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RESEARCH ARTICLE OPEN ACCESS

Effectiveness of Intercropping Cabbage with Lemon Grass on the Control of Cabbage Aphids in Masheruka Sub-County, Sheema District

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Abstract

Cabbage has gained popularity as both food and cash crop across the globe. However, its production is still constrainedby major insect pests and diseases. Aphids are on record as the most damaging pests of cabbage. Dependence on chemical pesticides to control these pests, has not only led to increased production costs but equally contributes to environmental degradation. Thus cultural practices act as an alternative in cabbage insect pest control.The study assessed the effectiveness of intercropping cabbages with lemon grass on the control of cabbage pests and enhancing cabbage productivity. The study focused on; identifying major pests that attack cabbages, determining the effects of intercropping cabbage with lemon grass on the control of cabbage aphids and determining the growth and yields of cabbage under intercropping system. The experiment was conducted in a Randomized Complete Block Design (RCBD) with four treatments each of which was replicated three times. The treatments were; sole cabbage (T1); 1 row of cabbage alternating with 1row of lemon grass (T2); 2 rows of cabbage alternating with 1 row of lemon grass (T3) and 3 rows of cabbage alternating with 1 row of lemon grass (T4). The study revealed that planting cabbage with one row of lemon grass had the lowest aphid infestation among all varieties compared to other treatments while planting cabbage as monocrop registered the highest infestation. The study found out that aphids, leaf miner, cut worms, root knot nematodes, diamond back moth and cabbage webworm in their order of infestation were the insect pests attacking cabbage in Masheruka sub-county. Intercropping cabbage with lemon grass significantly reduced aphid infestation in seasons one ($p<0.05$) and two ($p<0.05$) respectively. Lemon grass is repellant with the insecticidal properties against insect pests. The study further found out that intercropping cabbage with lemon grass does not necessarily increase cabbage yield ($p>0.05$). In conclusion, the study confirmed that there are various pests attacking cabbage in Masheruka sub-county such as aphids, leaf miner, cut worms, root knot nematodes, diamond back moth and cabbage webworm in their order of infestation. Intercropping cabbage with lemon grass reduced aphid infestation. Intercropping cabbage with lemon grass does not necessarily increase cabbage yield. The study recommends usage of lemon grass as an intercrop in cabbage production should be promoted as an alternative insect pest management tool in the study area and country in general. To reduce costs in controlling insect pests, farmers should endeavor to grow cabbage in wet seasons when there is low insect pest infestations. Further studies should be conducted to (i) assess the level of aphid infestation on cabbage with altitude and (ii) economic returns as a result of use of lemon grass as an intercrop and (iii) management of lemon grass to reduce its competition with cabbage for light, moisture and nutrients.

Key words: effectiveness, intercropping, lemon grass,coffee productivity, cabbage aphids, Masheruka, Sheema, Uganda.

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Background

Cabbage, *Brassica oleracea* L. is an exotic leafy vegetable grown in many tropical areas. It is a biennial potherb, usually cultivated as an annual crop(Dassou and Tixier, 2016). The vegetable is often used in stews, boiled in soups and also eaten fresh as an ingredient of salads (Zhou *et al.,* 2013; Alhadidi *et al.,* 2018). Its succulent nature has attracts many insect pests which feed on it (Lyocks *et al.,* 2013). The most common insect pests of cabbage include aphids (*Aphis brassicae)*, diamondback moth (*Plutella xylostella)*, the cabbage webworm (*Hellula undalis),* the cabbage looper (*Trichoplusia ni),* white fly (*Bemisia tabaci)*. These pests damage the crops head by making holes in the leaves, destroying the growing buds and tunnel into mature heads. Feeding activities of these pests reduce the quality of cabbage heads affecting its market value, leading to financial losses to the farmer.

In Africa,the most destructive insect pestsof cabbage areaphids(Lewis *et al.,* 2016). Aphid attacks result in yield losses of up to 90%. Countries like Togo and Benin have experienced losses due to 'windowed' and detached head leaves haveexceeded30% in spite of applications of synthetic insecticide (Mondédji *et al.,* 2016). Such damages by insect pests have forced farmers to either give up on growing the vegetable (Sujayanand *et al.,* 2015) or reduce the area coveredby the crop to focus on other crops (Mondédji *et al.,* 2021).

