ISSN : 1812-5379 (Print)
ISSN : 1812-5417 (Online)
http://ansijournals.com/ja

JOURNAL OF AGRONOMY

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Journal of Agronomy 5 (2): 201-204, 2006
ISSN 1812-5379

Farmyard Manure as Alternative Nutrient Source in Production of Cold Tolerant Sorghum in the Dry Highlands of Kenya

[1]G.B. Ashiono, [2]J.P. Ouma and [1]S.W. Gatwiku
[1]Kenya Agricultural Research Institute-Lanet, P.O. Box 3840 Nakuru 20100, Kenya
[2]Department of Agronomy, Egerton University, P.O. Box 536 Njoro 20115, Kenya

Abstract: An experiment was conducted over three seasons to determine the effects of different rates of application of Farmyard manure and inorganic fertilizer on growth and yield of cold tolerant sorghum variety E1291. The trial was conducted on a sandy loam soil at the Kenya Agricultural Research Institute-Lanet, Kenya. Farmyard manure obtained from the centre cattle shed was incorporated into the soil at the time of sowing at 0, 5, 10, 15, 20, 30 and 40 Mg ha^{-1} in a Randomized Complete Block Design replicated three times. Standard inorganic fertilizer was included as a control at the rate of 60 kg N ha^{-1} and 30 kg P_2O_5 ha^{-1}. The highest grain yield was produced where 5 Mg ha^{-1} of farm yard manure was applied during the first year while 40 Mg ha^{-1} produced lowest yield among manure treatments. During the second year significantly ($p<0.05$) higher grain yields were achieved from treatments of 30 and 40 Mg ha^{-1}. In the third year, no significant differences ($p<0.05$) were observed among the manure treatments but 30 and 40 Mg ha^{-1} farm yard manure produced highest yields. Manures produced higher yields in all years than the recommended inorganic fertilizer. After three seasons of evaluation, 10 Mg ha^{-1} of farm yard manure produced similar grain yields to the standard control while 30 and 40 Mg ha^{-1} farm yard manure consistently produced highest yields. These yield differences were not significantly different from treatments with 15 Mg ha^{-1} of farm yard manure.

Key words: *Sorghum bicolor*, organic manures, soil-fertility, fertilizers

INTRODUCTION

Sorghum (*Sorghum bicolor* L. Moench) is an important staple food crop in the semi-arid tropics of Africa, South Asia and Central America. In Kenya, sorghum is ranked third after maize (Anonymous, 2002) and is adapted to drought prone environments receiving 400 mm rainfall or more. Along with other millets sorghum has the highest production potential (House, 1985) in Kenya where 75% of the land area receives between 300-760 mm of rainfall per annum. Most of these areas are regarded as semi arid or arid zones and are characterized by low and unreliable rainfall.

Sorghum can be grown successfully on a wide range of soils and can tolerate a pH range from 5.5 to 8.5 and some degree of salinity, alkalinity and poor drainage. Cold tolerant sorghum has a potential average yield of 14 to 18 Mg DM ha^{-1} of forage and more than 6 to 8 Mg ha^{-1} of grain in Kenya (Van Arkel, 1978) and can be an important food and fodder crop for these dry parts of the country. The development of better adapted and higher yielding cultivars have increased the yield potential of sorghum. Consequently, increased yield potential requires more plant nutrients. However, low soil fertility and the high cost of inorganic fertilizers are major constraints to sorghum production in marginal rainfall areas in Kenya.

