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Efficacy of chemical insecticides and botanicals in the management of diamondback moth (*Plutella xylostella*) in cabbage (*Brassica oleracea* var. *capitata* L.)

Rahimgul Stanikzi, Sasya Thakur

Department of Entomology, SHIATS, Allahabad, Uttar Pradesh, India

Abstract
The present investigation entitled "Efficacy of chemicals insecticides and botanicals in the management of Diamondback moth (*Plutella xylostella*) in cabbage" cultivar. i.e. Golden acer was conducted during November, 2015 to March, 2016 at Agricultural research farm, SHIATS, Allahabad. The occurrence of, Diamondback moth (*Plutela xylostella*) in 2015-2016 *rabi* season commenced from 6th standard week (February second week) with an average 0.25 larvae/plant. The Diamondback moth population increased and gradually reached peak level of 3.40 larvae/plant at 13th standard week (March last week). There after declined trend was observed.
The percentage reduction of Diamondback moth (*Plutella xylostella)* on cabbage damage percent revealed that the maximum reduction per cent of Spinosad 45 SC recorded highest reduction of Diamondback moth population i.e. (49.45)% which was significantly superior over control followed by Indoxacarb 14.5% SC (45.305), Cypermethrin 5% EC (44.215), Emamectin benzoate 5% SG (42.78), Profenophos 50% EC (40.975), Neem Seed Kernal extract (39.195), Neem oil (39.705) was least effective among all the treatments respectively. The highest yield was recorded in Spinosad 45% SC (187.60 q/ha), followed by Indoxocrab 14.5%SC (178.25 q/ha), Cypermethrin 10 EC (175.48 q/ha), Emamectin benzoate 5%SG (173.75 q/ha), Profenophos 50% EC (165.24 q/ha), Neem oil (157.38 q/ha), NSKE 5% (152.61 q/ha), as compared to untreated check (80.24 q/h).

Keywords: Chemical Insecticides and botanicals, Diamondback moth (*Plutella xylostella),* cabbage Crop

1. Introduction
Cabbage is the second most important Cole crop, which originated in Europe and in the Mediterranean region after cauliflower. Cabbage is one of the most popular winter vegetables grown in India. The botanical name of cabbage is *Brassica oleracea* var. *capitata*, Family-Cruciferae and Chromosome number: 2n=18. The English name cabbage comes from the French caboche, meaning head, referring to its round form. The edible portion includes the leaf blades, stalks and core (stem) inside the head. Cabbage is grown in most major temperate vegetable growing areas and is available year-round in most markets. It has been cultivated since at least 2500 B.C., with several var.ieties known to the Greeks and Romans.
India is the second largest producer of cabbage in the world after China. India producing 909.2 million tonnes (5.5 percent of total vegetable production) in an area of 400.1 ha. (4.3 percent of total vegetable area) with a productivity of 22.6 Mt/ha. Highest production of cabbage in India is found in West Bengal. Highest Cabbage producing states of India, West Bengal, Orissa and Bihar, 2197.4 tonnes, 1150.9 tonnes and 735.0 tonnes respectively. (Anonymous, 2014) [1].
Cabbage mostly used as culinary and dietic articles, salad, pickles, boiled vegetable and can also is used for feeding livestock. Cabbage juice is said to be remedy against poisonous mushrooms. From nutritional point of view, it ranks very high. Cabbage is rich in minerals like phosphorus, potassium, calcium, sodium, iron, vitamins A, B, C and proteins (Chaudhary, 1967). Cabbage has also medicinal value, as it helps to prevent constipation increases appetite, and speeds up digestion.
Vegetables are excellent choice for a cash crop. Vegetable crops can be grown quickly producing good yields and generate higher prices at markets. Vegetable crop suited for production on small land pieces, cultivating vegetables provides more jobs. It will diversify and income greater than other produces.
Several insect species like beetles, aphids, hoppers, moths, boreres, scales, bugs, etc. are inimical to us and have capacity to infest and cause widespread destruction to crop plants. Thus, it is evident that every year a large portion of agriculture produce is damage due to insects.
The pest losses due to insect infestation or merely their presence affect the quality and market value of the vegetables var.y adversely, which are more important than the yield loss. Exploiting full potential of crops has become difficult due to many biotic constraints, Worldwide annual loss due to these biotic constraints especially insect pests are estimated at billion of dollars. In India insect pests alone cause field loss to about 15-20% which approximately amount Rs.150 crores but in case of outbreaks, losses increased up 50-90 %.
Several insect pests are known to reduce the production of cabbage viz. Diamondback moth (*Plutella xylostella),* leaf webber (*Crocidolomia binotalis),* cabbage butterfly (*Pieris brassicae*), cabbage head borer (*Hellula undalis*), aphids (*Lipaphis erysimi, Brevicoryne brassicae* and *Myzus persiae*), Painted bug (*bargrada hilaris*), Bihar hairy caterpillar (*Spilosoma oblique*), tobacco caterpillar (*Spodoptera litura*) Mustard sawfly (*Athalia lugens proxima*)etc.
Among them tobacco caterpillar *Spodoptera litura fabricius* (*Noctuidae: Lepidoptera*) and Diamond back moth, *Plutella xylostella (Linn,*) (*Yponomeutidae: Lepidoptera)* are the