In Uganda, cabbage is one of the most widely grown vegetables. It is a valuable part of the diet in the urban areas and important vegetable for both internal and regional trade. Cabbages are grown in all districts of Uganda. Kabale district has the highest production followed by Mbarara, Kasese and Bushenyi districts which also produce large volumes of cabbages. Mpigi, Masaka, Kibaale and Kabalore districts are also important producers (Gebru, 2015). Cabbages are usually grown as sole crops under rain fed conditions. The common cultivated varieties of cabbage in Uganda are: Drumhead (large), Sugarloaf (large), Copenhagen market (medium) and Red drumhead (small). Despite their economic role, they attract many insect pests which feed on them for survival (Lyocks *et al.,* 2013). The most common insect pests include aphids, diamondback moth and cabbage webworm. These pests damage the crops' head leading to reduced quality, market value and financial losses to the farmer.Tiraşçi *et al.,* (2017) noted that the destructive nature of cabbage pests has necessitated the application of control measures to minimize the negative effects of these pests. Chemical insecticides have been widely adopted and used against these particular insect pests. However, chemical insecticidesare reported to be associated with issues likepest resistance, environmental contamination, and increased health hazards (Lewis *et al.,* 2016).

Qasim *et al.,*(2013) states that it is therefore important to use alternative means of controlling the pests that are environmentally friendly.Some of the alternative methods include cultural, biological and mechanical. Cultural methods are however the cheapest and locally available to farmers.Intercropping with some repellants like onions, chilli pepper has been the most widely applied and studied by many farmers and researchers in controlling pests of different crops (Mattuso *et al.,* 2014). This research was centered on the use of lemon grass in the control of cabbage aphids (*Cymbopogon citratus*). Lemon grass is an odorous tropical grass which yields oil that smells of lemon (Gao and Wu, 2014; Dewangan and Sahu, 2014 and Abd *et al.,* 2014). It has repellant properties that can be used in the control of insect pest (Karavina *et al.,* 2014; Wszelaki, 2014). Although much research work has been done on lemon grass, most studies have focused on medical component of lemon grass than focusing on the other side of controlling insect pests in crops it was against this background that this study was conducted to assess the effectiveness of intercropping cabbage with lemon grass on cabbage aphid control in Masheruka sub-county.

Statement of the problem

Cabbage, has gained popularity as both food and cash crop among farmers in Uganda (Lopes *et al.,* 2016). However, its production is still low not to the expectations due to insect pests and diseases. The most damaging cabbage pests include aphids (*Brevicoryne brassicae* L. Homoptera: Aphididae) and the diamondback moth (*Plutella xylostella* (L.) Lepidoptera: Plutellidae) (Brooker *et al.,*2015). Dependence on chemical pesticides to control these insect pests, has led to increased production costs, environmental pollution and development of resistance to pesticides (Raseduzzaman and Jensen, 2017). In Uganda most farmers are resource-poor and cannot afford pesticides. Therefore, there is a need to explore other control measures that minimize use of inorganic insecticides. Literature indicates that intercropping cabbage with repellant cropcould reduce insect pest infestation (Ben-Issa *et al.,* 2017). This cultural practiceis effective against some of the cabbage insect pests, and can be used as components of an integrated pest management. Although intercropping has been adopted as a management practice that could control cabbage aphids, no comprehensive study has been carried out to determine the effectiveness of intercropping cabbage with lemon grass on the control of cabbage aphids.The study was purposively carried out to determine the effectiveness of intercropping cabbage with lemon grass on aphid infestation, control and cabbage crop output (growth and yield) in Masheruka Sub-county, Sheema District.The study was conducted specifically to; document major insect pests that attack cabbages, determine the effect of intercropping cabbage with lemon grass on infestation of cabbage aphids and determine the effect of intercropping cabbage with lemon grass on growth and yield of cabbage.

Hypothesis

Ho: there no insect pests of cabbage existing in Masheruka Sub County.

Ha:there are different insect pests of cabbage that exist in Masheruka Sub County

Ho: intercropping cabbage with lemon grass has no significant effect on cabbage aphid infestation.