Farmyard Manure (FYM) is an important organic resource for agricultural production in crop-livestock-based farming systems in the semi-arid tropics of Kenya. Animal manure represents a valuable source of Phosphorous (P) released following breakdown by micro organisms in the soil that can sustain crop requirements. Farms with a total stocking rate of 1.1 t live weight ha^{-1}, had high manure potential that contained enough P balance for crop-needs that could exclude the use of inorganic phosphatic fertilizers (Zaccheo *et al*., 1997). Manures are very variable products often difficult to apply accurately and release nutrients in the soil at a rate that is very dependent on environmental conditions. However some studies have shown that FYM applied alone, or in combination with inorganic fertilizers, was effective in maintaining soil quality under continuous cultivation. Applying Farmyard manure increased Electrical Conductivity (EC), Cation Exchange Capacity (CEC), organic carbon and soil moisture content (Oswal, 1994). Similar results where FYM was found to increase water storage, soil nutrient availability and crop yield have been reported by Aggarwal *et al*. (1997). In contrast, continuous inorganic fertilization was found

Corresponding Author: Dr. Ouma Josephine, P., Department of Agronomy, Egerton University, P.O. Box 536, Njoro 20115, Kenya

to negatively affect the soil quality because of depletion of organic matter (Tolanur and Badanur, 2003), the reservoir of plant available N and P in weathered tropical soils.

Commercial fertilizer has been shown to contribute significantly to crop yields world over with the average percentage of yield attributed to fertilizer being generally higher than 60% in the tropics (Stewart *et al*., 2005). In Kenya, the Fertilizer Use Recommendation Project (FURP), which conducted extensive trials (Anonymous, 1994), the use of inorganic fertilizers to increase crop yields. Despite these recommendations little or no fertilizer is applied to sorghum due to low returns from the produce. To improve and maintain soil fertility and sustain sorghum yields, there is need to identify other nutrient sources that are less costly. The use of organic manures that are readily available on farms in the dry highlands was considered an appropriate nutrient source likely to address this need. A study was therefore initiated to study the effect of FYM on growth and yield of sorghum.

MATERIALS AND METHODS

The trial was conducted at the Kenya Agricultural Research Institute-Beef Research Centre, Lanet located on latitude 0°, 30° S and longitude 36° E and at an altitude of 1920 m.a.s.l. The annual rainfall at this site is 800 mm and is unreliable and poorly distributed. The area has two rainfall seasons per year. The long rains season begins in March and ends in August. Short rains season begins in October and ends in December. The soil is a deep sandy loam, with good water holding capacity and is classified as of marginal agricultural potential in ecological zones III and IV (Jaetzold and Schmidt, 1983). Prior to the setting up of the experiment the soil from the experimental site and the cattle manure were analyzed for nutrients.

Cold tolerant Sorghum cultivar 1291 that matures in 160 days was used for this study over three seasons. Dry FYM collected from the cattle shed and broken into small pellets was incorporated into the soil at the time of sowing at different rates of 0, 5, 10, 15, 20, 30 and 40 Mg ha^{-1}. Inorganic fertilizer was applied as the control at 60 kg N ha^{-1} and 30 kg P_2O_5 ha^{-1}. A Randomized Complete Block Design with four replications was used to evaluate these fertilizer responses. Each plot consisted of 4-five metre-long rows with sorghum plants spaced at 60 cm between rows and 20 cm within rows. Agronomic practices including weeding and pest control were followed according to recommended practices. Although top dressing was not carried out in manure treatments it was done for the control with 100 kg N ha^{-1} one month after emergence. At harvesting, the sorghum panicles were cut with a knife from two middle rows. The heads were subsequently threshed and the grain weighed when the moisture content was 10%. The sampled whole plants were chopped and a sub-sample obtained for dry matter analysis after drying at 65°C for 48 h. The data was subjected to statistical analysis using SAS Statistical Package (Anonymous, 2000).

RESULTS

The soil from the experimental site taken at the initiation of the trial was slightly acidic (pH 5.2) and contained major nutrients (NPK) but was deficient in nitrogen (Table 1). Other trace nutrients were also available and the soil was therefore regarded as fairly fertile. The manures contained higher levels of nutrients compared to the soil and were alkaline (pH 8.7). Results showed no significant grain yield differences between manure treatments and the recommended inorganic fertilizer rate during the first year (Fig. 1). However, manure levels of 5 Mg ha^{-1} produced the highest and 40 Mg ha^{-1} the lowest sorghum grain yields. Manure and the inorganic fertilizer treatments produced significantly higher grain yields compared to the treatment where no manures or fertilizer were applied.

