American Journal of Food Technology

ISSN 1557-4571

Academic Journals Inc.

www.academicjournals.com

American Journal of Food Technology 5 (4): 269-274, 2010
ISSN 1557-4571

Control of Diamondback Moth (*Plutella xylostella*) on Cabbage (*Brassica oleracea* var *capitata)* using Intercropping with Non-Host Crops

[1,2]E. Asare-Bediako, [1]A.A. Addo-Quaye and [1]A. Mohammed
[1]Department of Crop Science, University of Cape Coast, Cape Coast, Ghana
[2]Warwick HRI, University of Warwick, Wellesbourne, Warwicks, CV35 9EF, UK

Abstract: This study was conducted to evaluate the effectiveness of intercropping cabbage with non-host crops in reducing the effect of the diamondback moth pest on cabbage. The experimental design used was a randomized complete block design with five treatments and four replications. The treatments were cabbage-tomato intercrop, cabbage-pepper intercrop, cabbage-onion intercrop, pure cabbage stand sprayed with chlorpyrifos (Dursban) a synthetic insecticide and a pure cabbage stand that was not sprayed (control). Data were taken on plant height, DBM population per plant, leaf damage, head damage and head weight. Cabbage plants intercropped or sprayed with chlorpyrifos against the DBM pests recorded significantly higher growth and yield and less pest damage compared with controls. Intercropping cabbage with onion, tomato or pepper was found to be as effective as spraying the cabbage with chlorpyrifos. Cabbage intercropped with onion and tomato produced lower leaf and head damage and higher yield than those intercropped with pepper.

Key words: Diamondback moth, *Plutella xylostella*, cabbage, non-host intercrops, pest control

INTRODUCTION

Cabbage (*Brassica oleracea* var *capitata)* is an important exotic vegetable grown in Ghana on both large and small scale. It provides a source of livelihood to all individuals who are engaged in cabbage production from its cultivation till it gets to the final consumer (Sinnadurai, 1992). The cultivation of cabbage provides an excellent source of employment for both rural and urban dwellers as it is grown in many rural areas through truck farming and in the outskirts of towns and cities as market gardening and backyard gardening through which fresh vegetables are produced for homes in the urban areas. Furthermore, middlemen who purchase the vegetable from the farms and send to the urban centres as well as transport operators who convey the heads to the market centres, all obtain their source of livelihood from the crop.

Cabbage has high nutritive value and it is used in the preparation of various kinds of dishes. It is used in stews, eaten raw in salads or boiled and eaten (Norman, 1992). Contents per 100 g are: 93 g water, 1.6 g protein, 6.0 g carbohydrates, 55 mg calcium, 0.8 mg iron, 0.3 mg carotene, 0.06 mg thiamine, 0.06 mg riboflavin, 0.3 mg niacin, 46 mg vitamin C and 92 kJ energy (De Lannoy, 2001). Cabbage is also a source of foreign exchange for Ghana through its export to neighboring countries (Sinnadurai, 1992).

Corresponding Author: Elvis Asare-Bediako, Warwick HRI, University of Warwick, Wellesbourne, Warwicks, CV35 9EF, UK

In spite of the enormous benefits of cabbage to the growth and development of humans and the nation as a whole, production of the crop is beset with a lot of problems. Prominent among these problems in Ghana is pest attack. These pests include aphids *(Brevicoryne brassicae)*, Bagrada bug (*Bagrada hilaris)*, flea beetles (*Phyllotreta* sp.), diamondback moth (*Plutella xylostella)* and cutworm (*Agrotis* sp.) (De Lannoy, 2001). The most devastating pest that causes severe damage in cabbage production is the diamondback moth (DBM) (Kwarteng and Towler, 1994). However, this insect pest is resistant to many conventional pesticides and so spraying DBM-infested cabbage often has little effect on the pest; thus farmers may be tempted to carry out extensive spraying and eventually give up cabbage protection (Youdeowei, 2002). Furthermore, there is a growing concern about the pollution of the environment and its resultant effects on the health of humans and animals arising from the continued use of these pesticides. An effective and environmentally friendly approach in managing the DBM menace is thus required.

