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Pest Repellent Plants for Management of Insect Pests of Chinese Kale, *Brassica oleracea* L.

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ABSTRACT

This study was conducted to assess the potential of pest repellent plant (PRP) species for managing insect pests in Chinese kale (*Brassica oleracea* L.*)* in order to reduce the use of pesticides and to improve the quality of the product. Seven PRP species (viz. *Angelonia*, tomato, hot pepper, coriander, citronella grass, sweet basil & sacred basil) were assessed together with a control treatment (without PRP). The results showed that Chinese kale associated with sacred basil had the lowest number of both flea beetle (*Phyllotreta sinuata* Steph.) and cabbage webworm [*Hellula undalis* (Fabricius)], while citronella grass had the lowest number of common cutworm [S*podoptera litura* (Fabricius)]. Furthermore, the lowest % pest damage and the highest quality of yield were in plots associated with sacred basil. The study discloses the potential of integrating specific pest repellent plants in intercropping to reduce populations of specific insect pests and % pest damage and to increase the quality and marketable yield of Chinese kale.

Key Words: Chinese kale; Pest repellent plants; Flea beetle; Cabbage webworm; Common cutworm

INTRODUCTION

Chinese kale (*Brassica oleracea* L. var. *alboglabra* Bailey), is a popular and an economic crop in southeast Asia. Therefore high yielding hybrid varieties of this crop are often grown in intensive production systems. Chinese kale is mostly vulnerable to insect pests such as diamondback moth [*Plutella xylostella* (Linnaeus)], beet armyworm (*Spodoptera exigua* (Hübner), common cutworm [S*podoptera litura* (Fabricius)], cabbage looper (*Trichoplusia ni* Hübner), cabbage webworm [*Hellula undalis* (Fabricius)], leaf eating beetle (*Phyllotreta chontanica* Duvivier & *P. sinuata* Steph.) (Kianmeesuk *et al.*, 1999). Indiscriminate use of pesticides is very common in this crop culture (Kumar & Moorthy, 2001), which leads to destruction of beneficial insects and other non-target organisms, accumulation of toxic residues on produce and human poisoning, etc (Harris & Dent, 1999). Pesticide residues especially in vegetables may create health hazards to the consumers, which in turn restrict export markets of vegetables (Awasthi, 2001).

Planting insect pest repellent plants (PRP) as companion plants along with crops has been used as an alternative method in pest management (Anonymous, 2004a). A wide array of chemicals synthesized by plants has been shown to be effective on controlling many insect pests (Kareem, 1999). The chemicals extracted from plants include approximately more than 6,000 alkaloids, 3,000 terpenoids, several thousands of phenylterpenoids, 1,000 flavanoids, 500 quinones, 650 polyacetylenes and 4,000 amino acids and many of these chemicals serve to protect plants from insect pests and disease pathogens (Kareem, 1999). Zehnder (2004) also reported that some plants contain organic compounds that act as pest repellents. These plants protect crops by keeping pests away from the cropping system and thus avoiding potential pest damages.

Many plant species have been identified to contain repellent effects on pests. Planting basil (*Ocimum basilicum* Linn.) with tomatoes repels thrips (Anonymous, 2004a) and tomato hornworms (Anonymous, 2004c). Coriander (*Coriandrum sativum* Linn.) repelled aphids, spider mites and potato beetles in potato (Anonymous, 2004a). Garlic (*Allium sativum* Linn.) repelled aphids in roses, while mint (*Mentha cordifolia* L.) deterred white cabbage moths, ants, rodents, flea beetles, fleas and aphids in many crops (Anonymous, 2004a). Marigolds repelled Mexican bean beetles in beans (Anonymous, 2004c). Onion repelled cabbage lepidopterous pests in cabbage (Anonymous, 2004b). Palaniappan and Annadurai (1999) and Farlex (2004) reported that pest repellent plants may be an alternative method in controlling pests in organic agriculture as it needs to avoid the use of synthetic pesticides, growth regulators, livestock feed additives, etc.

Chinese kale attracts many pests and hence pesticides are applied extensively. This demands the development of alternative pest management methods to protect crops, environment and food safety. Use of pest repellent plants would be a long lasting option, if suitable pest repellent plants or a combination of pest repellent plants for specific pests could be identified. This study was conducted to assess the potential of pest repellent plant species for managing insect pests in Chinese kale in order to reduce the use of pesticides and to improve the quality of the product.

