EFFECTS OF NUTRIENT SOURCE AND LEAF HARVESTING INTENSITY ON PUMPKIN (*Cucurbita moschata* Duch.): 2. VEGETATIVE AND REPRODUCTIVE GROWTH COMPONENTS

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ABSTRACT
Multi-purpose pumpkin is an important vegetable that has gained popularity in Kenya. It is rich in mineral nutrients and antioxidant properties. The crop is sensitive to management practices, including defoliation that removes photosynthetic machinery. For better growth and development, balanced leaf removal and re-growth are necessary. Severe harvest of leaves compromises physiological functions that influence yields. Farmers in Kenya harvest the leaves indiscriminately and leave the plants to grow without any improvement in agronomic practices. As a result, the yields experienced remain suboptimal and poor in quality. To address this problem, an experiment was conducted at two sites in Kakamega and Nyeri Counties to elucidate the impact of varied leaf harvesting intensity and nutrient sources on vegetative and reproductive growth components that impact subsequent leaf and fruit yields and quality. The experimental design was Randomized Complete Block Design, with four replications. The factorial arrangement treatments were nutrient source (0, 4 g 10N:10P:10K, 5 and 10 t/ha farmyard manure) by leaf harvesting intensity (0, 1, 2 and 3 leaves per vine per week). Plants were spaced at 2 m x 4 m, with one plant per experimental unit. Data values were collected and subjected to analysis of variance. Means were separated using the Tukey's HSD test at $P = 0.05$. Results showed that leaf harvesting intensity and nutrient source had significant ($P<0.05$) effects on number of vines, leaf area and chlorophyll content index. The treatments did not significantly influence male to female flower ratio and mineral nutrient contents in leaf tissue, except phosphorous that significantly affected by nutrient source in Kakamega. The number of vines and leaf area increased with decrease in leaf harvest intensity and increase in FYM. The CCI increased with increase in FYM, but was constant for leaf harvesting intensity. The sex ratio ranged from 1 to 3 male flowers per 1 female flower, and was highest for no leaf harvesting and lowest for 3 leaf harvesting. The trends observed in these vegetative and reproductive growth components end up impacting edible leaf and fruit yields and quality either positively or negatively, depending on the function they perform in plants.
Keywords: Leaf area, Sex ratio, Farmyard manure, Pruning, Training

INTRODUCTION
In the FAO (2000) statistics, world production of pumpkin in African was low, estimated at 1.8 million tonnes on 140,000 ha, corresponding to about 12.8 t/ha and subsistence scale. In the report, no detailed information per species or country was availed. In Kenya, multi-purpose local pumpkin is variously described as "orphaned", "minor", "neglected", "under-utilized", "under-developed", or "under-exploited" species (Naluwairo, 2011). Moreover, it is regarded a "woman's" crop and not seriously considered a commercialisable crop (Ondigi *et al*., 2008). Consequently, it is mainly grown in marginal areas including abandoned cattle barns, kitchen waste dumpsites, and demolished mud houses (Masayi and Netondo, 2014). It is never readily available and users gather it with great drudgery and difficulty from volunteer stands in nature (Adebooye *et al*., 2003). Introduction of exotic pumpkin in mainstream agriculture has seen local pumpkin only used minimally during famine and by resource-poor households (Mnzava, 1997; Grubben and Chigumira-Ngwerume, 2004). Local pumpkin is studied little and has scanty physiological and developmental information documented. Consequently, it has remained "under-utilized" in many African countries economic development (Naluwairo, 2011). It receives little research and development attention owing to neglect by diverse stakeholders. In most institutions, research efforts with high precision equipment are concentrated on cash and staple crops, leaving local pumpkin with limited information to improve crop husbandry and post-harvest handling to suit consumer preferences and attract high-end markets.

Nonetheless, spreading pumpkin vines (branches) supply leaves, which are removed in succession for use as vegetables in food dishes. The crop is mainly grown as leaf vegetable on a subsistence scale, where the third and fourth leaves are harvested, while the tip and second leaves are left intact to grow bigger. In Kenya, rarely is the crop grown on commercial scale and for fruit production. Leaf harvesting may start 6 weeks after sowing and end when tender leaves stop emerging on vines. Male flowers are sometimes harvested for consumption. Occasionally, pumpkin fruits are picked when fully mature in several rounds until the primary and secondary production cycles end. Some farmers leave fruits lying in the fields for weeks owing to lack of postharvest handling knowledge or suitable storage facilities. In cases where fruits are consumed, seeds are extracted and often discarded. A few are stored for future planting or exchange with neighbours to grow. In spite of indiscriminate harvesting, leaves are very essential, especially for physiological purposes such as biosynthesis, photosynthesis and transpiration. Leaf defoliation compromises produce yield and quality on many small-scale farms in Kenya. As result, farmers end with low yields, which cannot be commercialised to date (Guha and Sen, 1998).

