UNESWA Journal of Agriculture. 2019. Volume 20, pp. 22-28 http://ojs.uniswa.sz/
ISSN: 1029-0873

EFFECTS OF ORGANIC FERTILISERS ON GROWTH, YIELD AND NUTRITIONAL CONTENT OF SNOW PEAS (*Pisum sativum* var. *saccharatum*)

Kwanele A. Nxumalo[1*], Michael T. Masarirambi[1], Paul K. Wahome[1], Mathole Zwane[1] and Amos O. Fadiran[2]

[1]*Department of Horticulture, Faculty of Agriculture, Luyengo Campus, University of Eswatini, P.O. Luyengo M205, Swaziland.

[2]Department of Chemistry, Kwaluseni Campus, University of Swaziland, P.O. Kwaluseni M200, Eswatini.
* aknxumalo@uniswa.sz , Tel. /Fax +268 2527 0639

Abstract

*Snow peas (*Pisum sativum var. saccharatum*) are one of the widely used baby vegetable in Swaziland; however, there is a dearth of information pertaining to its organic production. A field study laid out in Factorial Randomised Complete Block Design was conducted at the Horticulture Farm, Luyengo Campus, of the University of Swaziland. Organic fertilisers used were kraal manure, broiler manure, and Igrow, applied at 20, 40, and 60 (t/ha). Inorganic fertilisers 2:3:2 (22) + 0.5% zinc and limestone ammonium nitrate (28%) were applied at 100 kg/ha and 80 kg/ha respectively. A trend of superiority of the different levels of organic manure application was observed as snow peas provided with 40 t/ha and 60 t/ha exhibited higher values in vegetative and reproductive growth, marketable yield and protein content especially on broiler and kraal manure application. The use of broiler manure at 40 t/ha and 60 t/ha in the production of vegetables like snow peas should be encouraged, because their application resulted in increased growth and yield compared to synthetic fertilisers.*

Keywords: Organic fertilizers, Yield, Growth parameters, Nutritional content, Snow peas

INTRODUCTION

Agriculture is the backbone of the Swazi economy and is characterised by a large number of small-scale vegetable growers (Masarirambi *et al.*, 2010). It is, therefore, necessary to increase vegetable production in order to meet the needs of the increasing population. Since vegetables play a pivotal role in providing a good source of vitamins, minerals, proteins and carbohydrates which are important to human nutrition, their cultivation must be promoted (Deshmukh *et al.*, 2014). Also, large scale vegetable production provides employment and thus income, ensuring food security at household level and is very crucial for foreign exchange earnings (Esawy *et al*., 2009).

Recently, there has been a global shift from chemical fertilizer to organic fertilizer which is renewable, quite easily accessible, and relatively cheap (Omueti *et al.*, 2000). In Africa, soil structure and fertility is maintained or enhanced by the use of animal manure, compost, farm wastes and green manure (Gana, 2008). The application of organic wastes combined with or without mineral fertilizer to soil is considered a good management practices in any agricultural production system because it improves plant quality and soil fertility (Esawy *et al.*, 2009). Besides 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 (Xu *et al*., 2005).

Pea (*Pisum sativum*) is one of the important vegetables in the world and ranks among the top 10 vegetable crops of the world (Gad El-Hak *et al.*, 2012). Pea is commonly used in human diet throughout the world and it is rich in protein (21-25%), carbohydrates, vitamin A and C, calcium, phosphorous and has high levels of amino acids, lysin and tryptophan (Babatola *et al.*, 2008). The cultivation of this vegetable maintains soil fertility through biological nitrogen fixation in association with symbiotic *Rhizobium* bacteria prevalent in its root nodules (Ganie *et al.*, 2009). Thus, it plays a vital role in fostering sustainable agriculture. Apart from meeting its own requirement of nitrogen, peas are known to contribute significant residual nitrogen in soil 50-60 kg/ha (Mishra, 2014).

While growing approximately 3 million tons of peas per year, Canada is currently the largest world producer and exporter of peas (Babatola *et al.*, 2008). France, China, Russia, and India are also large-scale producers of this legume vegetable crop. Despite being a large-scale producer of peas, India is also the world's largest importer of this vegetable due to its great popularity in that country (Babatola *et al.*, 2008).

The information regarding organic and inorganic fertilizer on pea growth, yield and its nutritional quality is very meager under the local climatic conditions. Also, as a result of increased popularity of organic vegetable production, more information is needed pertaining to the growth, yield and nutritional content of vegetable crops produced using organic or inorganic fertilizer. Therefore, the objectives of this study were to determine the growth, and yield of snow peas when applied with organic manures, and to determine the nutritional content of organically produced peas.