serious and major insect pests. They cause enormous damage by reducing its, yield and marketable quality.

Diamondback moth, *Plutella xylostella (Linn)* (*Yponomeutidae: Lepidoptera*) has become a destructive pest of crucifers in many cabbage growing areas of the world **(**Jones and Jones, 1998; Talekar and Shelthon, 1993) [5, 14]. This pest is distributed North America, the southern portion of South America, India and Srilanka (Harcourt 1962). More management of this pest poses serious concern due to development of insecticide resistance to organophosphates (Noppun *et al*., 1986), Carbamates (Sun *et al.,* 2007) [12] and Synthelic pyrethroids (Liu *et al*. 2000) [7] causing about 60-80 per cent yield loss.

Botanical insecticides, which contain plant extracts as active components, are safer as well as environmentally friendlier than synthetic insecticides. Therefore, this research was conducted to assess the effectiveness of two botanical insecticide formulations in reducing the major cabbage insect pests and their impact to natural enemies and cabbage crops in field test.

Control of insect pest by chemicals can be spectacular but it has its limitations such as high capital investment, non-remunerative, short term measures and also the ill effects of a chemical pesticides on human health and the environment development of resistance in pests to pesticides and higher level of pesticides residue in food items, there is crying need to develop suitable alternative to chemical pesticides for use in pest control. Use of pest avoidance tactics, enhancement of biological pest suppression and adoption of other non-chemical methods of pest management would certainly be able to improve our capabilities in solving much of the pest problems. So alternative storages have included the investigation for new type of insecticide, and the re-evaluation and use of traditional botanical pest control and these botanical pesticides, which are eco-friendly as well as economic to use. Annual growth rate in the consumption of pesticides was 9.5 percent in the last decade and more than 50 percent of the pesticides are common. Therefore, a pest management technology is economically viable environmentally safe ensuring maintenance of resource base should be adopted.

Neem, *Azadirachta India* is one such perennial tree, which grows in India, Its potential was first demonstrated by Pradhan *et al.,* 1962, who actually saved the crops against pests, Neem is already stated has diverse biological effects on insects and about 200 insect species have so far been reported to respond to neem treatments. They contain terpenoids (Schmutterer, 1984) that are phagodeterrent (Pradhan *et al.,* 1962 growth inhibitors (Rembold *et al.,* 1980) and ovipositor suppressant (Jacobson *et al.,* 1978; Sharma *et al*. 1984).

2. Material and Methods

Studies on the "Efficacy of chemical insecticides and botanicals in the management of Diamondback moth (*Plutella xylostella* L.*)* In cabbage (*Brassicas oleracea* var. *capitata* L" in Allahabad (U.P.) were carried out with a view to manage the Diamondback moth, *Plutella xylostella* L) with the help of some chemical insecticides, botanicals and their combinations. The investigation was carried out during Rabi season 2015-2016 in the field of Department of Plant Protection, Sam Higginbottom Institute of Agriculture, Technology and Sciences (Deemed-To-Be-University), (Trans Yamuna Region) Allahabad. There were eight treatments including an untreated control and each treatment was replicated thrice in the randomized block design.