It is obviously known that achieving a good plant stand is a good start to premium yields and quality. Supplying plant growth essential nutrients in available form is one of the important ways that can help defoliated plants recover the photosynthetic leaves (Mondel *et al*., 1978). Poor soil fertility is recognized as an impediment to food production and farm incomes in Africa (Stoorvogel *et al*., 1993; Sanchez *et al*., 1996; Place *et al*., 2003). Pumpkin plants grow well on organic matter and are often encountered on manure and compost heaps, but on a small-scale. When grown formally, pumpkin responds well to compost and side-dressing with liquid manure. In modern production trends, application of 50–100 kg/ha N, 20–40 kg/ha P and 40–80 kg/ha K during the vegetative phase is recommended, depending on inherent soil fertility. Top-dressing with 50 kg/ha 10N:10P:10K after three and six weeks post-germination is recommended.

The general objective of the present study was to enhance productivity and quality of multi-purpose pumpkin through application of optimal leaf harvesting and nutrient rates that could be adopted by smallholder farmers. The specific objective was to determine the combined effect of nutrient source and leaf harvesting intensity and their interaction on biosynthetic, vegetative and reproductive growth components that subsequently impact leaf and fruit yields and quality.

MATERIALS AND METHODS

Site Description

The present research was conducted in two agro-ecologically different sites. One site was located in Kakamega at latitude 0º28'S and longitude 34º75'E. The other site was located in Nyeri at latitude 0º41'S and longitude 37º16'E (Jaetzold *et al*., 2005). The two sites were chosen because they are regional service units recommended for implementation of the pumpkin productivity and agribusiness project on a large-scale to benefit small-scale farmers there nd beyond. Seeds used were of multi-purpose pumpkin (*Cucurbita moschata* Duch.) local landrace preferred for its edible leaves, fruits and occasionally seeds. It is cultivated in almost all countries in the tropics (Grubben and Chigumira-Ngwerume, 2004) and its increasing demand and tolerance to tropical climatic conditions necessitates growth, development and physiological studies. The research was conducted in a 4 x 4 factorial arrangement embedded in a randomized complete block design with four replications at each site in Kakamega and Nyeri. The two factors studied were: nutrient source (0, 4 g 10N:10P:10K standard rate, 5 and 10 t/ha farmyard manure) and leaf harvesting intensity (0, 1, 2 and 3 leaf-harvest once per branch per week). One plant formed an experimental unit, and the plants were spaced at 2 m by 4 m. Blocks were separated by 2-m paths. The experimental field was prepared mechanically by digging in Nyeri, ploughing and harrowing in Kakamega to pulverise and produce a fine tilth. The NPK and FYM were applied to respective holes and mixed with the soil. The pumpkin seeds were germinated and grown in a nursery until they attained the 2-true leaf stage. The seedlings were transplanted to the main fields and planted in the prepared holes. The plants were nurtured until they started developing vines, which were systematically coiled around each hole, leaving them in contact with the soil to develop adventitious roots. Standard good agricultural practices such as weeding, irrigation and crop protection were applied as necessary.

Mature pumpkin leaves were analyzed for nitrogen (N), phosphorus (P) and potassium (K) contents. Nitrogen content (%) was determined using the Kjeldal method. Phosphorus content (ppm) was determined using the Vanadate-Molybodate method, using a UV-visible spectrophotometer. Potassium content was analyzed using a flame photometer (Chapman and Pratt, 1982). The number of branches (vines) were counted and recorded every 2 weeks for 10 weeks, starting from 8 weeks after seedling emergence. The leaf area was estimated using linear non-destructive measurements. The formula applied was leaf length x width x a constant, corresponding to: $A = 0.838x - 0.558$, where A = area, and x = length × width (Young *et al*., 2007).

Chlorophyll content was determined on recently fully expanded leaves using a chlorophyll content meter (CCM-200, Opti-sciences, Inc. Tyngsboro, MA, USA) with a precision of ± 1.0 chlorophyll concentration index units. Chlorophyll content was measured at the second, third and fourth month after transplanting and averaged. The male and female pumpkin flowers were counted and recorded once every two weeks and their ratio calculated to estimate the sex ratio.

Data Analysis

The data values were separately subjected to analysis of variance for the two sites that varied in agro-ecological conditions, and then the significant means were separated using the Tukey's Honestly Significant Difference test at *P*=0.05. The SAS statistical software (SAS Institute, 2005) was used in data analysis.