MATERIALS AND METHODS

Experimental site: The research was conducted at the Horticulture Department Experimental Farm in the Faculty of Agriculture, Luyengo Campus of the University of Swaziland, between July and October 2015. This farm is located between latitude 26°58' S and longitude of 31°18' E at an altitude of 734 m above sea level. The mean annual precipitation is 980 mm with most of the rain falling between October and April. The average summer temperature is 27ºC and winter temperature is about 15ºC. The soil type is an oxisol (M-set) of the Malkerns series (Murdoch, 1970).

Experimental design: The experiment was a 3 x 4 factorial laid out in a Randomized Complete Block Design (RCBD). Experimental plots were 3 x 3 m in size and separated by 1 m foot-paths. Intra-row spacing was 30 cm and inter-row 60 cm, with each plot having six rows. The four inner rows were used for data collection, whilst the two outer rows were used as guard rows. Each treatment was replicated three times.

Fertilisation: There were four different types fertilisers used at basal dressing, i.e. broiler manure, kraal manure, Igrow and 2:3:2 (22) + 0.5 Zn (control). Igrow is a slow release organic made from different animals including horses, goats, cattle and chickens. Igrow is a blend of a similar organic fertiliser found in Holland, a country which is known to be the best in organic farming throughout Europe (Sibandze (2015). The broiler manure, kraal manure and Igrow were applied at different levels which were 20, 40 and 60 t/ha. The control, 2:3:2 (22) + 0.5 Zn was applied at 100 kg/ha at basal dressing and later Limestone Ammonium Nitrate (LAN) was used for top-dressing at the rate of 80 kg/ha after two weeks. The method of application was the banding and incorporation method. Both kraal and chicken manures were kept in the open for four weeks, to "age" or allow for further decomposition (Sajitha *et al.*, 2007). Organic manures were applied one month before planting by broadcasting and incorporated into the soil. The aged manures were incorporated into the soils using a fork three weeks before planting at the different levels specified in the treatments and they were irrigated to field capacity twice a week to activate the action of micro-organisms in them.

Plant materials and planting: Planting was done on 22nd July 2015 using snow pea seeds (*Pisum sativum* var. *saccharatum*). The seeds were bought from National Agricultural Marketing Board, Manzini, Swaziland. Two seeds were planted per station. Cultural practices such as irrigation, weeding, diseases and pest control, uniformly carried throughout the period of the experiment.

Data collection: Four randomly selected plants were sampled per plot for data collection. Data was collected every two weeks after germination until harvesting. Data collection included the following parameters: number of leaves, leaf area, chlorophyll content, plant height, number of flowers, number and length of pods, number of root nodules, fresh and dry masses of shoots and roots, weed density, marketable yield, and soil moisture content.

Chlorophyll Content measurement: a chlorophyll meter (SPAD-502 meter, Tung Yung LTD, Beijing, China) was used to determine the chlorophyll content of leaves per sampled plants.

Determination of crude protein and mineral content: The determination of crude protein and mineral content was carried out using the procedure outlined by Association of Analytical Chemists (2000). Determination of minerals was done using the wet digestion method as outlined by Association of Analytical Chemists (2000).

To calculate nitrogen percent of sample the following formulae was used:

$$N\% = \frac{(ml\ acid\ titrated - ml\ blank\ titrated) \times 0.1 \times 0.14 \times 100}{weight\ of\ sample\ (g)}$$

$$Crude\ protein\ (CP)\% = N\% \times 6.25$$

$$Adjust\ \%\ CP\ on\ DM\ basis = \frac{CP\%\ on\ sample}{DM\ on\ sample} \times 100$$

Standard solutions of 0.5ppm, 1.0 ppm, 1.5ppm, and 2.0 ppm were prepared from a 1000 ppm stock solutions of calcium, iron, magnesium, potassium, phosphorus, manganese and zinc using the formula: $C_1V_1 = C_2V_2$. With a known concentration (C_2) and volume (V_2) required, the volume of the 1000 ppm stock solution was calculated and necessary dilutions were done to make V_2. Standards were run in the atomic absorption spectrophotometer (AAS) to determine their absorbance from which calibration curves were plotted.

Data analysis: Data collected was subjected to analysis of variance (ANOVA) in a Randomised Completely Blocked Design, using MSTAT-C (Nissen, 1989) statistical software. Where statistical differences were detected, means were separated using the Duncan's New Multiple range Test (DNMRT) at P≤0.05 (Gomez and Gomez, 1984).

RESULTS

Plant height: The results showed significant (P<0.05) differences in growth amongst treatments. The highest plants were obtained from snow peas provided with 40 t/ha kraal manures (Figure 1). The lowest plant height was obtained from snow peas supplied with kraal manure at 20 t/ha.

