The Pharma Innovation Journal 2022; SP-11(5): 675-678

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(5): 675-678

www.thepharmajournal.com
Received: 13-03-2022
Accepted: 15-04-2022

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Screening the different varieties of cabbage against diamond back moth (*Plutella xylostella* L.)

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Abstract
Ten cabbage varieties were screened for their reaction against *P. xylostella*, none of the variety was found immune to the *P. xylostella* attack however variety Pusa Drumhead and Golden Acre were considered as resistant, Puma, Pusa Samandh, Pride of India, Selection- 51 as moderately resistant, while, Green Flesh, Vasudha, NO-5005 and GS-455 were considered as susceptible.

Keywords: Cabbage, diamond back, *Plutella xylostella* L.

Introduction
Cabbage is most important in terms of nutritional and economic significance and grows in winter season. In the world China ranks first in cabbage production followed by India. In India area and production being 0.403 lakh hectare and 93.69 million tones, respectively (Anonymous, 2019) [2]. In Rajasthan, the area and production under cabbage was 12000 hectares and 11690 metric tonnes, respectively (Anonymous, 2017-18) [1].

Different insect pests pose threat to the production of cabbage throughout the world. Maison (1965) [6] listed 51 insect pests which damage cruciferous crops throughout the world out of which diamondback moth (DBM), *Plutella xylostella* (Linnaeus); (Lepidoptera : Plutellidae) is one of the major constraints in the profitable cultivation of cole crops, wherever they are grown (Talekar and Shelton 1993) [9]. It was estimated that at least 53-80 percent loss in marketable yield is due to *Plutella xylostella* (Chelliah and Srinivasan, 1986) [4].

In order to prevent the loss caused by insects and produce a quality crop, it is essential to manage the pest population at appropriate time with suitable measures. Economic significance of the cabbage crops compelled the vegetable growers to use more frequent insecticide applications of recommended and non-recommended chemicals for eliminating the pest population and try to fetch better marketable yields.

Use of excessive and indiscriminate dosages of conventional insecticides posed severe problems such as, adverse effect on non-target organisms, development of resistance in target pest and pest resurgence. Hazardous implications of these pesticides and their residues at various tropic levels have also caused incalculable damage to every aspect of environment, globally. Amit *et al.* (2018) reported that the greatest challenge facing by the nation in the coming years is to demand safe food for the growing population in the country. Inspired by this, organic farming which leads to improving the health of agro-ecosystem has gained wide detection as a valid alternative to conventional food products and confirms safe food for human consumption. Therefore, It is necessary to use of resistant varieties is recognized as an important tool in bio-intensive pest management system. The morphological and physical characteristics of plants and head are associated with attraction, feeding and oviposition of the pest. The identification of physical and biochemical characteristics from insect resistant varieties is most practical significance. Keeping this in mind present studies has initiated to identify eco-friendly Integrated Pest Management (IPM) strategy for diamondback moth on cabbage.

Materials and Methods
The field experiment was conducted for Screen out the different varieties of cabbage against diamond back moth (*Plutella xylostella* L.) in randomized block design (RBD) in three replication and ten treatments with row to row distance and pant to plant distance 45 cm x 45cm and plot size (2.25 M X 1.8 M) at Instructional Farm, College of Agriculture, S.K.R.A.U., Bikaner during *rabi*, (2018-19 and 2019-20), using cabbage variety Golden Acre,

Pride of India, Pusa Samandh, Pusa Drumhead, Puma, Selection-51, Vasudha, GS-455, NO.-5505, Green Flesh grown following recommended practices.

The seed of varieties of the cabbage were collected from different agencies, the seedling were raised at hitech nursery, S.K.R.A.U., Bikaner and transplanted in November 2018 -19 and 2019-20. The crop was kept free from insecticides.

Methods of observations

Five plants from each plot were selected randomly and tagged to record the observation. Observations were recorded at weekly interval just after transplant to harvest of cabbage. The varieties were screened by using following scale (Dreyer 1987) [5].