Cultural methods of controlling pests are very useful and effective but have not received the needed attention and support. Low DBM population have been reported in intercropped cabbage fields (Trevor, 1990; Ofuya, 1991; Theunissen *et al*., 1994; Said and Itulya, 2003; Stoll, 2003; Meyer, 2007). Cabbage-tomato intercropping is reported to reduce infestation of DBM in the cabbage (Makumbi, 1996; Facknath, 2000; Bijlmaker, 2005). The odour from the tomato intercrop repels the DBM (Stoll, 2003; Minja *et al*., 2003; Silva-Aguayo, 2007) or has an oviposition deterring effect on DBM (Endersby and Morgan, 1991). Onion (Said and Itulya, 2003; Endersby and Morgan, 1991) and garlic (Facknath, 2000; Bijlmaker, 2005) were also found to have repellent effect on DBM. The Intercropping reduces pests' populations because they act as physical barriers to the movement of the insect pest, natural enemies are more abundant and/ or the chemical or visual communication between the pest (DBM) and the cabbage is disrupted (Sheehan, 1986). This study was therefore conducted to evaluate the effectiveness of intercropping cabbage with non-host crops in an effort to control the diamondback moth pest.

MATERIALS AND METHODS

The experiment was conducted in 2007 at the Teaching and Research Farm of the School of Agriculture, University of Cape Coast located within the Coastal Savannah thicket zone of Ghana with annual rainfall ranging from 300 to 800 mm per annum.

Seedlings of the cabbage variety KK-cross and the intercrops (Pepper, onion and tomato) were each raised on separate beds measuring 1.2×2 m. All the plants were pricked out 7 days after germination with the exception of onion seedlings, which required no pricking out.

The intercrops were first transplanted at a spacing of 90×90 cm onto prepared seed beds measuring 1.35×1.80 m, raised to a height of 0.20 m and spaced 1 m apart. Two weeks after planting the intercrops, the cabbage (main crop) was interplanted in alternate rows with the intercrops at inter-row and intra-row spacing of 45×45 cm. There were four rows of crops on each plot and 5 plants per row.

The treatments consisted of pure cabbage stand (control), cabbage sprayed fortnightly with chlorpyrifos (Dursban) at the rate of 35 mL per 15 L of water (1.2 kg a.i. ha^{-1}), cabbage intercropped with onion, cabbage intercropped with tomato and cabbage intercropped with pepper. The experimental design was a randomized complete block with four replications.

The plots were fertilized with poultry droppings at the rate of 45 ton ha^{-1} (4.5 kg m^{-2}) during seedbed preparation. Cultural practices such as weed control; irrigation and supplying-in were carried out when necessary.

Data Were Taken on the Following Parameters

Plant height, population of DBM per plant; mean number of leaf damage by DBM; mean number of heads damaged at harvest and mean head weight at harvest.

All data were subjected to analysis of variance using MSTATC computer software programme. Means comparison was done using Duncan Multiple Range Test (DMRT) and graphical comparison presented using Microsoft Excel.

RESULTS

Plant Height

Generally, the heights of cabbage plants, which were intercropped or sprayed with chlorpyrifos against diamond back moth attack, were significantly higher ($p \leq 0.01$) than the controls (Table 1). Plant heights of the treated cabbage were, however, not significantly different among them, even though, cabbage plants intercropped with onion recorded the highest (8.0 cm) whilst those sprayed with chlorpyrifos (Dursban) gave the lowest (7.2 cm).

