

Influence of Fertilizer Types on Seed Quality Aspects of Indigenous Vegetables

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Abstract

Indigenous vegetables play an important role in most families in Western Kenya. The management practices that the farmer uses during its seed production has a greater effect on the final seed obtained. Fertilizer application has been determined to be the basic input that contributes to the final seed quality. This experiment was set out to determine the effects of different fertilizer types on the seed aspects of three AIVs. The experiment was laid out in a split plot in a Randomized Complete Block Design with three replications at the University of Eldoret farm. Three species were subjected to two fertilizer types: chicken manure (organic) and mavuno fertilizers (inorganic). Three plants in each of the varieties of spider plant and Amaranthus planted were tagged randomly. The silique lengths of the spider plant varieties, the inflorescence length of the Amaranthus were measured. Thousand seed weight of seeds of the three species was also done. Seeds of these species were kept at 4°C temperature for seven months then tested for the germination potential. The data obtained was then analyzed by Genstat software and the separation of means done by Tukey's. The silique lengths did not vary significantly among the three different types of fertilizers used ($P>0.05$). However, the inflorescence lengths of the Amaranthus species differed significantly ($P<0.05$). There was a significant difference in the germination potential of seeds in which fertilizer had been used during planting ($P<0.05$). In all the three varieties, the use of fertilizers resulted in increased germination potential. The thousand seed weight of the three species differed significantly in spider plant and black night shade but not in Amaranthus. The use of chicken manure leads to increase in the length of inflorescence of Amaranthus species; thousand seed weight of spider plant and black night shade but it has no effects on silique lengths of spider plant and thousand seed weight of Amaranthus.

Keywords: Silique length, inflorescence length, thousand seed weight, germination test, fertilizer.

INTRODUCTION

Vegetables are rich sources of micronutrients, vitamins and minerals with leafy vegetables being the most important source of minerals (Lola, 2009). Indigenous vegetables play a significant role in both subsistence and income generation among rural and urban population in Kenya (Maina, 2008). Most of the urban communities consider this as a poor man's food even though most recent research as shown that indigenous vegetable can act to help alleviate most of the life style diseases that the current generations are facing. Utilization and increased production of indigenous vegetables can promote economic opportunities, empowering the poor and enhancing social security to alleviate poverty and better nutrition as well as improving the food security of the country (Abukutsa et al., 2007). The most common indigenous vegetables that are being consumed by many homesteads include: Spider plant, Amaranth and black night shade. These indigenous vegetables contain rich sources of nutrients thus contribute substantially to vitamin and mineral intake (Waudu et al., 2007).

Seed quality is a major component considered during seed production in the seed fields. Seed quality is comprised of genetic, physiological, analytical and seed health aspects that ensure this achievement of high quality seed. High quality seed have got high viability, purity and germination potential which if combined with good agricultural practices leads to maximum production of seed quality and quantity thus increased incomes to the farmer and seed producer. Seed quality is influenced by environmental conditions of the mother plant, seed maturity, agronomic practices and processing techniques used. The low production of AIVs in most countries are associated with lack of high quality seeds, poor husbandry practices, lack of information on the production of these indigenous vegetables and are in danger of being lost in Africa. Farmers are replacing them with improved varieties, they lack seed and they lack information about their performance and about input requirements. Information on how farmers can fit them into the production and marketing systems are therefore important.

Fertilizer application is one of the main agronomic practices that are considered paramount in order to maximize production of indigenous vegetables. Nitrogen and phosphorus are major limiting nutrients in most of the Kenyan soils. Nitrogen is the main essential element associated with increasing the crop yield and crop performance (Undie et al., 2012). It is usually ascribed with the building up of leaf tissues. It is a constituent of all protein and chlorophyll. Plant tissue, usually contains more nitrogen than any other nutrients. Nitrogen application is used to produce rapid vegetative growth of vegetables (Ojetayo et al., 2011). One of the major constraints to vegetable production especially in Western Kenya has been the lack of use of fertilizers by farmers during their production (Abukutsa et al., 2000).

The main objective of this study was to evaluate the effects of organic and inorganic fertilizers on the inflorescence length, silique length thousand seed weight and germination potential of three indigenous vegetables.

MATERIALS AND METHODS

Experimental Site and Factors

The study was carried out at University of Eldoret, Uasin Gishu County in western Kenya. The site is located at Lat 00° 35'N, Long 350° 18'E and altitude of 2140 m above sea level. The soils are acidic ferralsols with low to medium fertility. The experiment was carried out at the University of Eldoret farm between October 2012 and December 2013. The experimental factors consisted of 3 species, subjected to two fertilizer types. The seeds used in this experiment were obtained from KARI Kakamega where an ongoing seed production program of indigenous vegetables is being undertaken.

