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ORIGINAL ARTICLE

Effect of Soil Supplementation with Fortified Tithonia Mulch and Directly Applied Inorganic Fertilizer on Growth and Development of Potted Okra Plants

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ABSTRACT

The pot experiment was carried out to investigate the efficiency of biomass transfer of nutrients to potted okra (Abelmoschus esculentus) L plants. Fortified *Tithonia* leaf biomass from hedges i.e. those grown in fertilized and inoculated F^+M^+, fertilized and uninoculated F^+M^-, unfertilized and inoculated F^-M^+, and unfertilized and uninoculated F-M- plots were applied as mulch to supplement the soil of potted okra plants with unsupplemented soil as control and supplementation with inorganic fertilizer NPK (20:10:1O) as reference. Okra fruits yield response to soil supplementation was in the order: soil + Tithonia mulch > soil + fertilizer > unsupplemented soil. Soil supplementation with fortified Tithonia diversifolia mulch promoted growth and development of potted okra plants better than supplementation with chemical fertilizer. Okra fruits from mulch-assisted plants possess better table qualities than those from fertilizer-assisted ones. This further emphasizes the need for a biological approach to yield improvement in agricultural practices.

Key words: Biomass transfer, , mulch supplementation, NPK fertilizer, okra fruit yield, okra table qualities, Tithonia diversifolia

Introduction

Biomass transfer is an agroforestry technique which involves using the foliage of selected trees, shrubs and other plants as organic fertilizer or green manure. *Tithonia diversifolia* is a Mexican shrub belonging to the family of Asteraceae (compositae). The concentration of NPK in a green leaf biomass are relatively high (Jama *et al*, 2000) and these nutrients are rapidly released in plant available form during decomposition (Nziguheba *et al*, 1998 and Gachengo *et al*, 1999). Tithonia is thought to be introduced into Nigeria by Colonial settlers and was at first used as a cover crop. However, Tithonia has continued to replace common weeds on road sides as well as farmlands in the humid savanna (Akobundu, 1987) and open spaces in the forest region (Liasu and Atayese, 1999).

The transfer of Tithonia biomass to crop is one of several techniques under investigation for replenishment of soil fertility in East Africa (Burresh and Niag 1997, Rao *et al*, 1998). The use of *Tithonia* as an effective source of nutrient biomass for annual crops has also been reported in the case of maize in Kenya, Malawi and Zimbabwe (Jama *et al*, 2000). *Tithonia* is typically found in hedges or as small area of pure stands in on-farm context, even though it may also extend for large areas as pure stands on common lands particularly the less populated areas of East and West Africa. Tithonia plants grown in hedges can be considered as a useful source of phosphorus via biomass transfer whereas those planted in nutrient depleted field sites cannot. Applying small amount of Tithonia biomass to mulch vegetables has enormous potential for guarantying profitable yield as long as biomass of sufficient nutrient concentrations from hedges is used (Jama *et al*, 2000).

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The economy of using Tithonia mulch from cultivated stands to supply nutrients to adjoining farmlands had been limited by the inherently poor nutrient content of the soils. The use of Tithonia plantations supplied with chemical fertilizer for the purpose of converting nutrients from the chemical fertilizers into organically derived nutrients is not as efficient as expected. However, naturally growing wild stands were more efficient in absorbing nutrients especially those from hedges that develop along roadsides etc for biomass transfer into agricultural plots. According to Dupriez and De-Leener (1989), when crops are fed by nutrient enriched mulch (such as those enriched through biomass transfer of inorganic fertilizers), cultivated plants are often harder and healthier than when nutrients come to them straight from factory made chemicals. The efficiency of biomass transferred nutrients in supporting growth of vegetables like Okra has not been compared with that of directly supplied factory made nutrients in this part of the world. More important is the age long dogma among traditional consumers of vegetables and fruits that plant products derived from fertilizer assisted farms lack good taste when compared with those from natural plots.