Leaf Damage per Plant

The mean leaf damage recorded for the unprotected cabbage plants were significantly higher ($p \leq 0.01$) than those, which were treated in various ways (Table 2). Mean leaf damage recorded for the treated cabbage plots differed significantly among the treatments. Mean leaf damage recorded for cabbage sprayed with chlorpyrifos and those intercropped with onion were not significantly different but were significantly lower ($p \leq 0.01$) than those intercropped with tomato and pepper (Table 2).

Population of Diamondback per Plant

Generally, the mean diamondback moth (DBM) population recorded for cabbage, which received the various pest management treatments at the 5th week, was significantly lower ($p \leq 0.01$) than the controls (Table 2). Among the treated plants, those that were sprayed with chlorpyrifos had significantly lower pest population (0.78) than those, which were intercropped with pepper, onion and tomato (Table 2). Mean DBM populations among cabbage plants which were intercropped were however, not significantly different.

Table 1: Mean cabbage plant height at 5th week after transplanting

Treatments	Mean plant height (cm)
Pure cabbage stand (control)	5.8b
Pure cabbage stand sprayed with chlorpyrifos	7.2a
Cabbage-tomato intercrop	7.5a
Cabbage-pepper intercrop	7.3a
Cabbage-onion intercrop	8.0a
Statistical analysis	
CV (%)	12.61
SE	0.45

Means with similar letter(s) are not significantly from each other by the Duncan multiple range test at 0.05 alpha level

Table 2: Mean diamondback moths (DBM) population and mean number of cabbage leaves damaged at 5th week after transplanting

Treatments	Mean leaf damage	Mean DBM population
Pure cabbage stand (control)	4.25a	2.90a
Pure cabbage stand sprayed with chlorpyrifos	2.25c	0.78c
Cabbage-tomato intercrop	3.25b	1.85b
Cabbage-pepper intercrop	3.50b	1.78b
Cabbage-onion intercrop	2.50c	1.78b
Statistical analysis		
CV (%)	17.63	22.06
SE	0.28	0.20

Means with similar letter(s) are not significantly different from each other by Duncan multiple range test at 0.01 alpha level

Table 3: Mean pest damage at harvest (holes in head or heart)

Treatments	Mean damage (holes in head)
Pure cabbage stand (control)	7.1a
Cabbage sprayed with chlorpyrifos (Dursban)	3.7c
Cabbage-tomato intercrop	2.2c
Cabbage-pepper intercrop	5.5b
Cabbage-onion intercrop	4.6c
Statistical analysis	
CV (%)	8.56
SE	0.22

Means with similar letter(s) are not significantly different from each other by Duncan range test at 0.05 alpha level

Table 4: Mean cabbage head weight/plant at harvest

Treatments	Mean weight (kg)
Pure cabbage stand	2.70b
Cabbage sprayed with chlorpyrifos (Dursban)	4.35a
Cabbage-tomato intercrop	4.57a
Cabbage-pepper intercrop	3.18a
Cabbage-onion intercrop	4.35a
Statistical analysis	
CV (%)	16.30
SE	0.31

Means with similar letter(s) are not significantly different from each other by Duncan multiple range test at 0.01 alpha level

Pest Damage at Harvest

Control cabbage plants had significantly higher ($p \leq 0.01$) head damage than those, which received the various pest management treatments (Table 3). Mean head damage also differed significantly among the treated cabbage plants. Cabbage plants intercropped with tomato, those sprayed with chlorpyrifos and those intercropped with onion were not significantly different in terms of their mean head damage but were significantly lower than those intercropped with pepper (Table 3).

Head Weight at Harvest

Significantly higher head weight per plant was recorded for cabbages that received treatments against the pest attack compared with the controls (Table 4). Eventhough the cabbage-tomato intercrop produced the highest mean head weight and this was double the mean head weight of the control, the head weights recorded for the various pest management treatments however did not differ significantly (Table 4).

