



Growing cabbage (*Brassica oleracea* var. *capitata*) under low cover Agronets prevents pest infestation and increases yields in Kenya

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Abstract

Cabbage (*Brassica oleracea* var. *capitata*) is an important vegetable crop in Kenya both in production and income provision to smallholder farmers. Pests are serious hindrance to its production and most farmers rely on synthetic insecticides. Such reliance has negative effects on non-target organisms, environment, animal and human health. This study was carried out from May to October 2011 to determine impact of low cover nets of different mesh size and cover duration on reducing cabbage pest infestation and yields. The study was conducted at Kenya Agricultural Research Institute Kabete and Practical Training Centre Thika based on a randomized complete block design with five replicates. Treatments included Agronets of fine (0.4mm) and large (0.9mm) mesh covered over the crop permanently (season-long) or temporarily (opened three times a week from 9am to 3pm) and control where no Agronet was used. The results show that the number and damage by diamondback moth (DBM) was significantly lower on cabbages grown under the Agronets compared with control. Infestation by thrips was lower on cabbages grown under permanent cover compared with those under temporal cover and without cover. However, there was no significant difference of aphids infestation. The marketable yield was significantly higher on cabbages grown under the Agronets, recording about 17% yield loss compared with control that recorded about 90% yield loss. The study concludes that Agronets provide an important component of integrated pest management strategy for cabbage production in Kenya with high crop yields benefit and highly recommended for application by growers.

Key words: Agronet, Aphids, Cabbage, Diamondback moth, Thrips



Introduction

Cabbage (*Brassica oleracea var. capitata*) is grown mostly by small-scale farmers in Kenya for domestic market. The area of production, yields and value has been fluctuating over the years. On average, the crop is grown annually (2006-2010) in an area of 19,840 ha with production of 28.28 MT/ha valued at KES 274,271.00 per ha (equivalent to USD 3,226.72) (HCDA, 2014). The crop is second after tomato in terms of the area under production and its value, which is 12% of vegetable value in Kenya. Pests are reportedly the main challenge to production of this crop (HCDA, 2014). Farmers depend on synthetic insecticides to manage pests (Oruku & Ndungu, 2001), reducing the crop profitability due to increased cost of production. In addition, these pests are known to develop resistance to pesticides (Talekar, 1992), resulting to inadequate management of the pests and further causing farmers to purchase more pesticides. Such dependence on synthetic pesticides by farmers is common in Kenya (Oruku & Ndungu, 2001).

Among the cabbage pests in Kenya, Diamondback moth (DBM, *Plutella xylostella*) is the most important. Others include aphids (*Brevicoryne brassicae*, *Myzus persicae* and *Lipaphasis erysimi*) (Oruku & Ndungu, 2001; Nyambo & Lohr, 2005), cutworms (*Agrotis* Spp), and cabbage looper (*Trichoplusia ni*) can cause high losses. Other minor pests

include African bollworm (*Helicoverpa armigera*), cabbage skeletonizer (*Crociodolomia pavonana*) and Bagrada bug (*Bagrada hilaris*). Usually the frequent use of synthetic insecticides alters the pest balance and can result to upsurge of minor pests, un-expectantly causing high crop losses. Reliance on synthetic pesticides is not sustainable and in the long run may make cabbage growing challenging especially by small growers who many times lack capital. The year-round production of cabbages thus requires integrated approaches to reduce pest infestation and associated losses.

Promotion and use of a single pest management option is still not effective due to effects of control options for other pests. For example, even with a decade of field release of parasitoid, *Diadegma semiclausum* against Diamondback moth followed by pest reduction in some parts of the country (Lohr *et al.*, 2007), there are still pest outbreaks owing to high use of broad-spectrum synthetic pesticides against aphids, which have contributed to lowering the parasitoid population. New technologies for specific pests are being suggested: for example, Grzywacz *et al.* (2010) advocates for use of genetically engineered varieties, which can express Bt toxins against DBM. While this could be a good inclusion in an integrated pest management (IPM) system, these products are currently not accepted by the Kenyan public and not yet allowed in the country. In Benin, low



lying mosquito nets reportedly protected cabbages against DBM (Martin *et al.*, 2006; Licciardi *et al.*, 2007).

