Evaluation of Border Crops against Infestation and Damage of Cabbage by Diamondback Moth (*Plutella xylostella*)

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ABSTRACT

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Different trap crops were evaluated to determine their effectiveness in reducing diamondback moth (DBM) infestation on cabbage. Tomato, kale, Indian mustard, coriander, cleome and radish were planted around cabbage var. Copenhagen market plots to pull or push the DBM away from the cabbage. The field experiment was carried out in two relay cropping periods (September to December 2008 and January to March 2009) at University of Nairobi farm, Kenya. Border crops were planted 15 days prior to cabbage transplanting to facilitate cabbage protection around the whole plot, in a Randomized Complete Block Design with four replicates. The counts of larvae, pupae and damage score were recorded weekly in situ on five randomly selected cabbage plants per plot from third week of cabbage transplanting for eight weeks. At maturity, cabbage heads were counted and weighed, then classified as marketable or unmarketable depending on the level of damage. Results showed that there was significantly ($P < 0.05$) lower number of immature DBM in cabbage surrounded with Indian mustard compared with other types of border crops. In addition, there was significant difference between marketable and unmarketable cabbage heads among the border crops, with Indian mustard and coriander bordered plots recording highest marketable yield. These two border crops were more effective in reducing DBM infestation. Farmers are advised to incorporate these crops in the management of the pest in the field. By adopting these, farmers will be able to reduce pesticide sprays targeting this pest and also gain from these border crops through generation of extra income.

Key words: Border crops, cabbage, diamondback moth**,** marketable yield, trap-cropping

Cabbage (*Brassica oleracea* var. *capitata*) suffers huge yield and quality losses caused by insect pests mainly Lepidopteran species particularly diamondback moth (DBM) (*Plutella xylostella*). Most ovipositing Lepidopterans prefer to lay their eggs on hosts where their larvae are able to survive (6). In the warm humid tropics, DBM breeds throughout the year, and can have more than ten generations annually (4). Larvae of *P. xylostella* cause significant losses in terms of marketable yield and hence family income. However, DBM can cause serious damage even with application of several different insecticides because of its ability to develop resistance to almost all

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insecticides (12). The insecticide resistance by DBM has made the pest the focus of IPM research in many parts of the world. The negative impact of pesticides and increasing pesticide resistance capacity on DBM have increased the interest in alternative control methods, with emphasis on biological control, plant resistance, cultural control and other non-polluting methods (8). Use of trap crops could reduce the pest damage and number of sprays needed to produce economic crop since they can push or pull away pests from the main crop (5). Trap crop system is especially important in subsistence farming, practiced mainly in developing countries due to its ability to reduce reliance on pesticides and also lower production costs (7). In some areas, farmers inter-crop cabbage with other brassica crops or crucifer weeds that are more attractive to DBM than cabbage. Mitchell *et al.* (9) found that collards attracted more DBM's larvae in the cabbage fields which make trap cropping with collards a popular practice in the United States of America. Similarly, Charleston and Kfir (2) found more egg laying, but low survival rate of the larvae on Indian mustard used as a trap crop. However, Indian mustard failed in several other countries like Taiwan, South East Asia, Canada (14) and in South Africa the DBM crop preference is not known but Indian mustard was found to have potential to act as a trap crop for DBM (2). This study was done to evaluate effectiveness of six trap crops against DBM infestation and damage of cabbage.

MATERIALS AND METHODS

The study was carried out at Kabete Campus Field Station Farm, University of Nairobi in two relay cropping periods, from September to December 2008 and from January to March 2009. Border crops evaluated were three host plants from family Brassicaceae i.e. Indian mustard (*Brassicas juncea*), kale (*Brassica oleracea* var. *acephala*) and radish (*Raphanus sativus hortensis*), and other three non-host plants belonging to family Solanaceae i.e. tomato (*Lycopersicon esculentum*), Capparidaceae i.e. coriander (*Coriandrum sativum*) and another in the family Apiaceae i.e. cleome (*Cleome gynandra*). Cabbage var. Copenhagen market was used for this study. Control consisted of a fallow land that surrounded the main plot and the fallow was kept weed free throughout the season. All border crops were established in the field 15 days before transplanting cabbage seedlings. The experiment was laid in a Randomized Complete Block Design with four replicates in plot sizes of 4.0 × 4.0 m. An alley of 1 and 2 m was maintained between plots and blocks, respectively. The intra-row spacing for border crops was 10 cm for coriander, 15 cm for Indian mustard, 20 cm for radish, 25 cm for kale, 45 cm for tomato, and 45 cm cleome. One month-old cabbage seedlings were transplanted (on 25 September and 30 December, first and second relay cropping period, respectively) in ploughed and fine tilled plots spaced at 60 cm inter-row and 45 cm intra-row surrounded by the different border cropping treatments. During transplanting, diammonium sulphate fertilizer was applied at a rate of 20 g per planting hole. After one month of transplanting, top dressing was done at rate of 20 g per seedling using calcium ammonium nitrate. Plots and alleys were kept weed free manually throughout the season. Sampling was done by counting numbers of immature stages of DBM (larvae and pupae) and scoring their

