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Efficacy of Intercropping as a Management Tool for the Control on Insect Pests of Cabbage in Ghana

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Keywords: *Brassica oleracea* – *Plutella xylostella* – *Hellula undalis* – *Chromolaena odorata* – *Mentha spicata* – *Lycopersicon esculentum* – *Allium cepa* – Intercropping

Summary

The efficacy of intercropping cabbage with other vegetables and herbs as a management tool in migitating insect pests problems of cabbage was investigated in the field at Kwadaso, Kumasi during a three season period in the forest region of Ghana. The results showed that Plutella xylostella *could be effectively controlled when cabbage is intercropped with onion, spearmint and tomato. However, there is the need to control* Hellula undalis *in endemic areas with pesticides up to six weeks after transplanting. Both Karate (cyhalothrin) and Dipel 2X (the biopesticide* Bacillus thuringiensis *subsp.* Kurstaki*) were effective in mitigating the problem of* H. undalis *in the intercropping experiments and both are recommended.*

Résumé

Efficacité de l'association des cultures sur la lutte des insectes nuisibles du chou au Ghana

Une étude a été menée dans un champ situé dans une zone forestière à Kwadaso, Kumasi au Ghana pendant trois saisons culturales. L'objectif était de voir si le chou cultivé en association avec d'autres légumes ou d'autres herbes pouvait résister à l'attaque des insectes nuisibles. Les résultats obtenus montrent que les attaques du chou par Plutella xylostella *pouvaient être minimisées si le chou était cultivé en association avec l'oignon, la menthe et la tomate. Il a été également constaté que le traitement des choux avec des pesticides contre* Hellula undalis *était nécessaire dans les zones où ce ravageur était endémique jusqu'à six semaines après le repiquage. L'utilisation de Karate (cyhalothrin) et de Dipel 2X (un bio-pesticide à base de* Bacillus thuringiensis *subsp.* Kurstaki*) s'est montrée efficace et a atténué l'attaque des choux par* H. undalis *si le chou était cultivé en association avec d'autres plantes. Ces produits sont à recommander.*

Introduction

The importance of cabbage, *Brassica oleracea* (L.) as an urban vegetable in Ghana cannot be overemphasized. However, production of this vegetable is hampered by pest insect damage, particularly by *Plutella xylostella* (L.) (Lepidoptera: Plutellidae) and *Hellula undalis* (F.) (Lepidoptera: Pyralidae). Current control methods of these pests include the use of chemical and biological insecticides, and plant extracts such as cyhalothrin, *Bacillus thuringiensis* subsp. *Kurstaki* and azadirachtin respectively.

In most market gardens and small holder cabbage farms, it is quite usual to intercropp cabbage with other vegetables. Hower, intercropping as practised by Ghanaian farmers is not targeted to control pests per se but for economic reasons. Studies conducted in Russia and Asia (1) have, however, demonstrated that intercropping reduced cabbage pest populations in the field.

Insects are known to cue on the odours emanating from their host plants to land and feed. Stronger odours from non-host plants in association with the host plant tend to mask the odours of the host plant. This phenomenon is said to confuse insect pests and reduce their ability to locate their host plant (6).

According to Norman (3), research on intercropping has previously been neglected by many investigators

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because of the belief that it did not lend itself easily to modern cultivation technology. However, recent demonstrations of advantages of the system, even at high levels of appropriate technology, has brought this assumption into question (7, 8).

The objective of this study was to evaluate the efficacy of intercropping cabbage with other vegetables or herbs in an attempt to control insect pests on cabbage.

Material and methods

Three seperate intercropping experiments were conducted between February 1994 and January 1995 at Kwadaso, that is near Kumasi in the forest region of Ghana. The interplants used were *Chromolaena odorata* (L.) King and Robinson *(Eupatorium odoratum* L.*)* (acheampong), *Lycopersicon esculentum* (L.) (tomato), *Allium cepa* (L.) (onion) and *Mentha spicata* (L.) (spearmint). Sole cabbage, *Brassica oleracea* was used as a control plot.

Five treatments were tested: cabbage/onion intercrop, cabbage/spearmint intercrop, sole cabbage (control), cabbage/tomato intercrop and cabbage/acheampong intercrop.

Each treatment was replicated three times in a randomized complete block design. A plot measured 5.3 x 2.1 m and contained two rows of cabbage and three rows of the interplant, except for the control which had five rows of cabbage. Cabbage was planted at 0.45 m in the row and 0.45 m between rows. Interplants were however planted as follows: tomato (variety "Wosowoso"): 0.60 m within rows spaced 0.45 m from cabbage rows; spearmint: 0.75 m within rows and 0.45 m from cabbage rows; acheampong: 0.75 m within rows and 0.45 m from the cabbage rows, and onions at 0.10 m within rows and 0.15 m from the cabbage rows.