Table 1: Nutrient composition of soil from experimental site and of applied manure at start of experiment

Nutrient	Soil	Manure
pH (1:1)-H_2O	5.20	8.70
Na (me%)	0.23	1.50
K (me)	0.80	2.80
Ca (me)	6.50	64.00
Mg (me)	1.10	6.10
P (ppm-Mahlich)	45.00	250.00
Mn (me)	0.22	0.65

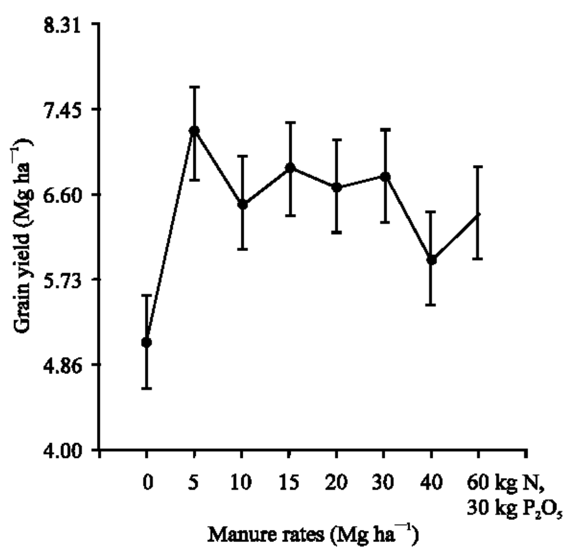

Fig. 1: Effect of FYM on sorghum grain yield, 1996 crop season

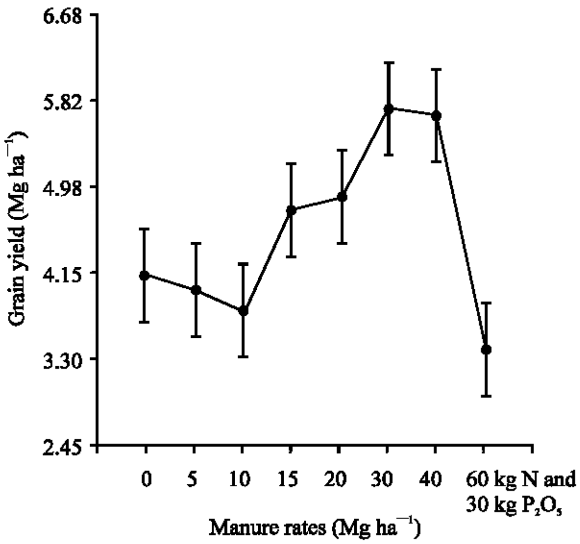

Fig. 2: Effect of FYM on grain yield of sorghum during 1997 crop season

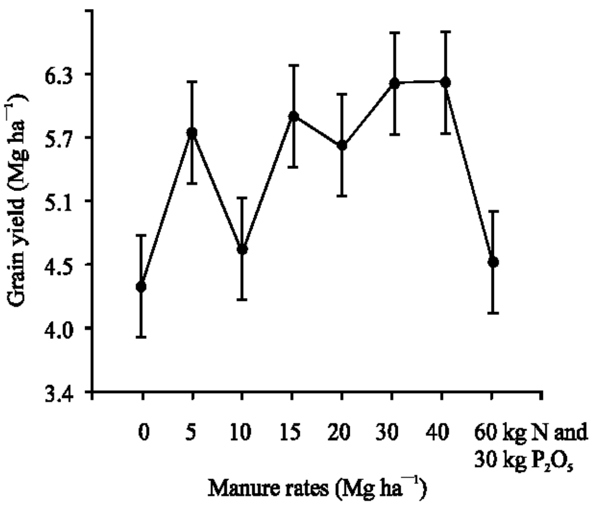

Fig. 3: Cumulative effect of FYM on sorghum grain yield after three crop seasons

In 1997 significant yield differences were observed between treatments (Fig. 2). Treatments with manure rates of 30 and 40 Mg ha^{-1} produced significantly higher grain yields compared to other treatments. Treatment with inorganic fertilizer produced significantly low grain yield compared to treatments with 20, 30 and 40 Mg ha^{-1} of farm yard manure during the year under study. However, no significant differences were observed between the inorganic fertilizer treatment with manure treatments of 5 and 10 Mg ha^{-1}. During the crop season of 1998 the treatment where 40 Mg ha^{-1} of farm yard manure was applied produced highest sorghum grain yield.

Table 2: Grain yield increment (kg ha^{-1}) of manure treatments over standard inorganic fertilizer at Lanet, Kenya

Treatment (Mg ha^{-1} FYM)	Grain yield increment (kg ha^{-1}) 1996	1997	1998	Mean
5	277	586	1388	740
10	833	385	-277	498
15	462	1357	1296	1038
20	277	1481	740	833
30	370	2345	1111	1275
40	-462	2284	2129	1317
60 kg N+ 30 kg P_2O_5	0	0	0	0

Cumulative effects of FYM application over three seasons produced yields that were generally higher than those obtained from the recommended inorganic fertilizer rate. Manure rate of 30 and 40 Mg ha^{-1} produced significantly greater yields than the recommended inorganic rate (Fig. 3). However the application of 40 Mg ha^{-1} of farmyard manure did not significantly differ from those treatments with manure rates 15, 20 and 30 Mg ha^{-1} but out yielded the rest of the manure rates. The application of 10 Mg ha^{-1}of FYM produced similar grain yield as the recommended inorganic rates. However, yield increases due to manures in relation to the standard inorganic fertilizer were higher when manure rates are increased (Table 2).

DISCUSSION