Ha: intercropping cabbage with lemon grass has a significant effect on cabbage aphid infestation

Ho: intercropping cabbage with lemon grass has no significant effect on cabbage growth and yield

Ha: intercropping cabbage with lemon grass has a significant effect on cabbage growth and yield

Materials and methods

The experiment was courried out in Masheruka sub-county, Sheema District in Southwestern Uganda. The District is bordered byBuhweju District to the north, Mbarara District to the east, Ntungamo District to the south, Mitooma District to the southwest and Bushenyi District to the west. Kibingo, where the district headquarters are located, lies approximately 33 Kilometres (21 mi), by road, west of Mbarara, the largest city in Ankole sub-region. The coordinates of the district are: 00.32^0S, 30.24^0E.The total population of the district is 7,600 of which 2,967 are male and 4633 are female. The farming system of the study areas is characterized by crop-livestock mixed farming. Farm households depend mainly on crop and livestock both for food and cash income. Two types of cropping season are known in the study areas, namely main season (rain-fed agriculture) and full irrigation in the dry season. The major crops cultivated in the district are maize, millet, beans and banana under rain-fed conditions. The principal crops grown under irrigation are tomato, head cabbage and water mellon.

The study was experimental in nature employing a Randomized Complete Block (RCBD) design. There were four (4) treatments as follows (Fig.1); sole cabbage (T1); 1 row of cabbage alternating with 1row of lemon grass (T2); 2 rows of cabbage alternating with 1 row of lemon grass (T3) and 3 rows of cabbage alternating with 1 row of lemon grass (T4). Thirty-six experimental plots each measuring 4.5 m x 1.5 m were laid out, each separated by 0.5 m path. The design was a Randomized Complete Block (RCBD) with three replications. Cabbage varieties used were Gloria, Copenhagen and Drum head. Cabbage seedlings were transplanted 3 weeks after germination and lemon grass was planted one month before

transplanting cabbage seedlings. Spacing between the cabbage plants, both within and between rows was 0.45 m and the row intercropping was used. There were 30 cabbage plants perplot, both on the sole cabbage and any of the intercropping options. Materials used were cabbage seeds for three varieties which included Gloria, Copenhagen and Drum head bought from certified agent called East African Seeds Company limited. A household survey was also carried out to farmers who adopted intercropping cabbages with lemon grass to reduce prevalence of aphids.

Experimental measurementswere done. In field, assessment on the status of cabbage aphids, distribution of cabbage aphids, and their natural enemies in the study area were done. Also recorded was the insect pest affected cabbage, their population per plant and number of plants affected. The plants were sampled by observation for the presences of cabbage aphid and other insect pest species. To assess the effect of intercropping cabbage with lemon grass on infestation of cabbage aphids, 15 plants per plot were sampled randomly from each treatment. Each plant was tagged with numbers and monitored for the presence of aphid. The numbers of aphids on leaves were counted with the help of hand lens and mean number per plant were recorded for each treatment. Data was also collected on plant parameters (height, stem girth and number of leaves). 15 cabbage plants from the middle rows per plot were randomly selected for data collection.Yield of 15 mature cabbage plants was determined by harvesting the above ground biomas and cleaning them from traces of soil and then weighing the individual heads on pan balance. Total weight per plot was then obtained by adding all the weight of individual cabbages. Severity of damage by aphids was assessed by scoring the plants based on whole plant observation following a pest scoring scale of 0-9 as guided by Litsinger et al.(2001).

Data from experiment was cleaned to eliminate errors, and entered into a computer and analyzed using Microsoft office excel 2013 and Genstat 12th edition. Genstat (12th edition) statistical package was used to generate analysis of variance (ANOVA) using the generalized linear model to evaluate the influence of cropping system on aphid infestation. Significant means were separated using Fischer's protected LSD at 5 %.The results were expressed as mean (±) standard error. Where the difference was significant, the means were separated using the Tukey's standardized range. Significant difference was measured at $P \leq 0.05$.Data outputs were presented in tables, pie-charts and graphs.