Field experiment

The field experiment was carried out in a Randomly Complete Block Design laid out in a split plot during the October-December 2012 season. There were three species (Amaranthus; local variety and UG-AM-40), Spider plant (UG-SF-15, ML-SF-29 and Local Variety and Black Nightshade (BG-16, SS-49 and Local Variety)) planted in three replicates. The plots were planted with two fertilizer types: Inorganic (Mavuno fertilizer) and Organic (chicken manure). The plots were 4M by 2M each consisting of four rows onto which the seeds were sown. The fertilizers were applied onto the furrows and mixed with the soil to avoid the seeds being scorched hence affecting the germination of the seeds. The soils were adjusted to PH 5.5 by applying lime at a rate of 2 tonnes per Ha. The chicken manure was applied at a rate of 2.15kg per 8M² as per recommendation for these indigenous vegetables so as to

supply the required N amounts of 0.2%N. The Mavuno fertilizers were applied at the recommended rate of 250kg NPK for N: P: K-20:10:10. The seeds were sown at a spacing of 60cm between the rows for all the varieties. However, the interplant spacing was 40cm for black night shade and 25cm for spider plant and Amaranthus species. The seedlings were left to grow till it was at the six true leaf stage then thinning was done to ensure that one healthy plant remain in each hill. The normal agronomic practices of weeding, irrigation and nicking were done on the plants to ensure proper growth.

In the field, the silique length of three plants of spider plant and inflorescence length of Amaranthus varieties were measured using a meter ruler in each plot. The seeds of the varieties of the three species were harvested at physiological maturity when the moisture content of the seed was between 16-25%. After harvesting, the seeds were dried, threshed and cleaned by hand followed by Analytical purity determination. TSW and germination capacity was done and their means recorded for analysis. Germination capacity of normal seeds was expressed as the total number of seeds planted and calculated as a percentage as per ISTA, 2004.

Data analysis was done using Genstat (Genstat, 12th edition) for silique length, inflorescence length, Thousand seed weight and germination test. The level of significance was at $p \leq 5\%$ and mean separation was done using Tukey's separation.

RESULTS

Effects of fertilizer type on the silique length

There is no significance difference in the silique lengths of the three varieties of spider plant when grown under the three types of fertilizers. In local variety, the use of fertilizers has no influence on the length of silique length. The lengths of variety ML-SF-15 and UG-SF-15 was the longest when grown under chicken manure compared to the other two fertilizer types. In all the varieties, local variety performed the best in plots planted with mavuno and those in which there was no fertilizer (F0) application. This was followed by Variety ML-SF-29 and finally UG-SF-15. In all the three varieties, the plots in which mavuno fertilizers (F1) were used showed the least increase in length.

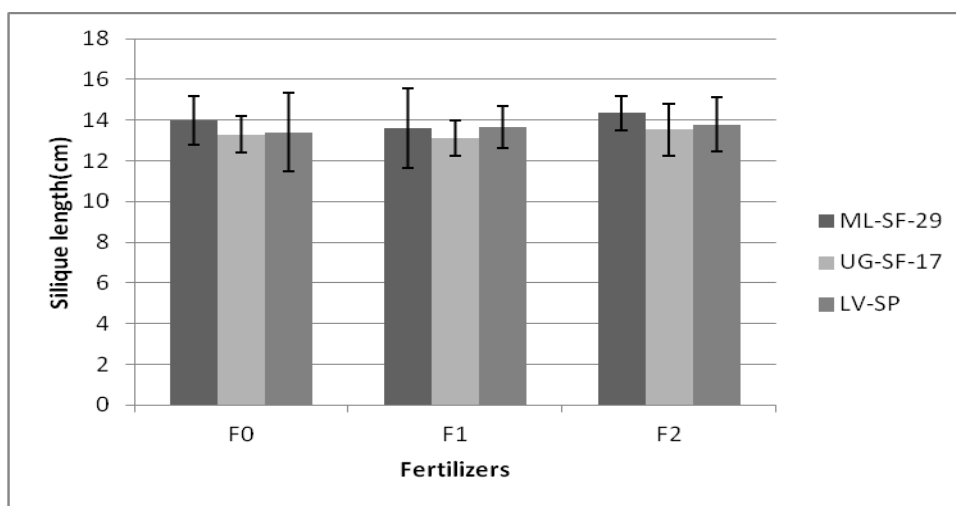


Figure 1: A graph of Silique length against fertilizer type

NB: The error bars were obtained from the standard deviations of the observations.

Effects of fertilizer types on the inflorescence length of *Amaranthus* species

There was significant difference between the different fertilizer types ($P < 0.05$). In both species, the inflorescence length increased with the application of fertilizers. The inflorescence was the longest in local variety plants where no fertilizer application was used. The inflorescence length was the highest in chicken manure followed by Mavuno fertilizers and finally control. Local variety has longer inflorescence length in mavuno fertilizer as compared to UG-AM-40 variety. However, in chicken manure the inflorescence length is longest in variety UG-AM-40 compared to local variety.

