

Nitrogen Fertilizer Equivalency of Selected Organic Materials in the Central Highlands of Kenya

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Introduction

- Soil fertility decline is a major cause of low yields in high potential areas for crop production and drier areas with lower crop production potential due to low inputs use
- Organic materials (OM) have potential to improve soil fertility but because research is recent, important information e.g. fertilizer equivalencies (FE) of these materials are not known
- FE is specific amount of an OM that can have the same effect on crop yield as a certain amount of inorganic fertilizer

Objective:

- Determine the N fertilizer equivalency values of selected organic inputs in a biomass transfer system

Methodology

The study site was Meru south (Mucwa) and Mbeere district, (Machang'a) Kenya in a sub humid and semi-arid area, respectively

- The experiments were in randomized complete block design replicated thrice with the plots measuring 6 x 4.5 m.
- The test crop was maize
- The OM treatments were 1) manure, 2) tithonia, 3) calliandra/lantana, and 4) mucuna.
- OM were harvested from nearby plots
- The fertilizer N equivalency values were determined from the 0, 30, 60 and 90 kg N ha⁻¹ treatments.
- In Meru south District, there was a good site (relatively better in soil fertility) and a poor site
- Soils in Meru south: Humic Nitisols and Machanga: Xanthic Ferralsol
- Fertilizer equivalencies (FE) of organic materials were obtained using a quadratic function with the equation:
 $y = aFE^2 + bFE + c$,

the following formula for solving quadratic equations was used:

$$FE = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a}$$

Where a, b, and c are constants, y is the yield from a particular organic material and FE is the fertilizer response. In order to compare the fertilizer responses of organic materials, the % fertilizer equivalency (FE) values were calculated according to the following method:

$$FE (\%) = \frac{FE \times 100}{N \text{ applied}}$$

Where: N applied = actual amount of N applied (60 kg N).



Tithonia diversifolia *Calliandra calothyrsus*



Cattle manure

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Results & Discussions

- During the SR 05 season, in Mucwa good site the quadratic equation for the curve was $y = 0.0001x^2 + 0.0135x + 1.544$; ($r^2 = 0.95$). Calliandra had the highest fertilizer equivalency of 123.9 kg N ha⁻¹ translating to a percentage fertilizer equivalency ratio of 206.4% (Table 1).
- During the LR 06 season, in Mucwa good site, the quadratic equation of the curve was $y = -0.000005x^2 + 0.0153x + 0.2275$ ($r^2 = 0.88$). Calliandra gave the highest fertilizer N equivalency values followed closely by tithonia with 144.8 and 117.7 kg N ha⁻¹ (FE% of 241.3% and 196.2%, respectively (Table 1)).
- In Machang'a during the SR 04 season, the quadratic equation of the curve from the different rates of mineral fertilizer was $y = 0.0001x^2 - 0.0014x + 1.322$ ($r^2 = 0.94$). Manure recorded the highest fertilizer N equivalency with 124.3 kg N ha⁻¹ with FE% of 207.1% (Table 2).
- These observations implies that the OM performed better in terms of increasing maize grain yields than an equivalent amount of mineral fertilizer. This corroborates with other findings by Bationo et al. (2007) who reported N equivalency values of 113% with manure in Niger.
- The high yields from the organic treatments are attributed to positive effects of the organic materials on soil physical and chemical properties, such as moisture retention and addition of micronutrients (Wallace, 1996; Kimetu et al., 2004).

Table 1: Maize grain yield (t ha⁻¹) and fertilizer equivalencies (kg N ha⁻¹) of different organics during the SR 05 and LR 06 seasons at Mucwa good site, Meru South District

Treatment	SR 05		LR 06	
	Grain yield	Fertilizer Equivalency	Grain yield	Fertilizer Equivalency
Calliandra	4.9 a	123.9	3.7 a	144.8
Mucuna	3.0 c	72.2	2.2 c	95.3
Tithonia	3.1 bc	73.3	2.9 b	117.7
Manure	3.5b	88.1	2.3 bc	97.1

Table 2: Fertilizer equivalency (kg N ha⁻¹) and maize grain yield (t ha⁻¹) of different organics during the SR 04, LR 05 and LR 06 seasons at Machang'a site, Mbeere District

Trt	SR 04		LR 05		LR 06	
	Yield	Equiv	yield	Equiv.	yield	Equiv.
Lantana	1.8 c	62.5	2.7 b	142.3	2.2 b	76.4
Mucuna	1.5 c	32.1	2.3 c	123.1	1.9 b	64.2
Tithonia	2.2 b	87.5	2.6 bc	141.3	2.3 b	84.0
Manure	3.0 a	124.3	3.1 a	163.4	2.7 a	97.3

Conclusions and recommendations

- Calliandra, manure and tithonia recorded high FE values with over 100% in the sub-humid area (Mucwa good site).
- In Machanga, (semi-arid) manure consistently recorded the highest FE over the three seasons
- High FE of over 100% suggest that the organic amendments have beneficial roles other than the addition of soil N, such as, addition of micronutrients and better water holding capacity.
- The role of organics in improving yields was well demonstrated in this study, in both the sub humid and semi-arid zone.

References

- Bationo A, Waswa B, Adamou A, Bado V, Bonzi M, Iwuafor E, Kibunja C, Kihara J, Mucheru M, Mugendi D, Mugwe J, Mwale C, Okeyo J, Olle A, Roing K, Sedogo M (2007). Lessons learnt from long term trials in Africa. Paper presented in Stockholm, Sweden.
- Kimetu JM, Mugendi DN, Palm CA, Mutuo PK, Gachengo CN, Bationo A, Nandwa S and Kungu JB (2004). Nitrogen fertilizer equivalencies of organics of differing quality and optimum combination with inorganic nitrogen source in central Kenya. Nutrient Cycling in Agroecosystems 68: 127-135.
- Wallace JS (1996). The water balance of mixed tree-crop systems, in Ong, CK and Huxley (eds) Tree-crop interactions, a physiological; approach. CAB International, Wallingford, UK, pp 73-158