Asian Journal of Agricultural Sciences 4(1): 58-64, 2012
ISSN: 2041-3890

Submitted: October, 31, 2011 Accepted: November, 18, 2011 Published: January, 25, 2012

Effects of Kraal Manure, Chicken Manure and Inorganic Fertilizer on Growth and Yield of Lettuce (*Lactuca sativa* L. var Commander) in a Semi-arid Environment

Michael T. Masarirambi, Bekhumusa M. Mbokazi, Paul K. Wahome and Tajudeen O. Oseni
Horticulture Department, University of Swaziland, P.O. Luyengo, M205, Swaziland

Abstract: The experiment was carried out at the Horticulture Department Farm, Faculty of Agriculture, Luyengo campus of the University of Swaziland to determine the yield of lettuce (*Lactuca sativa*) when fertilized with kraal manure, poultry manure and inorganic fertilizer, and to assess the rate of weed emergence on plots fertilized with various materials. The treatments were of kraal or chicken manure applied at 40 t/ha and 60 t/ha, and chemical fertilizer 2:3:2 (22) applied at 80 kg/ha. The results showed that growing lettuce using the five treatments significantly affected its growth rate, leaf number, fresh mass, dry mass and weed infestation. Lettuce grown with chicken manure at 60 t/ha was found to have higher leaf number, fresh mass, dry mass and apparently higher weed infestation as compared to the other treatments. There were no significant ($p>0.05$) growth parameter differences from the kraal manure at 40 t/ha and the chicken manure at 40 t/ha treatments. Lettuce grown using inorganic fertilizer had the least leaf number, leaf area, leaf area index, fresh and dry mass as compared to the other treatments. Weed infestation was found to be higher in the chicken manure treatments which had severe weed coverage, followed by the kraal manure treatments with intermediate weed coverage and finally the inorganic fertilizers treatment with least weed coverage. The application of chicken manure at 60 t/ha is preferred as it was associated with higher leaf number, leaf area , fresh and dry weights of lettuce. The application of chicken manures at 60 t/ha is therefore recommended for farmers to use to obtain higher yields of lettuce.

Key words: Chicken manure, kraal manure, *Lactuca sativa* L., subtropical environment, yield

INTRODUCTION

Manure refers to organic materials such as cattle and chicken waste, and other bulky, natural substances that are applied to the soil with the intention of increasing the productivity of crops. Nutrient content of manure varies depending on source, moisture content, storage, and handling methods. Nitrogen content in manure varies with the type of animal and feed ration, amount of litter, bedding or soil included, and amount of urine concentrated with the manure (Van Averbeke and Yoganathan, 2003). Organic production of vegetables using materials like manure and compost has been gaining momentum in the region (Kuntashula *et al.*, 2006; Masarirambi *et al.*, 2010).

Manure is an important resource for crop production and soil sustainability. Manures are a source of almost all the essential nutrients (Ogunlela *et al.*, 2005). By using manure the soil organic matter content is increased thus the soil structure is progressively improved, reducing its susceptibility to water and wind erosion. As a result of high energy cost used in production of synthetic fertilizers, these fertilizers have since become fairly expensive. This expensiveness has prompted proper fertilizer management including the use of organic sources such as animal manures and cover crops in order to save energy and money (Anonymous, 2007).

Among the practices recommended for improving the soil quality and soil fertility in tropical and subtropical regions is the application of composted organic wastes such as manure (Eghball, 2001). In addition to supplying plant nutrients, organic compost has been shown to increase the level of soil organic matter, enhance root development, improve the germination rate of seeds, and increase the water-holding capacity of soil (Muse, 1993). The application of composted organic material slowly releases significant amounts of nitrogen and phosphorus, increase the level of soil organic matter, enhance root development, improve the germination rate of seeds, and increases the water-holding capacity of soil (Muse, 1993). Applied organic materials promote biological activity in the soil, as well as a favorable nutrient exchange capacity, water balance, organic matter content and soil structure (Muse, 1993). The effects of manure on the soil are beneficial. As the soil absorbs manure, nutrients are released. This enriches the soil, which in turn, promotes

Corresponding Author: M.T. Masarirambi, Department of Horticulture, University of Swaziland, P.O. Luyengo, M205, Swaziland, Tel.: +268 25274021

plant growth and development. The most important benefit of using manure is its ability to condition the soil. For instance, mixing manure with sandy soils helps to retain moisture levels.