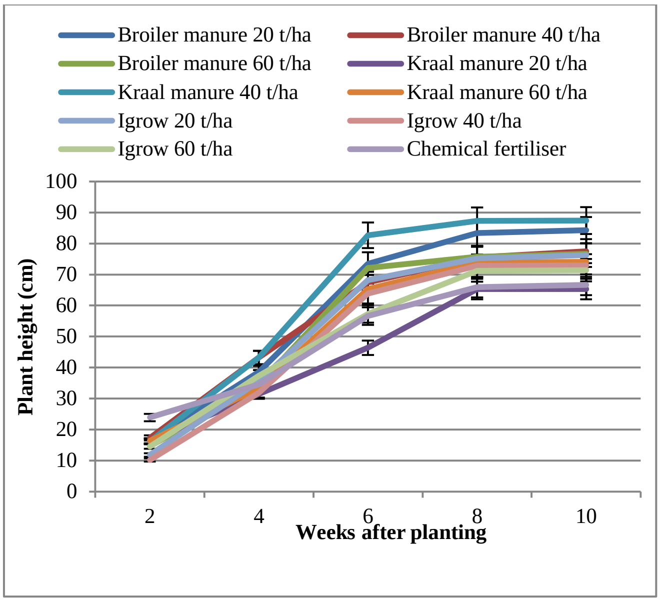

Figure 1: The effects of fertilisers on plant height in snow peas. Vertical bars represent standard error (SE±) below and above the mean.

Chlorophyll content of snow peas: There was no significant (P>0.05) difference on chlorophyll content between the different organic manures as well as the different application rates at 2 WAP. However, significant (P<0.05) differences were observed at 4, 6, 8, and 10 WAP. The highest chlorophyll content at 10 WAP was 62.5 nm which was obtained from plants supplied with broiler manure at 60 t/ha (Figure 2). The lowest chlorophyll content was 32.5 nm obtained from plants supplied with Igrow at 40 t/ha.

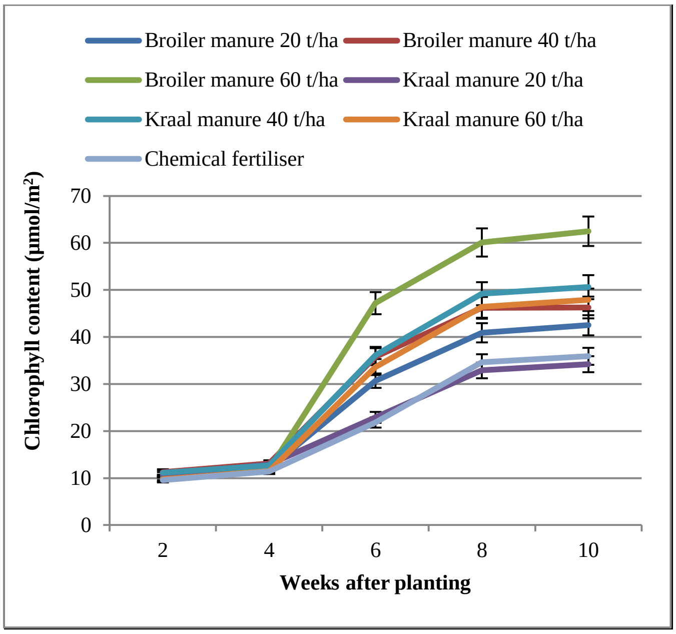

Figure 2: The effects of fertilisers on chlorophyll content of snow peas. Vertical bars represent standard error (SE±) below and above the mean.

Leaf area of snow peas: Significant (P<0.05) difference on leaf area between the different organic manures as well as the different application rates were observed at 2 and 4 WAP, while significant (P<0.01) difference were observed at 6, 8 and 10 WAP. The highest leaf area was 242.9 cm^2 which was obtained from plants supplied with broiler manure at 60 t/ha (Figure 3). The lowest leaf area was 83.1 cm^2 obtained from plants supplied with kraal manure at 20 t/ha.

