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Original research article

Effects of Intercropping of Marigold and Yardlong Bean on Population of Cowpea Aphid, Aphis Craccivora Koch

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ABSTRACT

The experimental field was planted at Pathum Thani Province to assess the effects of marigold and yardlong bean intercropping on a number of cowpea aphids, a number of natural enemies, growth and yield of yardlong bean and insect bio-diversity. The experimental design was a randomized complete block design (RCBD) with four treatments each of which was replicated three times. Each of the 12 plots measured 7 m x 5 m in the experiment. The distance between inter and intra row spacing for all treatments was 70 x 50 cm with 1 m spacing between plots. The intercropping treatments were: sole yardlong bean (T_1), 1 row of yardlong bean with 1 row of marigold (T_2), 2 rows of yardlong bean with 1 row of marigold (T_3) and 3 rows of yardlong bean with 1 row of marigold (T_4). The results showed that intercropping yardlong bean with marigold had significant ($p<0.05$) effect on the number of cowpea aphids, the number of natural enemies, growth and yield of yardlong bean and insect bio-diversity when compared with the sole yardlong bean. The 1 row yardlong bean + 1 row marigold had the lowest number of cowpea aphids from week1 to week6 when compared with other intercropping. The 1 row yardlong bean + 1 row marigold were value with 26.32 ± 1.24, 42.00 ± 0.61, 65.33 ± 1.69, 70.33 ± 1.69, 110.66 ± 1.24 and 145.00 ± 1.63 aphids/ 5 yardlong, ladybird beetles (34.60 + 1.24), black ant (30.80 + 1.24) and spider (17.33 + 0.94), plant height and weight (42.25 ± 0.82 cm and 2.75 ± 0.82 kg) and insect bio-diversity (1.44). Therefore, intercropping yardlong bean with marigold is an effective practice in the control of cowpea aphids and enhancing insect bio-diversity.

Keywords: Intercropping; Marigold; Yardlong Bean; Cowpea Aphid

1. Introduction

The yardlong bean, *Vigna unguiculata* subsp. *sesquipedalis* (L.) Walp, is one of the most important leguminous vegetable crops. It was originally found in West Africa and is now widely grown

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throughout the South and Southeast Asian countries such as Malaysia, the Philippines, Indonesia and Thailand [1]. In Thailand, the yardlong bean widely produced and both fresh and frozen beans are exported. The yardlong bean is nutritious and is a good source of protein, vitamin A, thiamin, riboflavin, iron, phosphorus and potassium. Additionally, growing yardlong bean helps improve soil productivity by fixing considerable atmospheric nitrogen with the symbolic *Rhizobium* bacterium [2].

In Thailand, the major problem for yardlong bean production is severe infestation and damage by various insect pests in the field (Benchasri and Bairaman, 2010). Especially, the cowpea aphid (*Aphis craccivora* Koch) is an important piercing-sucking insect pest of the yardlong bean [3]. Both nymphs and adults of cowpea aphids can cause significant economic damage directly by sucking cell sap from flowers, buds, pods and tender shoots of the plant. Heavy feeding can kill young plants. Indirectly, the cowpea aphids can transmit major viruses such as the cowpea aphid-borne mosaic virus (CAMV). They also disturb the photosynthesis process of the yardlong bean by the presence of sooty mold on the leaves [4]. More than 50% yield loss occurs when there are high infestations of cowpea aphids [5].

Farmers generally depend on chemical insecticides for controlling the cowpea aphid. Although chemical insecticides provide quick and adequate control, they are usually expensive and leave long lasting residues over the exposed surface of the crops, in soil and in water [6]. In addition, chemical insecticides can also cause other problems such as health hazards, undesirable side effects, developments of insecticide resistance, resurgence of target pests, outbreaks of secondary pests, and environmental pollution (Moreby, 1997; Han and Li, 2004) [7,8].

In order to protect farmers' crops from damages due to cowpea aphid infestation, intercropping is recommended as one of the important cultural practices in pest management and is based on the principle of reducing insect pests by increasing the diversity within the ecosystem [9]. Under field conditions intercropping between marigold and yardlong bean may disrupt the olfactory system of cowpea aphids which may reduce the density of cowpea aphid [10]. Integrating naturally repellent volatiles that defend plants by irritating insects may help reduce insect damage to crops. Therefore, the aim of this study was to assess the effect of intercropping of yardlong bean with marigold on the infestation levels of cowpea aphid and the insect biodiversity in a yardlong bean field.

