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Manipulation of crop habitat to encourage natural enemies against key pests of cabbage ecosystem

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Abstract
Field experiments were conducted during 2015-16 and 2016-17 to study the impact of habitat manipulation on the incidence of major pests of cabbage and their natural enemies revealed that out of four modules, T_1 module (Cabbage intercropped with cowpea and mustard as border crop) was found to be the best in reducing the larval population of *Plutella xylostella* (1.89 / plant), *Pieris canidia* (2.82/plant), *Agrotis ipsilon* (1.26 /plant) and *Brevicoryne brassicae* (2.03 aphid/leaves). The highest numbers of Coccinellid predator (1.81/ leaves) with highest yield of (17872 kg/ha) and highest cost benefit ratio (1: 4.60) also recorded from the same module. Thus cabbage intercropped with cowpea and mustard as border crop could be adopted to get rid of key pests of cabbage.

Keywords: Habitat manipulation, cabbage pest management, *Plutella xylostella*, *Pieris canidia*, *Brevicoryne brassicae*, *Agrotis ipsilon*, coccinellid predator

Introduction
Vegetables are the most essential component of Indian diet and India is the world's second largest producer of vegetables with 11 per cent share next to China (Bose *et al*., 1993) [4]. Cabbage, *B. oleracea* var. *capitata* L. is one of the most popular winter vegetable grown throughout India. Cabbage is cultivated in 0.380 M ha with the total production of 8.795 M mt (Anon, 2016) [2]. Cabbage has a great potential in modern agriculture as a short duration crop, which is nutritionally superior and capable of producing high quality food per unit area and time. States like Uttar Pradesh, Orissa, Bihar, Assam, West Bengal, Maharashtra and Karnataka are the major cabbage growing basket of India. In Assam, it is extensively cultivated in all the districts as a major cash crop in *rabi* season.

Out of the different causes of poor yield of cabbage in India, the prime reason is the damage caused by lepidopteran insect pests right from the vegetative to maturity stage. In India, cabbage is attacked by near about 37 numbers of insect pests which causes great economic losses to the growers (Lal, 1975) [10], out of which, a handful are of very important *viz*., diamondback moth, *P. xylostella* (L.), cabbage aphid, *B. brassicae* (L.), cabbage butterfly, *P. canidia* (L.), cutworm, *A. ipsilon* (Hfn.), flea beetle, *Monolepta signata* Oliv. etc (White, *et al.* 1995; Rai, *et al*. 2014; Ahmed, *et al*. 2016) [17, 15, 1].

It is fact that, synthetic chemical insecticides with novel mode of action have been used for many years to counter the problem of insect pests, but the pests become resistant to these conventional insecticides in recent years (Kabir *et al*. 1996) [8]. In many cases, the insecticides gradually decline in their effectiveness and leads to the unsatisfactory results to control the target pests. However, biological control of pest insects can be improved by providing natural enemies with additional food resources such as floral nectar within the production field (Nilsson *et al.* 2012) [14]. Manipulation of habitat by planting different intercrop and border crop can conserve natural enemies of various noxious pests. By improving the conditions for natural enemies within the agro ecosystems, a more efficient pest control can be achieved (Wolcott 1942; Altieri and Letourneau 1982; Landis *et al.* 2000; Gurr *et al*. 2003; Zehnder *et al.* 2007) [18, 3, 11, 5, 19]. Moreover, habitat manipulation is often more advantageous in horticultural crops than in agricultural crops, because vegetables have higher production value and growers can more easily bear the higher costs for introduction of habitat manipulation schemes, such as loss of production area and labour costs (Nilsson *et al.* 2016) [13]. Plants, which shelter the natural enemies during unfavourable periods like winter in high altitudes, dry

seasons in tropical areas, are called refugia. Artificially created grasses sown on raised earth bank are termed as Beetle banks and this kind of suitable plants can be selected for the habitat manipulation, which provides habitat for birds, small mammals, invertebrates and predators like carbides and Staphylinds (Thomas, 1992; Menasch, 1997) [16, 12]. So far Assam state is concerned, no systematic attempt has been made in past to evaluate the impact of habitat manipulation on pest management of cabbage. With this view in mind the present investigation was carried out and the results obtained are discussed here.

Materials and Methods

The experiment was conducted during the two consecutive *Rabi* seasons of 2015-16 and 2016-17 at the Farmer's field, Alengmora, Jorhat. Five modules of main crop and trap crop/ intercrop combinations were selected against pests viz., DBM and aphid, and predatory lady bird beetle as well as yield parameter with five (5) replications.