Adding manure to compacted soil helps loosen the soil. Manure produces increased soil carbon, which is an important source of energy that makes nutrients available to plants. Other benefits of manure include reduced runoff and leaching of nitrates in the soil. Manures supply essential plant nutrients and serve as a soil amendment by increasing soil organic matter. Organic matter in soil improves moisture and nutrient retention. The added organic matter increases the moisture holding capacity of the soil, lowers soil bulk density, and improves overall soil structure, thus increasing the efficiency of crop production and irrigation. Manure is quickly decomposed under warm, moist soil conditions (Haynes, 2008).

Manure is considered a slow-release plant fertilizer; it provides small amounts of nutrients over an extended period. This makes it an acceptable form of mulch for plants (Hamilton, 2009). However, fresh manure is too strong for plants, as it contains excessive amounts of nitrogen, which can burn the plants. Some manure consists of urine as well, which is also high in nitrogen. Too much nitrogen on plants can be detrimental for them (Browder, 1990). However, the release of available nitrogen from organic compounds during manure decomposition is very gradual. This slow release of nitrogen is manure's most important asset. It extends nitrogen availability and reduces leaching of particular importance in sandy soils. However, fresh animal manures may contain numerous viable weed seeds and are known to harbor human pathogens, such as *E. coli* or *Salmonella* spp. Factors that mitigate the possibility of vegetable contamination include the use of composted manure instead of fresh manure, incorporating the manure in the soil, and using polyethylene mulch to cover the soil (Jacobs *et al*., 2003). Among the practices recommended for improving the soil quality and soil fertility in tropical regions is the application of composted organic wastes such as manure (Eghball, 2001). In addition to supplying plant nutrients, organic compost has been shown to increase the level of soil organic matter, enhance root development, improve the germination rate of seeds, and increases the water-holding capacity of soil (Muse, 1993). Applied organic materials promote biological activity in the soil, as well as a favorable nutrient exchange capacity, water balance, organic matter content and soil structure (Muse, 1993).

Kraal Manure (KM) also called cattle manure is regarded as one of best bulky organic material commonly available as it adds worthwhile amount of organic matter in the soil. Cattle manure supplies useful amounts of organic matter which is about two-thirds that is supplied by chicken manure (Van Averbeke and Yoganathan, 2003).

Chicken Manure (CM) is the organic waste material from poultry consisting of bird feaces and urine. Chicken litter refers to the manure mixed with some of the bedding material or litter (wood shavings or sawdust) and feathers. Chicken manure is an excellent fertilizer material because of its high nutrient content, especially for Nitrogen (N), Phosphorus (P), and Potassium (K). Manures decompose (mineralize) in the soil releasing nutrients for crop uptake. The availability of chicken litter helps in reducing fertilizer costs in vegetable production (Ferguson and Ziegler, 2004). Chicken manure is an excellent source of nutrients and can be incorporated into most fertilizer programmes. The value of chicken manure varies not only with its nutrient composition and availability, but also with management and handling costs. The nutrient composition of chicken manure varies with the type of bird, the feed ration, the proportion of litter to droppings, the manure handling system, and the type of litter (Grandy *et al*., 2002).

In a research conducted to find the effects of animal manure on different crops, it was reported that chicken manure is appreciably richer in plant nutrients than other animal manures (Ministry of Agriculture, Fisheries and Food, 1976). When used regularly as fertilizer it can adjust plant nutrient ratios to be more in line with crop requirements (FAO, 2008). The application of chicken manure has shown to raise the soil phosphorus level appreciably but there was no effect on the potassium level. The nitrogen and phosphorus level were also raised by the application of chicken manure A significant increase in yield of vegetables has been achieved following the application of chicken manure (FAO, 2008). On some heavy soils and in drier areas continual application of chicken manure to cropped land can raise the fertility to undesirable high levels; plant lodging is difficult to avoid when soil nitrogen levels are too high (Ministry of Agriculture, Fisheries and Food, 1976).

Soil acidity and mineral deficiencies can be corrected by lime and fertilizers. Unfortunately, lime and fertilizers are not always easy options for small-scale and resource-poor farmers (Hue, 1992). The widespread adoption of synthetic fertilizer and associated agricultural practices had a host of unintended consequences to our environment, the quality of our foods, and the sustainability of our food system. Synthetic fertilization does not build up soil organic matter. Low soil fertility and high rates of erosion lead to poor crop yields, land abandonment, and deforestation (Pimentel *et al*.,2005). Degraded soil lack trace nutrients required by plants for proper growth and development that makes subsequent plant food nutritious (Deborah, 2006).

