil and plant productivity, or CaNaSTA (Crop Niche Selection in Tropical Agriculture) will be discussed.

Key words: *Decision support tools, GIS, resource endowment, socio-economic analysis*,

Model Validation through Long Term Promising Sustainable Maize/Pigeon Pea Residue Management in Malawi

C.D. Mwale[1], V.H. Kabambe[2], W.D. Sakala[1] (late), K.E. Giller[3], A.A. Kauwa[1] and D. Kamalongo[1]

[1]Chitedze Research Station, P.O Box 158, Lilongwe; [2]University of Malawi, Bunda College of Agriculture, P.O. Box 219, Lilongwe; [3]Wageningen University, Netherlands
Corresponding author email: cyprianmwale@yahoo.com*

Abstract

In 2005/06 season the Model Validation through Long-Term promising Sustainable Maize/pigeon pea Residue Management experiment was in eleventh year at Chitedze and Chitala, and in eighth year at Makoka and Zombwe. The experiment was a split –plot design with cropping system as main plot and residue management sub plot. All treatments were subjected to two fertilizer regimes. First regime was no addition of inorganic fertilizer and second was addition of inorganic fertilizer at Area Specific Fertilizer Recommendation Rate. The evaluation was done at Chitala, Chitedze, Makoka and Zombwe. Significant differences ($P \leq 0.05$) were observed in maize grain yield among sites and cropping systems. Highest grain yields were recorded at Chitedze (5342 kg/ha). However, the response trend in grain yield to different cropping systems remained the same in all sites. Best yields were recorded in maize grown following pigeon pea in rotation system followed by maize intercropped with pigeon pea. The addition of inorganic fertilizer increased maize yield significantly. Removal or retention of crop residue in the field did not contribute any significant yield increase of maize across sites. For resource poor small holder farmers, growing maize/pigeon pea in rotation and maize intercropped with pigeon pea seem to be more profitable in terms of resource utilization and soil fertility improvements.

Keywords:*, cropping systems, grain yield, long-term, Maize/pigeon pea, sustainability, model validation, management.*

Simplifying RothC for biomass data assimilation in C sequestration contracts

Traoré[1,]* P.C.S., Bostick[2] W.M., Jones[2] J.W., Bado[3] V.

[1]ICRISAT, Samanko Station, P.O.B. 320, Bamako, Mali, Tel.: +223 222-3375, Fax: +223 222-8683; [2]Ag. Biol. Eng. Dept., Univ. Florida, Gainesville, FL 32611, USA; [3]WARDA, Sahel Station, Ndiaye, B.P. 96, Saint Louis, Senegal
*Corresponding author: *p.s.traore@cgiar.org*

Abstract

Soil carbon (C) sequestration has been proposed as a transitional win-win strategy to help replenish organic matter content in depleted agricultural soils and counter increases in atmospheric greenhouse gases. Data assimilation and remote sensing can reduce uncertainty in sequestered C mass estimates, but simple soil organic carbon (SOC) models are required to predict tradeable amounts over large, heterogenous areas. This study compared the performance of RothC and a reduced 2-pool model on an 11-year fertilizer trial in subhumid West Africa. RMSE differences of 0.05 $tC.ha^{-1}$ between models on total SOC predictions suggest that for contractual purposes, SOC dynamics can be simulated by a 2-pool structure with labile and stable components. Faster and slower rates can be approximated as instantaneous and infinite decay. In these systems, simulations indicate that cereal residue incorporation holds most potential to mitigate transient C loss associated with land conversion to agriculture.

Keywords: *Carbon sequestration; Model simplification; RothC; Soil organic matter; Uncertainty.*

Soil carbon dynamics as a result of climate, cropping systems and soil type – rapid calculations using basic concepts

O. Andrén[1, 2],*, T. Kätterer[2]

[1]TSBF-CIAT, P.O. Box 30677-00100, Nairobi, Kenya; [2]Department of Soil Sciences, SLU, P.O. Box 7014, S-750 07 Uppsala, Sweden. Tel. +46 18 672421.
*Correspondence: *olof.andren@mv.slu.se*

Abstract

We have developed a relatively simple soil carbon model, the Introductory Carbon Balance Model (ICBM). The model has two compartments, young and old soil C, and only five parameters. The basic idea is to be able to make projections of soil C dynamics in a 30-year perspective even when detailed data are lacking. The information necessary is a rough estimate of annual carbon input to soil, a coarse measure of residue quality and some information about climate. If basic weather station data and water-related soil properties are available, a more exact projection can be made. Typically the model is used for making predictions in scenarios such as where all crop residues are either retained or removed from a field, how much soil carbon will have been gained or lost after 30 years? If only limited local data are available, rough estimates (climate zone, crop yield etc.) will make projections possible. Compared with more complex models, this approach is rapid and simple and does not necessarily give worse results. The model is available as an Excel spreadsheet, with which projections can be made and the effects of different agricultural treatments can be compared.

