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POTENTIAL FOR ORGANIC AND INORGANIC FERTILISATION FOR SUSTAINABLE COFFEE PRODUCTION IN UGANDA

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SUMMARY

The economy of Uganda is heavily dependent on Agriculture. Most of the export earnings come from coffee which is produced mainly by small scale farmers. However, the productivity of this crop has declined over the years. This has been atttibuted mainly to the decline in soil fertility. Therefore, experiments were set up in various parts of the country to study the effects of inorganic and organic fertilizers on robusta coffee yields. Coffee husks were the organic fertilizer and NPK the inorganic fertilizer. Results indicated that application of coffee husks and chemical fertilizers (NPK) in different combinations increased the productivity of the crop.

INTRODUCTION

Uganda's economy is heavily dependent on agriculture, and over 70% of GDP comes from this sector. Coffee is the country's major foreign exchange earner; it accounted for 98% of the total export earnings in 1980. Uganda still exports a lot of coffee despite the decline in world prices. In 1991, the country exported 141,487,000 kg of coffee. The crop occupies 240,000 hectares of arable land with an average annual output of 150,000-175,000 metric tonnes. The present average yield of clean robusta coffee is 0.6 tonnes per hactare, which is below the potential of 2-3.5 t ha^{-1} when 500 g ammonium sulphate nitrate (ASN) and 50 g SSP fertilizers are applied per tree per year.

Coffee production in Uganda, despite its importance, has remained within the framework of small scale farmers. Most coffee farmers own gardens of only up to one hectare (Ngambeki *et al.*, 1992). Increase in production has always been due to increase in area under the crop for most farmers. This approach to increased production is no longer possible under the prevailing population pressure on the same inelastic arable land.

Coffee farmers, being largely small holders, have continued to produce the crop without proper soil management practices. Very few farmers (20%) use some fertilizers in coffee production (Ngambeki *et al.*, 1992). Coffee is a heavy feeder crop, removing on average 130 kg K, 120kg N, 30 P, 30kg Mg and 20 kg S ha^{-1}, when 1.5 t ha^{-1} of clean beans are harvested (Kemmler and Hobt, 1987). Furthermore, on average 30% of soil nutrients leave the farm via sold produce (Wallace, 1994), yet the practice of returning coffee remains to mother fields hardly exists. Therefore, soils under coffee production have continued to be mined of nutrients through coffee exports. Efforts to redress the problem of soil fertility management in coffee producing areas need strengthening.

The use of inorganic fertilizers as a tool of soil fertility management is so far unpopular in Uganda not only in the coffee sub-sector, but for other crops as well. This could be attributed to

a spectrum of reasons, the most important of which might be absence of convincing research results demonstrating profitable coffee yield response to fertilizer application. The prohibitive cost of fertilizers in Uganda could be another major factor.

Organic fertilizer use in coffee plantations, however, has been on the increase. Use of animal manure, compost and coffee husks is becoming common on some farms. Coffee husks are applied to enhance soil fertility, control weeds, minimise soil erosion and conserve soil moisture, among other reasons.

A number of soil factors interact to result in nutrient supply to crops. To overcome the limitations caused by inadequate nutrient supply, it is important to first ensure that the properties of a soil are suitable for the crops to take up the nutrients. In this respect, soil acidity and organic matter content are perhaps the two most important factors which control satisfactory nutrient supply (Le Mare, 1984). Hence, it is not enough to simply provide the lacking nutrients in the soil; soil organic matter is a very important factor for crop production in the tropics. According to FAO (1984), the main role of organic matter is promoting microbial activity, improving soil structure, aeration, and water holding capacity, thereby allowing the soil to respond better to fertilizers.

Sole application of chemical fertilizers may not result in good crop responses especially in the relatively heavy soils. Joint application of both organic and inorganic fertilizers, however, may provide a more lasting solution to the declining crop production due to soil degradation. Stephens (1969) and Cooke (1977) found an increase in the level of exchangeable potassium using farm yard manure more than did potassium fertilizer applied alone. However, the interactive effect of both organic and inorganic fertilizers remains a question for investigation. The objective of this study, therefore, was to evaluate the interaction effects of organic and inorganic fertilizer materials and to establish optimum combination rates in coffee production.