RESULTS AND DISCUSSION

Effect of leaf harvesting intensity, nutrient source and their interaction on nutrient content

Leaf tissue analysis was done to assess N, P and K contents. No significant effect was observed on nitrogen. However, the results from Kakamega indicated that pumpkin plants with two leaves harvested had more total nitrogen content followed by those with one and three leaf harvesting, while the control had the lowest nitrogen. In Nyeri, plants with one leaf harvest had the highest total nitrogen content followed by those with three-leaf, two-leaf and lastly no-leaf harvest (Table 1).

Table 1: Effect of leaf harvesting intensity and nutrient source and their interaction on total nitrogen, phosphorous and potassium contents in leaf tissue

Leaf harvest intensity	Nitrogen content (%)				
Kakamega	0	4 g 10N:10P:10K	4 kg FYM	8 kg FYM	Mean
0 leaf/branch	1.69	3.22	2.84	2.29	2.51
1 leaf/branch	2.73	2.93	4.36	2.99	3.25
2 leaves/branch	3.59	2.87	3.28	3.61	3.34
3 leaves/branch	2.21	3.43	2.56	3.05	2.81
Mean	2.55	3.11	3.26	2.99	
Nyeri					
0 leaf/branch	1.68	3.28	1.28	2.99	2.30
1 leaf/branch	2.46	3.47	4.25	2.95	3.28
2 leaves/branch	3.76	1.57	2.36	2.68	2.59
3 leaves/branch	2.33	2.36	2.37	4.31	2.84
Mean	2.55	2.66	2.57	3.23	
Kakamega	Phosphorous content (ppm)				
0 leaf/branch	49.95	99.51	92.29	81.84	80.90
1 leaf/branch	60.44	131.41	80.30	96.83	92.24
2 leaves/branch	90.29	259.35	75.31	60.59	121.39
3 leaves/branch	96.06	224.78	64.17	115.65	125.16
Mean	74.19b	178.76a	78.01b	88.73ab	
Nyeri					
0 leaf/branch	64.80	71.52	88.36	44.96	67.41
1 leaf/branch	80.55	75.50	25.69	106.27	72.01
2 leaves/branch	136.78	66.86	121.42	42.19	91.81
3 leaves/branch	52.10	108.74	164.83	113.58	109.81
Mean	83.56	80.65	100.07	76.75	
Kakamega	Potassium content (ppm)				
0 leaf/branch	41.33	26.47	53.36	26.07	36.81
1 leaf/branch	44.34	5.31	72.08	30.58	38.08
2 leaves/branch	74.58	6.54	7.47	81.49	42.52
3 leaves/branch	72.24	24.57	7.07	67.65	42.88
Mean	58.12	15.72	34.99	51.45	
Nyeri					
0 leaf/branch	105.63	78.24	89.06	76.55	87.37
1 leaf/branch	91.77	79.99	146.48	81.51	99.94
2 leaves/branch	67.75	223.80	62.24	59.74	103.38
3 leaves/branch	148.81	158.81	91.00	64.83	115.86
Mean	103.49	135.21	97.20	70.66	

* Values within each factor and nutrient followed by the same or no letter are not significantly different at *P* = 0.05

Leaf harvesting intensity had no significant (*P*>0.05) influence on leaf tissue phosphorus content in both sites. However, there was increase in phosphorus content with the increase in leaf harvesting intensity (Table 1). Comparatively, pumpkin plants with three leaf harvest had the highest phosphorus content followed by those with two-leaf, one-leaf and lastly no leaf harvest.

Leaf harvesting intensity had no significant (*P*>0.05) influence on potassium content of pumpkin leaves (Table 1). However, increase in leaf harvesting intensity resulted in increase in potassium content in both sites. The lowest potassium content resulted in the control followed by one-leaf, two-leaf and lastly three-leaf harvest, which had the highest potassium content. However, the nutrients results were within the range sufficient for plant growth (Paris, 2000).

Nutrient source had no significant (*P*>0.05) influence on leaf tissue total nitrogen content. However in Kakamega, pumpkin plants that received 4 kg FYM had the highest total nitrogen content, followed by those that received 4 g NPK, 8kg FYM and lastly the control. In the case of Nyeri, pumpkin plants that received 8kg FYM had the highest total nitrogen content followed by those that received 4 g NPK, 4kg FYM and lastly the control.

Nutrient source had a significant (*P*<0.05) effect on leaf tissue phosphorus content in Kakamega (Table 1). The 4 g NPK and 8kg FYM had significantly high phosphorus, followed by 4 kg FYM and the control, which were not significantly different from each other. Although no significant difference was observed in Nyeri, plants that received 4 kg FYM had the highest phosphorus content, followed by 4 g NPK, the control and lastly 8 kg FYM.