Most large scale farmers use synthetic fertilizers on their soils. In rural areas chemical fertilizers are not readily available, yet without fertilizing the soil very low yields are obtained. As long as organic manures are available and comparable with synthetic fertilizers in yield improvement, their use as sources of plant nutrients for growing vegetable crops could assume an increasing importance (Ogunlela *et al*., 2005). The ever increasing prices of synthetic fertilizers and due to the concern of environmental pollution arising from their application have renewed interest in integrated plant nutrition, especially in the use of organic manures such as farm yard, kraal, compost and green manures to enhance plant growth and development.

Lettuce (*Lactuca sativa*) is an annual or biennial plant grown as a leaf vegetable. Lettuce is a cool season salad vegetable crop. It grows best in a relatively cool season with monthly mean temperatures of 12.8 to 15.6ºC with an average minimum of 7.2ºC and an average maximum of 24ºC (Jeavons, 1995; Norman, 1997). Lettuce can be grown under protected cultivation or in the open field (Mathew and Karikari, 1990; Filho, 2009). Lettuce leaves contain small amounts of lactucarium which is a mild sedative. Lettuce had been widely used for treating anxiety, insomnia and neurosis. Lettuce is a rich source of antioxidants such as quercetin, caffeic acid, and vitamin A and C. It was shown that ethanol extract of lettuce injected subcutaneously, significantly reduced accumulation of lipofuscin pigment granules (age granules) in brain of mice under accelerated ageing regime (Deshmukh *et al*., 2007). Lettuce has caught the vegetable grower's attention in the region, since it has become increasingly popular as a vegetable in salads (Maboko and Du Plooy, 2008). Despite the importance of lettuce as a vegetable and in herbal medicine there is dearth of information pertaining to its cultivation using locally available resources such as organic manures. The objectives of the study were to determine growth, development and yield of lettuce when fertilized with kraal manure, poultry manure and inorganic fertilizer and to assess the rate of weed emergence on plots fertilized with the various materials

.

MATERIALS AND METHODS

Experimental site: The experiment was carried out at the Horticulture Department Farm, Faculty of Agriculture, Luyengo campus of the University of Swaziland. The farm is located at Luyengo, Manzini region, in the Middleveld agro-ecological zone. Luyengo is located at latitude 26º4′ S and longitude 31º4′E. The average altitude of this area is 750 m above sea level. The mean annual precipitation is 980 mm with most of rain falling between October and April. Drought hazard is about 40%. The average summer temperature is 27ºC and winter temperature is about 15ºC. The soils of Luyengo are classified under Malkerns series. They are ferrasolic or merely a ferralitic soil integrated to fersialitic soils or typical ultisols. The soil in the experimental area is a sandy loam (Murdoch, 1970).

Experimental design: The experiment included five treatments which were laid out in a randomized complete block design (RCBD) as follows:

- Chicken Manure (CM) applied at a rate of 60 t/ha
- Chicken Manure (CM) applied at a rate of 40 t/ha
- Kraal/Cattle Manure (KM) applied at a rate of 60 t/ha
- Kraal/Cattle Manure applied (KM) applied at a rate of 40 t/ha
- Chemical fertilizers (2:3:2 (22) and Lime Ammonium Nutrient (LAN) [fertilizer] applied at 80 kg/ha

The chicken and cattle manure were applied 2 months before planting and were broadcasted on plots. The 2:3:2 (22) fertilizer was applied at planting while LAN was applied 7 days after planting. Experimental plots were 2.5 by 2.5 m in size and separated by 0.5 m footpaths. The spacing was 30 cm between rows and 20 cm between plants. Five rows were planted per plot; the three inner rows were used for data collection whilst the two outer rows were used as guard rows. There were 20 experimental plots, 4 plots for each treatment.

Soil analysis: Soil samples were taken from the experimental site using the zigzag method (Brady and Weil, 2007); (four point determination). The samples were taken to the Malkerns Research Station laboratory for analysis of, phosphorus, potassium, and pH. Similar analysis were performed on the organic manures used in this experiment in order to help in subsequent interpretation of results.

Planting material: Five weeks old lettuce seedlings of the cultivar 'Commander' were obtained from Vickery Seedlings, at Malkerns. They were transplanted on 2 March 2010. The plants were provided with optimal growing conditions, and all cultural practises according to need, for example irrigation, weeding and disease and pest control were done.

