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Seasonal incidence and insecticidal efficacy against Diamond Back Moth and Aphid of Broccoli

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ABSTRACT: *An experiment was conducted to find out seasonal appearance and chemical management options of diamond back moth (DBM) and aphid in broccoli. DBM caused much more damage than aphids at all the stages of crop growth with two peak appearances during 3rd week of November and 1st week of March. The maximum temperature 26.02 to 32.72^{0}C, minimum temperature 9.08 to 17.12^{0}C and 7.6 to 9.18 hour sunshine period could be favourable for its multiplication. The incidence of aphid on broccoli started from early December that reached its peak at end of February. The temperature (max.) around 30^{0}C and relative humidity (max.) 90 to 95 % favoured its multiplication. The significantly at par insecticidal efficacy against DBM was noticed for spinosad 2.5 SC, novaluron 10 EC and cartap hydrochloride 50 SP with respective percent mortality of 60.67, 60.61 and 57.54 after 5 days of pooled three round sprays. It was statistically highest (75.95 %) in spinosad followed by novaluron (69.69 %) after 10 days. The significant best mortality of aphid (78.62 %) observed in imidacloprid 17.8 SL at 10 days after pooled two round of sprays.*

Keywords: *Aphid, Broccoli, Diamond Back Moth and Efficacy*

INTRODUCTION

India is the second largest producer of broccoli after China, while the US ranks third. Among the cole crops, broccoli is yet to be as popular as cauliflower and cabbage. Its acceptability is increasing as an exotic vegetable in major vegetable growing states including Uttarpradesh, Karnataka, Maharastra, Bihar, West Bengal, Punjab and Haryana due to its special nutritional and export value. It is rich source of vitamins (A and C), minerals (phosphorus, calcium, sodium and iron) and cancer protecting as well as preventing agents (sulforaphane and brassinins) [1, 2 and 3]. This particular crop is grown almost round the year either in the hills or in the plains covering very small areas. It is mostly cultivated during winter with optimum range of temperature between 12 – 18^0 C for proper head development. The brassica crop in West Bengal has a multiple insect pest complex. The important insect pest species are diamond back moth (*Plutella xylostella* L), cabbage head borer (*Hellula undalis* F), tobacco caterpillar (*Spodoptera litura* F), cabbage looper (*Triplusia ni* Hb) and aphid (*Brevicoryne brassicae* W). The ideas of managing insect pests through employing knowledge on main insect pests along with their seasonal incidence level and use of comparatively eco-safe selective chemicals are gaining importance as prime components of advanced Integrated Pest Management (IPM). The information in these respects in broccoli is not enough till date. In view of this, the present investigation was carried out to find out seasonal incidence and chemical management options of diamond back moth and aphid as main insect pests in broccoli.

MATERIALS AND METHODS

The experiment was conducted at Horticulture Research station, Mondouri farm under Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal (22^{0}56′ N latitude, 88^{0}32′ E longitude and 9.75 m above mean sea level) from September to March during 2011-12. The crop broccoli (var: ultra green) was raised for three times respectively as early, mid and late crop adopting standard package of practices to take seasonal data on main insect pests' incidence. For

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efficacy testing of chemicals against DBM, the details of randomized 6 treatments with 4 replications were Novaluron 10 EC, Acetamiprid 20 SP, *Bacillus thuringiensis* var *kurstaki* 8 L, Spinosad 2.5 SC, Cartap hydrochloride 50 SP and untreated control. Here, the observations were taken on the day before spray, third, fifth and tenth days after each of three sprays at 10 days interval during the growing season. Similarly in case of aphid, the five treatments were Imidachloprid 17.8 SL, Acetamiprid 20 SP, Methyl demeton 25 EC, Monocrotophos 36 SL and untreated control. Here, the observations were taken on the day before spray, one, fifth, tenth and fifteen days after each of two sprays at an interval of 15 days. Five plants were selected randomly for each replication of the treatment for both the pests. Mean population numbers of DBM larva and aphid nymphs per plant were considered for analysis. Reduction percent was calculated by applying a correction factor given by Henderson and Tilton [4]. The effectiveness in terms of yield was recorded from the whole plot as total weight of marketable crop.