The following five modules were tested

T_1 = Cabbage intercropped with cowpea (5:1 ratio) and mustard (1 row) as border crop

T_2 = Cabbage intercropped with mustard (5:1 ratio) and buckwheat (1 row) as border crop

T_3 = cabbage intercropped with cowpea (5:1 ratio) and buckwheat (1 row) as border crop

T_4 = cabbage with buckwheat (1 row) as border crop

T_5 = cabbage as sole crop (untreated check).

As a part of habitat manipulation we had selected different combinations of mustard, cowpea and buckwheat as intercrop or border crop. Mustard and cabbage are belong to the cruciferous family, so the herbivore pests were also similar for both the crops, and most of the time local mustard is more susceptible to DBM than cabbage. On the other hand, the floral part of the buckwheat is important for conservation of natural enemies; it is evident that, the free living adult stages require nectar before courtship. However, the cowpea had provided indirect effects on the cabbage field; though the cow pea aphid, *Aphis craccivora* and cabbage aphid, *B. brassicae* both are different but fortunately cowpea aphid also harbors different species of predatory lady bird beetles, which acted as a broad spectrum bioagent for any kinds of aphids.

Larval counts of lepidopteran pests, sucking pests and natural enemies were randomly collected from 5 plants from each treatment at 10 days interval starting from 30 DAP. Moreover, to collect the parasitoids from eggs and immature stages of lepidopteran pests, the eggs and larvae were kept in the laboratory for emergence of parasitoids. Yield data of cabbage was recorded individually.

The cabbage seedlings (Varity: "CV" Drumhead) were transplanted at spacing at 60 cm x 30 cm during first fortnight of October in a large plot size of 20 x 15 m^2 for each module. As such five plots were prepared. From each plot five plants were selected randomly for pest count. The data were recorded from five randomly selected plants from each spot. Since aphids and Coccinellids were congregated towards terminal parts of the plant; three leaves were sampled from each of the five random plants and the number of aphids per leaf were counted under stereo zoom binocular microscope. Such observations were recorded at weekly interval in each plot of different modules including cabbage as sole crop also. As regard to yield, weight of the cabbage from 60 m^2 plots were clubbed together and converted on per hectare basis. The data of two year trials were subjected to Analysis of Variance (ANOVA) with least significant difference (P=0.05) as test criterion was converted to hectare basis and then, economics were calculated. Benefit cost analysis was expressed in terms of benefit cost ratio by using the following formula

$$\text{Cost benefit ratio: } \frac{\text{Net return (Rs. /ha)}}{\text{Cost of cultivation (Rs. /ha)}}$$

Results and discussion

It is evident (table 1) that amongst the five modules, T_1 (Cabbage intercropped with cowpea and mustard as border crop) was found to be the best in reducing the larval population of *P. xylostella* (L.), *P. canidia* (L.), *A. ipsilon*. In case of diamondback moth, lowest larval populations of 1.90 and 1.87 / plant were recorded during 2015-16 and 2016-17 respectively with an average of 1.89 / plant. Similarly, on an average of 2.82 and 1.26 /plant registered against *P. canidia* (L.) and *A. ipsilon* also reported from same treatment respectively. In case of *B. brassicae* (L.), T_1 (Cabbage intercropped with cowpea and mustard as border crop) registered lowest insect population of 2.10 and 1.96 per plant during 2015-16 and 2016-17 respectively with average of 2.03 aphid/leaves which was the lowest than any other pest management module. Similarly, highest numbers of Coccinellids (1.77 and 1.84 / leaves) also registered from same module during 2015-16 and 2016-17 respectively with an average of 1.81/ leaves (Table 2).

In addition T_1 (Cabbage intercropped with cowpea and mustard as border crop) also registered highest yield of 17872 kg/ha followed by T_2 (17170 kg/ha), T4 (16556 kg/ha), T_3 (16820 kg/ha) and T_5 (15882 kg/ha), respectively. In terms of cost benefit ratio, module T_1 (Cabbage intercropped with cowpea and mustard as border crop) only recorded highest cost benefit ratio of 1: 4.60 followed by T_2 (1: 4.37), T_3 (1: 4.32), T_4 (1: 4.30) and T_5 (1: 4.29), respectively (Table 3).