MATERIALS AND METHODS

This study was located on four sites in the robusta coffee producing areas in Uganda. These were Makerere University Agriculture Research Institute, Kabanyolo (MUARIK); Bbunibu-Kitezi (Farmer Managed) in Mpigi district; Mityana District Farm Institute (DFI) in Mubende district; and Kapeeka (Farmer Managed) in Luwero district.

Treatments consisted of four levels of coffee husks, 0, 5, 10, and 15 t ha^{-1}, represented as OM_1, OM_2, OM_3 and OM_4. Nitrogen P, and K were applied in the form of N: P_2O_5: K_2O fertilizer, at rates 0:0:0, 14:100:30, 80:200:60 and 120:300:90. These were symbolised as NPK_1, NPK_2, NPK_3 and NPK_4.

The experiment was laid out in a randomised complete block design with three replications. Weeding in all sites was done whenever necessary. Mature coffee berries were continuously picked, dried and weighed. Soil fertility status at the start of the experiment was assessed using soil samples from two depths, that is, 0-15 and 15-30 cm. The samples were analysed for pH, OM, Kjeldahl N, Bray 1 P, exchangeable Na^+, K^+, Ca^{2+}, Mg^{2+}; and clay, silt and sand contents. Characterisation of the coffee husks used was done for % total C, N, P, K, Ca, Mg, and Na content in the laboratory using routine methods for analysis.

RESULTS AND DISCUSSION

The study sites had acidic soils, low Kjeldahl N and available P, and low levels of exchangeable bases (Table 1) for coffee production. There is, therefore, need for soil fertility improvement for viable coffee production. The coffee husks used in this study contained fairly high levels of potassium (4%) and nitrogen (1.5%) though with a high C/N ratio (5:1) (Table 2). They also

contained considerable amounts of phosphorous and calcium. This means that coffee husks can generate nearly adequate amounts of nutrients for the coffee crop upon decomposition and mineralisation. However, due to the high C/N ratio, this fertilizer may require activation by chemical fertilizers to hasten mineralisation and release of nutrients. Hence, applying coffee husks and NPK fertilizer, in combination is an appropriate approach to the rehabilitation of the degraded soils used for high coffee production.

In Kiteezi coffee yield responded well to fertilization with coffee husks and NPK fertilizers. The highest yield was obtained when the 5 t ha^{-1} of coffee husks were interacted with 80 kg N, 200 kg P, and 60 kg K ha^{-1} (Fig. 1). However, this treatment was not significantly different from the highest rate of NPK applied singly (120 kg N, 300 kg P, 90 kg K ha^{-1}), but was different from the control and where 15 t ha^{-1} of coffee husks were applied. These results clearly show that soil management was one of the problems limiting coffee production in Mpigi site. Higher N, P and K supply was required to produce higher yields of the crop. The interaction of coffee husks and a modest amount of NPK fertilizer performed as well as the high rates of NPK fertilizer. This suggests that a farmer can save by using locally available coffee husks and little chemical fertilizer to achieve reasonable coffee yields.