Table 1: Details of Treatments

Treatment details / **T_0-Control**	**Trade Name**	**Dose (ml/lit.)**	**Group insecticides**	**Sources**
T_1-Spinosad 45% SC	Tracer	0.06ml/lit	Spinosyns	DOWAgro Sciences.
T_2-Indoxacarb 14.5% SC	Dhawa	0.5ml/lit	Organophosphate	Syngeta Company LTD
T_3-Cypermethrin5% EC	Cymbush	0.5ml/lit	Carbamates	Syngeta Company LTD
T_4-Emamectin benzoate 5% SG	FOB,CFR	0.5gr/lit	Halogenated Pyrroles	Syngeta Company LTD
T_5-Profenophos 50% EC	Curacron	0.75ml/lit	Organophosphate	Company syuqeuta co ltd.
T_6-Neem Seed Kernal 5%	Nimbecedin	4gr/lit	Botanicals	Osho chemical Ltd.
T_7-Neem oil	Costar	3ml/lit	Botanicals	Trans food chemicals

3. Results and Discussion

The data on per cent reduction larva population *Plutella xylostella* (Table 2) obtained at three, seventh and fourteenth days after first spray revealed that among different insecticidal treatments, Sponosad 45 per cent gave significantly the highest percent reduction of the pest with 47.09, 51.071 and 55.04 per cent reduction of this pest respectively. However, 42.50, 42.04 and 39.08 per cent reduction after three day, 46.64. 45.93 and 43.84 per cent reduction after seventh days, 48.88, 47.81, 45.94 per cent mortality after fourteenth days of first spray, respectively. The treatments of Sponosad 45 per cent gave significantly the highest percent reduction of the pest with 43.50, 46.50 and 53.50 per cent reduction of this pest respectively. However, 40.37, 40.00 and 37.55 per cent reduction after three day, 43.66. 43.50 and 40.37 per cent reduction after seventh days, 49.76, 46.50, 46.94 per cent mortality after fourteenth days of second spray, respectively.

Table 2: Efficacy of chemicals insecticides and botanicals against diamond back moth (Plutella xylostella) infesting cabbage after (1ST spray) during rabbi season 2015-2016

Treatments		% reduction larva population DBM				
		Before	3 DAS	7 DAS	14 DAS	Mean
T_1	Spinosad 45%SC	3.27	47.09	51.07	55.04	51.07
T_2	Indoxacarb 14.5% SC	3.13	42.50	46.64	48.88	46.01
T_3	Cypermethrin5% EC	3.20	41.56	45.93	47,81	45.10
T_4	Emamectin benzoate 5%SG	3.33	42.04	43.84	45.94	43.94
T_5	Profenophos 50%EC	3.07	39.08	41.77	43.64	41.50
T_6	Neem Seed Kernal extract	3.27	36.69	40.92	42.81	40.14
T_7	Neem oil	3.13	38.33	40.25	42.49	40.36
T_0	Control	3.07	0.00	0.00	0.00	0.00
Overal Mean		3.184	35.911	38.803	34.850	36.52
F- test		NS	S	S	S	S
S. Ed. (±)		0.749	1.273	1.058	1.012	5.737
C. D. (P = 0.05)		0.995	2.105	2.115	2.023	11.569

Table 3: Efficacy of chemicals insecticides and botanicals against the diamond back moth, (*Plutella xylostella*) infesting cabbage after (2nd spray) during rabbi season 2015-2016

Treatments		% reduction larvae population DBM				
		Before	3 DAS	7 DAS	14 DAS	Mean
T_1	Spinosad 45%SC	2.00	43.50	46.50	53.50	47.83
T_2	Indoxacarb 14.5% SC	2.13	40.37	43.66	49.76	44.60
T_3	Cypermethrin5% EC	2.00	40.00	43.50	46.50	43.33
T_4	Emamectin benzoate 5%SG	2.13	37.55	40.37	46.94	41.62
T_5	Profenophos 50%EC	2.20	36.36	39.54	45.45	40.45
T_6	Neem Seed Kernal extract	2.27	32.38	38.32	44.05	38.25
T_7	Neem oil	2.33	34.33	39.91	42.91	39.05
T_0	Control	3.20	0	0	0	0.00
Overal Mean		2.28	33.06	36.48	41.14	36.89
F- test		NS	S	S	S	S
S. Ed. (±)		0.754	1.241	1.436	1.602	3.414
C. D. (P = 0.05)		1.004	2.481	2.871	3.203	6.644