damage (Table 1) on five randomly selected cabbage plants per plot in situ. Sampling was done weekly from week 3 after transplanting for 8 weeks. The number and weight of marketable and unmarketable cabbage heads were recorded during harvesting. All the data were subjected to Analysis of Variance (ANOVA) using GENSTAT Discovery Edition after square root transformation, $(x + 0.5)^{1/2}$. Means are provided with standard error (SE) and probability value at 95% level.

Table 1. Modified scale of Dreyer (3) used for damage scoring on cabbage varieties at Kabete field station during September-December 2008 and January-March 2009

Score	Description
1	No damage, or few isolated small holes in the outer or lower leaves
2	Many holes but damage limited to outer or lower leaves
3	Considerable damage of the outer or lower leaves, slight damage on the cabbage head, head marketable with minor leaf removal of outer head leaves
4	Outer or lower leaves completely destroyed, moderate attack of inner leaves, head marketable after considerable removal of outer head leaves
5	Severe attack on the head (head unmarketable)

RESULTS

There was significant difference ($P < 0.05$) among the different border cropping treatments on immature DBM infestation level both in the first and the second cropping (Table 2). The lowest mean number of immature DBM was recorded on cabbage bordered by Indian mustard among the border crops of cruciferous family while coriander had the lowest number among non-cruciferous crops.

The results indicated that there was significant difference ($P < 0.05$) on damage of cabbage among border crops in the two cropping periods (Table 2). Cabbage plots bordered with Indian mustard had lowest damage score whereas the highest was recorded on the control treatment.

Table 2. Mean number of immature DBM and damage score on cabbage surrounded by different border crops at Kabete field station in two cropping periods September-December 2008 and January-March 2009

Treatment	Immature		Damage score	
	Cropping 1	Cropping 2	Cropping 1	Cropping 2
Fallow	5.41	6.31	2.94	2.56
Cleome	5.19	3.50	2.06	1.63
Coriander	3.66	4.59	2.13	1.59
Indian mustard	2.88	2.22	1.56	1.03
Kale	4.00	3.88	1.69	1.25
Radish	3.16	4.69	2.22	1.59
Tomato	4.38	3.88	2.22	1.47
Mean	4.09	4.15	2.12	1.60
SE	0.58	0.59	0.07	0.15
P value	< 0.05	< 0.05	< 0.05	< 0.05

Plots bordered with non-host plants did not significantly ($P > 0.05$) differ from each other in damage ratings. The damage levels were lower in the second cropping compared with the first cropping period. However, the results did not show significant interaction ($P > 0.56$) between sampling time and border crops on cabbage damage.

There were also significant differences ($P < 0.05$) in numbers of marketable and unmarketable cabbage heads from plots surrounded with different border crops (Table 3). Plots bordered by Indian mustard, radish and coriander had the highest mean number of marketable cabbage heads compared with the other treatments which were characterized by the highest mean number of unmarketable cabbage heads.

Table 3. Mean number and weight of marketable and unmarketable cabbage heads from plots surrounded with different border crops at Kabete field station in two cropping periods September-December 2008 and January-March 2009

Treatment	Mean cabbage heads number		Mean cabbage heads weight (Kg)	
	Marketable	Unmarketable	Marketable	Unmarketable
Fallow	9.00	33.50	15.30	9.32
Cleome	19.00	16.50	10.70	3.20
Coriander	29.00	12.00	22.00	5.07
Indian mustard	32.25	10.00	33.20	3.57
Kale	22.50	13.20	16.80	3.07
Radish	25.25	15.00	23.20	3.60
Tomato	20.25	16.80	15.00	5.02
Mean	22.46	16.70	19.50	4.70
SE	3.58	3.87	5.86	2.09
P value	< 0.05	< 0.05	< 0.05	> 0.05

The highest marketable cabbage weights were obtained in plots bordered with Indian mustard, radish and coriander which incidentally had highest number of marketable heads (Table 3). The control treatment had the highest weight of unmarketable heads compared with the other treatments.