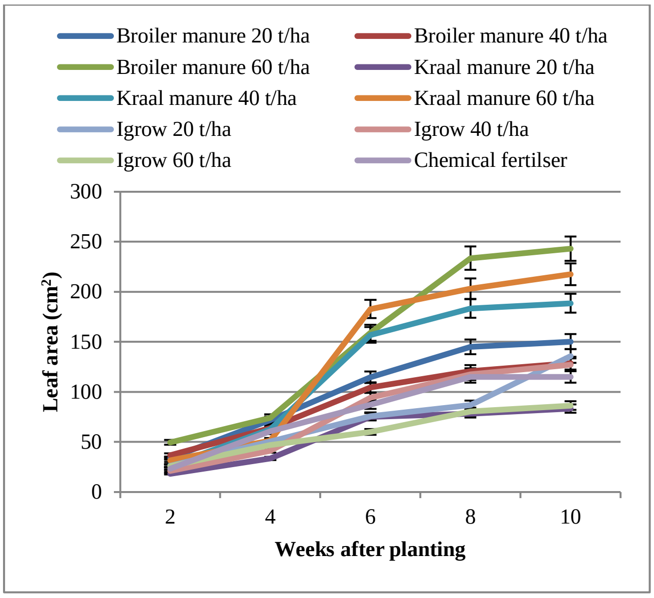

Figure 3: The effects of fertilisers on leaf area of snow peas. Vertical bars represent standard error (SE±) below and above the mean.

Number of leaves: The average number of leaves per plant was significantly (P< 0.05) different across all treatments. The highest number of leaves was obtained from snow peas provided with 60 t/ha broiler manures. Number of leaves decreased with each increase in level of chicken manure applied after 6 WAP (Figure 4). The lowest leaf number (74) was obtained from plants supplied with Igrow at 40 t/ha.

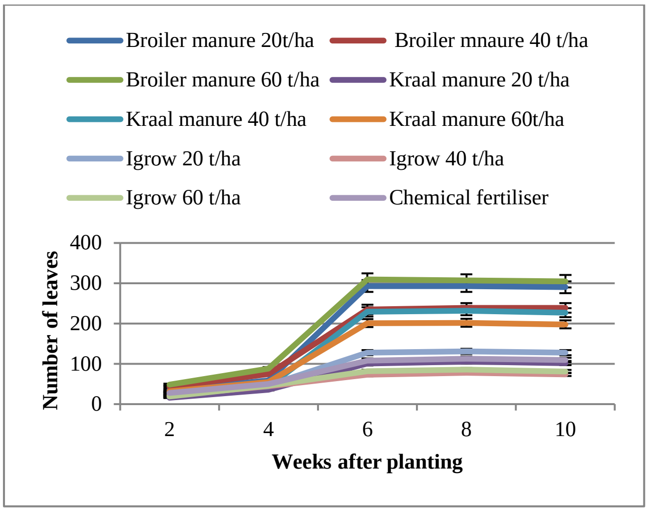

Figure 4: The effects of fertilisers on the number of snow pea leaves. Vertical bars represent standard error (SE±) below and above the mean.

Number of snow pea flowers: There were significant (P<0.01) differences on number of flowers between the different organic manures as well as the different application rates (Figure 5). The highest number of flowers (45) at 10 WAP was obtained from plants supplied with broiler manure at 20 t/ha. The lowest number of flowers (19) was obtained from plants supplied with kraal manure 20 t/ha and chemical fertiliser.

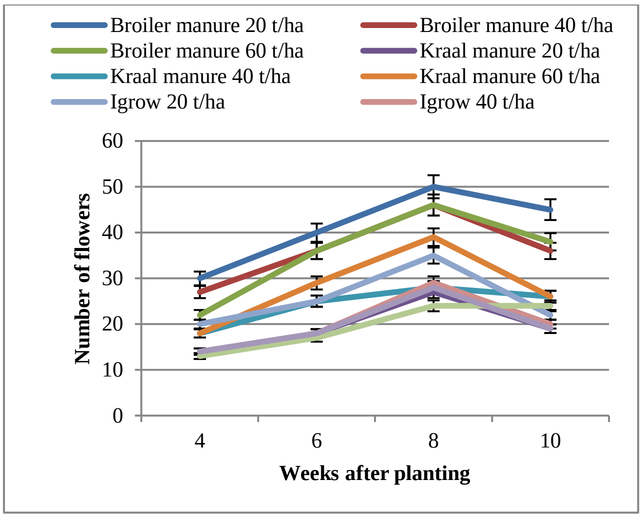

Figure 5: The effects of fertilisers on the number of snow pea flowers. Vertical bars represent standard error (SE±) below and above the mean.

Number of snow pea pods: There were significant (P<0.01) differences on pods number between the different organic manures as well as the different application rates (Figure 6). The highest number of pods (54) was obtained from plants supplied with broiler manure at 20 t/ha. The lowest number of pods was 28 obtained from plants supplied with Igrow at both 40 t/ha.