This study intends to investigate the efficiency of transferred nutrients in tithonia mulch from different fertilizer and arbuscular mycorrhiza fungus-assisted hedges on the growth and development of potted okra plants and compare this to that of directly applied inorganic i.e. chemical fertilizer.

Materials and methods

Experimental design and treatments.

Certified seeds of okra (*Abelmoschus –esculentus L)* purchased from the local farmers' shop were planted in pots. The various soil supplementation treatments were as follows:- (i) Soil supplemented with mulch from tithonia hedges grown on fertilized and inoculated (with Glomus mosseae) plots. F+M+; (ii) Supplimented with Tithoma mulch from fertilized and uninoculated plots. F+M-; (iii) Supplimented with Tithoma mulch from unfertilized inoculated plots F-M+; (iv) Supplimented with Tithoma mulch from unfertilized inoculated plots F-M-; (v) supplemented with inorganic NPK (20:10:10) fertilizer IF; and (vi) Unsupplimented soil control CE. Each of the six soil treatments were prepared in six replicates. The okra seeds were planted in all the pots and the pots were kept in a screen house watered twice daily until emergence. The germinated seedlings were allowed to grow to full establishment and after establishment, thinned to two per pot. The leaf biomass of Tithonia kept from a previous experiment was autoclaved and applied to the soil in the pots designated for supplementation with tithonia mulch as described above. 8g of NPK fertilizer (20:10:10) was added to the pots designated for supplementation with inorganic fertilizer and the pots for the control experiment were without supplementation. The developing okra plants growing in pots with all the six soil supplementation treatments were watered and their growth and developments closely monitored.

Data collection

As the experiment progressed, the vegetative growth data i.e. plant height, number of leaves and stem girth were measured at weekly intervals using a tape rule, direct counting and Vernier caliper respectively. Harvesting for total cumulative yield of okra fruit pods commenced immediately after the production of first fruit and continued till the experiment. The yield parameters included number of fruit, fruit weight and fruit length. Matured pods of okra were harvested at the green stage on a weekly basis and weighed using a compression weighing balance; the summation of all the weekly records for each treatment replicate was used to determine the total cumulative fresh weight yield of pods. The same procedure was used to calculate total number of fruits after weekly records was made by direct counting. A meter rule was used to measure the fruit length of okra fruits harvested. And the average fruit length from twelve harvests calculated.

Assessment of table qualities of okra fruit meal

A seven man taste panel drawn from diverse educational, age, occupation and gender lines were composed to assess the quality of the okra soup meal prepared from fruits harvested from plants grown on the various soil supplementation treatments and the control. Assessment was based on a six point qualitative grading system i.e.1= Excellent, 2 = very good, 3 = good, 4 = fair, 5 = poor, 6 = very poor. The common qualities associated with okra soup by the local communities are usually perceptions of taste, drawness, and colour of soup.

Result and discussion

Growth in length of okra plants was slow in all treatments during the first two weeks but increased sharply after the second week reaching a peak towards the end of the experiment in a typical sigmoid curve (Robert, 1972; Makinde, 1988). The height of okra plants growing in pots in all supplemented soils did not show significant differences (figure1). However soil supplementation promoted shoot height as the height of all okra