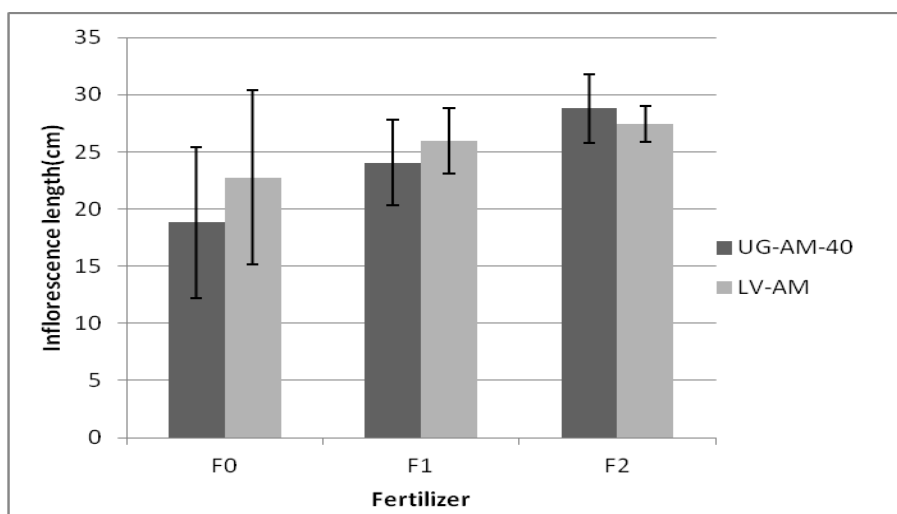


Figure 2: A graph of inflorescence length against fertilizer type

NB: The error bars were obtained from the standard deviations of the observations.

Effects of fertilizer type on thousand seed weight of spider plant

There is significance difference ($P < 0.05$) between the fertilizers types used to grow the three varieties. The varieties grown using chicken manure was heavier in local variety and ML-SF-29 whereas in variety UG-SF-15 the plants grown with mavuno was much heavier compared to chicken manure and no fertilizer plots. In all the varieties the thousand seed weight increases from plots grown without fertilizers to those in which fertilizer types are used. Similar findings were found from canola. Fertilizer application led to increased canola seed yield and yield components, number of seeds per silique, number of siliques per plant, 1000 seed weight, Plant height and finally seed yield (Mahboobeh, 2012).

In all the varieties of spider plant, the germination potential of seeds was higher in plot planted with fertilizers as compared to those in which no fertilizer was used. Different varieties respond differently to different fertilizer types. In this experiment, variety ML-SF-29 had seeds with a higher germination potential when planted with Inorganic fertilizer compared to organic fertilizers. Variety UG-SF-15 has got a higher germination potential when planted with Organic fertilizer compared to inorganic ones. It can be deduced that developed varieties i.e. ML-SF-29 and UG-SF-15 have got a higher germination potential compared to the local variety.