There were 24 cabbage plants per plot for each of the interplants and 60 for the control. The second and fourth cabbage rows in the control were used for data collection. Data collection was made on ten cabbage plants from each plot. Weeding was done when necessary with a hand fork. Each plot was separated 1m from the other. Ammonium Sulphate and 20:20:0 N:P:K fertilizer were applied to the cabbage at the rate of 10 g/plant, 10 and 30 days after transplanting. No fertilizer was applied to the intercrops.
Transplanting of cabbage seedlings to the field was done four weeks after nursing and was spaced 0.45 m x 0.45 m on the beds. Transplanting was carried out in the evening to avoid heat shock. Parameters investigated were: cabbage bud damage (multiple heading) caused by *Hellula undalis* and cabbage head damage caused by *Plutella xylostella* using a 1-5 point scale at harvest. On the scale 1 represented leaf damage by *P. xylostella* up to 5% on the scale; 2 for damage between 6 and 15%; 3 for damage from 16 to 25% damage while 4 and 5 represented damage between 26 and 50% and above 50%; damage respectively (Appendix 1). The yield (cabbage head weight) was also measured at harvest. No pesticides were applied to the treatments in the first two experiments.

The above methodology was used for the first two experiments. The third experiment was modified to a factorial design. Here, the intercrops (as above) formed the main treatments while for each of the plots one row of cabbage was treated with Dipe 2X *(Bacillus thuringiensis* subsp. *kurstaki)* at 1 g/l and the other with Karate (cyhalothrin) at 2.4 ml/l and these formed the sub-treatments. The pesticides were applied as sprays using a CP 15 Knapsack sprayer fitted with a shield to avoid pesticide drift. Frequency of pesticide application was weekly and this continued until head formation.
Ammonium sulphate and 20:20:0 N:P:K fertilizer were applied to the cabbage at the rate of 10 g/plant, 10 and 30 days after transplanting, respectively.
Ten cabbage plants in each sub-plot were used for data collection. The rest of the methodology was the same as described above.

Count data were transformed using the formula 'y=$\sqrt{(x+0.5)}$ (2). ANOVA was applied to all the results.

Table 1
Cabbage bud damage by *H. undalis* (%), head damage by *P. xylostella* (mean score on a 1-5 scale) and yield of cabbage head (t/ha) in the first experiment

Treatment	*H. undalis* damage (%)	*P. xylostella* damage (Mean score)	Yield (t/h)
Cabbage/Onion	15.0	1.5	9.9
Cabbage/Mint	18.3	1.6	5.0
Sole cabbage (Control)	13.3	1.3	9.7
Cabbage/acheampong	26.7	1.3	4.4
Cabbage/Tomato	26.7	1.4	8.9
LSD (5%)	22.9	0.6	5.3

Results and discussion

EXPERIMENT ONE

Cabbage Bud Damage by *H. undalis*

There were no significant differences among the treatments at the 5% level. The damage recorded, however, ranged from 15,0% to 26,7% (Table 1). The damage recorded here by *Hellula undalis* to cabbage bud was relatively high most probably due to the absence of pesticide application in this experiment.

Cabbage Head Damage by *P. xylostella*

Cabbage head damage in this experiment was low (mean scores ranging from 1.3 to 1.6) and not significantly different from each other at the 5% level (Table 1).

Table 2
Percentage insect abundance in second experiment

Insect	% Abundance
Hellula undalis	84.5
Plutella xylostella	1.0
Other insects	14.5

The other insects were identified as beneficial arthropods namely spiders (7.7%) and *Cotesia* sp. (6.8%)

Yield of Cabbage Head

Cabbage head weight did not show any significant differences at P= 0.05 (Table 1). The lowest yield was however observed in the cabbage/acheampong intercrop.

EXPERIMENT TWO

Cabbage Bud Damage by *H. undalis*

The field became heavily infested with *H. undalis* (Table 2). From one week after the crop establishment to the end of the fourth week, the field was completely destroyed. The field was therefore abandoned. The high incidence of pests in the second experiment was probably due to insect pest build-up resulting from the first experiment. This is the first time a cabbage field has been completely destroyed by *H. undalis* in ten years.

The very low population of *P. xylostella* may be attributed to the activities of natural enemies (*Cotesia* spp. and spiders) on the field (Table 2). Because of the concealed nature of *H. undalis*, the spiders probably could not reach them to feed on. Indications are that the continuous cultivation of cabbage is giving rise to the proliferation of *H. undalis*, which hitherto was only an occasional pest. The results prompted a third experiment with some modifications aimed at mitigating *H. undalis* infestation during the early stages of cabbage intercropping experiments.