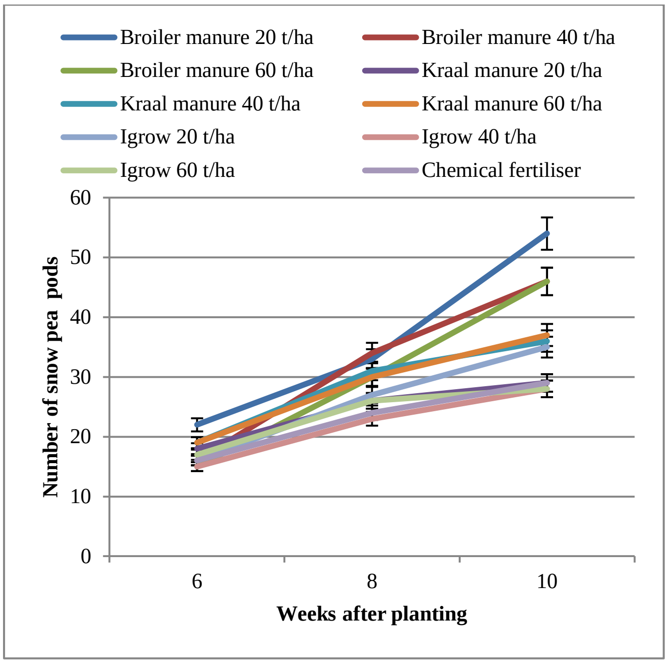

Figure 6: The effects of fertilisers on number of snow pea pods. Vertical bars represent standard error (SE±) below and above the mean.

Pods length of snow peas: There were significant (P<0.05) differences in pods length between the different organic manures as well as the different application rates (Figure 7). The highest pod length was 10.1 cm which was obtained from plants supplied with kraal manure at 20 t/ha. The lowest pods length was 6.5 cm attained by plants supplied with broiler manure at 60 t/ha.

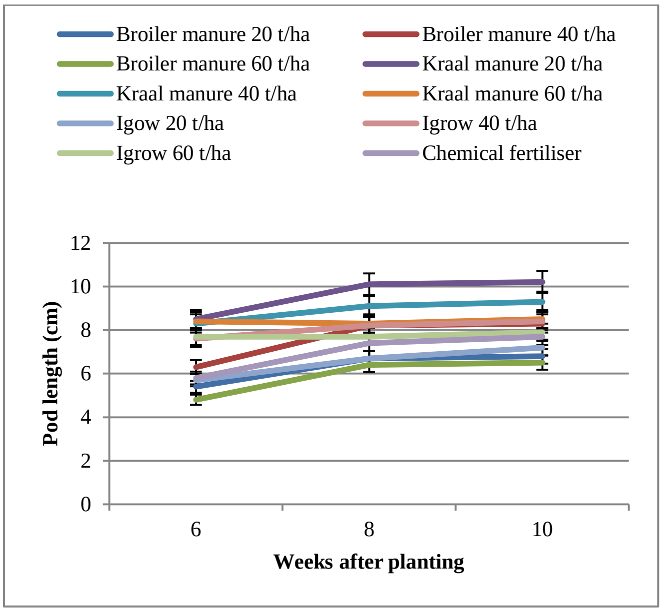

Figure 7: The effects of organic fertilisers on pods length of snow peas. Vertical bars represent standard error (SE±) below and above the mean.

Fresh mass of pods: There were significant (P<0.05) differences in fresh mass of snow pea pods among the different fertilisers as well as the different application rates (Figure 8). The highest fresh weight was 49.3 g, which was obtained from plants supplied with broiler manure at 40 t/ha. The lowest fresh mass of pea pods was 31.4 g obtained from plants supplied with Igrow at 60 t/ha.

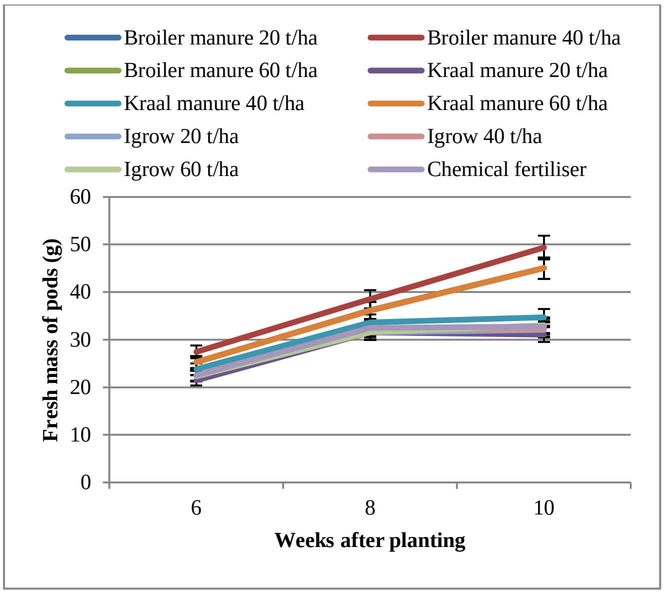

Figure 8: The effects of fertilisers on fresh mass of snow pea pods. Vertical bars represent standard error (SE±) below and above the mean.