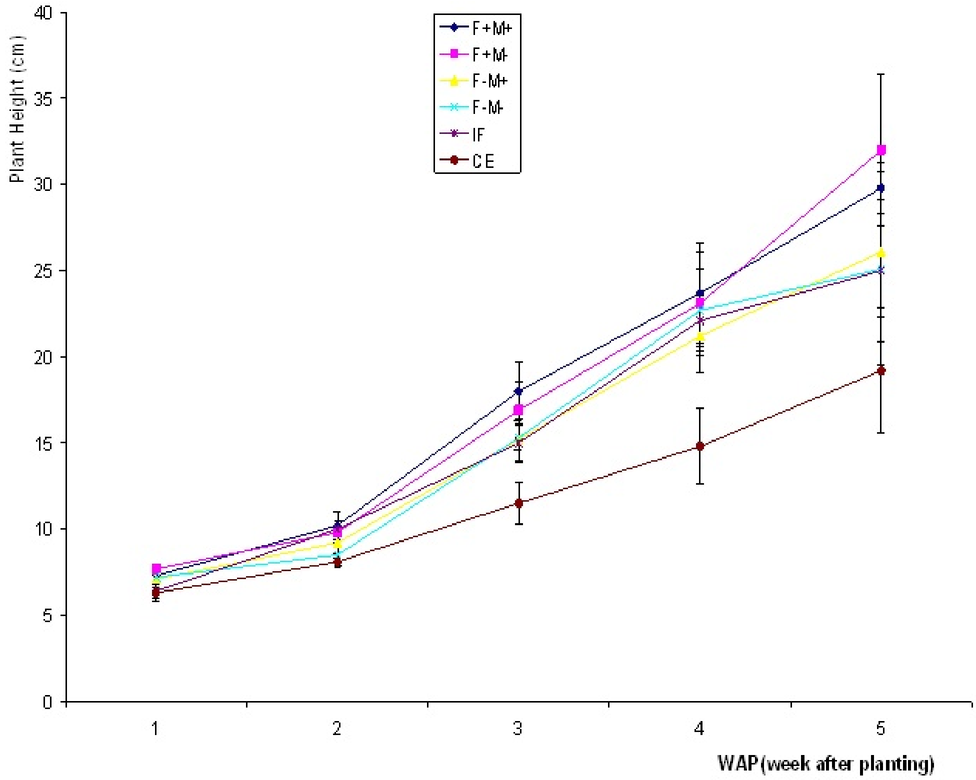

Fig. 1: Effect of Tithonia Mulch from different sources and chemical (NPK) fertilizer on weekly increase in height of Okro (*Abelmuschus esculentum*)L. Plant
F+M+ Supplimented with Tithoma mulch from fertilized and inoculated plots
F+M- Supplimented with Tithoma mulch from fertilized and uninoculated plots
F-M+ Supplimented with Tithoma mulch from unfertilized inoculated plots
F-M- Supplimented with Tithoma mulch from unfertilized inoculated plots
IF Inorganic fertilizer
CE Control experiment (Without Supplimentation)

plants in all supplemented soils were significantly higher than those in unsupplemented soils.There were no significant difference between the number of leaves of okra plants growing in soil supplemented with Tithonia mulch and that okra plants growing in soil supplemented with inorganic fertilizer. The number of okra plants growing in soil supplemented with Tithonia mulch and fertilizer were more than the number of leaves of okra plants growing in unsupplemented soil (Figure 2).

The stem girth tends to increase at initial stage in all the treatment. Those okra plants in supplemented soil with Tithonia mulch and inorganic fertilizer showed no significant difference in stem girth and the least stem girth was recorded for okra plants growing in unsupplemented soil (figure 3).

Mulch stimulates the activities of soil organisms through the breakdown of organic substances and slow release of plant available nutrients (Liasu, 2001; Muller-Samans and Kotschi, 1994; Dupriez and De-Leener, 1989) Mulch improves the soils chemical properties by increasing soil humus, thus bringing about an increase in CEC and the soil capacity to store nutrients (Muller - Samann and Kotshi, 1994). Mulch contributes nutrients directly to the soil when they are formed from nutrient rich leaves. They are acted upon by agents of decomposition (soil organisms) to increase the level of organic matter.