Data collection: Data were collected every two weeks after transplanting (WAT). Five randomly selected plants were used in each plot for data collection. Data collected included: leaf length, leaf width, leaf area, number of leaves, weed infestation and the leaf area index was computed. Fresh and dry mass of lettuce were determined after harvesting.

Weed infestation: Weed infestation, incidence and severity were measured starting at 2 WAT for all the treatments. Weed infestation was measured as and when weeding was done. The percentage of weed infestation was calculated as the area covered by weeds/total plot area) × 100 (Ossom, 2005). Weed density was estimated visually within a 50 cm square quadrant using a weed score scale from 1 to 6. On this scale the scores reflected the following:

- No weeds observed within the quadrant
- Sparse weed coverage
- Intermediate weed coverage
- General weed coverage
- Severe weed coverage
- total weed coverage within the quadrant (Ossom, 2005)

After scoring for weed infestation, identification of the major weed species within quadrant was done. Weed species identification and the degree of weed infestation were determined in 3 separate locations in each plot.

Leaf number and size: Fully expanded leaves of lettuce were counted from five plants per plot. The leaf size was determined by measuring the length and width of three leaves that were fully developed, per plant using a ruler. The leaf length was measured from the leaf base to the tip whereas the leaf length was measured at the broadest part of the leaf blade. The leaf area was the product of the leaf length, leaf width and number of leaves.

Leaf area determination: The Leaf Area (LA) was computed by multiplying the Leaf Length (LL) by the Leaf Width (LW) and the product multiplied by the correction factor;
LA= LL × LW × 0.578.

Leaf area index determination: The leaf area index (LAI) was determined as ratio of the leaf area of the whole plant to the area occupied by 1 plant using the base area of plot occupied by 1 plant;
LAI= (LA × number of leaves)/ area occupied by 1 plant

Table 1: Soil chemical and physical properties of the experimental site

pH (H_2O)	Exchangeable acidity (meq/100 g)	Available P (ug/kg)	Available K (ug/kg)
5.3	0.15	22	133

Table 2: Chemical and physical properties of kraal/cattle and chicken manure used in the experiment

Treatment	pH (H_2O)	Exchangeable acidity (meq/100 g)	Available P (μg/kg)	Available K (μg/kg)
Kraal manure	7.8	0.26	1490	2052
Chicken manure	8.0	0.31	4685	2149

Table 3: Weed infestation score (1 out of 6) as influenced by synthetic fertilizers, cattle manure and chicken manure on plots planted with lettuce (*Lactuca sativa*)

Treatment	Average score (out of 6)	Dominant weed species
Fertilizer (80 kg/ha)	3.5	*Oxalis latifolia*
Kraal manure (60 t/ha)	4.6	*Commelina banghalensis* L. *Ricardia brasilensis*
Kraal manure (40 t/ha)	4.2	*Commelina banghalensis* L. *Richardia brasilensis*
Chicken manure (60 t/ha)	5.4	*Richardia brasilensis* *Nicandra physaloides*
Chicken manure (40 t/ha)	4.5	*Richardia brasilensis* *Nicandra physalodes*

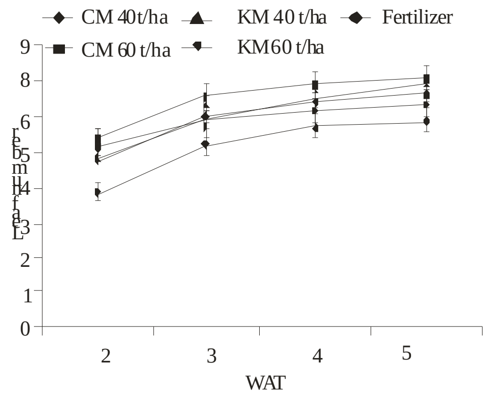

Fig. 1: Leaf number of lettuce (*Lactuca sativa* at 2, 3, 4 and 5 WAT for the various treatments

Fresh mass and dry mass determination: Five lettuce plants were sampled per plot at harvest. The plants were harvested, fresh mass or marketable yield was measured using a balance. These plants were oven dried at 70ºC for 48 h to determine the dry masses (Crozier *et al*., 2004).