Results

Table 1: Characteristics of the respondents

Category	Variables	Frequency	Percent
Gender of respondents	Male	43	58.1
	Female	31	41.9
Age of respondents	18-29	11	14.8
	30-39	23	31.1
	40 and above	40	54.1
Education qualification	No formal education	12	16.2
	Primary	16	21.6
	Secondary	25	33.7
	Secondary and above	21	28.4
Duration in Cabbage cultivation	< 5 years	14	18.9
	5-10 years	14	18.9
	>10 years	46	62.2

Land use for cabbage	<0.05Ha	2	2.7
	0.06-0.1Ha	18	24.3
	>0.1Ha	54	72.9

Results in table 1 show that58.1% of the respondents were malesand41.9% female. 14.8%wereaged 40 and above, 31.1% 30-39 years and 14.8% 18-29 years.16.2% of the respondents had never attended school, 21.6% had primary education, 33.7% secondary educationwhile 28.4% had post-secondaryeducation. Approximately 18.9% had grown cabbage for less than five years, 18.9% more than five years but less than 10 years while 62.2% hadgrown cabbage for more than 10 years.

Table 2: Summary of the major pests that attack cabbages

Pests	Frequency	Percent
Aphids	21	28.4
Leaf miners	12	16.2
cut worms	8	10.8
Root-knot nematodes	7	9.4
Diamondback moth	5	6.7
Cabbage webworm	8	10.8
Others	13	17.5
Total	74	100%

Results of the major pests that attack cabbagesin Masheruka sub-county, Sheema Districtwere presented in table 2. 28.4% of respondents mentioned aphids, 16.2% leaf minor, 10.8% cut worms, 9.4% root-knot nematodes, 6.7% diamondback moth, 10.8% cabbage webworm and 17.5% talked of other pests like, cabbage looper (*Trichoplusia ni*), cabbage whiteflies (*Bemissia tabacci*), Sawflies (*Athalia* spp), and snails

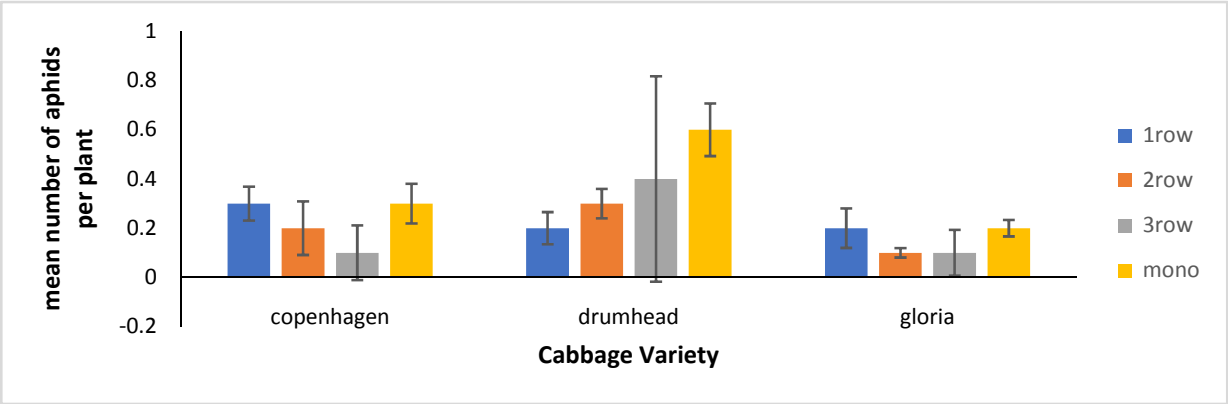

Figure 1: Mean number of aphid infestation per plant as influenced by intercropping cabbage with lemon grass under different varieties in season one.

Key. 1=one row of cabbage and one row of lemon grass, 2=two rows of cabbage and one row of lemon grass, 3=three rows of cabbage and one row of lemon grass, Mono=Cabbage rows not intercropped with lemon grass.

Aphid infestation was extremely low on Gloria variety than Copenhagen and Drum head. Within each variety, aphid infestation was higher in mono crop than intercrop though no significant difference

(Figure 1). Except in drumhead where the number of aphids per plant was significantly higher in mono crop ($p<0.05$).