2. Materials and Methods

2.1 Study area

The research was conducted in a farmer's field in Tambon Nai Muang, Amphur Muang, Pathum Thani Province during May 2014 – September 2014.

2.2 Experimental design

The experiment was a randomized complete block design (RCBD) with four treatments; each of which was replicated three times. Plot size was 7 x 5 m^2 with 70 x 50 cm plant spacing and 1 m between-plot spacing. The yardlong bean and marigold were planted in the seeding tray. After 7 days, the seeding of yardlong bean and marigold were transplanted into the experimental plots. The treatments are sole yardlong bean (T_1); 1 row of yardlong bean intercropped with 1 row of marigold (T_2); 2 rows of yardlong bean intercropped with 1 row of marigold (T_3) and 3 rows of yardlong bean intercropped with 1 row of marigold (T_4). All plots were conventionally fertilized, watered and hand weeded. The plots were maintained with no insecticide application throughout the study period. (Fig. 1)

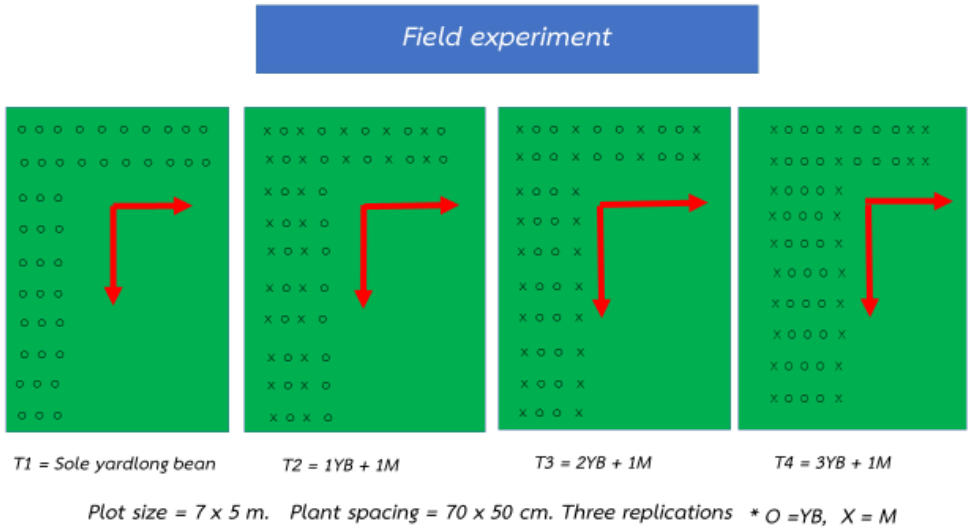

Fig. 1 Treatment layout for intercropping between marigold and yardlong bean

2.3 Data collection

Data was collected on the following parameters on yardlong bean: number of cowpea aphid, numbers of natural enemies, plant heights and fresh weights of pods. Sampling for cowpea aphid infestation was started after 10 days. The number of cowpea aphids was counted visually on 5 randomly selected yardlong bean plants per plot. Sampling for cowpea aphids was performed randomly sampled and counted from week1 to week6 after cowpea aphid infestation. Sampling for natural enemies was conducted randomly and counted every week the sampling for cowpea aphids. The insects were placed separately in vials, brought to the laboratory, identified, counted and numbers were recorded.

2.4 Data analysis

Data on aphid population and gross returns were analyzed using the SPSS program and analysis of variance (ANOVA) and mean comparisons were performed using Duncan' s Multiple Range Test (DMRT).

2.5 Bio-diversity Index in field experiment

The Shannon-Wiener species diversity index uses the following formula:

$$H' = - \sum_{i=1}^{n} p_i \ln p_i$$

where:

n = number of species found

p_i = proportion of number of individuals of species i^{th} and the total number of individuals of all species

In = logarithm to base e

3. Results and Discussion

3.1 Effect of intercropping yardlong bean with marigold on number of cowpea aphids

The results showed that the numbers of cowpea aphids between marigold and yardlong bean intercropping was significantly higher ($p<0.05$) when compared with the sole yardlong bean. Aphid infestations on the yardlong bean were observed in all intercoppings and increased every week. The 1 row yardlong bean + 1 row marigold (T2) had the lowest number of cowpea aphids from week1 to week6 when compared the other intercropping with the number of 26.32 ± 1.24, 42.00 ± 0.61, 65.33 ± 1.69, 70.33 ± 1.69, 110.66 ± 1.24 and 145.00 ± 1.63 aphids/ 5 yardlong beans respectively