Khan *et al*. (1997) [9] reported that Molasses grass (*Melinis minutiflora)* when intercropped with maize, reduce the infestation of crops by stem borer and increase the parasitism particularly by the native larval parasitoid, *Cotesia sesame*. The plant releases volatile substances that repel stem borers, but attracts parasitoids without being damaged. From another experiment, Hossain *et al*. (2001) [6] reported that strips of Lucerne with taller growth had greater natural enemies population than in more recently harvested strips. (Hossain, 2001) [6]. It showed that the egg parasitism by *Trichogramma* spp. on *Helicoverpa armigera* was greater in unharvested strips with dense parasitoid population. It demonstrated a 100-fold increase in larval parasitism of the diamondback moth (*P. xylostella*) when the parasitoid *Diadegma semiclausum* had access to nectar of flowering buckwheat plants (Nilsson *et al*. 2016) [13]. Joshi, 1999 reported that, cabbage – buckwheat or potato-buckwheat-mustard are a few famous crop combination in Himalayan foothills. Therefore, we had chosen buckwheat as one important component for habitat manipulation. Unfortunately, in our present experiment we could not able to recover any parasitoid from the experimental plots, more particularly from buckwheat. It might be the reason of non-significant result from other treatments where buckwheat was a component. From the above study, it could be concluded that the module comprising cabbage intercropped with cowpea and mustard as border crop, was

found most effective in controlling DBM and cabbage aphid. Interestingly, this module also registered the highest number of Coccinellids and significantly enhancing the yield over control apart from registering highest cost benefit ratio.

Table 1: Effect of habitat manipulation in cabbage on *Plutella xylostella*, *Pieris canidia* and *Agrotis ipsilon*

Modules	*P. xylostella*		Pooled mean	%ROC* (avg.)	*P. canidia*		Pooled mean	%ROC* (avg.)	*A. ipsilon*		Pooled mean	%ROC* (avg.)
	2015-16	2016-17			2015-16	2016-17			2015-16	2016-17		
T1	1.90^{d}	1.87	1.89	54.46	2.86^{c}	2.78	2.82	42.57	1.39^{c}	1.13	1.26	66.49
T2	2.79^{c}	2.75	2.77	33.25	3.40^{bc}	3.36	3.38	31.16	2.84^{b}	2.66	2.75	26.86
T3	2.72^{c}	2.14	2.13	48.67	2.96^{c}	2.99	2.97	39.51	1.63^{c}	1.49	1.56	58.51
T4	3.49^{b}	3.56	3.53	14.94	3.69^{b}	3.73	3.71	24.44	3.34^{ab}	3.40	3.37	10.37
T5	4.02^{a}	4.26	4.15		4.88^{a}	4.94	4.91		3.50^{a}	4.00	3.76	
CD	0.41	0.44	0.42		0.58	0.40	0.46		0.50	0.74	0.54	
CV (%)	10.79	11.27	10.79		12.07	8.41	9.68		14.74	21.66	15.94	

ROC* Reduction over control. # Average of 7 observations of different treatment at 10 days interval. Mean followed by same letter in a column do not differ significantly by DMRT (P=0.05).

Table 2: Effect of habitat manipulation in cabbage on *Brevicoryne brassicae* and coccinellids

Modules	Aphids/plant				Coccinellids / plant			
	#First year (2015-16)	#Second Year (2016-17)	Pooled mean	%ROC* (avg.)	#First year (2015-16)	#Second Year (2016-17)	Pooled mean	%IOC** (avg.)
T1	2.10^{c}	1.96	2.03	61.33	1.77^{a}	1.84	1.81	123.46
T2	3.92^{b}	3.79	3.85	26.67	0.90^{c}	1.08	0.99	22.22
T3	2.35^{c}	2.29	2.32	55.81	1.25^{b}	1.56	1.41	74.07
T4	4.84^{a}	5.02	4.93	6.10	1.14^{b}	1.15	1.15	41.98
T5	5.04^{a}	5.46	5.25		0.86^{c}	0.75	0.81	
CD	0.76	0.43	0.55		0.20	0.34	0.24	
CV (%)	15.47	8.74	11.12		13.33	19.58	14.54	

ROC* Reduction over control. IOC** Increase over control. # Average of 7 observations of different treatment at 10 days interval. Mean followed by same letter in a column do not differ significantly by DMRT (P=0.05).