MATERIALS AND METHODS

The study was conducted during May - August 2005 at the Agricultural Experimental Station, Asian Institute of Technology, Thailand. From a preliminary study conducted based on literature and from information gathered from selected farming communities, seven pest repellent plant (PRP) species [viz. *Angelonia* (*Angelonia goyazensis* Benth -T1), tomato (*Lycopersicon esculentum* Mill -T2), hot pepper (*Capsicum frutescencs* L.-T3), coriander (*Coriandrum sativum* L.-T4), citronella grass [*Cymbopogon nardus* L. (Rendle) -T5], sweet basil (*Ocimum basilicum* L.-T6) and sacred basil (*Ocimum sanctum* L.-T7)] were selected to incorporate for Chinese kale culture as an intercrop. An additional plot containing Chinese kale alone (without any PRP species) was used as a control treatment. The experimental treatments were arranged in a randomized complete block design (RCBD) with 3 replicates.

Selected PRPs were first grown in polythene bags in May 2005 and reared in a nursery. Land was plowed and harrowed, and raised beds of 4 m x 4 m were prepared in early July. At the time of harrowing, chicken manure was applied at the rate of 6.25 tons/ha and mixed with soils. The PRPs were transplanted first in 2 m x 1 m spacing and Chinese kale variety (BBT 35) was broadcasted in the rest of the plot area at a seeding rate of 12.5 kg/ha and covered with rice straw. Excess seedlings were thinned out at two weeks after broadcasting. The crop was managed as per Thailand Department of Agricultural Extension recommendation. Fertilizers were applied only at 2 weeks after broadcasting, and N, P and K were broadcasted at the rate of 100, 43 and 83 kg/ha, respectively. Plots were regularly irrigated twice a day using sprinklers. Pesticides were not applied to any plot nor in the research farm as non-pesticide methods are usually practiced.

As observations, insect pest species and their populations were recorded from randomly selected two one-square meter areas across the PRPs at three sampling dates at 21, 29 and 36 days after seeding. Number of plants damaged in the selected one-square meter area was counted and percentage damaged plants was computed based on the total number of plants in the same sampling area. The quality was assessed using 10 randomly selected Chinese kale plants from each plot by estimating % leaf area damaged by pest using 0 - 5 scale [0 - no apparent damage; 1 - minor feeding damage (1% leaf area eaten); 2 - minor-moderate feeding damage (2 - 5% leaf area eaten); 3 - moderate damage (6 - 10% leaf area eaten); 4 - moderate-heavy damage (11 - 30% leaf area eaten); and 5 - heavy damage (> 30% leaf area eaten)] (Greene *et al.,* 1969). Data on insect pest populations and % pest damage were transformed to log and arcsine values, respectively and ANOVA was used. Fisher's Protected Least Significant Difference (LSD = 0.05) was employed to compare the effect among PRPs.

RESULTS AND DISCUSSION

Number of pests. Six insect pest species were found in Chinese kale plots throughout the growing season: diamondback moth (DBM- *Plutella xylostella*), common cutworm (CCW-S*podoptera litura*), flea beetle (FBT-*Phyllotreta sinuata*), aphids (APH-*Aphis gossypii* Glover), cabbage looper (CBL- *Trichoplusia ni*) and cabbage webworm (CWW- *H. undalis*). However, repellence effects were observed only for CWW, CCW and FBT (Table I).

There were significant differences in the number of CWW larvae at 21 and 29 DAS (Table I). At 21 DAS, the mean number of CWW larvae was lowest in plots associated with sacred basil (2.0 insects/m^2) and citronella grass (2.0 insects/m^2) followed by sweet basil (2.3 insects/m^2) and *Angelonia* (2.4 insects/m^2). Similarly, the number of CWW was lowest in plots of sacred basil (0.6 insects/m^2) followed by citronella grass (0.8 insects/m^2) and sweet basil (0.8 insects/m^2) at 29 DAS.

The number of FBT adults was also significantly different among treatments at 29 DAS (Table I). Sacred basil associated plots had the lowest number of FBT (0.2 insects/m^2) followed by *Angelonia* (0.3 insects/m^2), sweet basil (0.5 insects/m^2), citronella grass (0.5 insects/m^2) and tomato (0.6 insects/m^2).