Nutrient source had no significant (*P*>0.05) effect on potassium content in pumpkin leaves. The lowest potassium content was observed for 4 g NPK and 8 kg FYM in Kakamega and Nyeri, respectively. The highest potassium content resulted for the control and 4 g NPK in Kakamega and Nyeri, respectively. Among the other treatments, 8 kg FYM had higher potassium content than 4 kg FYM in Kakamega. In the case of Nyeri, the control had higher potassium than the 4 kg FYM. This result was attributed to high inherent potassium in Nyeri soil (Place *et al.,* 2003).

No significant (*P*>0.05) interaction effect of nutrient source and leaf harvesting intensity was observed. However, in both sites, pumpkin plants under control treatment had the lowest total nitrogen content, while those where only one leaf was harvested and supplied with 4 kg FYM had the highest total nitrogen content.

Interaction between leaf harvesting intensity and nutrient source had a significant (*P*<0.05) influence on phosphorus content in pumpkin leaves. However, in Kakamega the control had the lowest phosphorus content, while 4 g NPK with two-leaf harvest had the highest phosphorus content. In Nyeri, plants that received 8 kg FYM with two-leaf harvest had the lowest phosphorus content, while those that were supplied with 4 kg FYM with three-leaf harvest had the highest phosphorus content.

No significant (*P*>0.05) interaction between leaf harvesting intensity and nutrient source was observed on leaf tissue potassium content in both sites. In Kakamega however, the lowest and the highest phosphorus content was observed for 4 g NPK and one-leaf harvest, and 8 kg FYM and two-leaf harvest, respectively. In Nyeri, the lowest potassium content resulted when 8 kg FYM and two leaves harvested, while the highest potassium content resulted when 4 g NPK was applied and two leaves harvested. All the interaction nutrient contents were within the range reported to be adequate for pumpkin production (Robinson and Decker-Walters, 1997).

Effect of leaf harvesting intensity, nutrient source and their interaction on pumpkin vines

Leaf harvesting intensity had a significant (*P*<0.05) influence on the number of vines (Table 2). As expected, areas where no nutrients were applied had the lowest number of vines both in Kakamega and Nyeri. However, among the other treatments, there was no significant difference, except in Kakamega where those plants where three leaves were harvested had lower number of vines compared with those plants where one and two leaves were harvested which were not significantly different from each other. Leaf harvesting reduces photosynthetic surface, which in turn could lead to reduced vines (Mondel, et *al*., 1978; Madakadze and Kodzanaji, 2007).

Nutrient source had a significant (*P*<0.05) effect on the number of vines in both sites (Table 2). The 8 kg FYM treatment had significantly more vines than the other treatments, except in Nyeri where there was no significant difference between 8 kg FYM and 4 kg FYM. Among the other treatments, 4 kg FYM and 4 g NPK were not significantly different from each other. The lowest number of vines resulted in the control plants.

Table 2: Effect of leaf harvest intensity, nutrient source and their interaction on vines

Kakamega	Leaf harvest intensity (number harvested/ branch/week)				
Nutrient source/plant	0 leaf	1 leaf	2 leaves	3 leaves	Mean
0 g	10.0d	15.8bc	16.0b	12.5cd	13.6c
4 g 10N:10P:10K	10.0d	17.3b	17.0b	15.3bc	14.9b
4 kg FYM	10.0d	17.0b	17.3b	15.8bc	15.0b
8 kg FYM	10.0d	22.0a	18.0b	18.3b	17.1a
Mean	10.0cd	18.0a	17.1a	15.4b	
Nyeri	Leaf harvest intensity (number harvested/ branch/week)				
Nutrient source/plant	0 leaf	1 leaf	2 leaves	3 leaves	Mean
0 g	10.0e	14.3d	14.0d	14.5cd	13.2c
4 g 10N:10P:10K	10.0e	15.5bcd	15.0bcd	14.5cd	13.8bc
4 kg FYM	10.0e	15.3bcd	16.0abcd	16.5abc	14.4b
8 kg FYM	10.0e	16.8ab	17.8a	16.8ab	15.3a
Mean	10.0b	15.4a	15.7a	15.6a	

* Values within each factor followed by the same letter are not significantly different at $P = 0.05$

Nutrients play an important role in growth of plants and this could have contributed to the many vines on pumpkin plants that received nutrients. Similar results were observed in pumpkin and nightshade treated with animal manure (Azeez *et al.*, 2010).

A significant (P<0.05) interaction effect was observed on number of vines in both sites (Table 2). Plants receiving 8 kg FYM and one-leaf harvest had the highest number of vines, while the lowest vines were observed with zero nutrients, 4 g NPK, 4 and 8 kg FYM plus no-leaf harvest in both sites. It ispossible that high photosynthetic leaf surface for no leaf harvesting and more nutrients for 8 kg FYM could have led to growth of more vines (Mondel, et *al*., 1978; Madakadze and Kodzanaji, 2007).