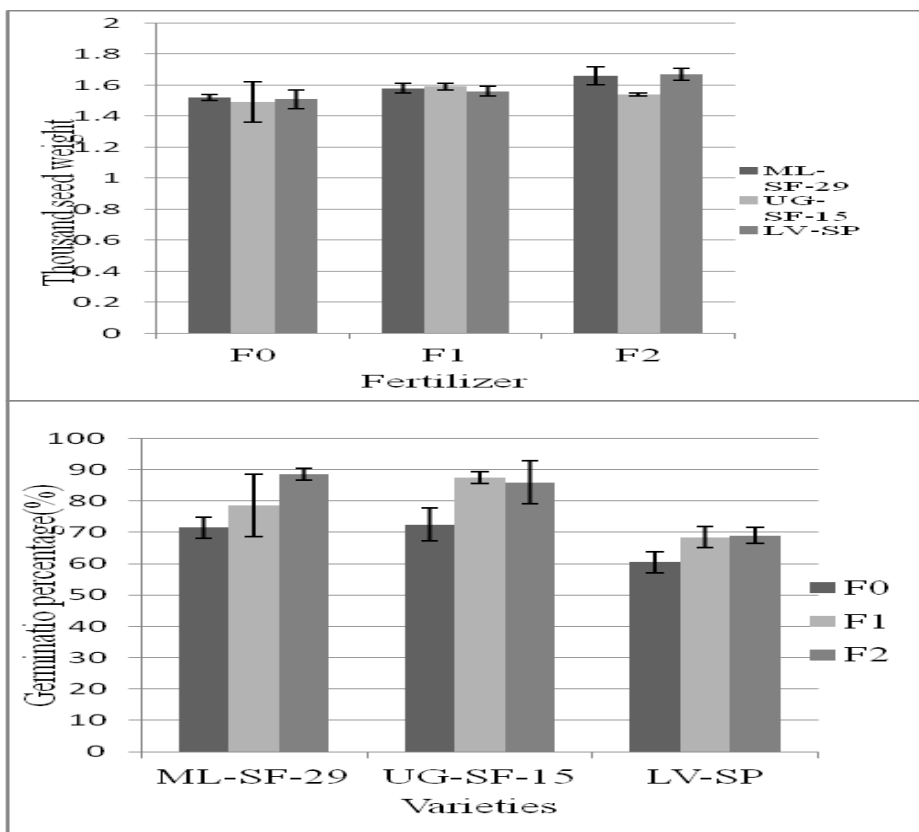


Figure 3: A graph of thousand seed weight and germination potential of spider plant against fertilizer type

NB: The error bars were obtained from the standard deviations of the observations.

Effects of fertilizers on thousand seed weight and germination percentage of *Amaranthus* species

There is no significance difference between the effects of different types of fertilizers to thousand seed weight. However, the seeds of local variety were heavier as compared to variety UG-AM-40. The seeds of plants planted with mavuno were the lightest compared to chicken manure and no fertilizer application in UG-AM-40. This shows that UG-AM-40 responds well to fertilizer application. In the local variety the plants planted with chicken manure had the heaviest seeds than those in which mavuno fertilizers were used.

In both varieties, the use of fertilizers led to a higher germination percentage compared to when no fertilizer was used during plant growth. The local variety of *Amaranthus* has got a higher germination capacity compared to the developed variety. Usually, *Amaranthus* is considered a hardy crop and the local variety may have adapted better to the local variety compared to UG-AM-40. In the both varieties, seeds harvested from plots planted with chicken manure had the highest germination capacity whereas those in which no fertilizer was used had the least germination capacity.

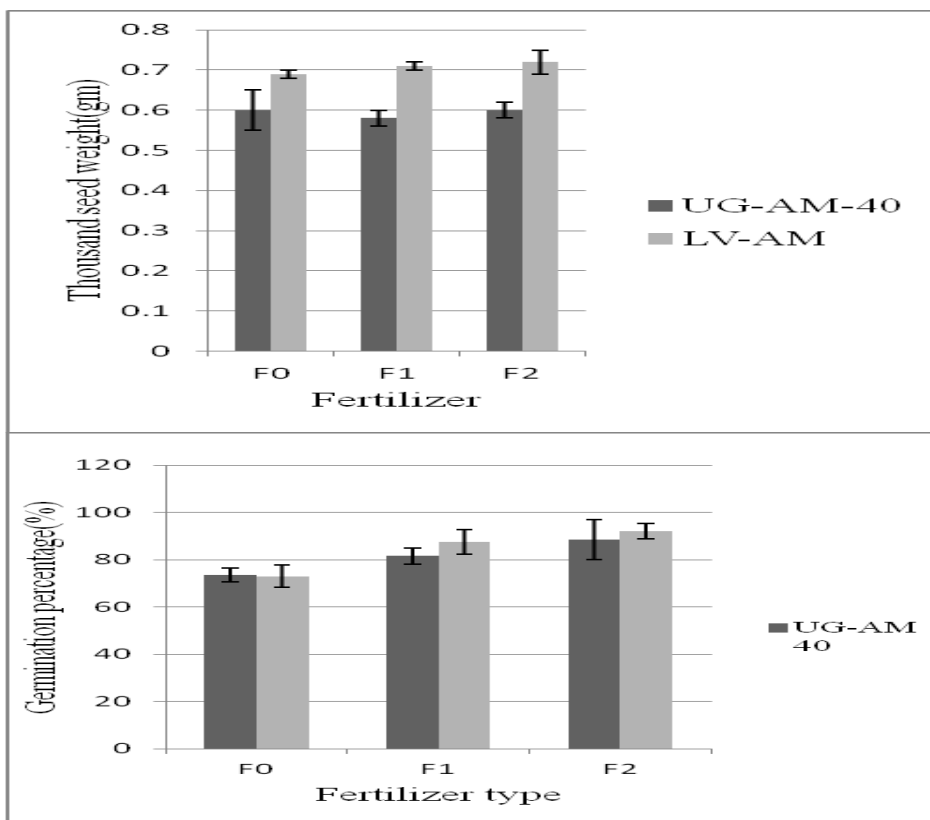


Figure 4: A graph of thousand seed weight and germination percentage of Amaranthus species against fertilizer type

NB: The error bars were obtained from the standard deviations of the observations.