The results showed a positive correlation between the mean number of immature DBM and mean damage score on cabbage heads (Table 4).

Table 4. Relationship between immature DBM and damage score on cabbage heads at Kabete field station during September-December 2008 and December 2008-March 2009.

	Damage Score	DBM immature
Damage Score	1.00	0.125*
DBM immature	0.125*	1.00

* Correlation is significant at the 0.05 level (two tailed)

DISCUSSION

Cabbage plots bordered with Indian mustard and coriander had lowest mean number of immature DBM on Copenhagen Market. The border crop, coriander, effects were most likely through repelling away adult DBM such that they did not lay eggs on the main crop, cabbage. The few DBM eggs that were hatched on cabbage resulted to fewer larvae but these caused high damage implying that coriander did not interrupt their feeding. Cabbage heads from plots bordered with Indian mustard

had lowest damage level which shows that Indian mustard border crop could have attracted DBM and was the most preferred host for eggs laying compared with cabbage. The lower damage level on cabbage heads bordered by Indian mustard is in agreement with Francisco *et al.* (6) findings suggesting that DBM prefers to lay eggs on mustard compared with cabbage although it results in low survival rate of the larvae on mustard. Shelton *et al.* (13) reported the potential use of mustard as a dead-end trap crop of the DBM regardless of whether is a *Bacillus thurigiensis* (Bt)-transgenic or not because it is more attractive for oviposition than the cash crop. In other studies, mustard intercropping had also significantly reduced DBM infestation in the field (11). Coriander did not support the feeding and development of DBM. The control plot attracted the highest number of DBM to lay eggs on cabbages which resulted in higher mean number of larvae and damage level as compared with other treatments. Plots with Indian mustard border crop produced highest marketable cabbage heads with highest weights compared with the other border crops. The control treatment had highest records of unmarketable cabbage heads compared with the other treatments. This implies that, among those border crops, better quality cabbage heads can be obtained with growing of cabbages surrounded by one of those border crops. Broad *et al*. (1) indicated that the success of crop diversification strategies through cropping systems such as border crops depends on the relative ability of the target herbivore to locate its host plant and the scale of diversity rather than diversity itself. However, in Kenya, the potential of diversification by use of border cropping system has been also reported in the management of aphids infesting okra (*Abelmoschus esculentus*) using pigeon pea (*Cajanus cajan*) as border crop which maintained the pest below economic damage (10). The positive correlation observed between the cabbage damage and DBM numbers was expected a priori. The DBM will reduce both the quality and quantity of the cabbage yields, hence impacting on the farmer income. Therefore, Indian mustard and coriander, which performed better, should be promoted for the management of DBM infestation on cabbage fields. Their adoption is expected to lower usage of pesticides in farmer fields, increase productivity and income of cabbage farmers.

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RESUME

Hasheela E.B.S., Nderitu J.H., Olubayo F.M. et Kasina M. 2010. Evaluation des cultures en bordure vis-à-vis de l'infestation et des dégâts de la teigne des crucifères (*Plutella xylostella*) sur le chou. Tunisian Journal of Plant Protection 5: 99-105.

Différentes cultures pièges ont été évaluées afin de déterminer leur efficacité pour réduire l'infestation du chou (*Brassica oleracea* var. *capitata*) par la teigne des crucifères (*Plutella xylostella*). La tomate, le chou frisé, la moutarde joncée (ou indienne), la coriandre, le cléome et le radis ont été plantés autour des parcelles chou var. Copenhagen market afin d'attirer ou de repousser la teigne des crucifères loin de cette culture. L'expérience au champ a été réalisée en deux saisons de cultures successives (de