Data analysis: The data collected were analysed using the M-SATC statistical package (Nissen, 1989). Data was subjected to analysis of variance (ANOVA) and where significant differences were detected mean separation test was performed using the Duncan's new multiple range test (DNMRT) (Steel and Torrie, 1980) at the 5%-probability level.

RESULTS

Soil analysis results: The results of the soil analysis are as shown in Table 1 while results of the chemical and physical properties of the kraal and chicken manure are as shown in Table 2.

Weed infestation: Weed infestation was highest in chicken manure applied plots followed by kraal manure applied plots and lastly inorganic fertilizer applied plots (Table 3).

Leaf number: Leaf number was significantly ($p<0.05$) higher in plants derived from chicken manure treated plots applied at 60 t/ha treatment and lowest in plants derived from chemical fertilizer treatment (Fig. 1). At 2 WAT, the mean leaf number was 5.8 for plants derived from chicken manure applied at 60 t/ha treatment, 5.6 for plants derived from kraal manure applied at 40 t/ha treatment, 5.4 for plants derived from chicken manure applied at 40 (t/ha) treatment, 5.8 for plants derived from kraal manure applied at 60 t/ha treatment and 4.4 for plants derived from the chemical fertilizer treatment (Fig. 1).

At 3 WAT the mean leaf number was 7.2 for plants derived from chicken manure applied at 60 t/ha and 5.6

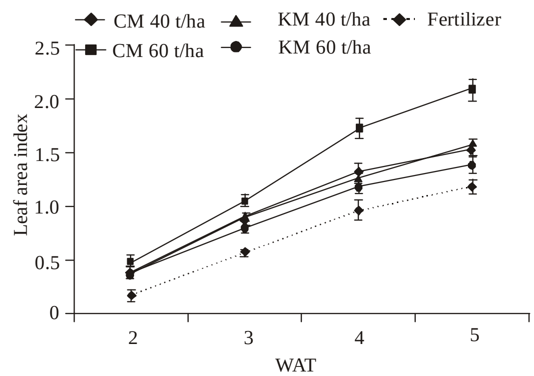

Fig. 2: Leaf area of lettuce (*Lactuca sativa*) at 2, 3, 4 and WAT for the various treatments

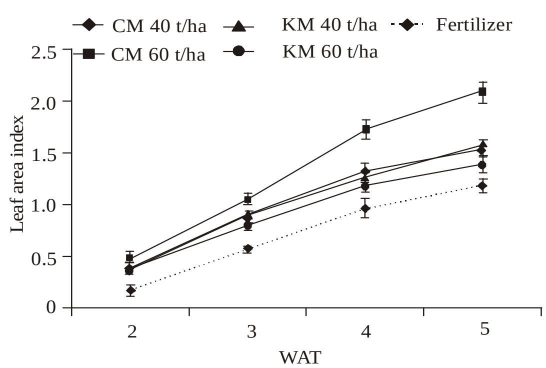

Fig. 3: Leaf area index of lettuce (*Lactuca sativa*) at 2, 3, 4 and 5 WAT for the various treatments

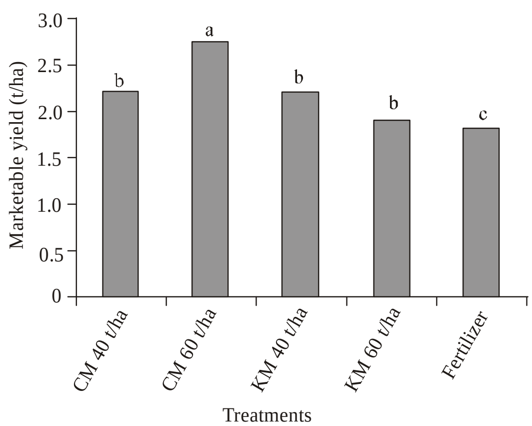

Fig. 4: Marketable yield of lettuce (*Lactuca sativa*) at 5 WAT for the various treatments. Treatments with different letters are significantly different at $p<0.05$

for plants derived from the chemical fertilizer treatment. At 4 WAT the mean leaf number was 7.7 for plants derived from chicken manure applied at 60 t/ha treatment, 6.9 for plants derived from kraal manure applied at 60 t/ha and 6.4 for plants derived from chemical fertilizer treated