Effects of fertilizers on thousand seed weight of Black night shade

There was significant difference ($P < 0.05$) between the fertilizers types used to grow the different varieties. In SS-49 and BG-16 the plots in which they were not planted with fertilizer were the lightest in weight. However, variety BG-16 seeds were heavier in plots planted with chicken manure. SS-49 had the heaviest seeds in plots planted with mavuno fertilizers. Seed weight of the local variety did not show any difference on the use of chicken manure and mavuno fertilizers.

There is no significant difference in the germination potential of seeds of variety BG-16 and Local variety which fertilizer was used during its production. In variety SS-49 there was a significant difference between the seeds in which chicken manure was used and those in which no fertilizer was used ($P < 0.05$). The germination potential of the seeds of the three varieties were directly related to the seed size.

SS-49 and BG-16 require fertilizers in order to get the best seed quality compared to the local varieties in which fertilizer application has no effect on its performance. Local variety is adapted to the local conditions hence it can grow under any conditions and produce seeds. The two developed varieties require fertilizer in order to perform better. The ecological conditions in which these varieties were planted may also have influenced their growth. In the two developed varieties the seed weights increased from the seeds harvested from plots in which there was no fertilizer applied to those with chicken manure.

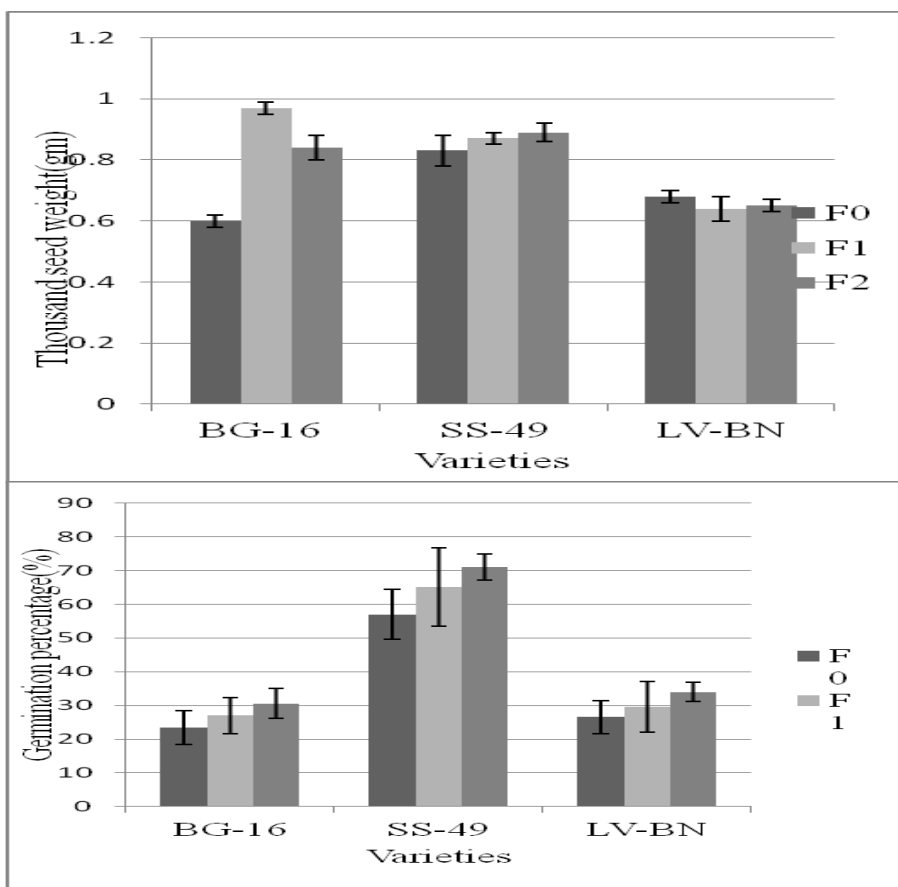


Figure 5: A graph of thousand seed weight and germination percentage of black night shade against fertilizer type

NB: The error bars were obtained from the standard deviations of the observations.

DISCUSSION

Fertilizer application has been studied to have profound effects on crop production. The use of organic and inorganic fertilizers supply plant nutrients required for crop growth and affects the plants physiological processes, which serve as important instruments in yield developments (Amujoyegbe et al. 2007). Most farmers are small scale and practice mixed farming involving livestock keeping. The high prices of inorganic fertilizers have made farmers to look for cheaper sources of fertilizers that they can easily access with minimal funds. Chicken rearing is a common activity practiced by the resource poor local communities. They require minimal feeds and can provide additional income through the sale of its products. Most farmers practice kitchen/home gardens for most indigenous vegetables hence the area in which the crops are grown are smaller in sizes. The use of chicken fertilizers as alternatives can thus provide a cheaper form of fertilization. Usually the poultry manure is mixed with other materials such as grass, sawdust and feathers from the poultry. When well composted, these manures can effectively supply the required mineral components. The seed aspects of most crops are affected by the growth environment