Effect of leaf harvesting intensity, nutrient source and their interaction on leaf area

There was no significant (P>0.05) effect of leaf harvest intensity on leaf area in both sites. The leaf area ranged from 420 to 488 cm^2, and was highest for one-leaf harvest intensity, which was in the middle of no defoliation and extreme defoliation. Therefore, a balance of leaves on the plant proved to be more supportive of leaf area growth than abundance or deprivation of leaves, and hence it should be practiced in good crop husbandry. The lack of a significant difference in leaf area agreed with the fact that pumpkin is hardy (Grubben and Chigumira-Ngwerume, 2004), as well as the findings of Fandika *et al.* (2011), that leaf area of pumpkin cultivars remains constant even under different treatments. Thus with or without leaf harvesting, the plants maintained their leaf area since they belonged to the same cultivar.

The effect of nutrient source on leaf area was significant (P<0.05) and the trend took a different pattern from that observed in leaf harvest intensity. In both sites, 8 kg FYM lead in leaf are development followed by 4 kg FYM, 4 g NPK and lastly no supplementary nutrition. The leaf area influenced by nutrient source ranged from 352 to 531 cm^2. The high leaf area for high FYM was attributed to the high nitrogen in FYM that promotes cell division, expansion and development (Aiyelaagbe and Kintomo, 2002; Mahmoud *et al*., 2009). Thus the 8 kg FYM is ideal for promotion of large leaves in pumpkins grown for edible leaf vegetable production.

Interaction had a significant (P<0.05) effect on leaf area development. The trend was such that high FYM with any leaf harvest intensity produced the highest leaf area, while no application of nutrients had the lowest leaf area in both sites. These results indicated that high FYM is able to compensate for severe defoliation to a great extent and enable the plant to recover and continue growing (Yeboah *et al.*, 2010). It is therefore prudent to grow pumpkins earmarked for edible leaf harvesting and large fruits with high FYM manure application. The practice may not be the same for pumpkins destined for enhanced fruit production and sweetness, since the effect of manure is known to be counterproductive by enhancing more vegetative growth at the expense of reproductive growth, and dilution of fruit solutes instead of concentrating the solutes (Madakadze *et al.*, 2004; Mahmoud *et al*., 2009; Oloyede *et al.*, 2013). The choice of management should therefore be guided by the purpose for which the pumpkin is grown.