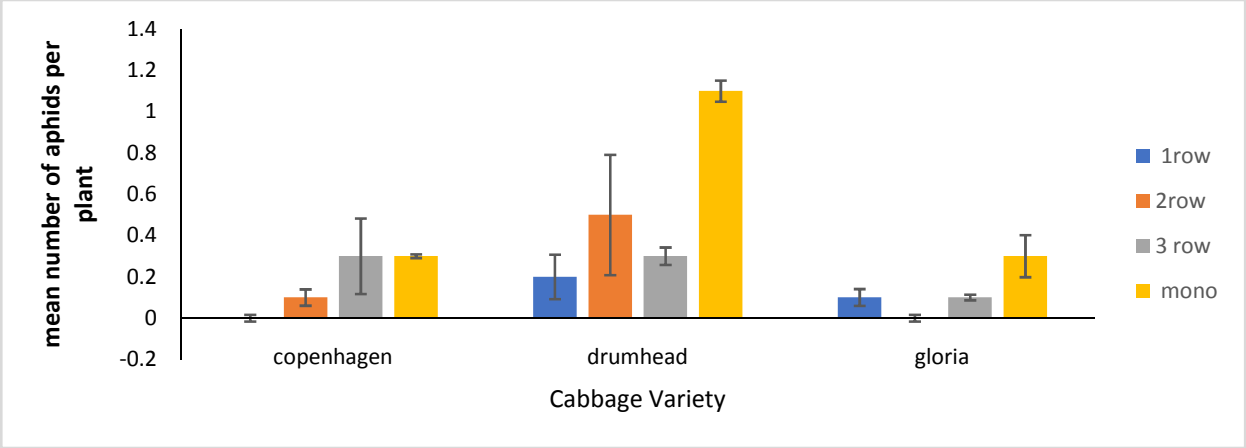

Figure 2: Mean number of aphid infestation per plant as influenced by intercropping cabbage with lemon grass under different varieties in season2.

Key. 1=one row of cabbage and one row of lemon grass, 2=two rows of cabbage and one row of lemon grass, 3=three rows of cabbage and one row of lemon grass, Mono=Cabbage rows not intercropped with lemon grass.

Aphid infestation was extremely low on Gloria variety than Copenhagen and Drum head (Figure 2). Within each variety, aphid infestation was higher in mono crop than intercrop though no significant difference ($p>0.05$). Except in drumhead where the number of aphids per plant was significantly higher in mono crop ($p<0.05$).

Table 3: Effect of intercropping cabbage with lemon grass on selected growth parameters

Cabbage Variety	Treatment	Plant height (cm)	No.ofnon-wrap-perleavesplant^{-1}	Shootweight(gplant$^{-1)}$
Copenhagen	T1	1.30	13.11	59.47
	T2	1.46	14.01	60.47
	T3	1.41	14.31	61.47
	T4	1.61	14.57	62.56
Drumhead	T1	1.22	14.36	35.88
	T2	2.02	15.46	36.01
	T3	2.75	16.16	38.58
	T4	2.87	16.96	39.21
Gloria	T1	1.24	14.64	48.17
	T2	2.76	15.04	48.89
	T3	2.32	15.13	49.12
	T4	3.45	16.64	49.99
S.EM(±)		0.07	0.64	0.71
LSD at 5%		0.21	1.84	2.08

There was a significant difference in cabbage height recorded for mono crop for the three cabbage varieties ($p < 0.05$). There was no significant difference in numberofnon-wrap-perleavesplant^{-1} for the three cabbage varieties ($p > 0.05$). The interaction between cropping systems and varieties was also not significant the ($p > 0.05$).The mean number of wrap-perleavesplant^{-1}of drumhead in T1 was 14.36, T2 was 15.46, T3 was 16.16 and 16.96 which was higher in Gloria and Copenhagen. The wrapper leaves did not form the head and they help in photosynthesis process.In terms of shoot weights, Copenhagen had 59.47g plant$^{-1)}$, Drumhead had 35.88 gplant$^{-1)}$ whereas Gloria had 48.17 gplant$^{-1)}$. This was insignificant at 5% confidence levels ($p>0.05$).There was no significant difference in cabbage stem girthbetween the different intercropping systems or planting pattern. There was no significant difference in mean shoot weight for Copenhagen, drumhead and Gloria.