The total fruit yield i.e. number of okra fruits, total fruit weight and average fruit length was highest in those harvested from soils supplemented with Tithonia mulch followed by those from soil supplemented with inorganic fertilizer and the least number of okra fruits was harvested from unsupplemented soil i.e. control (Fig 4) thus confirming the hypothesis that when soils feeding crops is rich in organic nutrients such as those derived from mulch, cultivated plants are usually hardier and healthier than when nutrients is applied straight from factory made minerals. (Dupriez and De-Leener, 1989). Also, organic matter accumulation from organic debris attract decomposers mostly saprophytes that aid organic matter decomposition and nutrient release (Lindermann, 1992). Mulching enhances rooting close to the soil surface leading to improved oxygen availability and better growth (Schroth *et al*, 1992).

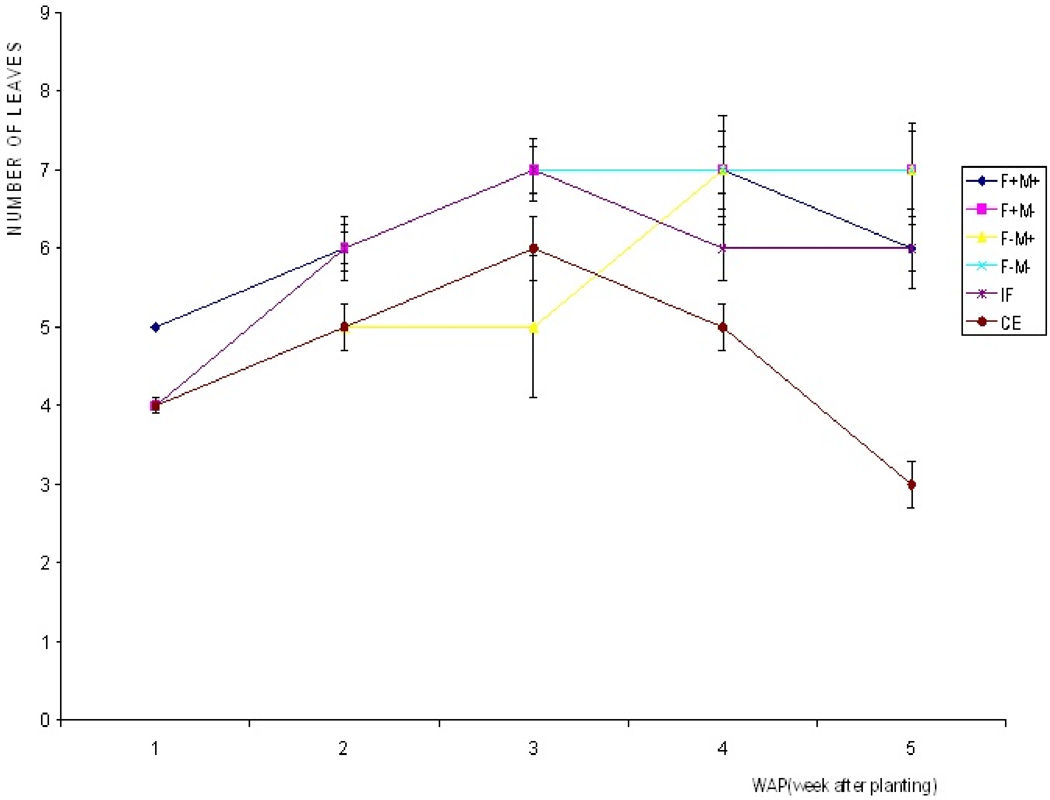

Fig. 2: Effect of Tithonia Mulch from different sources and chemical (NPK) fertilizer on weekly increase in number of leaves of Okro (*Abelmuschus esculentum*) L. Plant.
F+M+ Supplimented with Tithoma mulch from fertilized and inoculated plots
F+M- Supplimented with Tithoma mulch from fertilized and uninoculated plots
F-M+ Supplimented with Tithoma mulch from unfertilized inoculated plots
F-M- Supplimented with Tithoma mulch from unfertilized inoculated plots
IF Inorganic fertilizer
CE Control experiment (Without Supplimentation)

The consequences of all these effects are increased nutrient utilization by plants growing in soils supplemented with mulch leading to increased efficiency of growth and metabolism when compared with those growing in soils supplemented with inorganic fertilizer.