EXPERIMENT THREE

Cabbage Bud Damage by *H. undalis*

There were significant differences among the main treatments at the 5% level regarding cabbage bud damage (Table 3). There was, however, no difference in the sub-treatments, i.e. in the effect of pesticides applied. Thus both Karate and Dipel 2X were equally effective incontrolling *H. undalis* in the field.

The sole cabbage treatment showed very high infestation of *H. undalis* and this was significantly different from the other four treatments. The cabbage/onion treatment had no *H. undalis* damage but was not significantly different from the cabbage/mint and cabbage/tomato treatments. The cabbage/onion treatment was however significantly better than the cabbage/acheampong treatment at P<0.05.

Table 3
Cabbage bud damage by *H. undalis* (%), head damage by *P. xylostella* (mean score on a 1-5 scale) and yield of cabbage head (t/ha) in the third experiment

Treatment	*H. undalis* damage (%)	*P. xylostella* damage (Mean score)	Yield (t/h)
Cabbage/Onion	0.0	1.0	6.7
Cabbage/Mint	10.3	1.0	6.7
Sole cabbage (Control)	46.9	1.7	6.3
Cabbage/acheampong	20.4	1.0	4.6
Cabbage/Tomato	11.2	1.2	6.3
LSD (5%)	13.4	0.2	0.6

Cabbage Head Damage by *P. xylostella*

This parameter also showed some significant differences in only the main treatments at the 5% level (Table 3). The treatments with the lowest insect damage were the cabbage/onion, cabbage/mint and cabbage/acheampong interplants, though not significantly different from the cabbage/tomato treatment. However, all four treatments performed significantly better than the control at P<0.05.

Yield of Cabbage Head

The yield als showed significant differences in the main treatments but not in the sub treatments (Table 3). The lowest yield was recorded in the cabbage/acheampong treatment. This was significantly different from the other treatments, which were statistically the same at the 5% level.

The results showed that pesticide application is necessary to control *H. undalis* in intercropping of cabbage with other vegetables/herbs. This is probably because the interplants were too young for their odours to mask the odour of the cabbage. There was no significant difference between the two pesticides evaluated i.e. Karate and Dipel 2X in controlling *H. undalis* in the intercropping experiment. Since *H. undalis* has not yet developed resistance to either Dipel 2X or Karate, they could be used to control *H. undalis*. Secondly, since the two pesticides are compatible with each other (Braimah and Timbilla, unpublished), they could also be applied in a mixture to control *H. undalis*. Here the quick knockdown effect of Karate and the environmental safety of Dipal 2X could both be exploited.

The better performance of the intercrops in reducing populations of *P. xylostella* is probably due to the fact that *P. xylostella* attac comes later than *H. undalis*, thus the effect of the interplants could be realised. Srinivasan and Veeresh (5) also reported that intercropping cabbage with tomato reduced populations of *P. xylostella* and *C. binotalis* in India. Raros (4) demonstrated that intercropping of cabbage with tomatoes could reduce infestations of diamondback moth. Secondly, the activities of the natural enemies (*Cotesia* spp. and spiders) were additional factors.

The study also revealed that *H. undalis* attack ceased at the 6th week after transplanting when the cabbage heads were formed. This implies *H. undalis* needs to be controlled untill head formation when damage caused by the insect ceases.

The *C. odorata* intercrop was quite effective in controlling *P. xylostella* when cabbage was intercropped with it. This however resulted in very low yield of the cabbage heads (4.6 t/ha). This agrees with the results reported by Srinivasan and Veeresh (5). It is also possible that the allelopatic and shading effects of *C. odorata* contributed to the low yields. In some cases the effects of the *C. odorata* prevented head formation thus *C. odorata* cannot be recommended as an intercrop in the cab-

bage production. The yields in the other treatments (ranging from 6.3 t/ha - 6.7 t/ha) are however comparable with results obtained in sole cropping of cabbage by Srinivasan and Veeresh (5).

Conclusion

Based on the results obtained so far it is suggested that intercropping cabbage with onion, tomato and *M. spicata* is effective in reducing populations of cabbage pests. However, this has to be preceded with weekly applications of pesticides in order to control *H. undalis* during the first 6 weeks after transplanting in pest endemic areas.

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Appendix 1
Scale used for scoring *P. xylostella* damage

Score	Damage to leaf
1	0-5%
2	6-15%
3	16-25%
4	26-50%
5	>50%

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