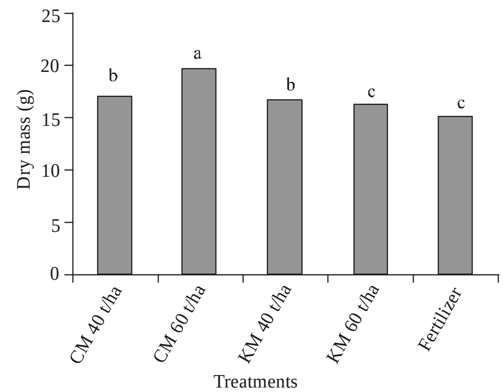

Fig. 5: Dry mass of lettuce (*Lactuca sativa*) at 5 WAT for the various treatments. Treatments with different letters are significantly different at $p<0.05$

plots. At 5 WAT the mean leaf number was 7.9 for chicken manure applied at 60 (t/ha) treatment, 7.8 for kraal manure applied at 40 (t/ha) treatment, 7.2 for chicken manure applied at 40 (t/ha) treatment, 7.1 for kraal manure applied at 60 t/ha treatment and 6.8 for the chemical fertilizer treatment (Fig. 1).

Leaf area: The leaf area was significantly ($p<0.05$) higher in lettuce provided with chicken manure at 60 t/ha and lowest in plants applied with chemical fertilizer. At 2 WAT the mean leaf area was 49.1 cm^2 in plants supplied with chicken manure at 60 t/ha and in decreasing order followed by plants supplied with chicken manure applied at 40 t/ha with 44.1 cm^2, plants supplied with kraal manure at 40 t/ha with 43.1 cm^2, plants supplied with kraal manure at 60t/ha with 38.5 cm^2 and lastly chemical fertilizer treatment with 24.8 cm^2 leaf area (Fig. 2).

Leaf area index: The leaf area index was significantly ($p<0.05$) higher in lettuce applied with chicken manure at 60 t/ha and lowest in plants provided with chemical fertilizer (Fig. 3). At 2 WAT the mean leaf area index was 0.487 for chicken manure supplied plants at 60 t/ha , 0.406 for kraal manure supplied plants at 40 t/ha, 0.411 for chicken manure supplied plants at 40 t/ha, 0.376 for kraal manure supplied plants at 60 t/ha and 4.4 for the chemical fertilizer treatment (Fig. 3).

Marketable yield: The marketable yield was significantly ($p<0.05$) higher in lettuce provided with chicken manure applied at 60 t/ha and lowest in plants provided with chemical fertilizer (Fig. 4). The plants from plots were chicken manure was applied at 60 t/ha had a mean plant marketable yield of 1.96 t/ha, 1.69 t/ha for chicken manure supplied plants at 40, 1.68 for kraal manure supplied plants at 40, 1.63 t/ha for kraal manure supplied plants at 60 and 1.52 t/ha for the chemical fertilizer treatment. The marketable yield of lettuce from plots applied with 40 t/ha kraal manure was not significantly ($p>0.05$) different from yield of lettuce from plots applied with 60 t/ha kraal manure or 40 t/ha chicken manure.

Dry mass: The leaf dry mass was significantly ($p<0.05$) higher in lettuce provided with chicken manure at 60 t/ha, and lowest in plants supplied with inorganic fertilizer (Fig. 5).

DISCUSSION

Different types of organic and inorganic fertilizers had varying effects on the growth and yield of lettuce. The highest leaf number was recorded in plants grown from chicken manure applied at 60 t/ha, which was significantly different from kraal manure applied at 40 t/ha and the lowest was obtained from the chemical fertilizer treatment. From the chemical analysis chicken manure showed to have more nutrients than kraal manure and thus the differences. These differences may be due to the availability of nutrients as affected by the water holding capacity of the soil (Jacobs *et al.*, 2003). Most probably because as the manure quantities increased the water holding capacity of the soil and subsequent nutrient release increased. Replacement of chemical fertilizer by organic manures has been reported to enhance soil biological activity, efficiency and the rate of microbial substrate use (Worthington, 2001). Recently higher yields of lettuce 'Veneza Roxa' were reported with chicken manure, and and in decreasing order cattle manure, bounce back and lastly inorganic fertilizer (Masarirambi *et al*., 2010). Increased vegetable yield with the use of manure has previously been reported for okra (Ogunlela *et al*., 2005).