The perceived okra fruit meal quality by the taste panel was in the order F+M+>F-M+>F+M->F-M->CE>IF particularly with respect to soup taste and drawness. This is in line with the long held dogma that soups and grain meal from plant products raised from fertilizer assisted plots normally lack good taste and flavour. Plant products raised under natural conditions are thought to possess certain essence which for want of an acceptable description could be called "naturessence". Natural essence without adequate nutrient will definitely translate to poor yield. Biomass transfer with the aid of tithonia will therefore provide the necessary biotechnological tool for getting the best of both yield and natural essence. The essence somehow gets incorporated into the calculations when the inorganic nutrients from NPK fertilizer get converted into organic forms as in tithonia mulch. In this way, the local dogma finds convergence with the views of modern research (Dupriez and De-Leener, 1989; Muller-Samans and Kotschi, 1994). It is suspected that the involvement of soil microbial resources like arbuscular mycorrhizal (AM) fungi, Plant Growth Promoting Rhizobacteria (PGPR), soil saprophytes, and organo-chemicals like siderophores, chelating agents, exudates from soil organic matter and other yet-to-be-known natural factors are responsible for the so called natural essence.

Conclusion

Soil supplementation with fortified *Tithonia diversifolia* mulch promoted growth and development of potted okra plants better than supplementation with chemical fertilizer. Okra fruits from mulch-assisted plants possess better table qualities than those from fertilizer-assisted ones. This further emphasizes the need for a biological approach to yield improvement in agricultural practices.