The soil analysis has shown the experimental site to be of moderate fertility although low in nitrogen (Table 1). Therefore, the response to applied manures is likely to be limited in such soils compared to when the application was done to deficient soils. The soils were also found to be slightly acidic a factor likely to reduce the availability of phosphorous to the plants. This probably partly explains why lower yields are obtained from the standard inorganic fertilizers. Under such situations farm yard manure is likely to be a better compensator for deficient soils. Analysis of the manures (Table 1) used in this experiment showed higher amounts of nutrients compared to the soil indicating their potential to restore the soil fertility.

Lack of significant responses among the applied manures in the first year may be related to lower germination of sorghum and slow rates of manure breakdown particularly in the higher rates of application. However the high grain yield achieved with the application of 5 Mg ha^{-1} of manure in the first year may also indicate that lower amounts of manure promotes greater activities of decomposer micro-organisms in the soil resulting in more nutrients being made available to plants.

The positive responses to applied manures in the first year contradict long held belief that response to manure application be expected in the following season. Higher grain yields achieved with the application of farm yard manures compared with the inorganic fertilizer may indicate that in additional to the supply of nutrients, the soil structure and properties may have been improved Sharma and Gupta (1994a) found the uptake of P, Ca and Mg increased with application of Farm yard manure and also observed an increase in the root Cation Exchange Capacity (Sharma and Gupta, 1994b). Studies where farm yard manure was found to improve other soil properties such as water conservation have been reported by Aggarwal *et al.* (1997). Results from this study agree with those of Agbenin and Goladi (1997) who in study in northern Nigeria found that the application of farm yard manure under continuous cultivation enabled carbon, nitrogen and phosphorous to be maintained in the soil consequently improving the soil quality. Similar findings in maize in the Kenyan North rift have also been reported (Kiiya *et al.*, 1997).

Higher rates of FYM (30 and 40 Mg ha^{-1}) produced higher grain yields in the second and third years. This may be partly explained by the fact that while potassium in the farm yard manure is readily available in the first year, the proteins are undigested and already well rotted therefore they decompose slowly over a number of years. A greater response from such higher rates is therefore likely to be significant beyond the first year of application (Fig. 3). The benefits from manure increased with time (Table 2), a fact that may support the application of Farm yard manure above 10 Mg ha^{-1}.