(Table 1). The cowpea aphid populations in sole yardlong bean exponentially increased from week 1 to week 6 and had the highest number of cowpea aphids in week6 at 180.33 ± 1.24 aphids/5 yardlong beans. (Table 1). The plants with aromatic qualities contain volatile oils that may interfere with host plant location, feeding, distribution and mating. The study of Promsattha, (2000) [11] showed that the plants contain chemical substances which can repel or deter pest insects and many of these products are used to produce botanical insecticides. The chemical substances mostly produced by the marigold plants are isoprene such as limonene, ocimene, caryophyllene, farnesene and neophytadiene. The compounds found in leaves, stems and flowers are indole, 2-cyclohexen-1-one, 3-methyl-6-(1-methylethyl) and neophytadiene, some of which have insect repellent properties. Isman (2006) [12] indicated that, throuth the release of repellent volatiles into the air plants may disrupt the olfactory orientation of insects. The marigold plant contains many secondary metabolites that act as repellents, feeding deterrents and toxins, which have roles in defensding against herbivores, pests and pathogens. The results show that the marigold and yardlong bean (1:1) had the lowest number of cowpea aphids. Similarly, Jaba, *et al.*, (2010) [13] found that the response of cowpea aphids to distant host plants have been based on olfactometer test. The olfactometers evaluate the importance of volatile semiochemicals in the host finding process, independently of visual stimuli. The effectiveness and duration of repellency of chemicals depend on the types of repellents (active ingredient and formulation), the modes of applications, and local conditions (temperature, humidity and wind). Undie *et al.*, (2012) [14] indicated intercrop plants caused to visual stimuli, taste, smell recognize the target.

Table 1. Mean numbers of cowpea aphids of yardlong bean infested under different marigold-yardlong bean intercroping systems

Cropping system	Mean number of cowpea aphids (aphids/5 yardlong beans)					
	Week1	Week2	Week3	Week4	Week5	Week6
Sole YB	39.33±1.24^{a}	76.33±0.19^{a}	101.33±2.05^{a}	137.0±1.63^{a}	165.66±1.24^{a}	180.33±1.24^{a}
1YB + 1M	26.32±1.24^{d}	42.00±0.61^{c}	65.33±1.69^{d}	70.33±1.69^{d}	110.66±1.24^{d}	145.00±1.63^{d}
	32.00±1.63^{c}	47.00±0.64^{bc}	76.66±1.24^{c}	93.33±1.24^{c}	124.66±2.05^{c}	155.66±2.60^{c}
2YB + 1M	35.66±1.24^{b}	49.66±0.43^{b}	85.33±1.24^{b}	101.0±1.63^{b}	137.33±1.69^{b}	168.66±1.24^{b}
3YB + 1M						

* Mean values in the same column with the same letter are not significantly different ($P < 0.05$ according to DMRT).

3.2 Effect of intercropping yardlong bean with marigold on natural enemies

The natural enemies of pests of yardlong bean were identified as the ladybird beetle (Coleoptera: Coccinellidae) spider (Araneae: Tetragnatidae and black ant (Hymenoptera: Formicidae). The numbers of the various natural enemies are presented in Table 2. The results showed the effects of intercropping between marigold and yardlong bean on natural enemies population were significantly high ($p<0.05$) when compared with the sole yardlong bean. This study found that the ladybird beetles populations were the highest on the 1 rows yardlong bean + 1 row marigold in which the average number of ladybird beetles was 34.60 ± 1.24 whilst the average number of ladybird beetle from sole yardlong bean was the lowest among treatments. A greater abundance of natural enemies was found in plots near marigold than in plots far from marigold. Silveira *et al.*, (2009) [15]

indicated that the flower of marigold was a food sources including pollen and nectar of natural enemies. The result showed the ladybird beetle populations were the highest on the 1 rows yardlong bean with 1 row marigold. The ladybird beetle is an effective predator for reducing cowpea aphid densities in the field. Jankowska (2010) [16] noted that on plots where cabbage, was Intercropped with plots of marrigold and French marigold cabbage aphid parasitization by *Diaeretiella rapae* (M'Intosh) was greated and the percentages of predatory Syrphidae to prey were more favorable than on the homogenous-crop.

