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Efficacy of different IPM modules against major pests of cabbage

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ABSTRACT: Different IPM modules untreated control were evaluated against Diamond back moth, *Plutella xylostella*, cabbage butterfly, *Pieris canidia,* cutworm, *Agrotis ipsilon* and cabbage aphid, *Brevicoryne brassicae*. Among the modules, Module (M5) i.e. lamda-cyhalothrin @ 25g a.i. per ha contributed maximum effectiveness in reducing the population of various pests followed by Module (M1) consisting of 3 releases of *Trichogramma chilonis* @ 1 lakh/ha at 10 days interval + 3 releases of *T. pieridis* @ 1 lakh/ha at 10 days interval + one spray of Bt@ 2ml/lit at 15 days after release of *Trichogramma* + one spray of NSKE 5%. However, the highest population of coccinellids was achieved in the biopesticide treated plots compared to lamda-cyhalothrin treated plots. The highest marketable yield was recorded in Module (M5) (262.50 and 252.50 q/ha) with a cost benefit ratio of 2.28 and 2.62 which was followed by Module (M1) contributed the yield of 212.78 and 202.67 q/ha as against 114.89 and 96.11 q/ha in the untreated control plots with a cost benefit ratio of 1.79 and 2.03 during 2013-14 and 2014-15, respectively. Though the maximum return was obtained from Module (M5) followed by Module (M1), considering the coccinellids population, it may be concluded that instead of use of chemical alone farmers can adopt the IPM module M1 for effective reduction of pests on cabbage.

KEYWORDS: Cabbage pests, IPM module, economics

INTRODUCTION

Cabbage, *Brassica oleracea* var. *capitata* L. is one of the most popular winter vegetable grown throughout India. As a short duration crop, which is nutritionally superior and capable of producing high amount of food per unit area and time, cabbage has a great potential in modern agriculture. Cabbage demonstrate wide adaptability, and hence it is grown over varied agroclimatic conditions ranging from lighter sand to heavier clay soils having a pH ranging between 6 to 6.5.In the plains the crop is extensively grown during cool season as a winter crop, but in the hills, it is grown as spring and early summer crop.

Despite introduction of potential hybrids, the production of cabbage is low as compared to potential yields obtained up to 0.63 million metric tonnes, particularly in Assam. Out of the different reasons for poor productivity of cabbage in India, one of the major limiting factors is the damage caused by lepidopteran insect pests right from the vegetative stage to maturity stage. Among various pests diamondback moth, *Plutella xylostella* (L.), cabbage butterfly, *Pieris canidia* (L.), cutworm, *Agrotis ipsilon* (Hfn.) and cabbage aphid,

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Brevicoryne brassicae (L.) are of major importance.

Although conventional insecticides having novel target site 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). It is a known fact that often only 1% of the active ingredients of the insecticide reach the target pests, while 99% of these substances, some of which are highly toxic, trouble the environment (Hassan, 1992).

However, excessive use of chemical pesticides at frequent intervals is more complicated in case of cabbage which resulted in many ecological problems due to mortality of natural enemies, resurgence of minor pests, environmental pollution and residues in vegetables, destruction of native flora and fauna. Keeping in view the ill effects of pesticides, adoption of integrated strategies for ecofriendly management and incorporating selective, safer, modern pesticides and biopesticides seem to be the best alternative. Hence, the present research studies are conductedon the efficacy of different PM modules on major pests of cabbage at Jorhat (Assam).

MATERIALS AND METHODS

The experiment was conducted in the Experimental Farm, Department of Horticulture, Assam Agricultural University (AAU), Jorhat during *rabi* season of 2013-14 and 2014-15 with six modules and four replicationsby adopting randomized block design (RBD). The details of modules are as follows:

IPM Module 1

Three releases of *Trichogramma chilonis* @ 1 lakh/ha at 10 days interval+3 releases of *T. pieridis* @ 1 lakh/ha at 10 days interval + one spray of Bt@ 2ml/lit at 15 days after release of *Trichogramma* + one spray of NSKE 5%.

Egg parasitoids viz. *T. pieridis* and *T. chilonis* were first released at 30 DAT of the crop. First release was made by *T. pieridis* at 30 DAT, subsequently 2nd and 3rd releases were made by *T. pieridis* at 40 and 50 DAT maintaining an interval of 10 days when the crop was at vegetative stage against cabbage butterfly, *Pieris brassicae*. *T. chilonis* was released at 60, 70 and 80 DAT from starting of head formation at an interval of 10 days. Altogether there were six releases of Trichogrammatids against lepidopteran pests of cabbage.