Statistical analysis

The weekly recorded data on incidence of both insects were subjected to statistical correlation with major weather parameters which was collected from local meteorological observatory. The means of their population under different selected treatments were separated at 5 % level of critical difference (CD).

RESULTS AND DISCUSSION

Main insect pests of broccoli

A number of insect pests were present in broccoli (2 crops) during the experimental period from September to March, 2011-12. Considering number of individual insects as well as damaging level, only two pests named DBM and aphid were observed as main culprits for raising broccoli. DBM caused much more damage than aphids at all the stages of crop growth. This particular insect was quite serious in early crop during September-November and in late crop during January-March. The next to DBM, aphid was also noticed as serious at the end of January to February. Boopathi and Pathak [5] reported sixteen insect species in broccoli. They categorized aphid, *Lipaphis erysimi* as major insect pest of broccoli.

Seasonal incidence of DBM and aphid

The data on weather parameters and seasonal population numbers of DBM and aphid in broccoli during 2011-12 have been presented in table 1. The infestation of DBM initiated under field condition in September end (0.26 larva/plant) and it was increasing in trend upto 3rd week of November. The larval mean population per plant ranged from 0.40 to 0.20 during last week of November to 2nd week of December. It was almost nil from 3rd week of December to about 1st week of January. It again appeared in broccoli from 2nd week of January and increased continuously its population upto 1st week of March ranging respectively from 0.40 to 4.00 larva per plant. Thereafter, the larval population build up was decreasing in trend resulting 0.60 larva per plant at the end of March. This trend in larval population growth indicated that the temperature 26.02 to 32.72^{0}C (max), 9.08 to 17.12^{0}C (min), 7.6 to 9.18 hour sunshine period could be favourable for its rapid multiplication leading to more or less sharp increase and reaching the peak during end February to mid March. As per present finding, the DBM abundancy in broccoli during February agrees with the works of Chowdhury and Pal [6].

The incidence of aphid nymphs (2.60 per plant) on broccoli started from early December that reached its peak (74.73 per plant) at end of February. Thereafter, it decreased gradually recording 6.53 nymphs per plant at end of March. The weather parameters including temperature (max.) around 30^{0}C and relative humidity (max) 90 to 95% favoured its multiplication. Such observation on seasonal incidence of aphid in broccoli is in more or less conformity with the results of Prasad [7] and Boopathi and Pathak [5] who reported that aphid infestation commenced from last week of November and reached peak at end of February.

Correlation of DBM and aphid infestation in broccoli with weather parameters

Table 2 indicates the result obtained by correlating the population of DBM larva and aphid nymphs with major weather parameters viz. temperature (maximum and minimum), relative humidity (maximum and minimum), rainfall and sunshine hour prevailed during the experimental period. The non-significant positive correlations (r = 0.030 and 0.356 for DBM & 0.061 and 0.345 for aphid) were observed with maximum relative humidity and sunshine period, respectively. The minimum relative humidity and rainfall had inverse effect on population build up of both insects. It was only significant in case of aphid with humidity (r = -0.580). The non-significant correlations of DBM larval population was noticed