The mean leaf area and marketable yield between the five treatments showed some variations. Overall, chicken manure lettuce from applied at 60 t/ha had the highest leaf area and marketable yield. However the marketable yield was not significantly different for chicken manure at 40 t/ha or kraal manure at 40 or 60 t/ha.Treatment to treated lettuce had the lowest mean leaf area and marketable yield. These results are in agreement with work done in Brazil where chicken manure, compost, charcoal, forest litter and chemical fertilizer 2:3:2(22) were tested during four cropping cycles with rice (*Oryza sativa* L.) and sorghum (S*orghum bicolor* L.) in five replicates in which the application of chicken manure amendments resulted in the highest cumulative yield (Fearnside *et al*., 2001). On the contrary, a study done by Worthington (2001) on the effects of applying organic fertilizers and inorganic fertilizers on the yield and nutritive value of head lettuce obtained equivalent yields regardless of the type of fertilizer used. In their studies with tomato their results showed that two organic fertilizer treatments provided better yield than chemical fertilizers (Yanar *et al*., 2011). It is important to note that marketable yield of lettuce from plots applied with 40 t/ha kraal manure was not significantly ($p>0.05$) different from yield of lettuce from plots applied with 60 t/ha kraal manure or 40 t/ha chicken manure. The reported levels of manure application most likely contained similar quantities of essential plant nutrients. In the case of kraal manure, there is no rationale at least from the results of this experiment to increase application rate from 40 to 60 t/ha when similar yield is obtainable.

The chicken manure treatments showed the highest weed infestation followed by kraal manure treatments and lastly inorganic manure, most likely because chicken manure provided the highest water holding capacity and nutrient release followed by kraal manure and lastly inorganic fertilizer. This trend was also similar in the promotion of lettuce crop growth. On the other hand the passing of seeds through animal digestive tracts has been reported to promote subsequent weed germination in some species after the breaking of dormancy.

CONCLUSION AND RECOMMENDATIONS

Lettuce plants grown in soil supplied with organic fertilizers showed better vegetative growth (leaf number, leaf area, fresh and dry weight) as compared to lettuce plants grown using inorganic fertilizers. The application of chicken manure at 60 t/ha is preferred as it was associated with higher leaf number, leaf area , fresh and dry masses of lettuce. The application of chicken manures at 60 t/ha is therefore recommended for farmers to use to obtain relatively higher yield. Results suggest that it is possible for organic farming to produce vegetables of higher yield than that of conventional farming with inorganic fertilizer. It is recommended that more research be conducted across different locations with varied ecology to validate the recommendation.

ACKNOWLEDGMENT

The authors would like to thank the Head of the Horticulture Department, of the University of Swaziland's Faculty of Agriculture for land allocation, technical and financial assistance.

REFERENCES

Anonymous, 2007. Johanas Announces Nitrogen Fertilizer Tool as Part of Energy Strategy. Retrieved from: http:// www.ssda.gov/portal/!ut/p/-s.7-0 1OB/.cmd/sd.sr/sa, (Accessed on: September 14, 2007).

Brady, N. and R. Weil, 2007. Nature and Properties of Soils. 13th Edn., Prentice Hall,New York, USA.

Browder, J.O., 1990. Extractive reserves will not save the tropics. Bio Sci., 40(9): 626.

Crozier, C.R., L.D .King and D.H. Greg, 2004. Tracing nitrogen movement in production systemsin the North Carolina Piedmont: Analysis of nitrogen pool size. Agron. J., 86: 642-649.

Deborah,K, 2006 change against to Against (put capital A)Hamilton, R., 2009. Change: Sci. American J. VOL: pp. to Sci. American, 19:16-17 (add vol. and pages)

Deshmukh, A.A., K.A. Gajare and M.M. Pillai, 2007. Protective effects of ethanolic extract of lettuce (*Lactuva sativa* L.) on neuronal lupifisino genesis in D galactose induced ageing accelerated albino mice. J. Herb. Med. Toxicol., 1(2): 43-47.

Eghball, B., 2001. Composting Manure and Other Organic Residue. Cooperative Extension (Nebguide), Institute of Agriculture and Natural Resources, University of Nebraska, Lincoln, Nebraska, USA.

FAO, 2008. Organic Materials as Fertilizers. Longman/FAO. Rome, Italy.

Ferguson, J. and M. Ziegler, 2004. Guidelines for Purchase and Application of Poultry Manure for Organic Crop Production. Retrieved from: http://edis.ifas.ufl.edu/HS217, (Accessed on: May 19, 2009).

Fearnside, P.M., P.M. Lima, A. Graca and F.J.A. Rodriques, 2001. Burning of Amazonian rainforest: Burning efficiency and charcoal formation in forest cleared for pasture near Manaus, Brazil. Ecol. Manage., 146: 115-128.