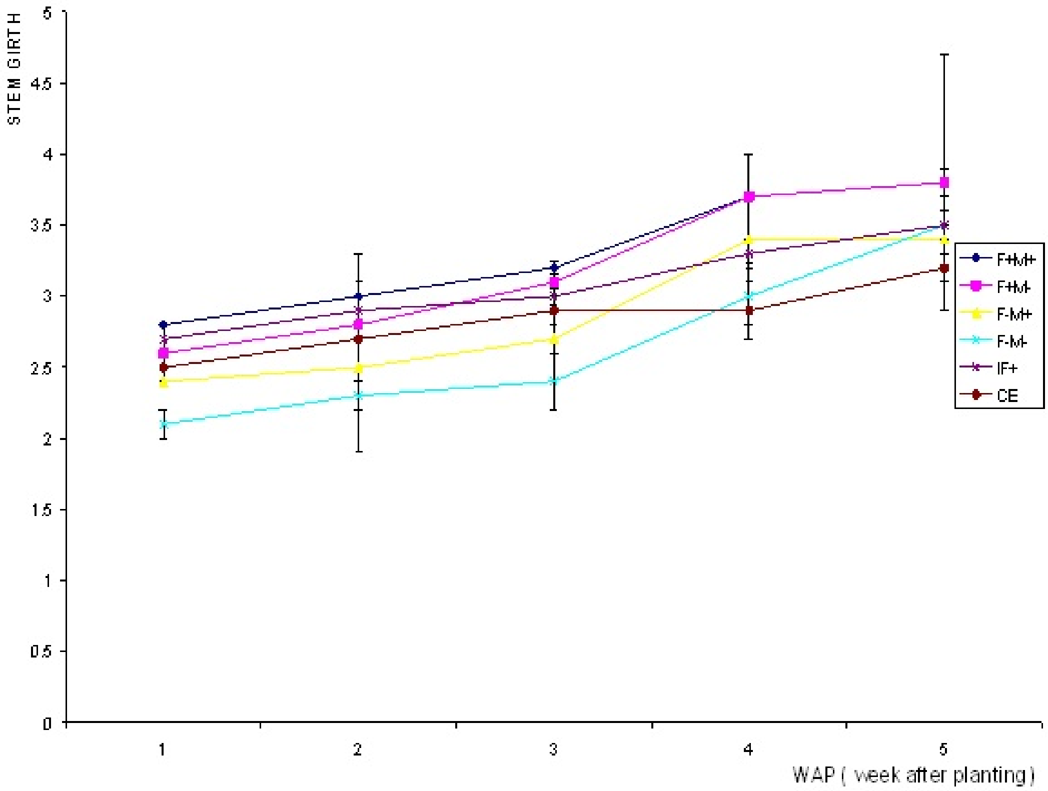

Fig. 3: Effect of Tithonia Mulch from different sources and chemical (NPK) fertilizer on weekly increase in stem girth okra (*Abelmuschus esculentum*) L. Plant.
F+M+ Supplimented with Tithoma mulch from fertilized and inoculated plots
F+M- Supplimented with Tithoma mulch from fertilized and uninoculated plots
F-M+ Supplimented with Tithoma mulch from unfertilized inoculated plots
F-M- Supplimented with Tithoma mulch from unfertilized inoculated plots
IF Inorganic fertilizer
CE Control experiment (Without Supplimentation)

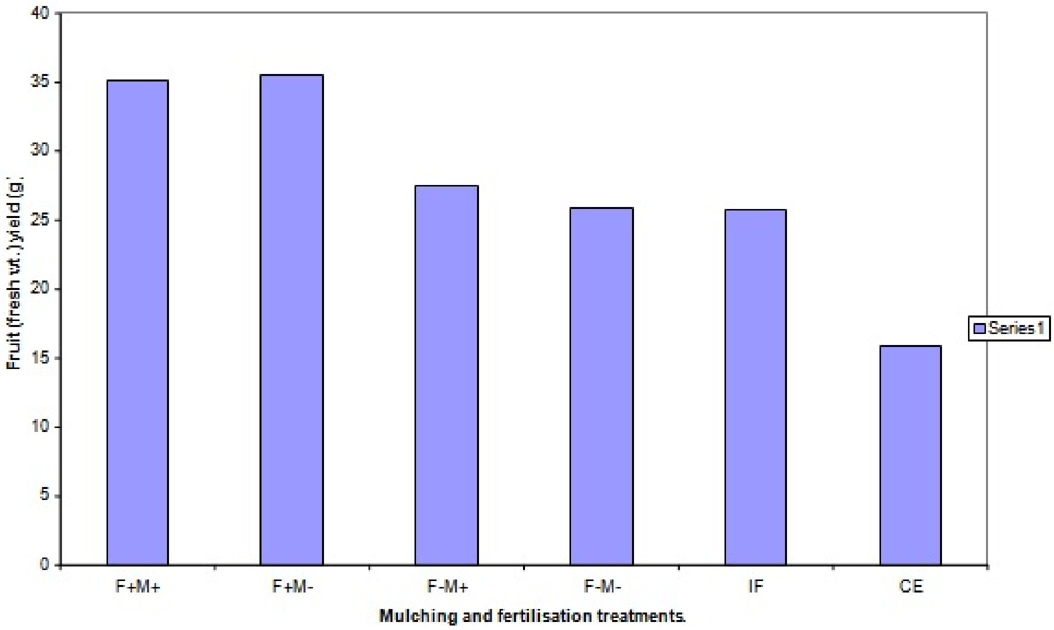

Fig. 4: Effect of Tithonia diversifolia mulch from different sources and directly applied NPK fertilizer on total fresh weight yield per plant of okra fruits.