The use of insect-proof nets is not new in the world and has undergone wide modification to improve efficiency (Antignus *et al.*, 1998; Berlinger *et al.*, 2002; Teitel, 2007). However, these high-cost insect-proof nets have been used particularly in tunnels an intensive agriculture to manage pests and hailstorm (for orchards). The Benin studies provide an innovative approach to extend use of these insect-proof screens to small scale farmers. Based on their findings, A to Z Textile Mills (Ltd), a company specialized in production of mosquito nets in East Africa agreed to produce synthetic nets (hereafter Agronets) to test and use in smallholder agriculture. Therefore, this study was carried out to test the Agronets in managing cabbage pests. It was done to determine the effects of Agronet pore size as well as duration of cover against main pests of cabbages in Kenya. Apart from pest exclusion, the Agronets were hypothesized to modify microclimate of the covered area, which would result to better crop.

Materials and methods

Study sites

The study was conducted in two experimental stations, at Kenya Agricultural Research Institute (KARI)-Kabete, Nairobi (National Agricultural Research Laboratories) (36°41'E and

01°15'S; 1737 m above sea level) from May to July 2011 and KARI-Thika (Practical Training Centre) (0° 59'S and 37° 04'E at an altitude of 1548 m above sea level) from July to October 2011. The popular cabbage variety Gloria was used. Seedlings were raised in the nursery beds at each station then transplanted in the field.

Crop establishment and management

Healthy cabbage seedlings were transplanted in plots measuring 2 m x 6 m, arranged in a completely randomized block design with 5 replicates. Plots were separated by 1 m within and between blocks. Seedlings were spaced at 50 cm x 50 cm, making a total of 48 plants per plot. Holes were dug per plot before transplanting and 5g Diammonium phosphate and 5 handfuls of farm yard manure mixed thoroughly with soil. Seedlings were placed and watered immediately after transplanting and thereafter daily in the first week for stability. Top dressing with Calcium Ammonium Nitrate was done two weeks after transplanting at the rate of one tea spoonful (approx. 5g) per plant. Watering was done manually using a watering can when necessary to supplement rainfall. Plots were kept weed-free throughout the season.

Trial setting

The treatments included; 1) season-long (permanent) cover of cabbage with insect-proof net (mesh size 0.4mm), 2) all season (permanent) cover of cabbage



with insect-proof net (mesh size 0.9mm), 3) opening the insect proof nets (0.4mm mesh size) covering cabbages 3 times a week from 09am - 3pm (Temporary), 4) opening the insect proof nets (0.9mm mesh size) covering cabbages 3 times a week from 09am -3pm (Temporary) and, 5) control where no net was used. The nets were supported by arches (four per plot) made of ordinary mild steel (measuring 0.5m high x 2m length). The structure ensured there was a gap of about 10cm from the Agronet to the crop. This way, it would prevent egg laying by insects landing on the net by ovipositing on plant tissue through the net pores.

Data collection and analysis

Data on insect infestation, and their damage were recorded starting from the first week after transplanting and continued weekly till harvesting. In each plot, 20 plants were randomly sampled (random numbers generated using Microsoft Excel 2010) from the two middle rows. Each plant was examined carefully to ensure all pests were recorded. At harvesting the cabbage heads per plot were counted and sorted out into marketable and unmarketable grades, based on current market measurements. The weight (g) was recorded. Data analysis was done with

Microsoft Excel 2010 (to calculate standard error deviation) and Minitab12 (for Kruskal-Wallis and Mann-Whitney tests). The Kruskal Wallis test was used to compare all effects and then the Mann-Whitney test was used to compare the treatments side-by-side.

Results

Among the pests recorded, diamondback moth (*Plutella xylostella*), aphids (*Brevicoryne brassicae*) and Thrips (*Thrips tabaci*), were the most important in terms of infestation levels and damage. Thrips population was high at Kabete, showing potential of this pest increasing its importance in cabbage production. Level of pest infestation was higher at Kabete compared with Thika, which was expected due to the differences in temperature levels where Kabete was a lot hotter than Thika, creating good conditions for these pests. Infestation by DBM larvae showed significant differences across the treatments both at Kabete and Thika (Table 1). In both study sites, the impact of the Agronet was clear, there was significantly less DBM larvae on cabbaged grown under Agronets compared with those grown without Agronets. Moreover, at Kabete, the number of DBM larvae was lower under permanent Agronets compared with other Agronets opened thrice a week.



Table 1: Pest infestation on cabbages grown at KARI-Kabete and PTC-Thika under nets of different mesh-size left permanently or opened from 9am to 3pm three days per week in Kenya.