Dry mass of pods: There were significant (P<0.05) difference in dry mass of snow pea pods among the different fertilisers as well as the different application rates (Figure 9). The highest dry mass at 10 WAP was 14.8 g, which was attained from plants supplied with kraal manure at 60 t/ha. The lowest dry weight was 5.4 g obtained from plants fertilised with Igrow at 60 t/ha.

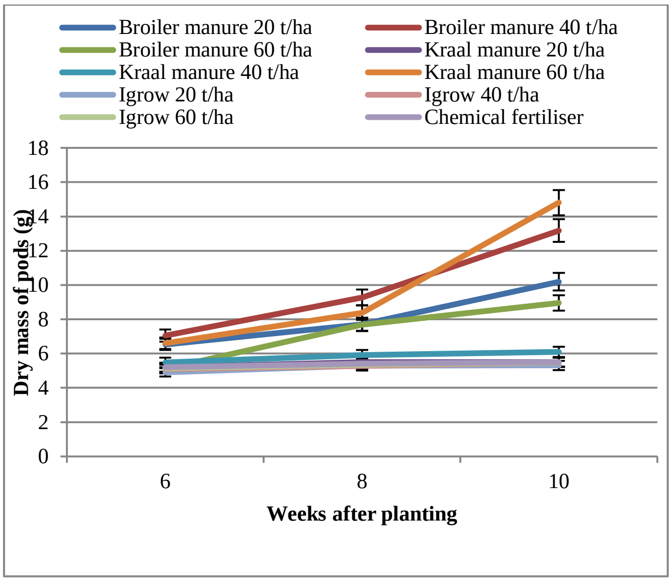

Figure 9: The effects of fertilisers on dry mass of snow pea pods. Vertical bars represent standard error (SE±) below and above the mean.

Protein content of snow pea pods: There were significant (P<0.05) difference in the protein content between the different treatments (Figure 10). The highest protein content was 5.9 g/100 g attained from kraal manure at 40 t/ha. The lowest protein content was 4.1 g/100 g from kraal manure at 20t/ha.

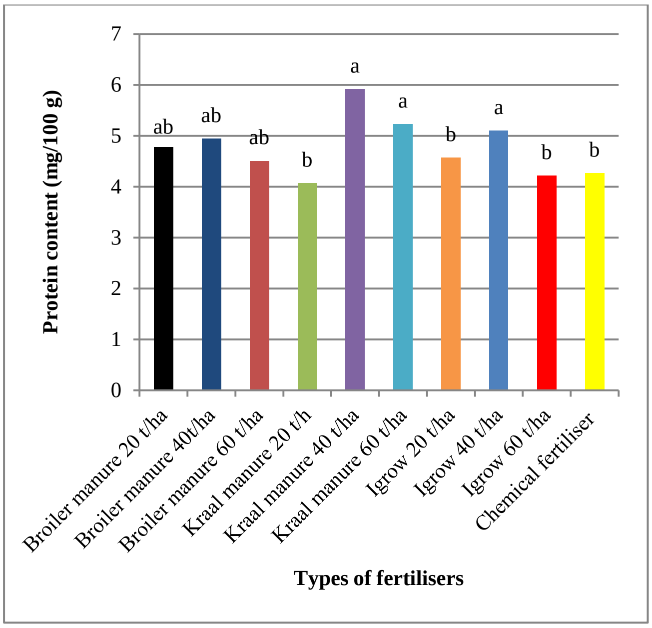

Figure 10: The effects of fertilisers on protein content snow pea pods.

Bars followed by the same letter are not significantly different. Mean separation by DNMRT at P=0.05

DISCUSSION

Plants that were fertilized with kraal manure at 40 t/ha and chicken manure at 40 and 60 t/ha exhibited higher growth and yield parameters. Similar results have been reported in the growth and yield of kohlabi (*Brassica aleraceae* var. gongylodes) [Uddin *et al*., 2009]. The authors reported that this could be attributed to the nutrient content of the fertilizer used. Cooperband (2002) reported that, the positive influence of poultry manure on the growth of the crop might be due to release of the balanced nutrients contained in the organic matter. Xu *et al.* (2005), Habimana *et al*. (2015) and Ouda and Mahadeen (2008) reported that increased leaf area implies higher light interception, increased the size of photosynthesizing surface and dry matter production, which invariably promotes plant growth.