DISCUSSION

The significantly lower plant height recorded for the control cabbage plants attests that monocultures with a narrow genetic base could lead to explosion of DBM numbers on the cabbage plants resulting in poor growth and development. This is consistent with the observation made by Hill and Waller (1982). However, intercropping cabbage with non-host crops such as onion, tomatoes and pepper, could lead to the disruption of life cycles of the pests and hence increased plant growth (Srinivasan and Krishna, 1991). The insecticidal property of chlorpyrifos and the repellant properties of the intercrops as reported by Stoll (2003) and Endersby and Morgan (1991) might have also reduced the insects' population on the cabbage and hence better growth of the crop. Silva-Aguayo (2007) has also reported that plant species used for plant protection exhibit an insect deterrent rather than the insecticidal properties. Contrarily, Endersby and Morgan (1991) has reported that tomatoes and onions are insecticidal to DBM and also have repellent properties.

The significantly higher pest numbers recorded for the unprotected cabbage plants compared with the protected ones is an indication of the effectiveness of the pest management practices used in protecting the cabbage against the DBM as was also found by Steiner (1982). The differences in the pest populations recorded could explain why cabbage plants that were not protected experienced significantly higher leaf damage due to DBM attack than the protected ones. The significantly lower population of DBM recorded in cabbage plants intercropped with tomato and onion can also be said to be due to the confusing olfactory and visual cues received from tomato and onion resulting in reduction in larval numbers as reported by Srinivasan and Krishna (1991).

There were no significant differences between the head damage of cabbage plants sprayed with chlorpyrifos insecticide and those intercropped with tomato, pepper and onion. This suggests that the repellant properties of the intercrops were as effective as the insecticidal property of the chlorpyrifos, as has been reported by Suglo (2000). Tomato, for instance, has been reported to exhibit deleterious effect on DBM larval and pupal stages (Buranday and Raros, 1973). Elwell and Mass (1995) also reported that tomato and onion release compounds which have repellant effect on adult DBM. Intercropping of cabbage with these non-host plants can therefore replace insecticides (e.g., chlorpyrifos) in managing DBM populations below the economic injury level and to improve the yield and quality of cabbage produced.

The low head weight recorded for the control cabbage plants could be attributed to the high population of DBM recorded on those plants with their corresponding higher leaf and head damage, which might have affected their photosynthetic ability and growth rates. The findings of this study are therefore consistent with that of De Lannoy (2001) in which DBM was identified as the most serious pest of cabbage responsible for low yield of the crop. The lack of significant differences between cabbage plants sprayed with chlorpyrifos insecticide and those intercropped with onion, pepper and tomatoes with respect to their mean head weight indicated that the intercrops were as effective as the insecticide in controlling the DBM pest. This finding is contrary to the report by Lingappa *et al.* (2006), who stated that intercropping is not reliable in controlling DBM.

CONCLUSION

Intercropping cabbage with non-host plants such as onion and tomatoes can replace insecticides such as chlorpyrifos in managing DBM pests' population below the economic injury level. This can improve both the yield and quality of cabbage heads produced.

REFERENCES

Bijlmaker, H., 2005. Farmers field schools for integrated pest management: Refresh your memory. The IPM DANIDA Project. Thailand.

Buranday, R.P. and R.S. Raros, 1973. Effect of cabbage-tomato intercropping on the incidence and out position of the diamondback moth (*Putella xylostella* L.). Philippines Entomol., 2: 369-374.

De Lannoy, G., 2001. Leafy Vegetables. In: Crop Production in Tropical Africa. Raemaekers, R.H. (Ed.). Directorate General for International Co-operation (DGIC), Brussels, Belgium, ISBN-10: 90-806822-1-7, pp: 403–511.

Elwell, H. and A. Mass, 1995. Natural pest and disease control. The Natural Farming Network, P.O. Box 301, Causeway, Harare, Zimbabwe.

Endersby, N.M. and W.C. Morgan, 1991. Alternatives to synthetic chemical insecticides for use in crucifer Crops. Biol. Agric. Hortic., 8: 33-52.