Table 1
Seasonal incidence of DBM and aphid during 2011-12 in broccoli

Weeks	*Temperature (^{0}C)*		*Relative humidity (% RH)*		*Rainfall (mm)*	*Total sunshine hour of day*	*Mean of DBM larval population per plant*	*Mean of aphid population per plant*
	Max.	*Min.*	*Max.*	*Min.*				
25.08.2008 to	32.77	26.32	96.85	76.71	10.10	5.47	0.00	0.00
01.09.2008 to	31.45	25.47	96.71	78.28	10.18	4.45	0.00	0.00
08.09.2008 to	32.30	25.47	95.85	73.28	0.00	5.48	0.00	0.00
15.09.2008 to	30.00	25.00	98.14	82.85	34.75	2.82	0.00	0.00
22.09.2008 to	31.50	26.20	97.00	73.28	3.04	6.88	0.00	0.00
29.09.2008 to	32.04	24.84	96.71	69.71	2.77	8.17	0.26	0.00
06.10.2008 to	33.45	25.05	92.28	67.14	3.42	7.97	0.33	0.00
13.10.2008 to	32.57	23.87	96.00	65.14	0.14	8.15	0.40	0.00
20.10.2008 to	33.22	23.62	98.42	60.12	0.00	8.48	0.46	0.00
27.10.2008 to	37.21	20.91	98.00	76.42	6.85	3.40	0.53	0.00
03.11.2008 to	31.80	20.10	96.57	54.57	2.02	9.37	0.86	0.00
10.11.2008 to	31.81	16.70	95.28	38.57	0.00	8.82	0.73	0.00
17.11.2008 to	30.47	17.28	96.85	45.42	0.00	8.54	0.93	0.00
24.11.2008 to	29.05	15.88	96.00	46.71	0.02	7.02	0.40	0.00
01.12.2008 to	26.12	11.71	92.71	35.85	0.00	8.25	0.35	0.00
08.12.2008 to	26.85	9.57	95.57	35.42	0.00	8.07	0.20	2.60
15.12.2008 to	26.30	11.28	94.85	41.85	0.00	8.12	0.00	7.80
22.12.2008 to	25.85	12.81	95.71	45.71	0.00	8.05	0.00	14.20
29.12.2008 to	25.87	12.35	94.71	46.85	0.00	7.51	0.00	19.00
05.01.2009 to	22.71	8.61	94.57	40.28	0.00	7.52	0.40	22.46
12.01.2009 to	27.37	7.97	93.42	33.28	0.00	8.58	0.86	28.00
19.01.2009 to	26.41	9.65	93.85	30.14	0.00	8.97	1.00	38.40
26.01.2009 to	26.02	9.08	96.28	33.57	0.00	8.28	1.40	43.80
02.02.2009 to	27.14	12.62	94.28	36.71	0.00	8.52	2.00	55.56
09.02.2009 to	28.02	10.27	95.57	27.14	0.00	9.18	2.80	66.87
16.02.2009 to	29.97	16.07	97.85	45.71	0.22	8.45	3.00	70.20
23.02.2009 to	31.38	19.77	95.00	44.00	0.27	7.60	4.00	74.73
02.03.2009 to	29.58	13.57	92.85	39.14	0.00	8.24	4.00	51.66
09.03.2009 to	32.72	17.12	93.14	30.71	0.00	8.60	3.20	33.53
16.03.2009 to	34.87	22.32	94.85	35.14	0.00	8.04	1.93	24.20
23.03.2009 to	33.71	22.75	94.57	47.28	0.00	9.35	0.93	13.80
30.03.2009 to	33.58	22.42	95.85	51.85	6.28	8.37	0.60	6.53

Table 2
Correlation of DBM and aphid infestation in broccoli with weather parameters

Weather parameters	*Mean DBM larval population/plant*	*Mean aphid nymphs/plant*
Maximum temperature (^{0}C)	0.095	- 0.238
Minimum temperature (^{0}C)	-0.031	0.057
R.H. (Max.)	0.030	0.061
R.H. (Min.)	- 0.515	- 0.058*
Rainfall (mm)	-0.275	0.279
Sunshine (hr.)	0.356	0.345

Table 3
Efficacy of different insecticides for the control of DBM (Plutella xylostella) in broccoli during 2011-12