in which it was exposed to during the growing period. The inflorescence of the *Amaranthus* plant is the seed bearing unit and the supply of adequate nutrients leads to well developed seeds that will ensure higher seed quality. During its growth and development, the UG-AM-40 performed better than the local variety. The developed variety (UG-AM-40) had a much shorter growing cycle. It reached the flowering stage 7 days earlier than the local variety. Additionally, it attained the physiological stage faster than its counterpart. From the results, the developed variety responded well to the organic fertilizer leading to increased in inflorescence length. The longer the inflorescence, the more the seeds and thus the increase in yields obtained. Additionally, the use of organic fertilizer led to increased in seed size which is directly related to the germination potential. Similar results on the importance of fertilizer application were obtained in Okra production (Frempong *et al.*, 2006).

In cattle compost manure similar results were obtained whereby there was tallest inflorescence, high yields and dry matter components (Oworu *et al.*, 2010). This shows that the use of organic fertilizers leads to increase in yield and yield components of the *Amaranthus* species. Organic fertilizers are considered to have additional soil amendments. The slow release of nutrients would supply adequate nutrients for its growth up till maturity has been obtained as compared to the inorganic fertilizer that which would supply abundant nutrients only at the early vegetative growth stage but marginal at the latter maturity growth stage. Poultry manure contains high percentage of nitrogen and phosphorus that is essential for the healthy growth of plants (Ewulo, 2005). Nitrogen is a very essential element in during the entire plant production. It is a constituent of all amino acids found in proteins and lipids and is a structural compound of the chloroplast which is essential in determining the photosynthates produced during the process of photosynthesis. The seed is the sink unto which the photosynthates are deposited after being manufactured. The seed size is usually associated with the presence of food reserves that will be able to sustain the young seedlings at its early stages. If the process of photosynthesis is interrupted, it leads to decreased food supply to the seed hence affecting its development. Germination potential of grain *Amaranth* was found to be 76.5% when the poultry manure was used during its production (Graham, 2010). The fresh and dry shoot yields and grain yield of *Amaranthus hypochondriacus* was significantly influenced by application of N rates (Olaniyi *et al.* 2008). The poultry manure is usually associated with high N nutrient levels and thus the best alternative instead of inorganic fertilizers.

Most of these indigenous vegetables are usually termed as hardy crops that can withstand harsh conditions hence ignore the use of fertilizer during its production. However, these local farmers use the locally available sources of fertilizer in their farms due to the high costs of inorganic fertilizers in the market. During spider plant growth, the plots in which chicken manure had been applied had the highest plant population, reached flowering, silique formation and physiological maturity much earlier than plots planted with mavuno. The significant improvement of seed quality aspects in the plots planted with organic manure compared to inorganic fertilizers could be attributed to observed significant improvement of the rooting system (Kipkosgei, 2004), which in turn improved nutrient and water uptake resulting in overall improvement in plant growth and development. The siliques produced by these plants were much longer than in mavuno fertilizers but were shorter than in plot in which no fertilizer was used. Fertilizer application may not have a direct influence on the silique length but it directly affects the seed weight. In ML-SF-29, the plants in plots planted with chicken manure reached the flowering stage much earlier, pod formation and physiological maturity. Plots in which manure was used gave significant increase in fresh leaf yields and biomass (Mutoro *et al.*, 2012).

The effects of the seed size were reflected in the germination potential of the spider plant species. Local variety is usually neglected since it is assumed that it has adapted to the prevailing condition and thus can thrive well even without fertilizer application. From the study, the use of fertilizer led to a higher germination potential. There is a significant difference in the use of chicken manure compared to no fertilizer application ($P < 0.05$). In the variety ML-SF-29 heavier seeds obtained from plots planted with organic fertilizers led to a higher germination capacity compared to inorganic fertilizers i.e. 88.5% compared to 78.5%. UG-SF-15 responds better to inorganic fertilizers (mavuno) than to organic fertilizers. In the germination test this was also evident since the germination percentage of seeds obtained from plots planted with Mavuno fertilizer was slightly higher than chicken manure was used. Similar results of spider plant response to fertilizer application were obtained (Maayo *et al.*, 2008).

This shows that organic fertilizers provide all the nutrients needed by the plant resulting in increased plant performance that is related to better seed quality. These results are similar to the other findings. Plant which had been planted with a higher fertilizer levels had a higher seed yield per hectare compared to those in which had lower fertilizer types. This may be attributed to the better development of fruits, increased uptake of nutrients in the plants leading to enhanced chlorophyll content and carbohydrate synthesis, higher accumulation of photosynthates and their distribution to the developing ovules and 100 seed weight (Ashok *et al.*, 2009). Additionally, the percentage germination was higher in the plants in which higher fertilizer rates had been used. This may be as a result of well developed seeds that can supply adequate food reserves to the developing seedlings. Additional studies revealed that application of fertilizers led to increased siliques per plant. This was related to the use of maximum doses of nitrogen fertilizers used (Khan *et al.*, 2002).