Table 1. Initial chemical analysis of soils of the sites

Site	Depth	pH	%OM	%N	AV.P (ppm)	Exchangeable Bases				%clay
						Na^+	K^+	Ca^{2+}	Mg^{2+}	
						(mg/100 g)				
Kapeeka										
	0-15	6.8	10.80	0.20	14.940	0.28	3.40	15.87	5.28	14.13
	15-30	6.5	10.41	0.77	14.500	0.22	3.13	14.79	4.94	N.D
MUARIK										
	0-15	5.3	9.34	0.19	1.740	0.13	0.62	2.92	1.83	25.17
	15-30	5.1	8.67	0.14	1.450	0.10	0.45	2.30	1.42	35.10
Mityana										
	0-15	5.8	7.68	0.17	8.920	0.26	1.35	6.46	3.30	N.D
	15-30	5.5	6.55	0.12	5.830	0.25	0.70	4.69	2.47	N.D
Kiteezi										
	0-15	6.0	8.87	0.13	5.250	0.17	3.31	14.71	4.81	N.D
	15-30	5.8	6.65	0.13	1.750	0.20	2.71	15.21	4.14	N.D
Buginyanya										
	0-15	5.7	17.80	0.32	0.026	0.16	0.53	6.33	14.16	N.D
	15-30	5.7	16.73	0.30	0.025	0.14	0.47	5.00	6.26	N.D

N.D = No data

Table 2. Chemical analysis of coffee husks (in percentages)

C	N	C/N	P	K	Ca	Mg	Na
76.34	2.20	35.00	0.17	4.00	2.10	0.8	0.42

Coffee yields in Mityana were similar to those at Kiteezi under coffee husks and NPK fertilization. The highest yields were obtained when 5 t ha^{-1} of coffee husks were interacted with 80 kg N, 200 kg P, and 60 kg K ha^{-1}. However, this treatment was not significantly different from the 120kg N, 300kg P, 90kg K, and 15 t coffee husks ha^{-1} applied singly. It was, however, significantly different from the control and the 10 t coffee husks rate interacted with NPK (14:100:30) (Fig. 2). This further demonstrated that soil fertility management is a key factor in increasing coffee production on this site as well. Responses to fertilization with coffee husks and NPK at Kabanyolo (Fig. 3) and Kapeeka (Fig. 4) were rather different from that obtained at Kiteezi and Mityana. Coffee yield at Kabanyolo was not significantly different among the treatments. This could be attributed to possibly earlier but unrecorded fertilization at this site. The yield exceeded that expected of an improved coffee plantation, that is 2.75 t ha^{-1} (Agricultural

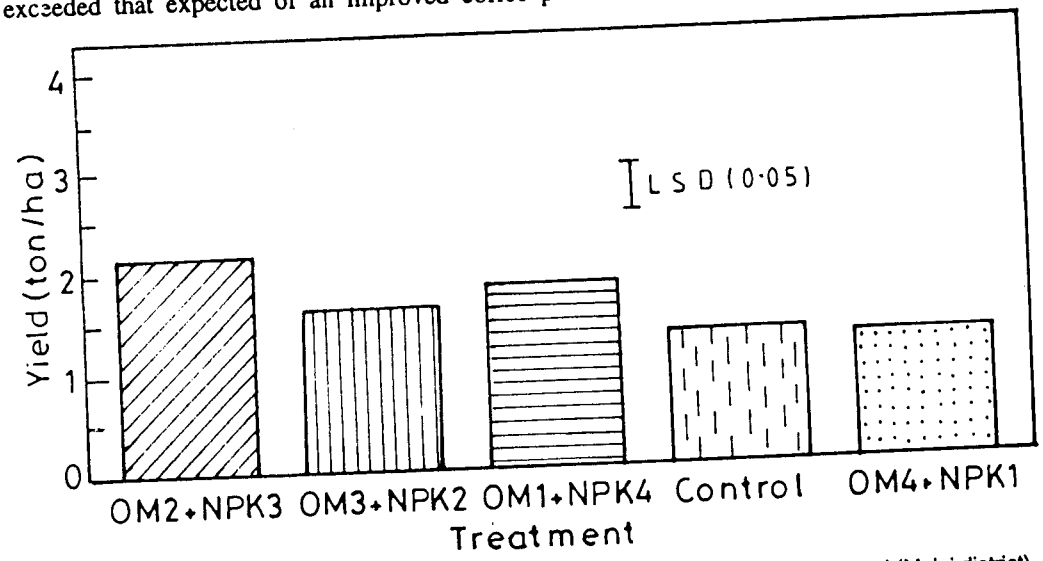

Figure 1. Effect of fertilizer and organic matter interaction on yield of robsta coffee in Kiteezi (Mpigi district)