Treatment	Dose	Percent (%) reduction in days after spraying												Yield
	(%)	1st spray			2nd spray			3rd spray			Mean			(t/ha)
		3	5	10	3	5	10	3	5	10	3	5	10	
Acetamiprid 20 SP	**0.05**	25.07 (30.38)	43.39 (41.49)	49.27 (44.87)	29.46 (33.19)	43.98 (41.83)	48.09 (44.19)	25.01 (30.34)	35.14 (36.66)	42.67 (41.08)	26.51 (31.30)	40.84 (39.99)	46.68 (43.38)	36.45
Novaluron 10 EC	**0.1**	26.32 (31.19)	64.99 (54.02)	71.93 (58.33)	35.44 (36.84)	56.27 (48.90)	68.09 (55.91)	34.85 (36.48)	60.57 (51.40)	69.04 (56.50)	32.20 (34.84)	60.61 (51.44)	69.69 (56.91)	43.10
***Bacillus thuringiensis var kurstaki* 8 L**	**0.1**	24.56 (30.04)	42.59 (41.03)	54.11 (47.65)	19.54 (26.60)	47.39 (43.79)	52.46 (46.70)	18.33 (25.71)	44.25 (41.99)	56.35 (48.94)	20.81 (27.45)	44.74 (42.27)	54.31 (47.76)	40.50
Spinosad 2.5 SC	**0.03**	35.84 (37.07)	54.34 (47.78)	74.34 (59.90)	33.07 (35.41)	62.54 (52.56)	80.75 (64.34)	27.91 (32.21)	65.12 (54.10)	72.76 (58.86)	32.27 (34.90)	60.67 (51.48)	75.95 (61.03)	44.50
Cartap hydrochloride 50 SP	**0.1**	47.67 (43.95)	64.71 (53.85)	64.15 (53.52)	45.58 (42.75)	52.06 (46.47)	55.86 (48.65)	48.67 (44.52)	55.85 (48.65)	58.20 (50.01)	47.31 (43.74)	57.54 (49.66)	59.40 (50.73)	41.75
Untreated control	**-**	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)d	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	31.75
SEm (±)	**-**	**1.01**	**1.08**	**0.91**	**1.65**	**1.04**	**1.04**	**2.44**	**1.25**	**5.15**	**1.25**	**1.65**	**1.82**	**0.87**
CD at 5 %	**-**	**3.06**	**3.24**	**2.74**	**4.97**	**3.13**	**3.14**	**7.366**	**3.87**	**15.53**	**3.95**	**5.19**	**5.74**	**2.63**

* Figures in parenthesis are angular transformed values

Table 4
Efficacy of insecticides against aphid

Treatment	*Dose*	*Percent reduction days after spraying*									*Yield*
	(%)	*1st spray*			*2nd spray*			*Mean*			*(t/ha)*
		1	*5*	*10*	*1*	*5*	*10*	*1*	*5*	*10*	
Acetamiprid 20 SP	**0.05**	5.87 (14.62)	61.72 (52.08)	75.46 (60.64)	6.93 (15.82)	61.81 (52.13)	70.99 (57.73)	6.4 (15.23)	61.77 (52.10)	73.23 (59.17)	47.25
Monocrotophos 36 SL	**0.2**	41.14 (40.18)	63.32 (53.02)	63.88 (53.36)	48.50 (44.43)	62.94 (52.80)	64.32 (53.62)	44.82 (42.31)	63.13 (52.91)	64.10 (53.49)	40.78
Methyl demeton 25 EC	**0.2**	46.70 (43.40)	67.69 (55.66)	70.44 (57.38)	53.31 (47.18)	65.56 (54.37)	66.66 (55.04)	50.01 (45.29)	66.63 (55.02)	68.55 (56.20)	42.33
Imidachlorprid 17.8 SL	**0.05**	6.66 (15.52)	69.33 (56.68)	78.34 (62.61)	8.47 (17.43)	65.66 (54.43)	78.89 (63.00)	7.57 (16.50)	67.48 (55.34)	78.62 (62.81)	49.80
Untreated ciontrol	**-**	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	0.00 (4.05)	34.56
SEm (±)	**-**	**2.00**	**0.86**	**0.69**	**1.38**	**1.32**	**0.69**	**0.89**	**0.50**	**0.79**	**1.27**
CD at 5 %	**-**	**6.15**	**2.66**	**2.11**	**4.26**	**4.05**	**2.11**	**3.49**	**1.97**	**3.10**	**3.09**