The number of CCW larvae was significantly reduced by PRP species only at 36 DAS (Table I). The mean number of insects ranged from 0.3 to 1.3 insects/m^2 with the lowest number in plots associated with citronella grass and the second lowest in sacred basil.

Pest damage. At harvest, the % pest damage was significantly different among PRP species (Table II). Both sacred basil and citronella grass had the lowest pest damage of 35 and 37% of the total number of Chinese kale plants in the plot, respectively. *Angelonia* and sweet basil also decreased pest damage to 47 and 53%, respectively. The other PRPs had pest damage more than 60%, while the control had the highest pest damage. This indicates that different plant species have difference in the pest repellence and both sacred basil and citronella grass are better in this aspect than the other plants used.

Yield and quality. The Chinese kale yield ranged from 2.2 kg/m^2 (21.8 t/ha) in plots associated with coriander to 3.0 kg/m^2 (29.6 t/ha) in sacred basil (Table II). However, the yield of Chinese kale was not significantly different among PRPs.

The quality score showed that the control with a quality score of 3.5 had moderate to moderate-heavy damage by insect pests (Table II). On the other hand, sacred basil had the highest quality with a mean score of 1.9. Except hot pepper and coriander, both had almost the same degree of quality as the control, the rest of the PRPs had the quality scores ranging between 2.3 and 2.6, which indicate minor-moderate to moderate quality reduction.

Table I. The mean number of cabbage webworm, common cutworm and flea beetle observed in Chinese kale plots intercropped with pest repellent plant

Pest Repellent Plant	Insect population, no./m²			
	Cabbage webworm larvae		Flea beetle adults	Common cutworm larvae
	21 DAS [1/]	29 DAS	29 DAS	36 DAS
1. Control [2/]	3.1±0.5 (0.61±0.05)[a 3/]	1.7±0.4 (0.43±0.07) [a]	0.9±0.4 (0.27±0.09) [ab]	1.0±0.6 (0.30±0.13) [a]
2. *Angelonia*	2.4±0.5 (0.52±0.07) [bc]	1.2±0.3 (0.33±0.06) [abc]	0.3±0.1 (0.10±0.04) [bc]	0.8±0.3 (0.25±0.08) [ab]
3. Tomato	3.0±0.9 (0.60±0.10) [ab]	1.2±0.5 (0.34±0.10) [abc]	0.6±0.1 (0.21±0.02) [bc]	0.8±0.6 (0.24±0.14) [ab]
4. Hot pepper	3.5±0.5 (0.65±0.05) [a]	1.3±0.4 (0.36±0.08) [ab]	2.0±1.5 (0.43±0.27) [a]	1.3±1.0 (0.34±0.18) [a]
5. Coriander	3.3±0.3 (0.63±0.03) [a]	1.5±0.6 (0.39±0.10) [a]	1.0±0.6 (0.28±0.13) [ab]	1.1±0.3 (0.32±0.06) [a]
6. Citronella grass	2.0±0.3 (0.47±0.05) [c]	0.8±0.2 (0.25±0.06) [bc]	0.5±0.2 (0.18±0.04) [bc]	0.3±0.4 (0.09±0.12) [c]
7. Sweet basil	2.3±0.2 (0.51±0.03) [bc]	0.8±0.6 (0.24±0.13) [bc]	0.5±0.4 (0.17±0.11) [bc]	0.8±0.2 (0.24±0.06) [ab]
8. Sacred basil	2.0±0.3 (0.47±0.04) [c]	0.6±0.2 (0.21±0.04) [c]	0.2±0.1 (0.06±0.03) [c]	0.5±0.1 (0.16±0.04) [bc]
LSD (p = 0.05)	0.091	0.140	0.206	0.134
CV%	9.3	25.0	55.5	31.4

[1/] DAS = Days after seeding

[2/] No pest repellent plant used in the control plot, and only Chinese kale was grown

[3/] Values in parenthesis are log-transformed values; Values within a column followed by different letters are significantly different at p = 0.05

Table II. Pest damage (%) at harvest (43 days after seeding), yield and quality score of Chinese kale in each pest repellent plant

