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Effect of different intercrops and border crops on major insect pests and natural enemies of cabbage

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Abstract
A field experiment was conducted in the Experimental farm, Department of Horticulture, Assam Agricultural University, Jorhat during *rabi* 2014-15 & 2015-16, respectively to study the effect of different intercrops and border crops against major insect pests and natural enemies of cabbage. The treatments were cabbage intercropped with mustard and cowpea (T_1), cabbage intercropped with mustard and oats as border crop (T_2), cabbage intercropped with cowpea and oats as border crop (T_3), oats as border crop (T_4) and cabbage as sole crop (T_5). Major insect pests recorded during the crop season were diamondback moth, *Plutella xylostella* (L.), cutworm, *Agrotis ipsilon* (Hfn.) and flea beetle, *Monolepta signata* Oliv. The predators were *viz.*, *Coccinella transversalis* (F.) and syrphid fly, *Episyrphus belteotus*. *Plutella xylostella* showed the highest occurrence followed by *Agrotis ipsilon.* Out of the five treatments, the pooled data revealed that T_1 was found to be more effective treatment in reducing DBM, cutworm and flea beetle (1.25,1.22 and 1.01) / plant, followed by T_3 (1.50,1.44 and 1.19) / plant. The highest population of coccinellid and syrphid was observed in T_1 (3.71, 2.88) / plant followed by T_3 (3.29 and 2.55) /plant, respectively. In case of insect pests as well as predators a significant difference was observed among all the treatments. The maximum yield was observed in T_1 with 212.78q/ha followed by T_3 with 205.28q/ha.

Keywords: Habitat manipulation, cabbage, ecosystem, sole crop, trap crop and border crop

1. Introduction

Cabbage (*Brassica oleracea* var. *capitata* L.) is a commercially important cruciferous vegetable. In India, it is cultivated on the hills and in the plains during the cool season. An area of more than 2.4 lakh hectares is under cabbage cultivation in India with an annual production around 56.2 lakh tonnes. The insect pests on cabbage alone causes a yield losses to the extent of 57 to 97% from planting to till harvesting. In India, cabbage is attacked by near about 37 insect pests that reduces its marketability [1], out of which, a handful are of major importance *viz.*, diamondback moth, *Plutella xylostella* (L.), cabbage butterfly, *Pieris canidia* (L.), cutworm, *Agrotis ipsilon* (Hfn.), flea beetle, *Monolepta signata* Oliv. etc. Synthetic insecticides have been widely used to manage insect pests with a collage of risks. The insecticides may contaminate water bodies, air and the soil [2], that leads to a growing concern in connection with environmental pollution. Hence, find an alternative means of controlling the cabbage is highly essential pests rather than using synthetic chemicals.

Monocultures are an example of agro ecosystems with low diversity and may be more susceptible to pest or disease outbreaks [3]. The concept of intercropping involves the cultivation of two or more crops simultaneously on the same field. It reduces pest population because of the diversity of crops grown. The advantages of intercropping over monoculture in terms of reduced pest incidence have been demonstrated in many studies [4]. An important advantage of intercropping systems is their ability to reduce the incidence of pests due to increased botanical diversity [5]. Therefore, conservation bio control or habitat management aims at preserving the natural enemies in the crop ecosystem to bring about effective management of the pests of cabbage instead of using insecticides [6]. Under habitat management, crop diversification through intercropping has to be incorporated as a major activity to earn the benefit of making natural enemies abundance in crop ecosystem. The use of mustard and cowpea as intercrop and oats as border crop with sole crop cabbage under organic production systems has been followed here to know about the effect of different intercrops and border crops on major insect pests and natural enemies of cabbage.

2. Materials and methods

The present investigation was conducted to study the habitat manipulation of natural enemies on cabbage pests. The field experiment was conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during *rabi* season of 2014-15 and 2015-16, respectively. The experiment was laid out in randomized block design (RBD) with four replications. The 25 days old seedlings were used for transplanting in the main field. The row and interplant spacing were 60cm and 30cm, respectively. There are altogether five treatments including untreated control. In T_1, Cabbage intercropped with Mustard and Cowpea, Cabbage intercropped with Mustard and Oats as border crop in T_2, Cabbage intercropped with Cowpea and Oats as border crop in T_3, in T_4 Cabbage with Oats as border crop and cabbage as sole crop in T_5.