* Figures in parenthesis are angular transformed values

respectively as positive (r = 0.095) and negative (-0.031) with temperature maximum and minimum. It was vice versa (r = -0.238 and 0.057) in case of population build up of aphid nymphs.

Efficacy of insecticides against DBM

The observations on efficacy of five selected insecticides against DBM has been presented in table 3 that revealed significant maximum larval mortality (47.31%) in cartap hydrochloride @ 0.1% after 3 days of pooled three round sprays. After 5 days, it was significantly at par for the treatments spinosad 2.5 SC @ 0.03%, novaluron 10 EC @ 0.1% and cartap hydrochloride 50 SP @ 0.1 % with respective mortality of 60.67, 60.61 and 57.54% respectively. The significant highest mortality (75.95%) was observed in spinosad 2.5 SC @ 0.03% followed by novaluron 10 EC @ 0.1% (69.69%) at 10 days after pooled three round sprays. At the same time, it was lowest (46.68%) for acetamiprid 20 sp @ 0.05% followed by 54.31% in *Bacillus thuringiensis* var *kurstaki* 8 L @ 0.1%. The present finding regarding efficacy of spinosad against DBM also agrees with the views of Syed *et. al.* [8].

The significant difference in yield of broccoli was noticed under different treatments against DBM in comparison to untreated plot. The highest yield (44.5 t/ha) recorded in case of spinosad which was statistically at par with novaluron (43.10 t/ha) followed by cartap hydrocloride (41.75 t/ha). It was lowest as 31.75 t/ha in untreated control.

Efficacy of insecticides against aphid

Efficacy of insecticides against aphid is presented in table 4. The pooled percent reduction of aphid population immediately after first day of two round sprays showed as 50.01 in methyl demeton 25 EC @ 0.2% followed by 44.82 in monocrotophos 36 SL @ 0.2%. Whereas the reductions were statistically at par in acetamiprid 20 SP (6.4%) @ 0.05% and imidacloprid 17.8 SL (7.57%). But after 5 days of spray, the highest mean mortality (67.48%) was recorded in imidacloprid followed by significantly at par with methyl demeton (66.63%). The next was monocrotophos (63.13%) and that was also statistically same with acetamiprid (61.77%). Considering 10 days after spray, the significant differences in reduction of pooled aphid population were observed among all treatments. It was highest in imidacloprid (78.62%) followed by acetamiprid (73.23%), methyl demeton (68.55%) and monocrotophos (64.10%). These results coincide with the findings of Sohail *et al.* [9] and Maula *et al.* [10] who respectively concluded the effectiveness of imidacloprid and methyl demeton against aphid, *L. erysimi*.

A statistically at par yields were recorded in treated plots by imidacloprid and actamiprid respectively with 49.80 and 47.25 t/ha. No significant difference prevailed between methyl demeton and monocrotophos in respect to yield getting 42.33 and 40.78 t/ha respectively. The lowest yield (34.56 t/ha) was recorded in untreated control plot.

CONCLUSION

It could be noted that very little work has been done on the insect pests of broccoli in west Bengal. So, there is an urgent need to determine the extent of crop losses due to insect pests attack. At present, the DBM during end September to 3rd week of November and aphid during early December to end February could be considered as main insects of broccoli. Emphasis is to be given for alternative using of target specific as well as relatively eco-safe chemicals to manage insect pests of broccoli.

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