Similarly, one NSKE was made at 15 DAT as the aphid was occurring early stage of the crop and there was a 15 days interval in between spraying of NSKE and released of parasitoids.

Bt was sprayed at 95 DAT against Diamond back moth because at latter stage of the crop infestation of Diamond back moth is very high.

IPM Module 2

Three releases of *T. chilonis* @ 1 lakh/ha at 10 days interval+3 releases of *T. pieridis* @ 1 lakh/ha at 10 days intervals + one spray of NSKE 5%.

First release was made by *T. brassicae* at 30 DAT, subsequently 2nd and 3rd releases were made by *T. brassicae* at 40 and 50 DAT maintaining an interval of 10 days when the crop was at vegetative stage against cabbage butterfly, *Pieris brassicae*. *T. chilonis* was released at 60, 70 and 80 DAT from starting of head formation at an interval of 10 days. Altogether there were 6 releases of Trichogrammatids against lepidopteran pests of cabbage.

Similarly, one NSKE was made at 15 DAT as the aphid was occurring early stage of the crop and there was a 15 days interval in between spraying of NSKE and released of parasitoids.

IPM Module 3

Three releases of *T. chilonis* @ 1 lakh/ha at 10 days interval + 3 release of *T. pieridis* @ 1 lakh/ha at 10days interval +one spray of Bt 2ml/lit at 15days after release of *Trichogramma*.

IPM Module 4

3 releases of *T. chilonis* @ 1 lakh/ha at 10 days interval + 3 releases of *T. pieridis* @ 1 lakh/ha at 10 days interval.

Table 1. Efficacy of different IPM modules on pest population of cabbage (2013-14 and 2014-15)

Module	DBM population per plant				Cabbage butterfly population per plant			
	Pre treatment count	15 DAT	30 DAT	45 DAT	Pre treatment count	15 DAT	30 DAT	45 DAT
M1	2.70	0.83	1.15	0.60	2.18	0.94	1.16	0.60
M2	2.86	1.80	2.30	1.70	2.27	1.90	2.12	1.63
M3	2.52	1.05	1.20	0.85	2.22	1.04	1.46	0.80
M4	2.72	1.90	2.34	1.70	2.20	1.95	2.10	1.70
M5	3.23	0.20	0.40	0.68	2.52	0.17	0.30	0.44
M6	3.69	4.26	5.43	5.80	2.18	3.72	4.17	4.50
S.Ed.(±)	0.57	0.30	0.46	0.30	0.64	0.20	0.43	0.45
CD (P=0.05)	NS	0.66	1.48	0.64	NS	0.46	0.92	0.96

Table 2. Efficacy of different IPM modules on pest population of cabbage (2013-14 and 2014-15)

Module	Cutworm population per plant				Aphid population per leaf			
	Pre treatment count	15 DAT	30 DAT	45 DAT	Pre treatment count	15 DAT	30 DAT	45 DAT
M1	0.90	0.31	0.47	0.63	6.65	3.55	3.13	4.45
M2	0.73	0.36	0.50	0.68	6.01	3.58	3.20	4.48
M3	0.95	0.82	0.80	1.12	6.40	5.60	4.93	6.01
M4	0.85	0.85	0.87	1.10	6.06	5.65	5.11	6.05
M5	0.90	0.10	0.12	0.22	6.42	1.67	1.07	2.00
M6	0.96	1.70	2.49	2.60	7.39	0.17	11.07	12.30
S.Ed.(±)	0.17	0.13	0.14	0.16	0.88	0.76	0.54	0.48
CD (P=0.05)	NS	0.29	0.32	0.35	NS	1.60	1.16	1.09

IPM Module 5

Chemical control (lambda - cyhalothrin) @ 25 g a.i/ha at appearance of pests. Total 3 sprays of lambda – cyhalothrin, from 30 DAT, 45 DAT and 60 DAT.