Table 4: Mean cabbage weight on different varieties under different cropping systems in season 1

	System			
Variety	**1row**	**2row**	**3row**	**mono**
Copenhagen	2.2	2.7	2.9	2.8
Drumhead	3.4	2.9	2.5	3.0
Gloria	3.7	3.9	4.1	3.5

CV= 18.0%, *LSD variety*= 0.48, *LSD cropping system*= 0.55

1row=1 row of cabbage intercropped with 1row of lemon grass, 2row= 2 rows of cabbage intercropped with 1 row of lemon grass,3row= 3 rows of cabbage intercropped with 1 row of lemon grass, mono=sole cabbage

Results indicated that there was no significant difference in cabbage yield between the different intercropping systems in season one and two (tables 4 and 5) ($P>0.05$). The interaction between cropping systems and varieties was also not significant ($P>0.05$).

Table 5: Mean cabbage weight on different varieties under different cropping systems in season 2

	System			
Variety	**1row**	**2row**	**3row**	**mono**
Copenhagen	4.9	4.1	4.3	5.3
Drumhead	2.2	2.6	2.8	2.7
Gloria	5.7	5.6	4.5	5.3

CV= 18.1%, *LSD variety*= 0.64, *LSD cropping system*= 0.74

1row=1 row of cabbage intercropped with 1row of lemon grass, 2row=2 rows of cabbage intercropped with 1 row of lemon grass,3row= 3 rows of cabbage intercropped with 1 row of lemon grass, mono=sole cabbage

Discussion

The study found out that the major insect pests attacking cabbages wereaphids. The results showed that those pests had a negative strong association with production of cabbages implying that pests reduce the production of cabbages.There were more attacks by aphids followed by Diamond back moth than other pests. The results are also in line with Tanyi et al. (2018) who asserted that pest incidence for aphids, diamond back moths, looper, cutworms and saw flies was higher during dry season and reduced when the rains increased. The results were also in line with Tiraşçi *et al.,* (2017) who propounded that the most serious pests that affected the head quantity and quality were aphids and diamond back moth.

The study found that intercropping of cabbage with lemon grass reduced the spread of aphids since lemon grass is repellant plant that produces a fresh, sharp lemon-like scent with a slight hint of exotic ginger which repells the cabbage aphids.Most important lemon grass contains monoterpenoid components (myrcene, eugenol, citral and citral) that demonstrate antioxidant activity especially eugenol, which contains scavenging properties against free radicals which repels away aphids. This is in line with Tak and Isman (2016) who noted that lemon grass was efficient in killing insect pest still at the larval stage, such as cabbage looper when intercropped. The findings also concur with Naufalin *et al.,* (2019) who asserted that lemon grass extract in microencapsulation revealed enhanced antioxidant activity, maltodextrin and cyclodextrin.Thus lemon grass extract with a cyclodextrin microcapsule had improved antioxidant activity in cabbages. The results were also in agreement with Qasim *et al.,* (2013) who noted that the reduction of *B. brassicae* numbers on the intercropped plants subsequently lead to a reduction in damaged leaves. Gebru, (2015) stated that intercropping cabbage with garlic and onion significantly reduced the population of aphids on cabbage. Similarly, Gao and Wu, (2014) indicated that the odour from onion is able to repel P. xylostellafrom settling on cabbage when in an intercrop. Garlic and onion produce a pungent alliaceous compound, allyl-epropyl-disulphide, which is responsible for its pest repellent attribute.

The results show that the reduction of pest numbers on the intercropped plants subsequently leads to a reduction in damaged vegetative plant parts and hence increased crop yield (Wszelaki, 2014). MacCarthy *et al.,* (2020), stated that diversity of plants in agro-ecosystem may be an important factor that influences the presence of pests as well as their natural enemies. He noted that on plots where cabbage was intercropped with pot marigold and French marigold, cabbage aphid parasitisation by *Diaeretie llarapae* was greater and the percentages of predatory *Syrphidae* to prey were more favourable than on homogenous crops. The combination with Pot Marigold turned out to be the best in this respect.