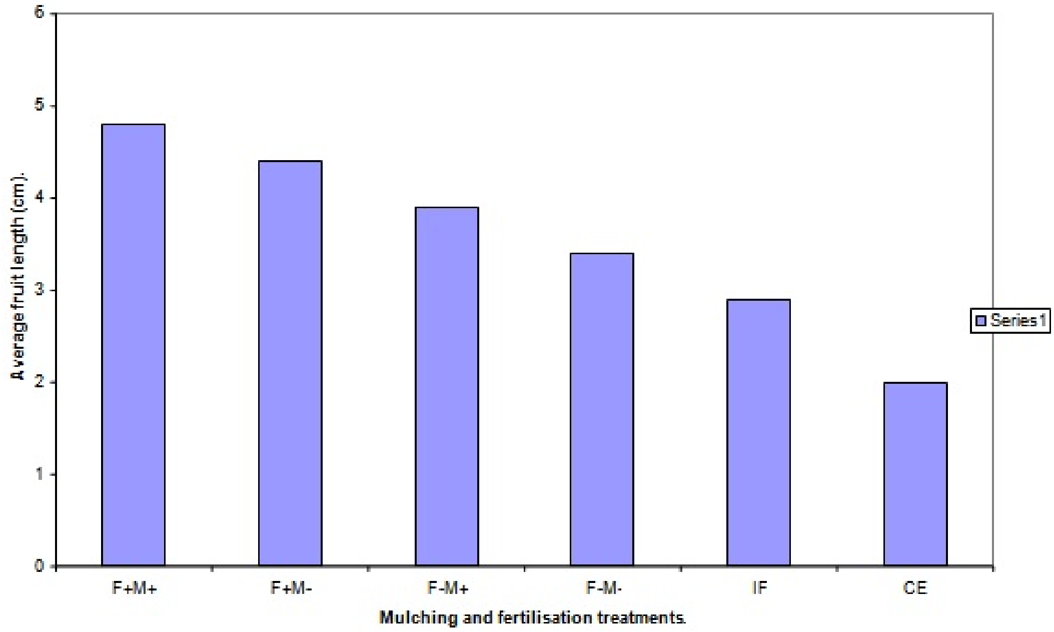

Fig. 5: Effect of Tithonia diversifolia mulch from different sources and NPK fertilizer on average fruit length of okra plants.

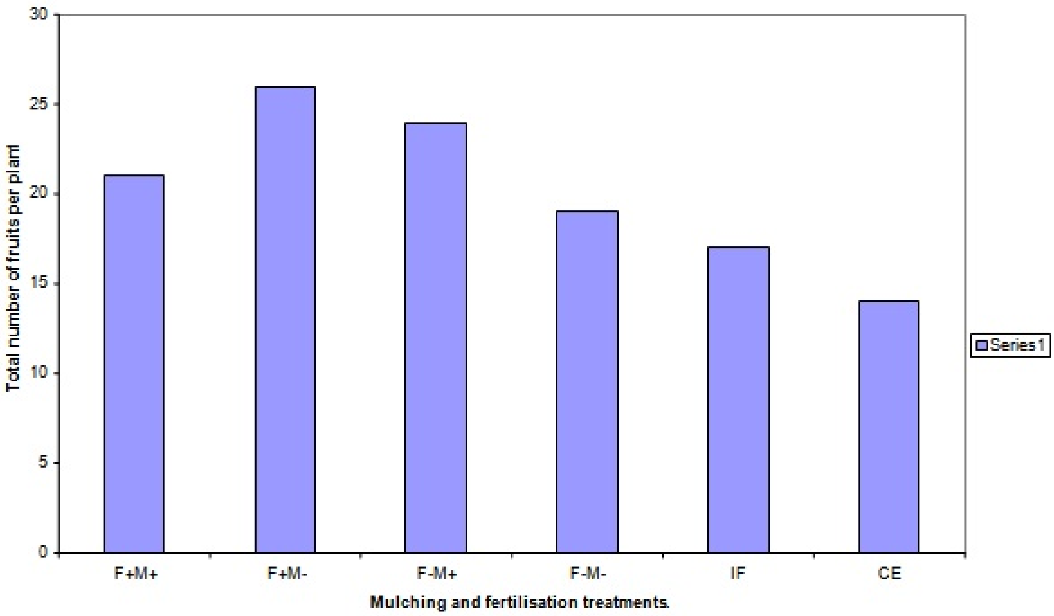

Fig. 6: Effect of Tithonia diversifolia mulch from different sources and NPK fertilizer on average total number of fruits per plant produced by okra plants.