The use of fertilizers in the production of black night shade seeds does not have an influence on the seed weight. However, the growth of the plants in which fertilizers were used were much better than in plots which no fertilizer was used. The performance of plants in the field thus cannot be related to the seed weight. In BG-16, the plots in which chicken manure were used performed better than those in which mavuno and no fertilizer were applied. This is in agreement with results that found that they use of organic fertilizers such as FYM in the production of *Solanum villosum* could improve the quality of the vegetables (Kipngetich *et al.*, 2003). The plants reached flowering and berry formation than in mavuno fertilizers. The seed weight is further heavier compared to in mavuno fertilizers. In SS-49, plants that were planted with mavuno fertilizers performed better than in chicken manure. The seeds from this plants were heavier than in chicken manure. The use of inorganic fertilizer in SS-49 results to greater plant performance as well as high seed weight. The amount of nutrients, antinutrients and toxic substances and the environmental factors depend majorly on soil nutrients content (Tena *et al.*, 2011). The plant nutrition can thus be directly related to better seed quality. The use of fertilizers results in better plant performance and subsequent seed quality. There was a significant increase in yield production of soybean (number of flowers, number of pods, weight of 100 grains and yield ha⁻¹) when organic fertilizer was used during its production (Yamika *et al.*, 2012).

The long time in which BG-16 and SS-49 take in order for them to grow may be associated with the high requirement of fertilizers to provide the plant with the required nutrition for all its structures. In addition, this developed varieties will enable farmers obtain income through the sale of leaves for a longer time due to the long growth cycle as well as the sale of the

seeds that are heavier in weight. During the production of black night shade, it is vital that organic fertilizers and especially chicken manure is used to ensure better yields in both leaves and seed and are usually associated with good quality. The positive response from organic fertilizers could also be related to the importances that the organic fertilizers are known to add to the soil. This is related to the ability to improve water holding capacity, microbes existence, buffering ability, aggregation, increased soil aeration and lower bulk density, insistent surface crust, increased water retention and supply plant nutrients (Yafan *et al.*, 2004; Rosin *et al.*, 2009).

CONCLUSIONS

In conclusion, the use of fertilizers leads to increased seed quality aspects in indigenous vegetables. Chicken manure led to longer inflorescence, heavier seed weights and a higher germination capacity of seeds of the three indigenous vegetable. However, it doesn't have any impact on the silique length of the spider plant. The use of fertilizers during seed production results to increased seed weight which is usually correlated to seed quality parameters e.g. germination and vigour. The use of chicken manure is also an advantage to farmers since they are readily available, contain both the essential elements as well as the trace elements that will foster growth, development and enhance seed quality of vegetables leading to higher yields and better prices in the market. However, the developed varieties of most indigenous vegetables perform better when fertilizers are used compared to when they are not grown with fertilizers.

REFERENCES

- Abukutsa, M. O. (2007). The diversity of cultivated African leafy vegetables in three communities in western Kenya Volume 7 no. 3 2007. African Journal of Food, Agriculture, Nutrition and Development.
- Abukutsa, M.O., Obiero, H. and Miruka, M. (2000). Indigenous green leafy vegetables in Kenya: a case of a neglected resource. Kenya Agricultural Research Institute, Soil Management and Legume Research Network Projects. Pp 245-256.
- Akanbi, W.B. Togun, A.O., Olaniran, O.A, Akinfasoye, J.O. and Tairu, F.M. (2007). Physico-chemical properties of Eggplant (*Solanum melongena* L.) fruit in response to nitrogen fertilizer and fruit size. *Agricultural Journal* 2(1): 140-148.
- Amuyogegbe, B.J., Opabode, J.T., Olayinka, A. (2007). Effect of organic and in-organic fertilizer on yield and chlorophyll content of maize (*Zea mays* L.) and sorghum (*Sorghum bicolor* L. Moench). *African J. Biotechnol.* 6:1869-1873.
- Ashok S. S. and Manjunath, P. (2009). Effect of fertilisers and growth regulators on seed yield and quality in pumpkin (*cucurbita moschata* poir.). *Agric. Sci. Digest*, 29 (1): 20-23.
- Chadha, M.L. (2003). AVRDC's experiences within Marketing of Indigenous Vegetables – A Case Study on Commercialization of African Eggplant.
- Ewulo, B.S., (2005). Effect of poultry and cattle manure on sandy clay loam soil. *J. Anim. Vet. Sci.*, 4: 839-841.
- Frempong, M. E., Ofosu-Anim, J. and Blay, E.T. (2006). Nutrient supply strategies on growth and yield components of okro (*Abelmoschus esculentus* L. moench). *Ghana Journal of Horticulture* Volume 5.
- Graham, M. W. (2010). Grain amaranth production and effects of soil amendments in Uganda. Thesis Presentation.
- John L. W., James, D. B., Samuel, L. T. and Warner, L. W. (2004). Soil fertility and fertilizers: An introduction to nutrient management, pp.106 -153, Pearson Education, India.
- Khan, N., Jan, A., Khan, I., and Khan, N. (2002). Response of canola to nitrogen and sulphur nutrition. *Asian J. Plant Sci.*, 1: 516-518.
- Kipkosgei, L. (2004). Response of African Nightshades (*Solanum villosum*) and Spider plant (*Cleome gynandra*) to Farmyard Manure and Calcium Ammonium Nitrate fertilizer and Pest Infestation in Keiyo District, Kenya. M. Sc. Thesis, University of Nairobi.
- Kipkosgei, L.K., Akundabweni, L.S.M. and Hutchinson, M.J. (2003). The effect of farmyard manure and nitrogen fertilizer on vegetative growth, leaf yield and quality attributes of *Solanum villosum* (Black nightshade) in Keiyo district, Rift valley. *African Crop Science Conference Proceedings*, Vol. 6. 514-518.
- Lola, A., (2009). The effect of boiling on the nutrients and anti-nutrients in two non conventional vegetables. *Pak. J. Nutr.*, 8: 1430-1433.