Treatment	KARI-Kabete			PTC-Thika		
	Aphids	Thrips	Diamondback moth larvae	Aphids	Thrips	Diamondback moth larvae
0.4 mm Temporary	12.0±2.2*	253.6 ab**	22.0±10.1 ab	6.2±1.1	1.8±0.9	14.8±3.4 a
0.4 mm Permanent	16.0±3.6	157.8 a	11.6±3.6 a	7.8±0.5	0.4±0.4	19.5±6.6 a
0.9 mm Temporary	11.2±2.0	281.8 b	34.6±6.1 b	6.4±0.4	1.8±1.2	13.0±2.5 a
0.9 mm Permanent	13.6±4.4	167.6 a	6.8±3.8 a	5.8±0.2	1.0±0.6	16.6±5.3 a
No net	9.6±1.3	273.6 ab	142.8±12.7 c	5.8±0.8	0.8±0.7	88.8±10.2 b
p-value	0.587	0.026	0.002	0.193	0.598	0.015

* Confidence levels are calculated with the standard deviation

**Values within columns followed by the same letter are not significantly different.

Damage caused by Diamond-back moth larvae was significantly lower under nets than without nets both in Thika and Kabete (Table 2). Moreover, at Kabete, the cabbages grown under temporal large (0.9 mm) mesh-size Agronet had more damages compared to those grown under the permanently cover large mesh-size. However, this result was not shown in the treatments with 0.4mm mesh-size where the permanent and temporal Agronets gave similar results. Infestation by thrips was low in Thika but was higher in Kabete where significant differences

between the treatments were observed. The lowest number of thrips was recorded under permanent Agronets and the highest number under the temporal Agronets. No significant results were found between the treatments for aphids and the percentage of mummies did not significantly differ at Thika. At Kabete, the percentage of mummies under 0.9mm mesh-size nets left permanently was lower than the others which were not significantly different from each other.



Table 2: DBM and Thrips damages on 20 plants of cabbages grown at KARI-Kabete and PTC-Thika under nets of different mesh-size left permanently or opened from 9am to 3pm three days per week in Kenya.

Treatment	KARI-Kabete		PTC-Thika	
	DBM damage	Trips damage	DBM damage	Thrips damage
0.4 mm Temporary	200.0±55.6* ab**	4.8±2.3	212.6±46.2 a	0.0±0.0
0.4 mm Permanent	127.0±16.5 ab	5.0±1.8	282.5±93.1 a	0.0±0.0
0.9 mm Temporary	299.4±54.6 b	8.8±1.7	226.8±53.5 a	0.0±0.0
0.9 mm Permanent	104.6±12.5 a	5.6±1.4	262.0±22.6 a	0.0±0.0
No net	814.6±68.7 c	3.8±2.2	1054.4±73.4 b	0.0±0.0
p-value	0.003	0.390	0.013	1

* Confidence levels are calculated with the standard deviation

**Values within columns followed by the same letter are not significantly different.

Yield effects

Plots that had no Agronet protection recorded the lowest marketable yield compared with those covered with Agronet. The percent marketable yield in control plots was on average 10% while from Agronets it was 83% (Figure 1). Cabbages from temporally covered plots

gave 85% marketable yield compared with those from permanent cover who gave 77% marketable yield. Large-sized mesh Agronets resulted to 82% marketable yield while fine mesh Agronet gave 79% marketable yield. However, there was no significant difference between the different treatments under Agronets.