Facknath, S., 2000. Application of neem extract and intercropping for the control of some cabbage pests in Mauritius. Proceedings of the International Neem Conference, Queensland, Australia, Feb. 1996.

Hill, D.S. and J.M. Waller, 1982. Pests and Diseases of Tropical Crops. In: Principles and Methods of Control, Payne, W.J.A. (Ed.). Longman Group Ltd., UK., pp: 174.

Kwarteng, J.A. and M.J. Towler, 1994. West African Agriculture. MacMillan Education Ltd., UK.

Lingappa, S., K. Basavanagoud, K.A. Kulkarni, S. Roopa and D.N. Kambrekar, 2006. Threat to Vegetable Production by Diamondback Moth and its Management Strategies. Vol. 1., Springer, Netherlands, pp 357-396.

Makumbi, H., 1996. Ifoam'96 book of abstracts. Proceedings of the 11th IFOAM Scientific Conference, Aug. 11-15. Copenhagen, Denmark.

Meyer, W., 2007. Asia Brief Cabbage for All in DPR Korea Partnership Result. Swiss Agency for Development and Cooperation, Bern, Switzerland.

Minja, E.M., J. Ogecha, J.K.O. Ampofo and H.A. Mziray, 2003. Integrated pest management training workshop report. Training of Adult Eduacation Teachers on General Principles of Crop Husbandry and Integrated Pest Management. International Centre for Tropical Agriculture (CIAT), KARI-Kissi Kenya.

Norman, J.C., 1992. Tropical Vegetable Crops. In: Elms Court Ilfracombe, Stockwell, H. (Ed.). Devon Publishers, UK., pp: 52-77.

Ofuya, T.I., 1991. Observations on insect infestation and damage in cowpea, *Vigna unguiculata* intercropped with tomato, *Lycopersicon esculentum* in a rain forest area of Nigeria. Exp. Agric., 27: 407-412.

Said, M. and F.M. Itulya, 2003. Intercropping and nitrogen management effects of diamondback moth and yield of collards in the highlands of Kenya. Afr. Crop Sci. J., 2: 35-42.

Sheehan, W., 1986. Response of specialist and naturalist natural enemies to agroecosystem diversification: A selective review. Environ. Entomol., 15: 456-461.

Silva-Aguayo, G., 2007. Botanical insecticides in Radcliffe's IPM world textbook. University of Minnesota, USA.

Sinnadurai, S., 1992. Vegetable Cultivation. Asempa Publishers, Accra, pp: 59-60.

Srinivasan, K. and M.P.N. Krishna, 1991. Indian mustard as a trap crop of major lepidopterous pests of cabbage. Trop. Pest Manage., 37: 26-32.

Steiner, K.G., 1982. Intercropping in Tropical Smallholder Agriculture with Special Reference to West Africa. German Agency for Technical Cooperation (GTZ), Eschborn, Germany.

Stoll, G., 2003. Natural Crop Protection in the Tropics. Margraf Publishers, Weikersheim.

Suglo, J.V., 2000. Pesticide dealers handbook: Technical handbook. Plant Protection and Regulatory Services Department, Ministry of Food and Agriculture, Accra, Ghana, pp: 165-170.

Theunissen, J., Booij, C.J.H. and L.A.P. Lotz, 1994. Effect of intercropping white cabbage with clovers on pest infestation and yield. Entomologia Experimentalist et Applicata, 74: 7-16.

Trevor, G.F., 1990. Successful Organic Pest Control: Environmental friendly Ways to Deal with Unwanted Garden Pests and Diseases. Thorsons Publishers Ltd., Wellingborough, England.

Youdeowei, A., 2002. Integrated pest management practices for the production of vegetables: Integrated pest management extension guide 4. Directorate of Plant Protection and Regulatory Services, Ministry of Food and Agriculture, Ghana/German Development Cooperation (GTZ). pp: 49.