- Mahboobeh, N., and Jahanfar, D. (2012). Effect of different nitrogen and biofertilizers effect on growth and yield of Brassica napus L. ISSN 2227-670 IJACS journal.
- Maina, S. and Maina, M. (2008). Vegetables in East Africa. Elewa Publications, Farming Resources Series. www.elewa.org.
- Mauro, L. W., Anjichi, V. E., Wambugu, G. W. and Omunyini, M. E. (2008). Effect of nitrogen fertilizer levels on fresh leaf yield of spider plant (*Gynandropsis gynandra*) in Western Kenya. Scientific Research and Essay 3 (6) pp 240-244.
- Muturo, K. Masinde, P.W. Kebwaro, D. and Onyango, C. A. (2012). Evaluation and selection of spider plant (*Cleome gynandra* L.) Varieties suited for Production in Kenya.
- Ochudho, J.O. 2005. Physiological basis for seed germination in *Cleome gynandra* L. PhD Thesis, University of KwaZulu-Natal, Pietermaritzburg, South Africa.
- Ojetayo A.E., Olaniyi, J.O., Akanbi, W.B. and. Olabiyi T.I. (2011). Effect of fertilizer types on the nutritional quality of cabbage varieties before and after storage. Journal of Applied Biosciences, 48: 3322-3330.
- Olaniyi, J.O., Adelasoye, K.A. and Jegede, C.O. (2008). Influence of nitrogen fertilizer on the growth, yield and quality of grain amaranth varieties. World Journal of Agriculture Science 4, 506 – 513.
- Oworu, O.O., Dada, O.A. and O.E. Majekodunmi (2010). Influence of Compost on Growth, Nutrient Uptake and Dry Matter Partitioning of Grain Amaranths (*Amaranthus hypochondriacus* L.) Libyan Agriculture Research Center Journal International 1 (6): 375-383, 2010.
- Rosin, C. and Campbell, H. (2009). Beyond bifurcation: Examining the conventions of organic agriculture in New Zealand. J. Rural Stud., 25: 35-47.
- Tena, W. and Beyene, S. (2011). Identification of growth limiting nutrient(s) in alfisols: Soil Physico-chemical properties, nutrient concentrations and biomass yield of maize. Am. J. Plant Nutr. Fertiliz. Technol., 1: 23-35.
- Undie, U.L., Uwah, D.F. and Attoe, E.E. (2012). Growth and development of late season maize/soybean intercropping in response to nitrogen and crop arrangement in the forest agro-ecology of South Southern Nigeria. Int. J. Agric. Res., 7: 1-16.
- Waudu, J., Kimeywe, J., Mbithe, D. and Maundu, P. (2007). Utilization and Medical Value of Indigenous Leafy Vegetables Consumed in Urban and Peri-urban Nairobi. African journal of food Agriculture Nutrition and Development. ISSN 1684-5374. 7:4.
- Yafan, H. and Barker, A.V. (2004). Effect of composts and their combinations with other materials and their combinations with other materials on nutrient accumulation in tomato leaves. Communications in Soil Science and Plant Analysis, 35(19&20): 2809- 2823.
- Yamika W.S.D. and Ikawati, K.R. (2012). Combination Inorganic and Organic Fertilizer increased Yield Production of Soybean in Rain-Field Malang, Indonesia. American-Eurasian Journal of Sustainable Agriculture, 6(1): 14-17.