CONCLUSIONS

Farm yard cow manure has been found to increase sorghum grain yield compared to the recommended fertilizer rate. Grain yield from the application of 10 Mg ha^{-1} farm yard cow manure is comparable to that of the recommended fertilizer rate. Benefits from the application of farm yard cow manure for sorghum cultivation increases with time and this supports higher rates of manure beyond 10 Mg ha^{-1} for tropical soils such as those found at Lanet.

REFERENCES

Agbenin, J.O. and J.T. Goladi, 1997. Carbon, nitrogen and phosphorus dynamics under continuous cultivation as influenced by farmyard manure and inorganic fertilizers in the savanna of northern Nigeria. Agric. Water Manage., 63: 17-24.

Aggarwal, R.K., K. Praveen and J.F. Power, 1997. Use of crop residue and manure to conserve water and enhance nutrient availability and pearl millet yields in an arid tropical region. Soil Tillage, 41: 43-51.

Anonymous, 1994. Fertilizer use recommendation project. Southern Rift Valley (Nakuru, Narok) Kenya Agric. Res. Inst. Natl. Agric. Lab. Nairobi, Kenya, 17: 14.

Anonymous, 2000. SAS Statistical Package.

Anonymous, 2002. Kenya Agricultural Research Institute: Medium Term Plan. July 2003/4 to 2007/8, pp: 28.

House, L.R., 1985. A Guide to Sorghum Breeding. 2nd Edn. Patencheru. Inter. Crops Res. Inst. Semi-Arid Tropics, pp: 2-10.

Jaetzold, R. and H. Schmidt, 1983. Farm management handbook of Kenya. Central Kenya. Ministry of Agriculture, Kenya Co-operation with Germany Technical Team (GAT) of Germany Agency of Technical Cooperation (GTZ) 2: 384-388.

Kiiya, W.W., R.M. Onyango, T.J. Mwangi, S. Rono and D. Cheruiyot, 1997. Effect of organic and inorganic fertilizers on the performance of maize in the north Rift valley province of Kenya. Proceedings of the Soil Management and Legume Research Network Projects Conference: Kanamai, Kenya, 24-26 March, pp: 1-8.

Oswal, M.C., 1994. Soil water functional relationships of sandy soils and their modification. J. Ind. Soc. Soil Sci., 41: 145-147.

Sharma, P.K. and J.P. Gupta, 1994a. Effect of phosphorus, lime and farmyard manure on the yield and uptake of calcium and magnesium at different growth stages in late sown wheat in an acid Alfisol of Himalayan region. J. Ind. Soc. Soil Sci., 42: 77-80.

Sharma, P.K. and J.P. Gupta, 1994b. Phosphorus utilization and root Cation exchange capacity in wheat as influenced by phosphorus, lime and FYM on an Alfisol of western Himalayas. J. Ind. Soc. Soil Sci., 42: 65-68.

Stewart, W.M., D.W. Didds, A.E. Johnson and T.J. Smyth, 2005. The contribution of commercial fertilizer nutrients to food production. Agron. J., 97: 1-6.

Tolanur, S.I. and V.P. Badanur, 2003. Effect of integrated use of organic manure, green manure and fertilizer nitrogen on sustaining productivity of rebi sorghum-chickpea system and fertility of a vertisol. J. Ind. Soc. Soil Sci., 5: 41-44.

Van Arkel, H., 1978. The yield of cold tolerant sorghums grown under semi-arid high altitude conditions as affected by fertilizer applications. FAO/76/20 Working Paper No. 5

Zaccheo, P., P. Genevini and D. Ambrosini, 1997. The role of manure in the management of phosphorus resources at an Italian crop-livestock production farm. Agric. Ecosys. Environ., 66: 231-239.