The studies on pest and natural enemies of cabbage and the effect of plant diversification on natural enemies were carried out during *rabi* season of 2014-16, respectively. The crop was regularly monitored to record the appearance of insect pests as well as natural enemies. The different insect species and natural enemies encountered in the field were collected and brought to the laboratory for the identification. The observations were recorded randomly from five plants of each treatments at 10 days intervals to assess the number of sucking pests, lepidopteran pests as well as natural enemy complex. Pooled data obtained from the field experiments on the management of the pests were statistically analyzed by Fisher̉ s method of "Analysis of variance". The significance and non- significance of a given variation was then ascertained by Duncan̉ s Multiple Range Test (DMRT).

3. Results and Discussion

Two major lepidopteran and one coleopteran insect pests were observed in the field during 2014-15 and 2015-16, respectively. Diamondback moth, *P. xylostella* constituted the largest population followed by cutworm, *A.ipsilon* and flea beetle, *M. signata*. A considerable number of coccinellid and syrphid predators were also recorded during the experimental period. The pooled data of two years revealed that out of the five treatments, the lowest mean number of *P. Xylostella*, *A. ipsilon* and *M. signata* were recorded in the plots treated with T_1 (cabbage intercropped with mustard and cowpea) with 1.25, 1.22 larvae/plant and 1.01 adult/ plant followed by treatment T_3 (cabbage intercropped with cowpea and oats as border crop) with a population of 1.50, 1.44 larvae/plant and 1.19 adult/ plant, T_2 (cabbage intercropped with mustard and oats as border crop) with 1.72, 1.65 larvae/plant and 1.36 adult/ plant and treatment T_4 (cabbage with oats as border crop) with 1.91, 1.84 larvae/plant and 1.51 adult/ plant (Table 1, 2 and 3). However, highest number of *P. Xylostella*, *A. Ipsilon* and *M. signata* were found in T_5, where cabbage was planted as sole crop with 2.28, 2.05 larvae/plant and 1.66 adult/ plant. It was observed that out of different treatments, the best treatment was found to be T_1, followed by T_3, T_2 and T_4. While comparing the significance of difference among the different treatments, it was found that all the treatments were on par in their efficacies except treatment T_5 (cabbage as sole crop). Lower populations of DBM were recorded in cabbage plants intercropped with other non- host plants due to the confusing olfactory and visual cues received [7]. Similarly, supression of *A. ipsilon* might be due to the present of mustard crops repellants [8]. Intercropping of cabbage with other species such as clovers indicated insect pest suppression and it was reported that such approaches adopted properly by farmers could protect the misused of chemicals [9]. Minimum damage of *M. signata* was observed in intercropped collards [10]. The highest mean value of coccinellid and syrphid were observed in treatment T_1 (3.71 adults/plant and 2.88 larvae/ plant) which was found to be the best treatment and significantly differed from all the treatments (Table 4 and 5). The highest number of coccinellid observed might be due to the effect of intercropping of cabbage with mustard and cowpea. The enhancement of aphidophagous syrphids by provision of flowering plants [11]. The lowest number of coccinellid and syrphid with 1.87 adult/plant and 1.33 larvae/ plant were observed in treatment T_4 (Table 4 and 5). A significant difference was observed among all the treatments. As regards to yield, treatmentT_1 contributed the maximum yield of 212.78q/ha followed by T_3 with 205.28q/ha, T_2 with 196.01q/ha and T_4 (cabbage with oats as border crop) with 187.18q/ha. However, the lowest yield of 176.24q/ha was registered in treatment T_5 (Table 6). While comparing the effectiveness of all different treatments during 2014-16, it was noticed that T_1 had shown the better result in reducing the mentioned pests followed by T_3. That means these two treatments are more effective treatments than others in reducing the mentioned pests.

Table 1: Effect of different treatments on *P. xylostella* population during 2014—16

Treatment	Larvae per plant								Pooled Mean*
	Days After Planting (DAP)								
	20	30	40	50	60	70	80	90	
T_1	0	0.35	0.85	1.07	2.25	2.80	1.92	0.77	1.25^b
T_2	0	0.70	1.30	1.87	2.82	3.40	2.52	1.20	1.72^b
T_3	0	0.57	1.22	1.45	2.52	3.10	2.20	1.02	1.50^b
T_4	0	0.82	1.55	2.32	3.15	3.70	2.75	1.40	1.91^b
T_5	0	0.97	1.77	2.77	3.67	4.12	3.02	1.77	2.28^a
S.Ed. (±)	0	1.05	0.20	0.28	0.21	0.15	0.11	0.10	0.14
CD (P=0.05)	0	0.20	0.44	0.56	0.47	0.33	0.25	0.30	0.32

Table 2: Effect of different treatments on *A. ipsilon* population during 2014-16