Table 1: Effect of *Tithonia* mulch from different Sources and fertilizer application on mean perception of table qualities (i.e. taste, color and draw ness) of okra (*Abelmoschus esculentus)* L. fruits *by* selected taste panel.

Mulch and fertilizer treatment	Taste	Drawness	Colour
F^+M^+	2	1	3
F^+M^-	3	3	4
F^-M^+	1	2	2
F^-M^-	4	4	1
IF	6	6	5
CE	5	5	6

Keys to number code: 1. Excellent, 2. Very Good, 3. Good, 4. Fair, 5. Poor, 6. Very poor

References

Jama, B., C.A. Buresh, R.J. Niang, A. Gachengo, C. Nziguheba and B. Amadalo, 2000. *Tithonia diversifolia* as a green manure for soil fertility improvement in western Kenya: A review. Agroforestry Systems, 49: 201-221.

Nziguheba, G., C.A. Palm, R.J. Buresh and P.C. Smithson, 1998. Soil phosphorus fractions and adsorption as affected by organic and inorganic sources. Plant and soil, 198: L159-168.

Gachengo, C.N., C.A. Palm, B. Jama and C. Othieno, 1999. *Tithonia* and *Senna* green manures and inorganic fertilizers as phosphorus sources for maize in western Kenya. Agroforestry Systems, 44: 21-36.

Akobundu, I.O., 1987. Weed Science in The Tropics: Principles and Practice. John Wiley and Sons. Chichester, pp. 222.

Liasu, M.O. and M.O. Atayese, 1999. Phenological changes in *Tithonia diversifolia* community with rainfall pattern and its potential for soil conservation. Nig. Journ. Of Weed Science, 12: 163 - 70.

Buresh, R.J. and A.1. Niang, 1997. *Tithonia diversifolia* as a green manure: Awareness, expectations and realities. Agroforestry Forum, 8(3): 29-31.

Rao, M.R., A. Niang, F. Kwesiga, B. Duguma, S. Franzel, B. Jama and R. Buresh, 1998. Soil fertility replenishment in sub-Saharan Africa: new techniques and the spread of their use on farms. Agroforestry Today, 10(2): 3-8.

Dupriez, J.P. and P. De-Leener, 1989. Land and Life: African Gardens and Orchard, - Growing vegetables and fruits. C.T.A. Terres and MacMillan Netherlands.

Linderman, R.G., 1992. Vesicular-arbuscular mycorrhizae and soil microbial interactions: In (Ed) G. Bethlenfalvay, 1992. Mycorrhiza in Sustainable Agriculture ASA special publication No 54 Agronomy society of America. Madison WI, pp. 45.

Robert, M.B.V., 1972. Functional Approach Biology. Great Britain: Longman, pp. 413.

Makinde, S.C., 1988. Genetic Characterization of Okra. M.Sc.Thesis. Department of Biological Sciences, University of Ilorin. Ilorin.

Liasu, M.O., 2001. The Effect of Mycorrhizal Inoculation on Productivity of Cassava and Hedgerow Trees in Continuing Alley Cropping System in Ajibode Village, Nigeria. PhD Thesis. University of Ibadan. Nigeria.

Muller-Samann, K.M. and J. Kotschi, 1994. Sustaining Growth: Soil Fertility Management in Tropical Smallholdings. Magraf Verlag. Weikersheim.

Scroth, G., W. Zech and H. Heiman, 1992. Mulch decomposition under agroforestry conditions in subhumid tropical savvana: processes an influence of perennial plants. Plants and soil, 147: 1 - 1.

Osundina, M.A. and M.O. Liasu, 1995. Responses of Tomato (Lycopersiaim esculentum Mill syn) To vesicular Arbusucular mycorrhizal inoculation soil subjected to chemical and organic fertilization.