Table 2. Mean numbers of natural enemies of yardlong bean grown under different marigold-yardlong bean intercropping systems

Cropping system	Mean number of natural enemies/ plot		
	ladybird beetles	spiders	black ants
Sole YB	14.33 ± 0.47 a	5.33 ± 0.47 a	21.33 ± 0.47 a
1 YB : 1 MG	34.60 ± 1.24 c	17.33 ± 0.94 b	30.80 ± 1.24 b
2 YB : 1 MG	26.00 ± 0.81 b	9.00 ± 0.47 a	29.00 ± 1.24 b
3 YB : 1 MG	23.33 ± 0.47 b	7.33 ± 0.81 a	27.33 ± 0.94 b

* Mean values in the same column with the same letter are not significantly different ($P < 0.05$ according to DMRT).

3.3 Effect of intercropping yardlong bean with marigold on plant height and weight of yield

The results showed the effects of intercropping between marigold and yardlong bean on plant height and weight of yardlong bean were significantly low when compared with the sole yardlong bean. The 1 rows yardlong bean + 1 row marigold had the highest height with mean value of 42.25 ± 0.82 cm and the highest weight of yardlong bean with mean value of 2.75 ± 0.82 kg. Latati *et al.*, (2013) [17] reported that the yield production under intercropping was higher than in sole cropping systems because the olfactory and visual ability of insects were interfered with by the host plant (Table 3).

Table 3. Effect of intercropping systems on plant heights and weights of the yardlong bean

Cropping system	Plant height (cm.)	Plant weight (Kg.)
Sole YB	34.50 ± 0.86 a	1.50 ± 0.50 a
1 YB + 1 MG	42.25 ± 0.82 c	2.75 ± 0.82 c
2 YB + 1 MG	38.50 ± 1.11 b	2.50 ± 0.50 bc
3 YB + 1 MG	37.25 ± 0.82 b	2.25 ± 0.43 b

* Mean values in the same column with the same letter do not significantly different ($P < 0.05$ according to DMRT).

3.4 Effect of intercropping yardlong bean with marigold on diversity of Shannon-Weiner Index (H´)

The results the diversity of natural enemies and insect pests was high when compared with the sole yardlong bean. The

1 rows yardlong bean + 1 row marigold had the highest diversity of natural enemies and insect pests with a Shannon-Weaver index value with 1.75. The sole yardlong bean showed the lowest value with 1.44 (Table 3). Hongjiao *et al*., (2010) [18] reported that the intercropping will increase species richness, abundance and diversity of the arthropod communities in general and their predators. The highest abundance was found in the intercropping (141.67 predators/plot), whereas the lowest was found in the monoculture (97.67 predators/plot). Yanyong (2013) [19] showed that the high of diversity indicated a long food chain and food web complexity, or an ecosystem which has high biodiversity.

Table 4. Effect of intercropping yardlong bean with marigold on diversity of Shannon-Weaver Index (H´)

Cropping system	Shannon-Wiener index
Sole yardlong bean	1.44 b
1 rows yardlong bean + 1 row marigold	1.75 a
2 rows yardlong bean + 1 row marigold	1.73 a
3 rows yardlong bean + 1 row marigold	1.67 a

***** Mean values in the same column with the same letter do differ significantly ($P < 0.05$ according to DMRT

4. Conclusions

Intercropping between marigold and yardlong bean can reduce cowpea aphid populations. The diversity of Shannon-Weaver index was the highest value with 1.75 when compared the sole yardlong bean showed the lowest value with 1. 44. The marigold normally has bad smell in the leaves, stems and flowers. The marigold releases strong volatiles which can repel the cowpea aphids.

Therefore, intercropping between marigold and yardlong bean can reduce cowpea aphid populations, reduce the use of chemicals and environmentally friendly aphid control. Intercropping is a way to increase diversity in an agricultural ecosystem. Besides, the farmers can also sell the flower of marigold bring income into the home.

References

[1] Nooprom K, Santipracha Q. Effect of Varieties on Growth and Yield of Yard Long Bean under Songkhla Conditions, Southern Thailand. Modern Applied Science 2015;9(13): 247-51.