Table 1: Dreyer scale used to record damage score on cabbage varieties

Score	Description
1.	No damage or few isolated small holes in the outer or lower leaves
2.	Many holes but damage limited to outer or lower leaves
3.	Considerable damage of the outer or lower leaves slight damage on cabbage head, head leaf marketable with minor removal of outer
4.	Outer or lower leaves completely destroyed moderate attack of head marketable after considerable removal of outer head
5.	Severe attack on the head (head unmarketable)

The average value of damage score of the diamondback moth was calculate by the cut off value of each cultivars as per formula suggested by Rana *et al.* (1975). On the basis of cut off values, rating system developed by considering mean number of damage score. The cultivars which showed less mean of damage score than the cut off value were considered as resistant and designed by alphabet 'R'. similarly, the cultivars which supported greater mean damage score than the cut off value were considered as susceptible and designed by alphabet 'S'. the rest value of cultivar were designed by alphabet 'MR' considering moderately resistant.

Results and Discussion

Infestation of diamondback moth, *P. xylostella* on different cabbage varieties during 2018-2019

Ten varieties of cabbage were screen for their relative damage of diamondback moth, *P. xylostella* following the Dreyer scale during 2018-19 & 2019-20 under field conditions. The varieties were Golden Acre, Pride of India, Pusa Samandh, Pusa Drumhead, Puma, Selection-51, Vasudha, GS-455, NO-5005, Green Flesh. the observations on pest infestation were started after fifteen days of transplanting and continued till last harvesting of head at seven days interval. The studies revealed that none of the varieties was found completely free from the *P. xylostella* infestation (Table 2 to 4).

The mean damage score of *P. xylostella* infestation during whole *rabi* 2018-2019 indicated that damage score was ranged from 2.02 to 2.64 per plant (Table 2). Lowest damage score was recorded in the variety Pusa Drumhead (2.02 per plant) which was followed by Golden Acre (2.09 per plant) while, the highest damage score was recorded in GS-455 (2.64 per plant) followed by NO-5005 (2.63 per plant). *P. xylostella* damage score ranging from 2.12 to 2.54 per plant was observed in Puma, Pusa Samandh, Pride of India, Selection-51, Green Flesh and Vasudha ranked in middle order of infestation.

Infestation of diamondback moth, *P. xylostella* on different cabbage varieties during 2019-2020

The mean damage score of *P. xylostella* infestation for whole *rabi* season, 2019-020 was recorded in the range from 2.06 to 2.77 per plant. Minimum damage score was recorded in the variety Pusa Drumhead (2.06 per plant) which was followed by Golden Acre (2.13 per plant) while, the maximum damage score was recorded in GS-455 (2.77 per plant) followed by NO-5005 (2.74 per plant). The damage score recorded in the ranged of 2.16 to 2.67 per plant in varieties Puma, Pusa Samandh, Pride of India, Selection-51, Green Flesh and Vasudha ranked in middle order of *P. xylostella* infestation (Table 3).

Table 2: Relative susceptibility of cabbage varieties to diamondback moth during 2018- 019