IPM Module 6

Untreated control

The twenty five days old cabbage variety Asha F1 seedlings of about 25 days were transplanted in the plot of 7.5 m^2 with a spacing of 60 cm × 30 cm during November for both the period. All together six modules including untreated control were applied in the experimental plot. The recommended agronomic practices were followed. All the treatments specially plant extracts *viz.,* Neem Seed Kernel Extract (NSKE 5%), Bt@2 ml/l, biocontrol agents *viz., Trichogramma chilonis*, *T. pieridis*@ 1 lakh/ha at 10 days were released during morning hours without contaminating the adjacent plots. Chemical and untreated check plots were kept in different places which was located at 50m away from IPM plots to avoid drifting of insecticides. Trichocards containing the appropriate number of eggs of biotic agents i.e. *T. pieridis* and *T. chilonis* @ 1 lakh/ha were glued to the disposal glass that containing honey and placed it over the stick. First spray and release of bioagents were started on 15

Table 3. Effect of different IPM modules on coccinellid predators population (2013-14 and 2014-15)

Modules	Pre treatment count	Post treatment count			% reduction (-) or increase (+)
		15 DAT	30 DAT	45 DAT	
M1	1.08	0.57	0.60	0.85	21.29(-)
M2	1.25	0.50	0.70	0.94	24.80(-)
M3	1.02	1.13	1.17	1.29	26.47(+)
M4	0.91	1.05	1.22	1.43	57.14(+)
M5	1.27	0.17	0.35	0.40	68.50(-)
M6	1.62	1.93	2	2.18	34.57(+)
S.Ed.(±)	0.30	0.14	0.18	0.13	
CD (P=0.05)	NS	0.29	0.38	0.28	

The symbol (-) implies reduction of pest population; The symbol (+) implies increase of pest population

Table 4. Economic viability of different IPM modules in cabbage (2013-14 and 2014-15)

Module	2013-14				2014-15			
	*Yield (q/ha)	Return (Rs./ha) Ratio	**Total cost (Rs./ha)	Cost Benefit	*Yield (q/ha)	Return (Rs./ha)	** Total cost (Rs./ha)	Cost Benefit Ratio
M1	212.78	4,25,560	6980	1:1.79	202.67	4,05,340	6980	1:2.03
M2	196.01	3,92,020	3430	1:1.68	156.66	3,13,320	3430	1:1.60
M3	205.28	4,10,560	5410	1:1.74	187.18	3,74,360	5410	1:1.89
M4	177.94	3,55,880	1860	1:1.53	133.55	2,67,100	1860	1:1.38
M5	262.50	5,25,000	452	1:2.28	252.50	5,05,000	452	1:2.62
M6 (control)	114.89	2,29,780	-	-	96.11	1,92,220		-

* Total of 6 harvest; ** Total cost of plant protection based on two rounds of treatments
For one round of treatment = cost of insecticide per hectare + cost of labour (2 labour per day @ Rs. 135 per labour
Market price of cabbage @ Rs. 2000 per quintal for both the seasons
Cost of NSKE = Rs.1300/spray; Cost of *B. thuringiensis* = Rs.3280/spray
Cost of *Trichogramma chilonis* = Rs. 525/3 releases; Cost of *T. pieridis* = Rs.525/3releases
Cost of lamda- cyhalothrin 5 EC = Rs. 91.00/100 ml

days after transplanting when the eggs of lepidopteran pests were seen in the field and subsequently, the treatments were imposed at 15 days interval. In chemical control plot, lamda-cyhalothrin @ 25 a.i./ha was sprayed and altogether three sprays were given at 15 days interval. Care was taken at the time of spraying of insecticide and biopesticide like NSKE, *B. thuringiensis* so as to give thorough coverage for better affectivity. No management practices were followed in case of control plot except water spray. Pest population were recorded before and after imposing of each treatment at 15 days interval. For pre treatment and post treatment count,ten plants were randomly selected from each plot to assess the number of lepidopteran pests as well as natural enemy complex. In case of counting of aphid (nymph and adult),observations were recorded on three leaves from top, middle and bottom.Yields of marketable heads per plot were also recorded at the time of harvesting from each plot and records of all pickings were pooled together to get the average yield.The data generated were subjected to statistical analysis and the efficacy of different module were assessed.

RESULTS AND DISCUSSION

The results of present investigation indicated that all the modules exhibited overall significant effect in keeping down population of pests over untreated control. Among the six modules tested against the pests it was evident that the population of diamondback moth (0.20, 0.40, 0.68 per plant) as well as cabbage butterfly (0.17, 0.30 and 0.44 per plant) were significantly low in Module (M5) (lamda-cyhalothrin) followed by Module 1 registering 0.83, 1.15, 0.60 of DBM per plant and 0.94, 1.16, 0.60 of cabbage butterfly at 15, 30 and 45 days after treatment (DAT) during 2013-14 and 2014-15, respectively.