Pests are expected to accumulate in simpler habitats, where their specific prey usually achieve higher densities and are easier to find (Alburquerque *et al.,* 2014). However, parasitoids utilising flower resources have benefited from more diversified systems (Fening *et al.,* 2013). Examinations of the effect of plant diversity on generalist natural enemies have often shown an increased abundance in diverse systems (Bybee-Finley, *et al.,*2016). However, there are variations in the responses not only among predator species, but also within the same species when different studies are compared Raseduzzaman and Jensen, (2017) and these differences are likely to be explained by factors such as prey density (Boudreau, 2013), and prey preference hierarchies of specific crops.

Besides an alteration in the host plant environment of intercropping systems directly affecting herbivore behaviour, crop plants in intercropping systems often compete with the intercrop for resources such as light, water and nutrients. These factors may have consequences on plant growth (Verret *et al.,* 2017), morphology (Sharaby *et al.,* 2015) and chemical composition (Tang *et al.,* 2017; which in turn could affect host plant finding and acceptance by herbivores (Dassou and Tixier, 2016). Indirectly, this might

also change the suitability of the crop plant as a food source for insect herbivores (Shalaby and Fouad, 2016), which could have consequences for their development rates (Alhadidi *et al.,* 2018). Among plant quality traits found to affect herbivore development are their fibre and nutrient contents (Bedoussac *et al.,* 2015), which can both be affected by environmental conditions Baidoo& Adam, (2012), and might therefore be expected to vary between mono-cultured and intercropped plants.

Plant competition in intercropped systems may affect the allocation of resources to either plant growth or to the maintenance of their defence mechanisms Amoabeng *et al.,* (2013). In cruciferous plants, the sulphur and nitrogen containing glucosinolates are considered to be an important part of their defence system against herbivores and pathogens (Fening *et al.,* 2013). When plant tissues are damaged, the glucosinolates are hydrolysed by plant myrosinase enzymes, and a wide range of volatile and nonvolatile compounds are produced, of which the isothiocyanates (mustard oils) are the best known (Miah *et al.,* 2015). These compounds are largely responsible for the characteristic flavours of crucifers and are toxic to generalist herbivores (Gao and Wu, 2014). Specialised herbivores, on the other hand, use glucosinolates and isothiocyanates in their host plant finding and acceptance (Karavina *et al.,* 2014) but also to environmental stress factors (Gebru, 2015). As plants are rarely subjected to only competition or herbivory, there are likely to be interactive effects which may have consequences for plant quality aspects such as fibre, nutrients and the concentration of glucosinolates, and hence for the development of feeding herbivores.

The study found no significant change in cabbage yield across different lemon grass intercrops. This finding is in agreement with findings in the study by Fening *et al.,*(2014)who also reported a non-significant effect of different intercropping systems on growth characteristics and yield of cabbage compared with sole cabbage cropping except for radish as an intercrop, which affected adversely the yield and some growth characteristics of cabbage.

The results are also in line with Fening *et al.,*(2013) who noted that maximum values for most of the yield parameters in sole cabbage plots may be attributed to efficient utilization of space and light interception along with nutrient uptake and availability of applied nutrients which ultimately increased the production of assimilates and the rate of biosynthesis of various metabolic activities leading to increased rate of growth and development, which is expressed in higher head weight.

However, Isman, (2019) propounded that intercropping cabbage with pea (*Pisum sativum* L.), produced decreased: numbers of leaves, total head weight, head yield, stem length and stem weight compared with mono-cropped cabbage and other crops.

Conclusion

In conclusion, the study confirmed that there are various pests attacking cabbage in Masheruka sub-county. These include aphids, leaf miner, cut worms, root knot nematodes, diamond back moth and cabbage webworm in their order of infestation.Intercropping cabbage with lemon grass reduces aphid infestation. Lemon grass is repellant with the insecticidal properties against insect plants. Intercropping cabbage with lemon grass does not necessarily increase cabbage yield.

Recommendations

- Usage of lemon grass as an intercrop in cabbage production should be promoted as an alternative insect pest management tool in the study area and country in general.
- To reduce costs in controlling insect pests, farmers should endeavor to grow cabbage in wet seasons when there is low insect pest infestations.

- To boost head cabbage production lemon grass should be used because of its aphid repellant effect on field trial so farmers have an option to use the locally available treatments especially *Endod* berry and *Neem* kernel for suppressing cabbage aphid infestation.

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Conflict of interests

None.

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