Treatment	Damage score per plant on different intervals												Mean
	16.12.18	23.12.18	30.12.18	6.1.19	13.1.19	20.1.19	27.1.19	3.2.19	10.2.19	17.2.19	24.2.19	3.3.19	
Golden Acre	1.00	1.07	1.20	1.40	1.53	1.66	1.77	2.33	2.93	3.00	3.33	3.80	2.09
GS-455	1.27	1.40	1.53	1.79	1.99	2.19	2.25	2.93	3.80	4.00	4.15	4.35	2.64
Pride of India	1.07	1.27	1.33	1.39	1.59	1.73	1.86	2.60	3.20	3.40	3.60	4.00	2.25
Puma	1.00	1.07	1.27	1.39	1.52	1.72	1.85	2.40	2.93	3.20	3.33	3.73	2.12
Vasudha	1.27	1.33	1.46	1.72	1.92	2.12	2.18	2.87	3.53	3.70	4.00	4.33	2.54
Selection-51	1.07	1.13	1.33	1.39	1.52	1.79	1.91	2.66	3.13	3.85	3.93	3.93	2.30
Pusa Drumhead	1.00	1.07	1.13	1.33	1.46	1.65	1.72	2.20	2.80	3.00	3.20	3.73	2.02
NO-5005	1.27	1.33	1.53	1.79	1.99	2.19	2.25	2.93	3.80	3.90	4.20	4.40	2.63
Green Flesh	1.27	1.33	1.39	1.65	1.85	2.05	2.11	2.93	3.60	3.79	4.00	4.20	2.51
Pusa Samandh	1.07	1.27	1.33	1.39	1.59	1.79	1.91	2.39	3.00	3.20	3.40	3.93	2.19

Table 3: Relative susceptibility of cabbage varieties to diamondback moth during 2019- 020

Treatment	Damage Score per plant on different intervals												Mean
	16.12.19	23.12.19	30.12.19	6.1.20	13.1.20	20.1.20	27.1.20	3.2.20	10.2.20	17.2.20	24.2.20	3.3.20	
Golden Acre	1.07	1.13	1.33	1.53	1.65	1.85	1.99	2.40	2.86	3.07	3.19	3.52	2.13
GS-455	1.33	1.46	1.79	2.05	2.32	2.52	2.65	3.07	3.73	3.98	4.07	4.26	2.77
Pride of India	1.13	1.20	1.53	1.65	1.78	1.98	2.17	2.80	3.13	3.24	3.46	3.80	2.32
Puma	1.07	1.13	1.33	1.53	1.66	1.86	2.05	2.47	2.86	3.07	3.19	3.65	2.16
Vasudha	1.27	1.46	1.71	1.98	2.24	2.44	2.57	2.99	3.60	3.73	3.93	4.13	2.67
Selection-51	1.13	1.33	1.53	1.65	1.85	1.98	2.17	2.73	3.13	3.33	3.46	3.80	2.34
Pusa Drumhead	1.07	1.13	1.26	1.46	1.59	1.79	1.92	2.33	2.73	2.90	3.06	3.52	2.06
NO-5005	1.33	1.46	1.79	2.05	2.32	2.52	2.65	3.06	3.66	3.85	4.00	4.20	2.74

Green Flesh	1.27	1.40	1.65	1.92	2.18	2.38	2.51	3.06	3.53	3.65	3.86	4.06	2.62
Pusa Samandh	1.13	1.33	1.53	1.65	1.85	2.05	2.25	2.59	3.00	3.13	3.33	3.80	2.30

Infestation of diamondback moth, *P. xylostella* on different cabbage varieties during 2018-2019 & 2019-020 (Pooled)

The data presented in (Table 4) indicated the pooled damage score of diamondback moth on different cabbage varieties during the two consecutive season *i.e. Rabi* 2018-019 and 2019-020. The *P. xylostella* pooled damgage score ranged from 2.04 to 2.70 per plant. The minimum damage score was observed in Pusa Drumhead (2.04 per plant) followed by Golden Acre (2.11 per plant), while, maximum damage score was recorded in variety GS-455 (2.70 per plant) followed by NO- 5005 (2.69 per plant) and Vasudha (2.60 per plant). *P. xylostella* damage score ranging from 2.14 to 2.57 per plant was recorded in the varieties of Puma (2.14 per plant), Pusa Samandh (2.24 per plant), Pride of India (2.29 per plant), Selection- 51 (2.32 per plant) and Green Flesh (2.57 per plant). These variety ranked in middle order of their susceptibility.