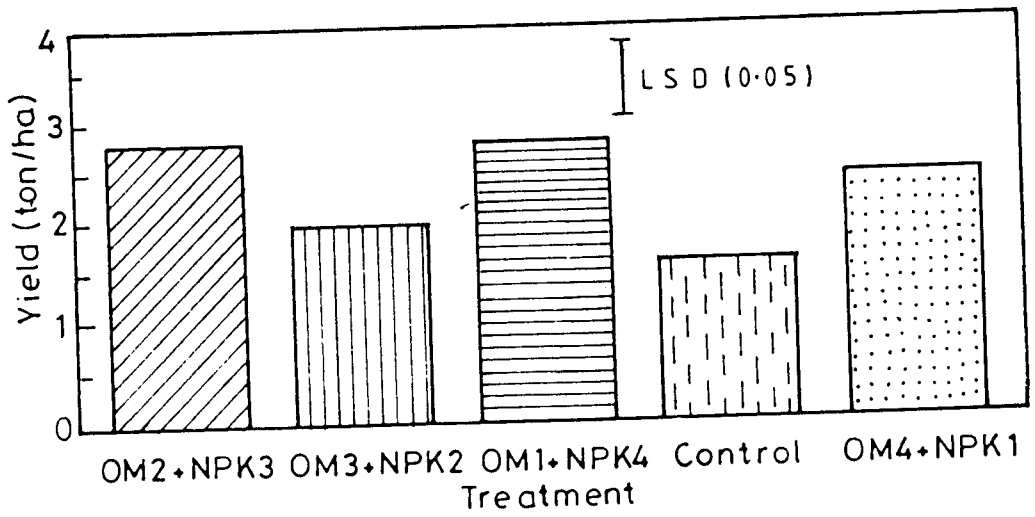

Figure 2. Effect of fertilizer and organic matter interaction on yield of robsta coffee in Mityana D.F.I (Mubende district)

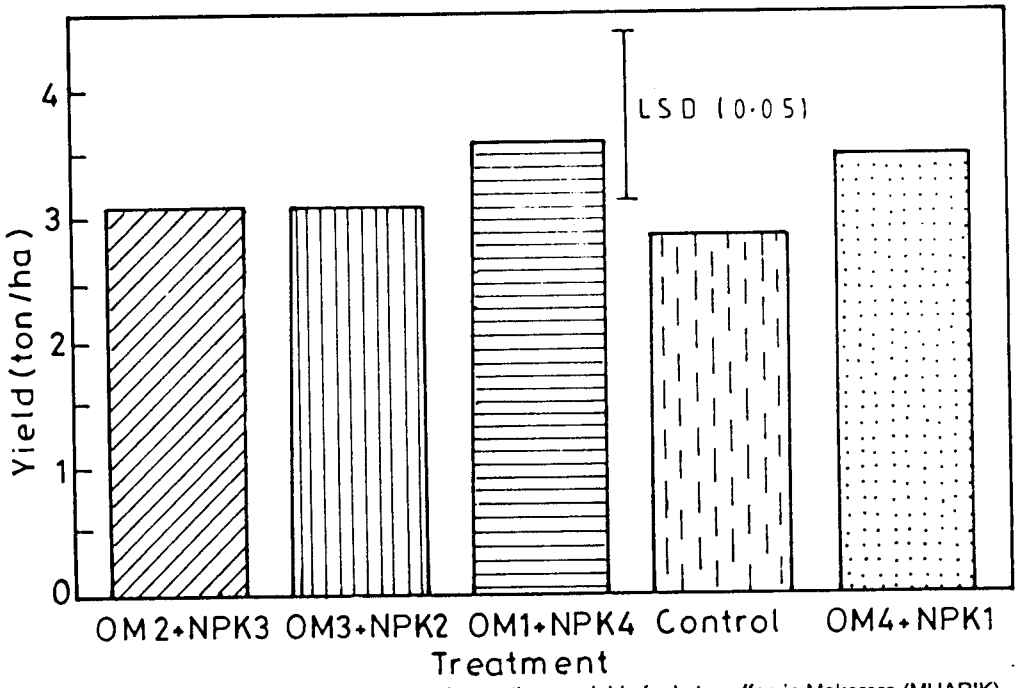

Figure 3. Effect of fertilizer and organic matter interaction on yield of robsta coffee in Makerere (MUARIK)