Snow pea plants applied with broiler manure exhibited relatively higher marketable yield and fresh weight of plants than those receiving the other kinds of fertilisers. . The longest pods were obtained in plants applied with kraal manure at 40 t/ha. Similar findings observed by Ganie *et al*. (2009) in garden pea, Sajitha *et al.* (2007) in garden bean and Sammauria *et al.* (2009) in cluster bean. Ogunlela *et al*. (2005) reported that kraal manure was also found to increase pod yield of okra. This could be attributed to the large quantities of available phosphorus and available potassium contained in the broiler manure, which may alter the pods length (Ogunlela *et al*., 2005). Industrial fertilisers do not possess good characteristics of aggregating the soil particles, thus the plants produced by inorganic fertilisers showed relatively lower yield compared to organic materials. Reduction in quality attributes due to chemical fertilizers can be attributed to the fact that they provide either single or two essential nutrients (Masarirambi *et al*., 2010).

Broiler manure applied at 20 t/ha resulted in plants with higher number of flowers and pods compared to the other fertilisers. Similar observations were made on different levels of poultry manure on performance of cluster bean Deshmukh *et al*. (2014). They reported that yield depended on the number of flowers produced and the loss of flowers or pods inversely affected it. Increased growth and number of pods per plant was due to increase in leaf area, which resulted in increased photosynthesis of cluster bean (Sajitha *et al*., 2007).

Kraal manure applied at 60 t/ha, broiler manure at 20 and 40 t/ha had no significant difference on the dry weight of pods. This is similar to a study by Magkos *et al*. (2003), who evaluated the dry matter content of several vegetables and found that organically cultivated crops had higher dry matter content than those grown conventionally. However, these findings were evident only for the plants that grow above the ground (leafy vegetables) such as spinach, lettuce, Swiss chard and savoy cabbage. Ganie *et al*. (2009) postulated that this trend was expected given the initial difference in total N, P and K of all three manures. The residual effects of applied manure vary with type of manure origin, nutrients content, which consequently affects the synthesis, and accumulated amount of food in pods (Ganie *et al*., 2009). Masarirambi *et al*. (2010) also reported that there were considerable variations in mean leaf dry matter of red lettuce among treatments which were 40 t/ha for chicken and cattle manures, 1.5 t/ha basal dressing and 1.0 t/ha side dressing for bounce back compost.

In all the treatments, the type of fertiliser and rate of application resulted in no significant effects in mineral composition of snow peas on fresh mass basis. However, significant differences were found on protein content with kraal manure fertilised plants at 40 t/ha recording the highest protein content. This is consistent with findings by Awodun (2007) in that organic manures produced significantly nutritious pumpkins compared to conventionally produced ones. Masarirambi *et al*. (2010) reported a significant effect in the mineral composition of red lettuce on fresh mass basis, with organic fertilisers having higher mineral contents. The authors explained that this could be attributed to the balanced quantity of nutrients in the organic manures. Worthington (2001) and Magkos *et al*. (2003) reported that although a small number of studies have been published, slightly higher contents of minerals have been obtained in organic vegetables. However, the majority of evidence has revealed no significant difference between organic and conventional vegetables (Worthington, 2001).

CONCLUSION

The study revealed that both synthetic and the organic manures improved the growth performance of snow peas, but to varying degrees. Application of organic manures in higher amount is not always beneficial, because almost similar results were obtained at 40t/ha or at 60t/ha. Inorganic fertiliser application resulted in lower yield compared to organic manures in the production of snow peas at Luyengo. However, the inorganic manure performed much better than the organic manure Igrow in most cases. The use of organic manure in the production of vegetables such as snow peas should be encouraged, because their application has resulted in increased growth and yield compared to synthetic fertilisers in this study and in other studies previously conducted across the world.

REFERENCES

Association of Analytical Chemists. (2000). *Methods of analysis, 12th edition*. Association of Analytical Chemists, Washington D.C, USA.

Awodun, M.A. (2007). Effect of poultry manure on the growth, yield and nutrient content of fluted pumpkin

(*Telfaria accidentalis* Hook). F). *Asian Journal of Agricultural Research*, 1:67-73.

Babatola, L. A., Ojo, D. O. and Lawal I. O. (2008). Influence of storage conditions on quality and shelf life of stored peas. *Journal of Biological Sciences*, 8(2): 446- 450.

Brady, N. and Weil, R. (2007). *Nature and properties of soils*, 13th edition, Prentice Hall, New York, USA.

Cooperband, L. (2002) Building soil organic matter with organic amendments. Centre for Integrated Agricultural Systems. Unpublished M.Sc. Thesis, University of Wisconsin, Madison, Wisconsin, USA.