By considering the overall damage score for concluding the result the pooled data of *P. xylostella* damage on cabbage varieties were categorized on the basis of formula developed by Rana *et al.* (Cut off value= Mean- S.D.). The varieties having *P. xylostella* damage score below the cutoff value were regarded as resistant, similarly, the varieties which supported greater mean damage score than the cut off value were considered as susceptible, while, the varieties having damage score in between cut off value and mean damage score value were considered moderately resistant. Based on this criteria the variety Pusa Drumhead and Golden Acre were considered as resistant, Puma, Pusa Samandh, Pride of India, Selection- 51as moderately resistant, while, Green Flesh, Vasudha, NO-5005 and GS-455 were considered as susceptible. More or less same order of susceptibility of cabbage verieties screened against diamondback moth, *P. xylostella* was recorded during both the year independently (Table 4).

The ascending order of susceptibility of varieties against *P. xylostella* infestation was Pusa Drumhead > Golden Acre > Puma > Pusa Samandh >Pride of India > Selection-51 > Green flesh > Vasudha > NO-5005> GS-455

Table 4: Degree of susceptibility in different varieties of cabbage (Pooled)

S. No.	Varieties/ Cultivars	Damage score			Degree of susceptibile
		2018-2019	2019-020	Pooled	
1.	Golden Acre	2.09	2.13	2.11	Resistant
2.	GS-455	2.62	2.77	2.70	susceptible
3.	Pride of India	2.25	2.32	2.29	Moderately resistant
4.	Puma	2.12	2.16	2.14	Moderately resistant
5.	Vasudha	2.54	2.67	2.61	susceptible
6.	Selection-51	2.30	2.34	2.32	Moderately resistant
7.	Pusa Drumhead	2.02	2.06	2.04	Resistant
8.	NO-5005	2.64	2.74	2.69	susceptible
9.	Green Flesh	2.51	2.62	2.57	susceptible
10.	Pusa Samandh	2.19	2.30	2.24	Moderately resistant
Mean		2.33	2.41	2.37	-
S.D.		0.23	0.27	0.25	-
Cut-off value		2.10	2.14	2.12	-

By considering the overall damage score for concluding the results the pooled data of *P. xylostella* damage on cabbage varieties were categorized on the basis of formula developed by Rana *et al.* (Cut off value= Mean- S.D.). The varieties having *P. xylostella* damage score below the cutoff value were regarded as resistant, similarly, the varieties which supported greater mean damage score than the cut off value were considered as susceptible, while, the varieties having damage score in between cut off value and mean damage score value were categorized as moderately resistant. Based on this criteria the variety Pusa Drumhead and Golden Acre were considered as resistant, Puma, Pusa Samandh, Pride of India, Selection- 51as moderately resistant, while, Green Flesh, Vasudha, NO-5005 and GS-455 were considered as susceptible. More or less same order of susceptibility of cabbage verieties screened against diamondback moth, *P. xylostella* was recorded during both the year independently.

The ascending order of susceptibility of varieties against *P. xylostella* infestation was Pusa Drumhead > Golden Acre > Puma > Pusa Samandh >Pride of India > Selection-51 > Green flesh > Vasudha > NO-5005> GS-455.

In past, Bhoir and Patil (1999) [3] observed Golden Acre and Pride of India as least preferred host for egg laying by *P. xylostella*, similarly, Nathu *et al.* (2000) [7] reported Pride of India and Pusa Drumhead as resistant while, Pusa Synthetic and Golden Acre as moderately resistant conform the present investigations. The work of *P. xylostella* against other varieties is not available in the literature thereafter could not be compared and discused.

Conclusion

The cabbage crops was found to be infested by Diamondback moth, *P. xylostella* was observed most serious pest attacking the crop throughout of the growth stage. Ten cabbage varieties were screened for their reaction against *P. xylostella*. On the basis of diamond back moth infestation and analysis of the varieties Pusa Drumhead and Golden Acre were considered as resistant, Puma, Pusa Samandh, Pride of India, Selection- 51 as moderately resistant, while, Green Flesh, Vasudha, NO-5005 and GS-455 were considered as susceptible.

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