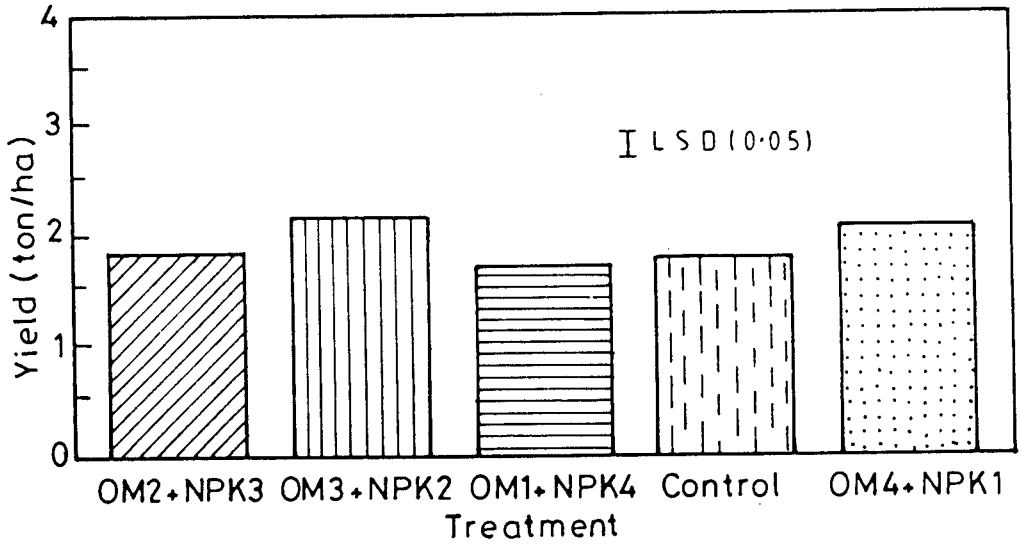

Figure 4. Effect of fertilizer and organic matter interaction on yield of robsta coffee in Kapeeka (Luwero district)

Secretariat, 1993/94). At the Kapeeka site, the soil could have rejuvenated through the war of the 1980s when the area was deserted and reverted to forest vegetation.

CONCLUSION

Results of this study indicate that application of coffee husks and chemical fertilizers (NPK) in different combinations increase the productivity of coffee. Farmers can purchase affordable amounts of inorganic and organic fertilizers and increase coffee productivity per unit area.

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Improving Coffee Management Sytems in Africa

A pan-African coffee conference was held at Kampala, Uganda during the period 4-6 September, 1995, with a theme: "*Improving Coffee Management Systems in Africa*". Delegates came mainly from member countries of the African Coffee Research Network (ACRN). Also in attendance was the Secretary General for the Inter-African Coffee Organisation (IACO). The conference discussed production, processing and marketing constraints in Africa and formulated new strategies for achieving competativeness within the global market structure. Fluctuations in world coffee prices was identified as the key problem to the survival of the coffee industry in the region. A well coordinated pan-African approach to this problem through the IACO and ACRN was emphasized. The need for a strong regional research base to address common coffee problems was recommended. Throughout the conference, recent marked progress in the coffee subsector was attributed to individual regional government initiatives to establish production and marketing reforms and liberalisation policies, which have revolutionalised the industry. The role played by national coffee authorities such as the Uganda Coffee Development Authority (UCDA), to coordinate and implement policy reforms, was appreciated.

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