Deshmukh, R.P., Nagre, P.K., Wagh, A.P. and Dod, V.N. (2014). Effect of different bio- fertilizers on growth, yield and quality of cluster bean. *Indian Journal of Advances in Plant Research*, 1(2): 39-42.

Esawy, M, Nasser, A., Paul, K. R., Nouraya, A. C. and Lamyaa, A. R. (2009). Effects of different organic and inorganic fertilizers on cucumber yield and some soil properties. *World Journal of Agricultural Sciences*, 5(4): 408-414.

Gad El-Hak, S. H., Ahmed, A. M. and Moustafa, Y. M. M. (2012). Legumes in the cropping systems of North-East Thailand. *Journal of Horticultural Science and Ornamental Plants*, 4 (3): 318-328.

Gana, A. K. (2008). Effects of organic and inorganic fertilizers on sugar-cane production. *African Journal of General Agriculture*, 4 (1): 1595-6984.

Ganie, N.A., Solanki R.B. and Allie, F.A. (2009). Effect of bio-fertilizers on growth and yield of garden pea (*Pisum sativum* L). *The Asian Journal of Horticulture,* 4(2): 507-509.

Gomez, K. A. and Gomez, A. A. (1984). *Statistical procedure for agricultural research*. 2nd edition. John Wiley and Sons, Singapore.

Habimana, S., Mukeshimana, C., Ndayisaba, E., and Nduwumuremyi, A. (2015). Effect of poultry manure and NPK (17-17-17) on growth and yield of carrot in Rulindo District, Rwanda. *International Journal of Novel Research in Life Sciences*, 2 (1):42-48.

Magkos, F., Arvaniti, F. and Zampelas, A. (2003). Organic food: Nutritious food or food for thought? A review of evidence. *International Journal of Food Science and Nutrition*, 54: 357-371.

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

Mishra, N. (2014). Growth and yield response of pea *(Pisum sativum* L.) to integrated nutrient management. A review. *Journal of Plant and Pest Science*, 1 (2): 87-95.

Murdoch, G. (1970). *Soils and land capability in Swaziland*. Swaziland Ministry of Agriculture, Mbabane, Swaziland.

Nissen, O. (1989). *MSTAT-C a micro-computer programme design, management and analysis of agronomic research projects*. Michigan State University, East Lansing, Michigan, USA.

Ogunlela, V. B., Masarirambi, M. T. and Makuza, S. M. (2005). Effects of cattle manure application on pod yield and yield indices of okra (*Abelmoschus esculentus* L. *Moench*) in semi-arid and subtropical environment. *Journal of Food, Agriculture and Environment*, 3(1): 125-129.

Omueti, J. A. I., Sridhal, M. K. C., Adeoye, G. O., Bamiro, O., & Fadare, D. A. (2000). *Organic Fertilizer use in Nigeria*: *Agronomy in Nigeria*. Polygraphic press, Ibadan, Nigeria, 208-215.

Ouda, B.A. and Mahadeen, A.Y. (2008). Effect of fertilizers on growth, yield components, quality and certain nutrient contents in broccoli (*Brassica oleracea L.*). *International Journal of Agriculture and Biology*, 10(5): 627-362.

Sajitha, J.P., Haripriya, K., and Mahesweri, U., Stella, D. (2007). Impact of organic nutrients on yield and quality of garden bean. *Acta Horticulture*, 5(7): 485-487.

Sammauria, R., Yadav, R.S., and Nagar, K.C. (2009). Performance of cluster bean (*Cyamopsis tetragonoloba*) as influenced by nitrogen and phosphorus fertilization and biofertilizers in western Rajasthan. *Indian Journal of Agronomy*, 54 (3):319-323.

Sibandze, S. (2015). Food security begins in your backyard. *Igrow organic fertiliser*. Times of Swaziland, June 5, 2015. Mbabane, Swaziland.

Suslow, T. V. and Cantwell, M. (2013). Effect of continuous cropping and fertilization on chemical properties of soil. Department of Plant Sciences, University of California, Davis, USA.

Uddin, J., Solaiman, A.H.M. and Hasanuzzaman, M. (2009). Plant characteristics and yield of Kohlabi (*Brassica oleracea* var. *gongylodes*) as affected by different organic manures. *Journal of Horticulture Science and Ornamental Plants*, 1 (1): 1-4.

Worthington, V. (2001). Nutritional quality of organic versus conventional fruits, vegetables and grains. *Journal of Alternative Complentary Medicine*, 7: 161-173.

Xu, H.L., Wang, R., Xu, R.Y., Mridha, M.A.U. and Goyal, S., (2005). Yield and quality of leafy vegetables grown with organic fertilisations. *Acta Horticulture*, 627 (13): 25-33.