[2] Phillipsa RD, McWattersa KH, Chinnana MS, Hunga YC, Beuchata LR, Sefa-Dedehb S, et al. Utilization of cowpeas for human food. Field Crops Res 2003;82(2-3): 193–213.

[3] Emden HFV, Harrington R. Aphids as Crop Pests. Wallingford Oxfordshire Press, United Kingdom 2007.

[4] Blackman RL, Eastop VF. Aphids on the world's crops: an identification and information guide. 2nd ed. Wiley Ltd, Chichester, West Sussex, United Kingdom: John Wiley & Sons; 2000.

[5] Ofuya TI. Control of the cowpea aphid, *Aphis craccivora* Koch (Homoptera: Aphididae, in cowpea, *Vigna unguiculata* (L.) Walp. Integrated Pest *unguiculata* (L.) Walp. Integrated Pest Management Reviews 1997;2(4): 199-207.

[6] Bahar H, Islam A, Mannan A, Uddin J. Effectiveness of Some Botanical Extracts on Bean Aphids Attacking Yard-Long

Beans. Journal of Entomology 2007;4: 136-142.

[7] Moreby SJ, Sotherton NW, Jepson PC. The Effects of Pesticides on Species of Non-target Heteroptera Inhabiting Cereal Fields in Southern England. Pesticide Science 1997;51(1): 39-48.

[8] Li F, Han Z. Mutations in acetylcholinesterase associated with insecticide resistance in the cotton aphid, *Aphis gossypii* Glover. Insect Biochemistry and Molecular Biology 2004;34(4): 397-405.

[9] Ijoyah MO. Review of intercropping research: Studies on Cereal-Vegetable based cropping system. Scientific Journal of Crop Science 2012;1(3): 55-62.

[10] Priyanka D, Shalini T, Navneet VK. A brief study on marigold (*Tagetes* species): a review. International Research Journal of Pharmacy 2013; 4(1): 43-49.

[11] Promsattha R, Milne M, Sangwanich A. Study on chemical compositions of marigold (Tagetes erecta). In: Proceedings of the 39th Kasetsart University Annual Conference: Plants, Agricultural Extension and Communication; 2000 Feb 5-7; Bangkok, Thailand. Bangkok: Thai Ministry of University Affairs; 2000. P.404-9.

[12] Isman MB. Botanical insecticides, Deterrents and Repellents in Modern Agriculture and an Increasingly Regulated World. Annual Review of Entomology 2006;51(1): 45-66

[13] Jaba J, Haseena B, Tripathy S, Hosamani AC, Amaresh YS. Olfactory response of cowpea aphid, *Aphis craccivora* Koch, to host odours and population of conspecifics. Journal of Biopesticides. 2010;3(1): 405-7.

[14] Undie UL, Uwah DF, Attoe EE. Effect of Intercropping and Crop Arrangement on Yield and Productivity of Late Season Maize/ soybean Mixtures in the Humid Environment of South Southern Nigeria. Journal of Agricultural Science. 2012;4(4): 37-50.

[15] Silveira LCP, Filho EB, Pierre LSR, Peres FSC, Louzada JNC. Marigold (*Tagetes erecta* L.) as an attractive crop to natural enemies in onion fields. Scientia Agricola (Piracicaba, Braz.) 2009;66(6): 780-7.

[16] Jankowska B. Effect of Intercropping White Cabbage with French Marigold (*Tagetes Patula* Nana) and Pot Marigold (*Calendula officinalis*) on Diamondback moth (*Plutella xylostella* L.) Population Density and its Parasitoid Complex. Vegetable Crops Research Bulletin 2010; 73: 107-17.

[17] Latati M, Pansu M, Drevon JJ, Ounane SM. Advantage of intercropping maize (*Zea mays* L.) and common bean (*Phaseolus vulgaris* L.) on yield and nitrogen uptake in Northeast Algeria. International Journal of Research in Applied Sciences 2013;1: 23-9.

[18] Cai H, You M, Lin C. Effects of intercropping systems on community composition and diversity of predatory arthropods in vegetable fields. Acta Ecologica Sinica 2010;30(4): 190-5

[19] Chalermsan Y. Using Ecological Engineering Approach in Rice Pest Management for Hom Nil Organic Rice Production at Ban Thung Yai, Nikompattana Sub-district, Bang Ra Kam District, Phitsanulok Province. Journal of Community Development and Life Quality 2013;1(2): 63-70.