Treatment	Larvae per plant								Pooled Mean*
	Days After Planting (DAP)								
	20	30	40	50	60	70	80	90	
T_1	0.02	0.87	1.22	1.75	2.37	1.85	1.07	0.62	1.22^e
T_2	0.10	1.27	1.67	2.27	2.97	2.20	1.55	1.22	1.65^c
T_3	0.05	1.07	1.47	1.92	2.70	2.02	1.35	1.00	1.44^d
T_4	0.07	1.47	1.92	2.45	3.20	2.40	1.80	1.42	1.84^b
T_5	0.10	1.67	2.15	2.70	3.52	2.62	2.02	1.62	2.05^a
S.Ed.(±)	0.06	0.03	0.04	0.07	0.07	0.07	0.04	0.05	0.05
CD(P=0.05)	0.15	0.06	0.08	0.17	0.17	0.15	0.09	0.12	0.16

Table 3: Effect of different treatments on *M. signata* population during 2014-16

Treatment	Adult per plant								Pooled Mean*
	Days After Planting (DAP)								
	20	30	40	50	60	70	80	90	
T_1	0	0.05	0.75	1.40	1.90	2.10	1.37	0.37	1.01[e]
T_2	0	0.20	1.30	1.87	2.37	2.60	1.77	0.80	1.36[c]
T_3	0	0.10	1.10	1.67	2.12	2.40	1.52	0.60	1.19[d]
T_4	0	0.22	1.50	2.07	2.62	2.82	1.95	1.00	1.51[b]
T_5	0	0.25	1.72	2.27	2.90	3.02	2.15	1.20	1.66[a]
S.Ed.(±)	0	0.11	0.06	0.06	0.06	0.07	0.08	0.10	0.05
CD(P=0.05)	0	0.24	0.14	0.13	0.13	0.16	0.18	0.23	0.13

*Column mean followed by same letter do not differ significantly at 5% level of probability.
Data based on mean of 4 replications

Table 4: Effect of different treatments on coccinellid predators population during 2014-16

Treatment	Adult per plant								Pooled Mean*
	Days After Planting (DAP)								
	20	30	40	50	60	70	80	90	
T_1	2.20	3.25	4.07	4.97	5.35	4.47	3.15	2.25	3.71[a]
T_2	1.52	2.27	3.32	3.70	4.02	3.62	2.42	1.70	2.82[c]
T_3	2.02	2.77	3.75	4.27	4.75	4.05	2.80	1.97	3.29[b]
T_4	0.87	1.07	1.77	2.82	3.12	2.57	1.67	1.05	1.87[e]
T_5	1.45	1.72	2.50	3.55	3.60	3.05	2.10	1.42	2.42[d]
S.Ed.(±)	0.13	0.18	0.19	0.18	0.15	0.17	0.11	0.10	0.15
CD(P=0.05)	0.30	0.39	0.41	0.41	0.35	0.37	0.25	0.22	0.33

Table 5: Effect of different treatments on syrphid population during 2014-16

Treatment	Larvae per plant								Pooled Mean*
	Days After Planting (DAP)								
	20	30	40	50	60	70	80	90	
T_1	1.07	2.60	3.75	4.10	3.95	3.25	2.65	1.72	2.88[a]
T_2	0.65	1.92	2.65	3.27	3.45	2.42	1.55	1.05	2.12[c]
T_3	0.87	2.32	3.40	3.75	3.57	2.92	2.20	1.37	2.55[b]
T_4	0.22	1.25	1.85	2.15	2.12	1.60	0.95	0.57	1.33[e]
T_5	0.40	1.62	2.35	2.82	2.75	2.00	1.25	0.85	1.75[d]
S.Ed.(±)	0.20	0.15	0.17	0.12	0.08	0.10	0.10	0.05	0.12
CD(P=0.05)	0.13	0.33	0.39	0.28	0.19	0.23	0.23	0.12	0.23

*Column mean followed by same letter do not differ significantly at 5% level of probability.
Data based on mean of 4 replications

Table 6: Effect of different treatment on the yield of cabbage

Treatments	Yield (q/ha)
	Pooled data
T_1	212.78 q/ha
T_2	196.01 q/ha
T_3	205.28 q/ha
T_4	187.18 q/ha
T_5	176.24 /ha

4. Conclusion

Out of five treatments, T_1 (Cabbage intercropped with mustard and cowpea) had to be found as more effective treatment in reducing *P. Xylostella*, *A. ipsilon* and *M. signata* in cabbage ecosystem followed by T_3 (Cabbage intercropped with cowpea and oats as border crop), T_2 (Cabbage intercropped with mustard and oats as border crop) and T_4 (Cabbage with oats as border crop). Highest pest population was found in T_5, where cabbage was planted as sole crop.

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