Filho, B.G.C., 2009. Growth of lettuce (*Lactuva sativa* L) in protected cultivation and open field. J. Appl. Sci. Res., 5: 529-533.

Grandy, A.S., G.A. Porter and N.S. Enrich, 2002. Organic management and crop rotation effects on the recovery of organic matter and aggregation in the potato cropping systems. Soil Sci. Soc. J., 66: 1311-1319.

Hamilton, R., 2009. Agriculture's sustainable future: Breeding better crops. Sci. American,19: 16-17.

Haynes, C., 2008. The Organic Green Revolution. Retrieved from: http://www.rodaleinstitute.org/ files/ GreenRevUP.pdf, (Accessed on: June 12, 2008).

Hue, N.V., 1992. Correcting soil acidity of lightly weathered ultisol with chicken manure and sewage sludge. Commun. Soil Sci. Plant Anal., 23: 241-264.

Jeavons, J., 1995. How to Grow More Vegetables. Ten Speed Press, California. USA.

Jacobs, R.D., D. Sloan and J. Jacob, 2003. Cage Layer Manure: An Important Resource for Land use. Retrieved from: http://edis.ifas.ufl.edu/PS005, (Accessed on: May 19, 2009).

Kuntashula, E., G. Sileshi, P.L. Mafongoya and J. Banda, 2006. Farmer participatory evaluation of the potential for organic vegetable production in the wetlands of Zambia. Otlook. Agric., 35(4): 299-305.

Maboko, M.M. and C.P. Du Plooy, 2008. Evaluation of crisphead lettuce cultivars (*Lactuca sativa* L.) for winter production in a soilless production system. Afr. J. Plant Sci., 2(10): 113-117.

Masarirambi, M.T., M.M. Hlawe, O.T. Oseni and T.E. Sibiya, 2010. Effects of organic fertilizers on growth, yield, quality and sensory evaluation of red lettuce (*Lactuca sativa* L.) 'Veneza Roxa'. Agric. Biol. J. North America, 1(6): 1319-1324.

Mathew, I.P. and S.K. Karikari, 1990. Horticulture Principles and Practices. Macmillan Press Ltd., London and Basingstoke, UK.

Ministry of Agriculture, Fisheries and Food, 1976. Organic Manures. London, UK.

Murdoch, G., 1970. Soils and Land Capability in Swaziland. Swaziland Ministry of Agriculture. Mbabane, Swaziland.

Muse, J.K., 1993. Inventory and Evaluation of Paper Mill By-products for Land Application. Unpublished M.Sc.Thesis. Auburn University, Auburn, Alabama, USA

Nissen, O., 1989. MSTAT-C a Micro Computer Programme Design, Management and Analysis of Agronomic Research Projects. Michigan State University, East Lansing, Michigan, USA.

Norman, J.C., 1997. Tropical and Sub-tropical Vegetable Crops. Longman. London, UK

Ogunlela, V.B., M.T. Masarirambi and S.M. Makuza, 2005. Effect of cattle manure application on pod yield and yield indices of okra (*Abelmoschus esculentus* L. Moench) in semi-arid and subtropical environment. J. Food Agric. Environ., 3: 5-15.

Ossom, E.M., 2005. Effects of weed control methods on weed infestation, soil temperature and maize yield in Swaziland. UNISWA Res. J. Agric. Sci. Technol., 8: 5-15.

Pimentel, D., P. Hepperly, J. Hanson, D. Douds and R. Seidel, 2005. Environmental, energeticand economic comparisons of organic and conventional farming systems. Bio Sci., 55(7): 573-582.

Steel, R.G. and J.H. Torrie, 1980. Principles and Procedures of Statistics. 2nd Edn., Mcgraw-Hill. Singapore.

Van Averbeke, A. and S. Yoganathan, 2003. Using Kraal Manure as Fertilizer. Department of Agriculture, Pretoria, South Africa.

Worthington, V., 2001. Nutritional quality of organic versus conventional fruits, vegetables andgrains. J. Altern. Complem. Med., 7(2): 342-353.

Yanar, D, N. Gebologlu, Y. Yanar, M. Aydin and P. Cakmak, 2011. Effect of different organic fertilizers on yield and fruit quality of indeterminate tomato (*Lycopersicon esculentum*). Sci. Res. Essay, 6(17): 3623-3628.