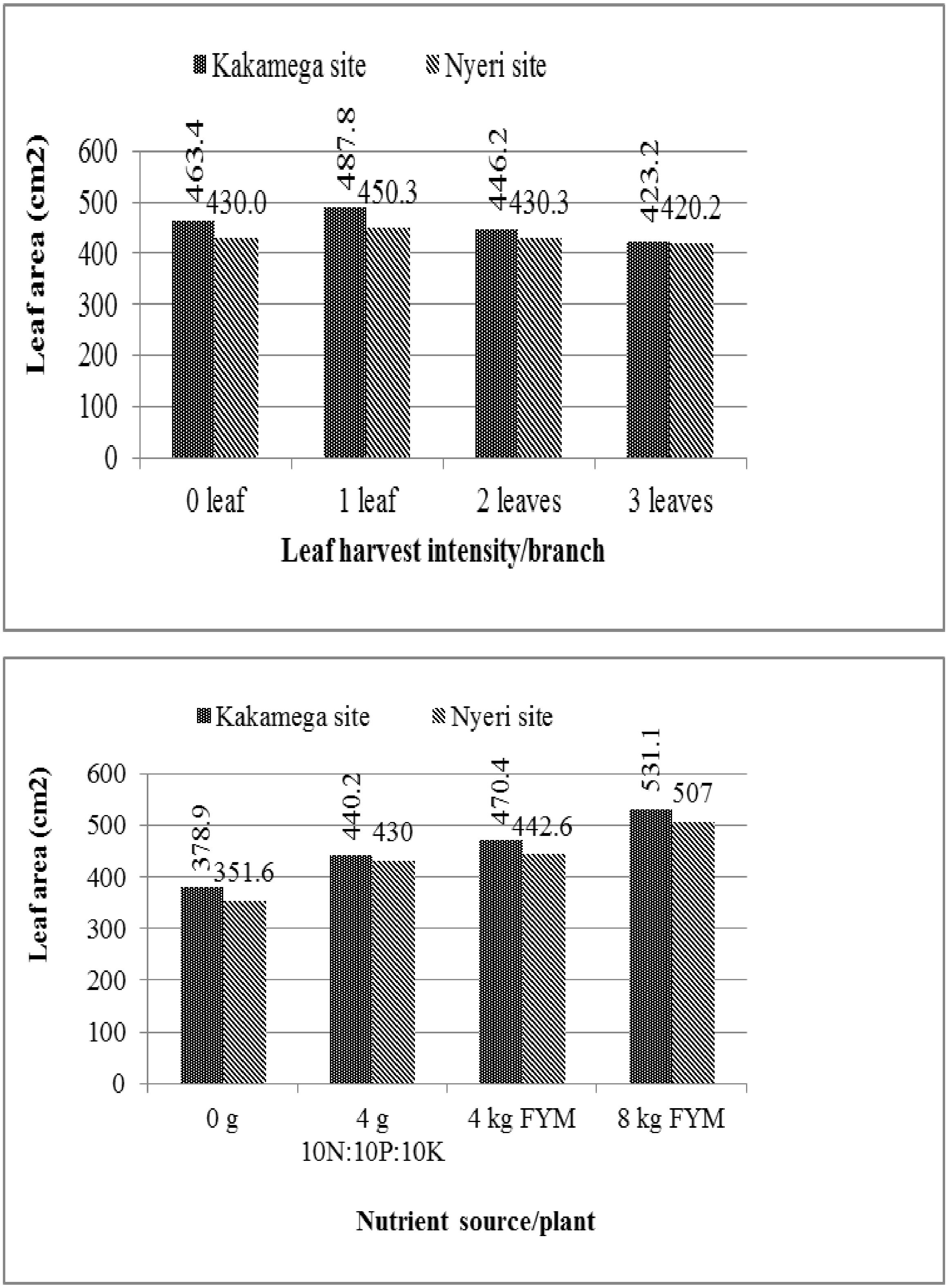
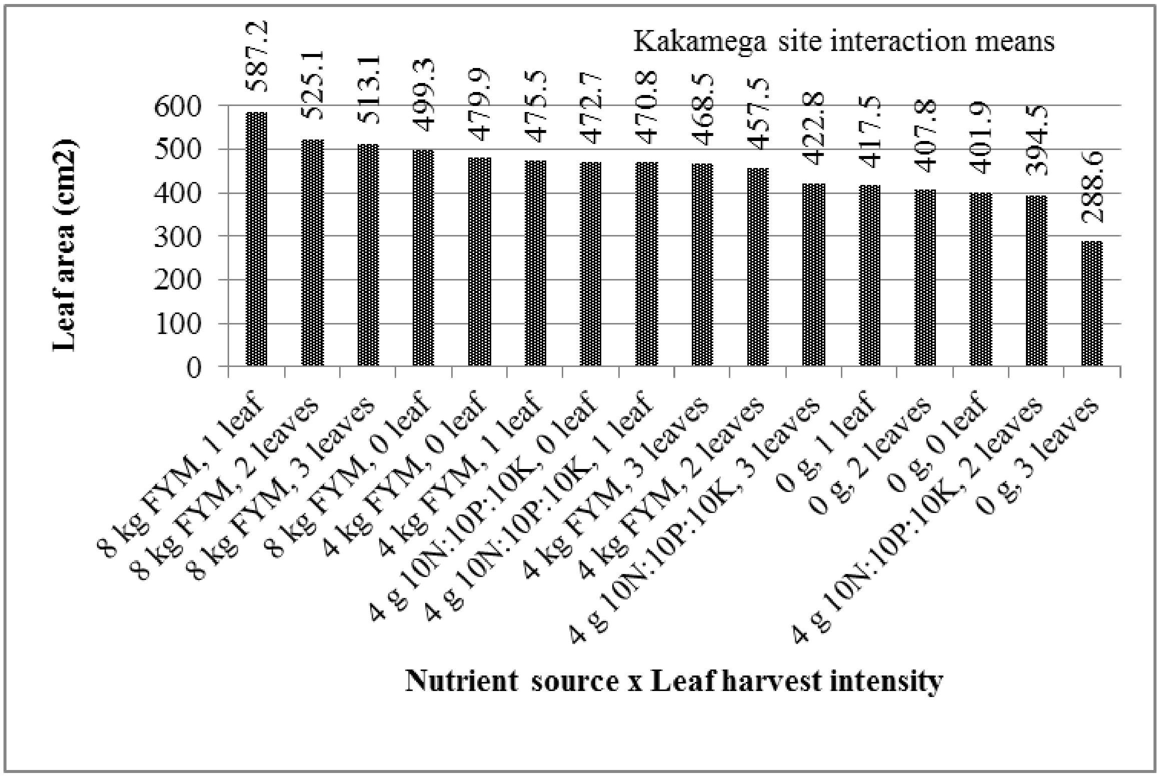