Table 3: Economics of different pest management modules against major pests of cabbage

Modules	Yield (kg/ha)			Increased in yield over control (kg/ha)	Increased in yield per cent over control	Price of increase yield (Rs./ha)	Cost of cultivation (Rs./ha)	Net profit (Rs./ha)	Cost benefit ration
	First year (2015-16)	First year (2015-16)	Pooled mean						
T1	17732	18012	17872	1990	12.53	19900	12757	58731	1: 4.60
T2	17440	16900	17170	1288	8.11	12880	12793	55887	1: 4.37
T3	16356	17284	16820	938	5.91	9380	12656	54624	1: 4.32
T4	16612	16500	16556	674	4.24	6740	12504	53720	1: 4.30
T5	16084	15680	15882				12000	51528	1: 4.29
CD	11.63	7.23	7.16						
CV (%)	5.15	3.20	3.17						

Average of 7 observations of different treatment at 10 days interval. Mean followed by same letter in a column do not differ significantly by DMRT (P=0.05). Average price of cabbage was Rs. 4/kg

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References

1. Ahmed SS, Saikia DK, Borkakati RN. Lepidopteran Pests of Cabbage: Exploration for Bio-intensive management. Lambert Academic Publishing, Germany, 2016, 51-139.
2. Anonymous. Horticulture Statistics Division, Department of Agriculture, Cooperation and Farmers Welfare, 2016. (http://www.mospi.gov.in/statistical-year-book-india/2016/178)
3. Altieri MA, Letourneau DK. Vegetation management and biological control in agroecosystems. Crop Protection 1982; 1(4):405-430.
4. Bose TK, Some MG, Kabir J. Vegetable crops. Naya Prakash, Calcutta, 1993, 9-283.
5. Gurr GM, Wratten SD, Luna JM. Multi-function agricultural biodiversity: pest management and other benefits. Basic Applied Ecology. 2003; 4(2):107-116.
6. Hossain Z, Gurr GM, Wratten SD. Habitat manipulation in Lucerne (*Medicago sativa* L): Strips harvesting enhance biological control of insect pests, International Journal of Pest Management. 2001; 47(2):81-88.
7. Joshi BD. Status of Buckwheat in India. Fagopyrum 1999; 16:7-11.
8. Kabir KH, Bakash ME, Rouf FMA, Karim MA, Ahmed A. Insecticide usage pattern on vegetables at farmer's level of Jossore region in Bangladesh: A survey finding. Banglades Journal Research. 1996; 21:241-254.
9. Khan ZR, Chiliswa P, Hassanali A. (14 August). Intercropping increase parasitism of pests, Nature. 1997; 338:631-32.
10. Lal OP. A compendium of insect pest of vegetables in India. Bulletin of Entomology. 1975; 16: 31-56.
11. Landis DA, Wratten SD, Gurr GM. Habitat management to conserve natural enemies of arthropod pests in agriculture. Annual Review of Entomology. 2000; 45:175-201.

12. Mensah RK. Local density responses of predatory insects of *Helicoverpa species* to a newly developed food supplement Envirofeast in commercial cotton in Australia, International Journal of Pest Management. 1997; 43(3):221-225.
13. Nilsson U, Porcel M, Świergiel W, Wivstad M. Key insect pests and natural enemies in annual vegetable cropping systems In. Report on Habitat manipulation - as a pest management tool in vegetable and fruit cropping systems, with the focus on insects and mites. Published by SLU, EPOK – Centre for Organic Food & Farming, 2016, 19-24.
14. Nilsson U, Rannback LM, Anderson P, Ramert JB. Herbivore response to habitat manipulation with floral resources: a study of the cabbage root fly. Journal of Applied Entomology. 2012; 136(7):481-489.
15. Rai AB, Halder J, Kodandaram MH. Emerging insect pest problems in vegetable crops and their management in India: An appraisal. Pest Management in Horticultural Ecosystems. 2014; 20(2):113-22.
16. Thomas MB, Sotherton NW, Coombes DS, Wratten SD. Habitat factors influencing the distribution of polyphagous predatory insects between field boundaries. Annals Applied Biology. 1992; 120(2):197-202.
17. White AJ, Wratten SD, Berry NA, Weigmann U. Habitat Manipulation to Enhance Biological Control of Brassica Pests by Hover Flies (Diptera: Syrphidae). Journal of Economic Entomology. 1995; 88(5):1171-1176.
18. Wolcott GN. The requirements of parasites for more than hosts. Science 1942; 96:317-318.
19. Zehnder G, Gurr GM, Kuhne S, Wade MR, Wratten SD, Wyss E. Arthropod pest management in organic crops. Annual Review of Entomology. 2007; 52:57-80.