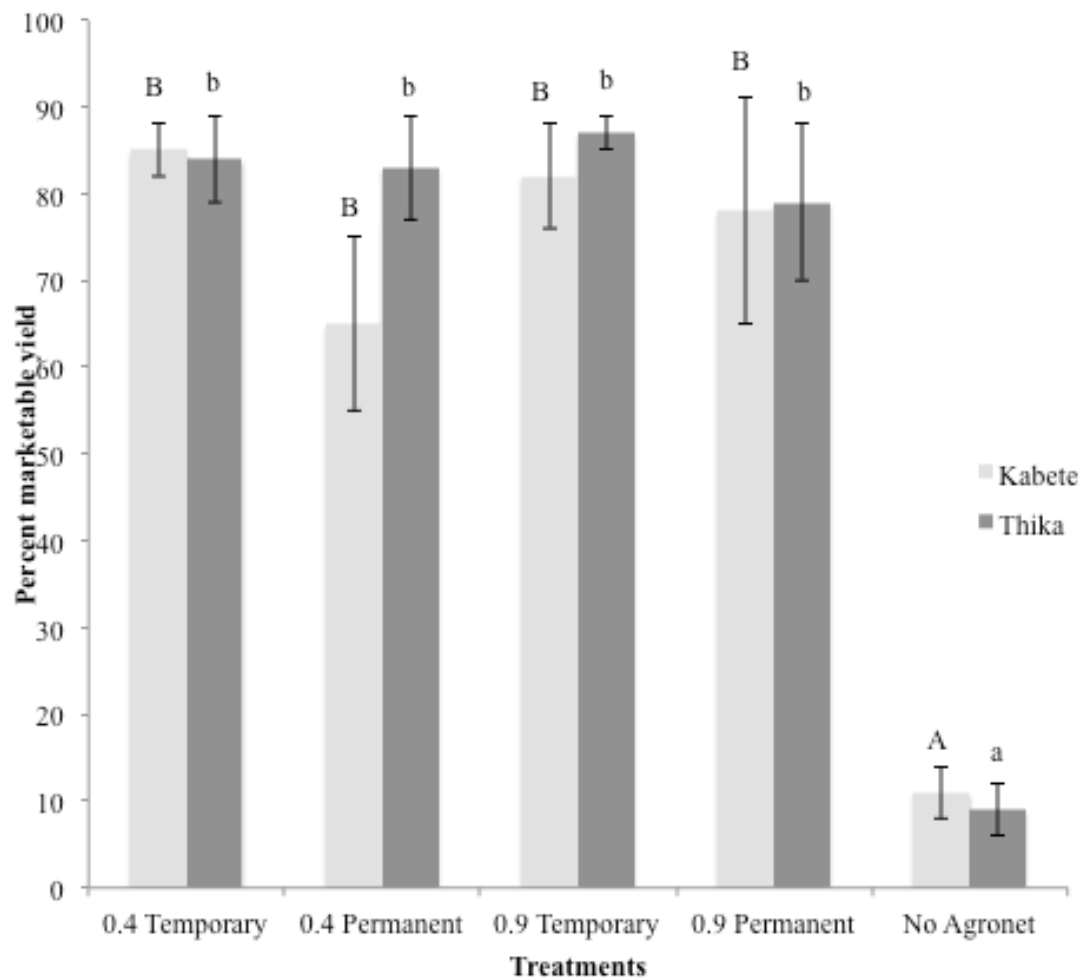


Figure 1: Percentage of marketable cabbages at harvest.

Cabbages grown at KARI-Kabete and PTC-Thika under Agronets of different mesh-size (0.4mm and 0.9mm) left permanently or opened from 9am to 3pm

three days per week. Confidence levels are calculated with the standard deviation and bars followed by the same letter are not significantly different.



Discussion

In this study, we observed that Agronets significantly reduce the number of Diamondback moth on cabbage and the damage it can cause, which is line with the results of Martin *et al.* (2006) who showed that this form of netting had better result than the control without nets, and then spraying a foliar insecticide. It can be explained by the fact that the net is a visual and physical barrier. The fact that no significant difference was found between the permanent and temporary cover seems to indicate that opening thrice a week from 9am to 3pm is not enough to allow the DBM access to the crop. It was observed that the level of thrips was lower under permanent netting than under temporary netting. Moreover, no significant difference was found between the temporary nets and the treatment without net. This suggests that the permanent netting reduce the entrance of thrips and that thrips enter under the temporary nets while they are open. This is confirming earlier findings by Gogo et al. (2012) that showed that using nets left permanently gave better results than temporary nets. No significant difference was found in the number of aphids, which can mean that nets don't have any impact on aphids but previous findings by Muleleke, (2012) on nursery or Martin *et al.* (2013) suggest that nettings reduce the number of aphids. Our results may then be explained by a low infestation of aphids which didn't lead to any significant difference or by the fact that we used untreated nets and Licciardi *et al.* (2007) found that if treated nets

reduce the number of aphids, untreated nets, on the other hand don't have any impact. In addition, covering crops reduces instantaneous solar radiation through shading which lowers evaporation from the ground, thus maintaining higher soil moisture contents (Moreno *et al.*, 2002). The yield of marketable cabbages was significantly higher under nets as compared to those without nets due to less damages caused by insects. This confirms previous findings by Martin *et al.* (2006) who showed that nettings had even better marketable yields than where a foliar insecticide was sprayed.

Conclusion and recommendations

These results demonstrate the potential of agronets covers as a viable strategy for improving yields of cabbages and quality through improvement of the microclimate around growing. The number of insect's pests was greatly reduced through exclusion thus avoiding attack and subsequent damage. Although the findings of this study provide a foundation to understand the role agronets covers can play in cabbage production, we recommend further studies to test the applicability of the technology on a range of brassica varieties and in different agroecological zones.

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