Figure 1 a: Effect of leaf harvest inensity and nutrient source on leaf area of multi-purpose pumpkin plants



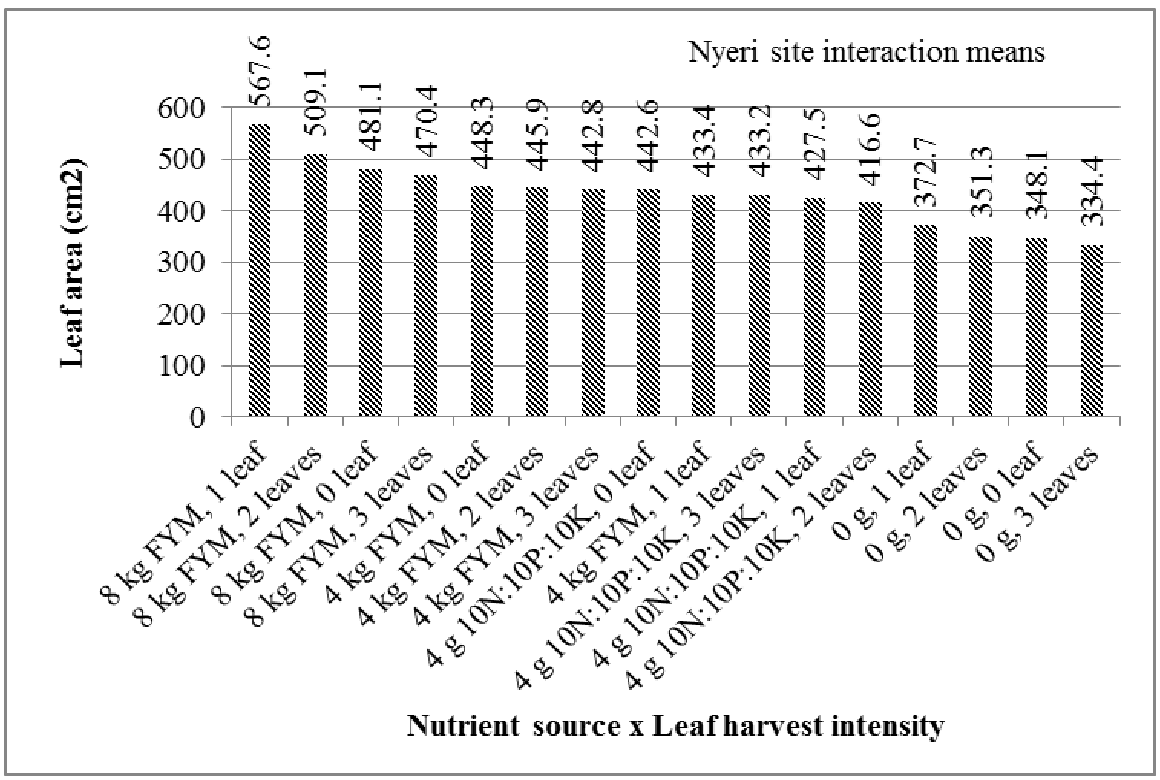


Figure 1 b: Effect of interaction between leaf harvest inensity and nutrient source on leaf area of multi-purpose pumpkin plants

Effect of leaf harvesting intensity, nutrient source and their interaction on chlorophyll content index in leaves

Leaf harvesting intensity had no significant (*P*>0.05) effect on leaf chlorophyll content index (CCI) of plants in both sites (Table 3). However, control plants had the lowest CCI owing to competition for chlorophyll-forming resources among the numerous leaves left on the plants (Oloyede *et al.,* 2013). Plants with three-leaf harvesting had the highest CCI. Of the other treatments, two-leaf were harvesting had more CCI compared to one-leaf harvesting.

Nutrient source had a significant (*P*<0.05) influence on leaf CCI in both sites (Table 3). Pumpkin plants receiving 8 kg FYM had the highest CCI followed by 4 kg FYM, then 4 g NPK and lastly the control, which had the lowest CCI, except in Nyeri where areas where 4 g NPK and the control did not have a significant difference. This result was attributed to the high nitrogen in FYM that may have promoted chlorophyll formation (Aiyelaagbe and Kintomo, 2002; Maunyo, 2007; Mahmoud *et al*., 2009).

No significant interaction (*P*>0.05) effect was observed between leaf harvesting intensity and nutrient source on CCI in both sites (Table 3). However, leaf CCI increased with application of nutrients and increase in leaf harvesting intensity. The control had the lowest leaf CCI, while one-leaf and three-leaf harvest had the highest CCI in Kakamega and Nyeri, respectively. These results were similar to those of (Aiyelaagbe and Kintomo, 2002; Oloyede *et al*., 2013).