Keywords: *Agriculture; carbon sequestration; modeling; soil carbon*

Using the crop simulation model APSIM to generate functional relationships for analysis of resource use in African smallholder systems: aggregating field-scale knowledge for farm-scale models

R. Chikowo[1,2,*], M. Corbeels[2], P. Tittonell[3,4], B. Vanlauwe[4], A. Whitbread[5] and K.E. Giller[3]

[1]University of Zimbabwe, Soil Science Department, Box MP 167 Harare, Zimbabwe; [2]UMR SYSTEM, Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) Agro M, 34060 Montpellier Cedex 2, France. [3]Plant Production Systems, Department of Plant Sciences, Wageningen University, Wageningen, The Netherlands. [4]Tropical Soil Biology and Fertility Institute of CIAT (TSBF-CIAT, Nairobi, Kenya. [5]CSIRO, Sustainable Ecosystems, Brisbane, Queensland, Australia.
*Corresponding author: *rchikowo@agric.uz.ac.zw;* Tel.: +263 303211

Abstract

The efficiency with which applied resources are utilized in sub-Saharan Africa is critical as the resources are scarce. Research efforts increasingly focus on whole farm productivity, emphasizing the importance of interactions and nutrient flows within the farm. Progress has been hampered by the complexity of the systems and wide management differences related to farmer resource endowment. Simulation modelling using summary models such as FIELD that utilize resource availabilities in relation to resource capture and utilization efficiencies can be useful to unravel this complexity. To this end, a detailed model, APSIM, was used to generate parameters and variables that can be introduced as descriptive functions in FIELD. We parameterized and tested APSIM based on field experiments carried out in western Kenya where nitrogen and/or phosphorus were applied. Nitrogen, phosphorus and rainfall capture efficiencies ranged between 0.22-0.85 kg kg^{-1}, 0.05-0.29 kg kg^{-1} and 0.10-0.53 mm mm^{-1}, respectively, depending on soil nutrient and physical conditions. Variation in the fraction of radiation intercepted with plant density was adequately described by the function $y = 0.058x + 0.11$ within a range of 1.5-5.5 maize plants per m^2. Investigation of weed management using the model identified a weed-free period of at least five weeks from maize emergence for minimum yield loss from weed-crop competition. The simulations confirmed that resource use efficiencies decrease on moving from relatively fertile 'close' fields to 'remote' soils within the same farm, giving more impetus on the need to expedite the search for better-targeted management strategies for spatially heterogeneous farms.

Keywords: *APSIM, FIELD, functional scaling, resource-use efficiency, simulation models*

Combining Field and Simulation Studies to Improve Fertilizer Recommendations for Irrigated Rice in Burkina Faso

Z. Segda[1*], S.M. Haefele[2], M.C.S. Wopereis[3], M.P. Sedogo[1] and S. Guinko[4]

[1]Institut de l'Environnement et de Recherches Agricoles (INERA), 04 BP 8645, Ouagadougou 04, Burkina Faso ; [2]West Africa Rice Development Association (WARDA), BP 96 St. Louis, Senegal ; [3]An International Center for Soil Fertility and Agricultural Development (IFDC) - Africa Division, BP 4483, Lomé, Togo; [4]Université de Ouagadougou (UO), 03 BP 7021 Ouagadougou 03, Burkina Faso

*Corresponding author; email: *zacharie.segda@messrs.gov.bf*

Abstract

Development of improved fertilizer recommendations entirely based on field experiments is time-consuming and costly. We employed a combination of two simulation models and selected field data to develop alternative fertilizer recommendations (AFR) for irrigated rice in Bagré, Burkina Faso. Existing fertilizer recommendations (EFR) are 82 kg N ha^{-1} (wet season) or 105 kg N ha^{-1} (dry season), 31 kg ha^{-1} P and 30 kg K ha^{-1}. The model RIDEV was used to improve timing of sowing date to avoid cold-induced sterility and timing of N fertilizer applications. The model FERRIZ was used to determine AFR, based on estimations of indigenous nutrient supply for N, P and K, yield potential (Y_{pot}), internal N, P, and K efficiency of rice, fertilizer N, P and K recovery fractions and fertilizer and rice prices. Simulations suggested decreasing P and K doses to 21 kg P ha^{-1} and 20 kg K ha^{-1} but to increase the N dose to 116 kg N ha^{-1} in the wet season (Y_{pot} = 8 t ha^{-1}) and to 139 kg N ha^{-1} in the dry season (Y_{pot} = 9 t ha^{-1}). AFR keeps the P-balance neutral, but a negative K balance was tolerated based on the high soil K supply. Compared to existing recommendations, yield gains of up to 0.5 t ha^{-1} were simulated at equal costs. These yield gains were more than confirmed in farmers' fields during four consecutive growing seasons. AFR increased gross returns above fertilizer costs by an average of about US$ 160 per season as compared to both farmers' practice and existing recommendations.

Keywords: *Burkina Faso, irrigated rice, nutrient management, simulation modeling*