The reasons for the superior performance of Module (M5) might be due to quick knock down effect of lamda-cyhalothrin. Similar report of high order of performance of lamda-cyhalothrin against DBM was reported by Liu *et al.*(2003). The effectiveness of Module (M1) might be due to inclusion of all treatments *viz*., NSKE (Neem Seed Kernel Extract), Bt and egg parasitoids like *T. chilonis* and *T. pieridis*. The present findings on superiority of NSKE against DBM agreed with the earlier findings as reported by Schmutterer (1999), who reported the effectiveness of neem seeds/neem kernels against *P. xylostella* and showed a reduction in larval population of the pest with an average of 2.9 larvae/head.Besides these, the effectiveness of Bt included in Module (M1) was also supported by the findings of Oke *et al.* (2010) according to whom application of thuricide (*Bacillus thuringiensis)* resulted in lower percentage of head damage (9 to 10%) in comparison to non-treated plots that resulted in maximum mean percentage of head damage of 92%. The superiority of *T. chilonis* and *T. pieridis* which was also an important component of Module (M1) in reducing DBM population had also been reported by Miura (2003). According to him, *T. chilonis* was found to be effectively control DBM population showing a per cent parasitism of 80.

Similarly, it was also evident from the present investigation that Module (M5) was found to be significantly superior over rest of the modules in keeping down cutworm population with 0.10, 0.12 and 0.22 larvae per plant followed by Module (M1) registering 0.30, 0.47 and 0.63 larvae per plant at 15, 30 and 45 days after treatment (DAT) during 2013-14 and 2014-15, respectively.

Furthermore, it was also vivid from the results that Module (M5) also brought about a significant reduction on the incidence of aphid (1.67, 1.07 and 2.00 per leaf) over control followed by Module (M1) with a population of 3.55, 3.13 and 4.45 aphids per leaf for both the period.

The superiority of the Module (M5) might be due to inclusion of non-systemic insecticide lamda-cyhalothrin which exhibits adulticidal, ovicidal and particularly,larvicidal activity and disrupt the normal functioning of the nervous system of insect. Moreover, being a conventional insecticide, lamda-cyhalothrin has quick knock down effect and acts as both systemic and nerve poison. The present findings on superiority of NSKE against cutworm in Module (M1) also corroborate the findings of Viji and Bhagat (2001) who also reported that NSKE @ 20kg/ha provided good protection at earlier stages against the infestation of cutworm, whereas, at later stages, NSKE were less effective but registered higher yields when compared with untreated control. Furthermore, foliar application of neem-based insecticides have been reported to be the most effective in reducing the rates of honeydew excretion of aphid to 14-40 per cent compared to control (Shannag *et al.*, 2014). Besides these, the effectiveness of Bt included in Module (M1) might be due to presence of Btä-endotoxins which were found to exhibit low to moderate toxicity on aphid population in terms of mortality as well as growth rate.

Considering the other effects like mortality of coccinellids it has been further observed that the highest reduction in coccinellid predators was found in Module (M5, 68.50 per cent) as compared to Module (M1), Module (M2), Module (M3) and

Module (M4) respectively. In case of module (M1) and (M2) population of coccinellids were decreased in compare to (M3), (M4) and (M6) because in module (M1) and (M2) population of aphids were significantly less than the (M3), (M4) and (M6). As the was less availability of food, so the population of aphid predator coccinellids were also less.

Therefore, it may be concluded that instead of use of chemical alone farmers can adopt the IPM module (M1) consisting of 3 releases of *Trichogramma chilonis* @ 1 lakh/ha at 10 days interval + 3 releases of *T. pieridis* @ 1 lakh/ha at 10 days interval + one spray of Bt@ 2ml/lit at 15 days after release of *Trichogramma* + one spray of NSKE 5% for effective reduction of pests on cabbage.

The marketable yield revealed significant variations ranging from 262.50 to 114.89 q/ha (2013-14) and 252.50 to 96.11 q/ha (2014-15). The highest marketable yield was recorded in Module (M5) (262.50 q/ha) followed by Module (M1) and Module (M3). The gross return was more in Module (M5) followed by Module (M1) and Module (M3).

The economics of marketable yield over two years revealed that Module (M5) was the best effective module with highest BC ratio of 2.28 and 2.62 followed by Module (M1) with BC ratio of 1.79 and 2.03 during 2013-14 and 2014-15, respectively. The highest cost benefit ratio attributed by module (M5) might be due to its lower cost. Therefore, it can be suggested that instead of use of chemical alone farmers can adopt the IPM module (M1) consisting of 3 releases of *Trichogrammachilonis* @ 1 lakh/ha at 10 days interval+3 releases of *T. pieridis* @ 1 lakh/ha at 10 days interval + one spray of Bt @ 2 ml/lit at 15 days after release of *Trichogramma* + one spray of NSKE 5% for effective reduction of cabbage pests.

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