Septembre à Décembre 2008 et de Janvier à Mars 2009) dans le domaine de l'Université de Nairobi, Kenya. Les cultures en bordure ont été plantées 15 jours avant la transplantation du chou afin de faciliter sa protection autour de la totalité de la parcelle selon un dispositif en blocs aléatoires complets avec quatre répétitions. Les comptages des larves et des pupes ainsi que l'estimation des dégâts ont été enregistrés chaque semaine *in situ* sur cinq plants par parcelle élémentaire choisis au hasard et ce, à partir de la troisième semaine après la transplantation du chou jusqu'à huit semaines. A maturité, les têtes de chou ont été comptées, pesées et ensuite classées comme commercialisables ou non commercialisables selon le niveau des dégâts enregistrés. Les résultats montrent l'existence d'un nombre significativement ($P < 0.05$) faible de stades immatures de la teigne des crucifères au niveau du chou entouré de moutarde joncée comparée aux autres types de cultures en bordure. De plus, il y a une différence significative entre les têtes de chou commercialisables ou non commercialisables parmi les cultures en bordure avec un rendement commercialisable plus élevé chez les parcelles entourées de moutarde joncée et de coriandre. Ces deux cultures de bordure ont été plus efficaces dans la réduction de l'infestation avec la teigne des crucifères. Les agriculteurs sont conseillés de les incorporer pour une gestion de l'insecte au champ. En adoptant cela, les agriculteurs peuvent réduire les traitements pesticides utilisés contre cet insecte et peuvent également avoir un revenu supplémentaire à partir de ces cultures en bordure.

Mots clés: Chou, cultures en bordure, culture piège**,** rendement commercialisable, teigne des crucifères

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ملخص

هاشيلا، إدّي ودجون نديريتو وفلورانس أولوبايو وموبو كازينا. 2010. تقييم الزراعات المحاذية ضد الغزو والأضرار على الكرنب/الملفوف بعثة الصليبيات ذات الظهر الماسي (*Plutella xylostella*).
Tunisian Journal of Plant Protection 5: 99-105.

تم تقييم زراعات صائدة مختلفة لتشخيص نجاعتها في الحد من غزو عثة الصليبيات ذات الظهر الماسي (*Plutella xylostella*) للكرنب/الملفوف (*Brassica oleracea* var. *capitata*). لذلك زرعت الطماطم/البندورة والكرنب المجعد والخردل الهندي والكزبرة والذفرة/زهرة العنكبوت والفجل حول قطعة تجريبية من الكرنب من صنف Copenhagen market لجذب أو لإبعاد العثة. نفذت التجربة الحقلية خلال موسمين متواليين (من سبتمبر/أيلول إلى ديسمبر/كانون الأول 2008 ومن جانفي/كانون الثاني إلى مارس/آذار 2009) في محطة جامعة نيروبي، كينيا. زرعت الزراعات المحاذية 15 يوما قبل تحويل شتلات الكرنب لتسهيل عملية الحماية حول كامل القطعة التجريبية التي كانت بتصميم القطع الكاملة العشوائية بأربعة مكررات. تم عد اليرقات والعذارى وكذلك تسجيل الأضرار أسبوعيا في عين المكان بالاختيار العشوائي لخمسة نباتات من كل قطعة بداء من الأسبوع الثالث بعد تحويل الكرنب لمدة 8 أسابيع. عند النضج، تم عد رؤوس الكرنب ووزنها ثم تصنيفها حسب صلاحيتها للتسويق من عدمه باعتبار مستوى الأضرار. بينت النتائج بأن عدد الفراشات ذات الظهر الماسي غير البالغة كان أقل معنويا ($P < 0.05$) على الكرنب المحاط بالخردل الهندي بالمقارنة مع الزراعات المحاذية الأخرى. كذلك، كان هناك فرق معنوي بين رؤوس الكرنب الصالحة وغير الصالحة للتسويق داخل الزراعات المحاذية مع تسجيل أعلى إنتاج صالح للتسويق عند النباتات المحاذية للخردل الهندي والكزبرة. كانت هاتين الزراعتين المحاذيتين أكثر نجاعة في تخفيض الغزو بالفراشة. ينصح الفلاحون بإدماج هذه الطريقة في إدارة الآفة في الحقل. باعتمادهم ذلك، يمكن للفلاحين تخفيض رش المبيدات الموجهة ضد هذه الآفة وكذلك تحقيق بعض الربح من مداخيل تلك الزراعات المحاذية.

كلمات مفتاحية: إنتاج صالح للتسويق، عثة الصليبيات ذات الظهر الماسي، زراعات صائدة، زراعات محاذية، كرنب

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