Table 4: Economics of Cultivation

S. No.	Treatment	Yield t/ha	Cost of yield Rs/q	Total cost of yield (Rs)	Common cost (Rs)	Treatment cost (Rs)	Total Cost (Rs)	Net returns (Rs)	B:C ratio
T_1	Spinosad 45% SC	187.60	714	133946.4	20170 Rs	3000	23170	110776.4	1:5.90
T_2	Indoxocrab 14.5%SC	178.25	714	127270.5	20170 Rs	1400	21570	105700.5	1:5.78
T_3	Cypermethrin 10 EC	175.48	714	125292.72	20170 Rs	1720	21890	103402.72	1:5.72
T_4	Emamectin benzoate 5%SG	173.75	714	124057.5	20170 Rs	2000	22170	101887.5	1:5.60
T_5	Profenophos 50%EC	165.24	714	117981.36	20170 Rs	2000	22170	95811.36	1:5.32
T_6	NSKE 5%	152.61	714	108963.54	20170 Rs	1400	21570	87393.54	1:5.05
T_7	Neem oil	157.38	714	112369.32	20170 Rs	2600	22770	89599.32	1:4.93
To	Control	120.25	714	85858.5	20170 Rs	0	20170	65688.5	1:4.26

Economics of var.ious treatments

The yields among the treatment were significant. The highest yield was recorded in Spinosad 45% SC (187.60 q/ha), followed by Indoxocrab 14.5%SC (178.25 q/ha), Cypermethrin 10 EC (175.48 q/ha), Emamectin benzoate 5% SG (173.75 q/ha), Profenophos 50% EC (165.24 q/ha), Neem oil (157.38 q/ha), NSKE 5% (152.61 q/ha), Control (135.45 q/ha). When cost benefit ratio was worked out, interesting result was achieved. Among the treatment studied, the best and most economical treatment was Spinosad 45% SC (5.90), followed by Indoxocrab 14.5% SC (5.78), Cypermethrin 10 EC (5.72), Emamectin benzoate 5%SG (5.60), Profenophos 50% EC (5.32), NSKE 5% (5.05), Neem oil (4.93), as compared to control (4.26).

All the treatments were found to be significantly superior over control. Spinosad was more effective in percentage damage reduction of cabbage with 68.86% reduction over control. Pramnik and Chatterjee (2003) [8] reported that spinosad gave the highest percentage of reduction of cabbage damage and its results are supported by Syed *et al.*, (2004) [13] and Ismail *et al.*, 2012 [3, 13] and Cypermethrin was found to be next effective treatment (58.16%) reduction over control reported that Ismail, *et al.*, (2012) [3].

Jasmine *et al.* (2007) [4] reported that the Spinoasd 45 SC at 75 g a.i./ha registed 62.2 percent reduction population of Diamondback moth and the yield recorded 33.0, 35.0 and 17.2 tonnes per ha in the first, second and third experiment, respectively.

Spinosad registered 80.9 percent reduction in population of DBM in the fourth spray, of first experiment on 7 DAT and same trend of efficacy was seen in the other experiment also. The efficacy of Spinosad against DBM has been reported by Syed *et al.* (2004) [13]. Yield: Gill and Joia (2008) [2] reported maximum marketble yield was recorded in spinosad with

minimum damage and its results are supported by Pramnik and Chatterjee (2003) [8].

Cost Benefit Ratio

Higher cost benefit ratio of 1:8.65 was obtained from spinosad treated plots. Gill and Joia (2008) [2] reported that highest grain yield and cost benefit ratio was obtained in the treatment of spinosad and proved to be best among treatments.

4. Conclusion

From the critical analysis of the present findings of **"**Efficacy of chemical insecticides and botanicals in the management of diamond back moth (*Plutella xylostella* L.*).* In cabbage (*Brassica oleracea* var. *capitata* L.)" Spinosad 45% SC, followed by Indoxocrab 14.5%SC, Cypermethrin 10 EC, Emamectin benzoate 5% SG, Profenophos 50% EC, Neem oil, NSKE 5%, proved to be the best treatment in managing *Plutella xylostella* reduction. Therefore, insecticides of short residual effect and botanicals like Spinosad may be useful in devising proper integrated pest management strategy against diamondback moth.

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