Pest Repellent Plant	Mean pest damage (%)	Yield (kg/m²)	Mean quality score [4/]
1. Control [1/]	91.7±2.9 (1.2±0.1) [a 2/]	2.7±0.1 (27.3±1.3) [3/]	3.5
2. *Angelonia*	46.7±11.6 (0.5±0.1) [cd]	2.5±0.3 (25.6±3.4)	2.6
3. Tomato	63.3±5.8 (0.7±0.1) [c]	2.5±0.7 (25.1±7.3)	2.6
4. Hot pepper	83.3±5.8 (1.0±0.1) [ab]	2.6±0.6 (25.6±6.5)	3.4
5. Coriander	80.0±10.0 (0.9±0.2) [b]	2.2±0.2 (21.8±2.3)	3.4
6. Citronella grass	36.7±5.8 (0.4±0.1) [d]	2.9±0.4 (29.1±3.8)	2.3
7. Sweet basil	53.3±15.3 (0.6±0.2) [cd]	2.8±0.9 (28.0±10.4)	2.5
8. Sacred basil	35.0±8.7 (0.4±0.1) [d]	3.0±0.4 (29.6±4.2)	1.9
LSD (p = 0.05)	0.216	ns [5/]	-
CV%	17.7	21.3	-

[1/] No pest repellent plant used, and only Chinese kale was grown

[2/] Values in parenthesis are Arc Sine-transformed values; Values within a column followed by different letters are significantly different at p = 0.05

[3/] Values in parenthesis are tons/ha

[4/] Quality score: 0 - no apparent damage; 1 - minor feeding damage (1% leaf area eaten); 2 - minor- moderate feeding damage (2-5% leaf area eaten); 3 - moderate damage (6-10% leaf area eaten); 4 - moderate-heavy damage (11-30% leaf area eaten); and 5 - heavy damage (>30% leaf area eaten)

[5/] ns – Not significant different at p = 0.05

This indicates the importance of PRPs in the pest repellence and protecting Chinese kale, which is a highly pest attractive crop.

The results indicate that the integration of some PRP species in intercropping with Chinese kale could reduce the population of specific insect pests such as CWW, CCW and FBT and % pest damage and as a result, the quality of the yield could be increased. Among tested PRP species, sacred basil gave the best performance in repelling FBT and CWW, while citronella grass was the best in repelling CCW. In addition, sacred basil had the lowest % pest damage and the highest quality of the Chinese kale yield in this study. Citronella grass also had a significant potential to reduce pest damage and to increase quality of Chinese kale. Both of these PRPs contain organic compounds having pest repellent effects (Kareem, 1999; Zehnder, 2004). Moreover, these PRPs are cash crops to farmers in Thailand and hence the adoption of this type of pest management system would be highly preferable.

However, the results clearly showed that the use of pest repellent plants alone could not control all insect pest species that attack Chinese kale. Planting PRPs as companion plants along with crops has also been used as an alternative method in pest management (Anonymous, 2004a). Palaniappan and Annadurai (1999) and Farlex (2004) reported that pest repellent plants might be an alternative method in controlling pests in order to avoid the use of synthetic pesticides, growth regulators, livestock feed additives, etc. Harris and Dent (1999) indicated that bio-pesticides are effective in controlling pests that have developed resistance to chemical pesticides and leaving little or no toxic residues thus are commonly harmless to beneficial insects and other non-target organisms. Bio-pesticides such as neem products have been reported to reduce the infestation of various insect pests in tea (Selvasundaram & Muraleedharan, 1999), okra (Anaso & Lale, 2001a & b) and cowpea (Lale & Kabeh, 2004). FAO (1999) also recommended that the pest control using chemicals or bio-pesticides with less harmful residues is needed especially for Chinese kale production. As other bio-pesticides, such as *Bacillus thuringiensis* (Bt), EM (effective microorganisms), etc. and mechanical measures are available, further studies are needed to advocate a complete array of management needs for pest management in Chinese kale and to avoid the pesticide contamination in the harvest and preventing the pollution of the environment.

CONCLUSION

There was a significant difference in the mean number of CWW, CCW and FBT among PRP associated plots. Sacred basil was the best in repelling FBT and CWW, whereas citronella grass was the best repellence of CCW. Moreover, sacred basil significantly reduced % pest damage and increased quality of the Chinese kale yield.

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