Table 3: Effect of leaf harvest intensity, nutrient source and their interaction on chlorophyll content index in pumpkin leaves

Kakamega	Leaf harvest intensity (number harvested/ branch/week)				
Nutrient source/plant	0 leaf	1 leaf	2 leaves	3 leaves	Mean
0 g	1.1	1.2	1.2	1.0	1.1d
4 g 10N:10P:10K	1.4	1.4	1.4	1.4	1.4c
4 kg FYM	1.6	1.6	1.6	1.6	1.6b
8 kg FYM	2.7	2.7	2.7	2.7	2.7a
Mean	1.7	1.7	1.7	1.7	
Nyeri	Leaf harvest intensity (number harvested/ branch/week)				
Nutrient source/plant	0 leaf	1 leaf	2 leaves	3 leaves	Mean
0 g	1.1	1.1	1.1	1.1	1.1b
4 g 10N:10P:10K	1.3	1.4	1.4	1.4	1.4b
4 kg FYM	1.6	1.6	1.6	1.6	1.6ab
8 kg FYM	2.7	2.7	2.7	2.4	2.6a
Mean	1.7	1.7	1.7	1.6	

* Values followed by same or no letter within a factor are not significantly different at *P* = 0.05

Effect on leaf harvesting intensity, nutrient source and their interaction on flower ratio

Leaf harvesting intensity had no significant (*P*>0.05) influence on flower sex ratios (Table 4). The male to female flower ratio was almost constant (1.7 to 1) for all leaf harvest intensities in both Kakamega and Nyeri sites. This response was attributed to the fact that the same cultivar was planted in the two sites and male flowers initiation, growth and development is dominant to female flowers (McCormack, 2005; Agbagwa *et al*., 2007; Maynard, 2007; OECD, 2012).

Nutrient source had a significant (*P*<0.05) effect on flower ratio in both sites (Table 4). The control had the lowest male to female flower ratio followed by 4 g NPK, 4 kg FYM and lastly 8 kg FYM. This result was attributed to the fact that male flowers respond faster to improved growth factors than female flowers (McCormack, 2005; Agbagwa *et al*., 2007).

In both sites, no significant (*P*>0.05) interaction effect was observed between leaf harvesting intensity and nutrient source on flower sex ratio (Table 4). The highest male to female flower ratio was observed when no leaf was harvested and 4 g NPK was applied, while the lowest ratio was observed when no fertilizer was applied at one-leaf harvest in Kakamega, while in Nyeri the lowest was observed for one-leaf harvest and 4 g NPK was applied. These results indicate that low, or competition for, growth resources suppresses male flower growth and development, and promote female flower to enable the cultivar perpetuate itself (McCormack, 2005; Agbagwa *et al*., 2007; Aremu *et al*., 2011).

Table 4: Effect of leaf harvest intensity, nutrient source and their interaction male to female flower ratio of pumpkin plants

Kakamega	Leaf harvest intensity (number harvested/ branch/week)				
Nutrient source/plant	0 leaf	1 leaf	2 leaves	3 leaves	Mean
0 g	3	2	2	1	2.0
4 g 10N:10P:10K	2	2	1	2	1.8
4 kg FYM	2	2	2	2	2.0
8 kg FYM	2	3	2	2	2.3
Mean	2.3	2.3	1.8	1.8	
Nyeri	Leaf harvest intensity (number harvested/ branch/week)				
Nutrient source/plant	0 leaf	1 leaf	2 leaves	3 leaves	Mean
0 g	3	2	3	2	2.5
4 g 10N:10P:10K	3	2	3	2	2.5
4 kg FYM	2	2	2	2	2.0
8 kg FYM	2	3	2	2	2.3
Mean	2.5	2.3	2.5	2.0	

* Values not followed by a letter within a factor are not significantly different at $P = 0.05$

CONCLUSION AND RECOMMENDATIONS

The results given above showed that leaf harvesting intensity and nutrient source significantly affected the number of vines, leaf area and chlorophyll content index. The treatments did not significantly influence male to female flower ratio and leaf tissue mineral nutrient contents, except phosphorous content in Kakamega. Decrease in leaf harvest intensity and increase in FYM increase the number of vines and leaf area. The leaf chlorophyll content increases with increase in FYM, but remains constant for the various leaf harvest intensities. The sex ratio ranges from 1 to 3 male to female flowers, and is highest for no leaf harvest and lowest for three-leaf harvest. The trends observed in these vegetative and reproductive growth components end up impacting edible leaf and fruit yields and quality of pumpkin either positively or negatively, depending on the function they perform in plants. They should be borne in mind during dispensation of agronomic practices to enhance desired pumpkin performance.

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