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Incidence of Aphid and Whitefly on Chilli and their Management using Biorational and New Generation Insecticides

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Authors' contributions

This work was carried out in collaboration between both authors. Author GD designed the study, performed the statistical analysis and prepared the final manuscript. The author MHH performed the experimental works in the field and wrote the draft manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

An experiment was conducted at Entomology field laboratory, Bangladesh Agricultural University, Mymensingh during the rabi season of 2019-2020 to investigate the incidence of aphid and whitefly on chilli and effect of some biorational and new generation insecticides for controlling those insects. The presence of aphids was first identified on 2nd week of January at the vegetative stage of the chilli plant with the density of 2.34 per leaf. Then a gradual increase and a subsequent decrease were observed in the aphid population. The population density was reached to the peak level by first week of February with the mean number of 16.69/leaf. Thereafter, the population decreased in a gradual manner and reached to the minimum level by the end of 3rd week of March. In case of whitefly, similar trend of incidence but comparatively lower incidence was recorded from seedling to fruiting stage. On the other hand, five biorational and new generation insecticides were evaluated against these insects in field condition. All tested insecticides were found very effective except Shurter 505 EC (Cypermethrin + Chlorpyriphos) regarding reduction of aphids and whitefly populations, curled leaf development and increases of yield of green chillies. Among rest of the four insecticides, the Imixam 70WDG @ 0.30 g/L water (Imidacloprid + Thiamethoxam) was found most

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effective that was significantly followed by 0.20 g/L. This findings was closely followed by Gain 20 SL (Imidacloprid), Lumectin 10WDG (Lufenuron + Emamectin Benzoate) and Biotrin 0.5% (Matrine) respectively considering all the parameters studied.

Keywords: Incidence; aphid; whitefly; insecticides; managements.

1. INTRODUCTION

The spice crop chilli (*Capsicum annuum* L.), known to be originated in tropical Asia, is cultivated in Bangladesh as the most important spice crop both during winter and summer seasons. Chilli is the fruit of the plants from the genus *Capsicum* belonging to the family Solanaceae. It is available in the form of green, dried and powder. It has become an essential ingredient in Bangladeshi as well as in South-Asian meals. The peoples of Bangladesh are usually use chillies in all curries preparation like meat, fish, vegetables, pulses etc. for its typical color, taste and flavour. Both red and green chillies contain large amounts of vitamin-C, potassium, magnesium and iron, small amounts of carotene (pro-vitamin-A), vitamin-B and B_6 [1,2]. According to present statistics [3], about 1,50,000 ha land is under chilli cultivation in Bangladesh during the rabi season and total production is about 2,05,000 metric tons per year and per hectare yield is about 1.55 metric tons. During the kharif season about 55,000 ha lands is brought under the chilli cultivation and a total production is about 56,000 metric tons and per hectare yield is about 1.56 metric tons.

More than 39 genera and 51 species of insects and mites have been reported to cause damage to chilli crop in the field as well as in storage including aphid, whitefly, jassid, thrips, cutworm, mealy bug, fruit borer etc. But aphid and whiteflies are considered as the most devastating sucking insect pests on chilli. These sucking insects cause damage both directly and indirectly. Specifically, these insects suck cell sap from the leaf and other parts of the plants resulting in the leaf curling or twisting, yellowing, dry up and finally dropping down. In addition, they act as an important vector of different viruses like chilli leaf curl virus (CLCV). The estimated loss due to sucking insect pests was up to 30 to 50 percent [4]. On the other hand, the incidence of sucking insects on chilli crops varied due to several factors like planting time, variety and most importantly abiotic factors. Different abiotic factors like temperature, humidity and rainfall plays an important role on the incidence and population dynamics of sucking insects [5].

Most of the chilli growers in Bangladesh mostly depend on different broad-spectrum conventional insecticides for controlling sucking insects. Indiscriminate and injudicious use of conventional insecticides eventually responsible for the development of insecticide resistance, high residues level, secondary pest outbreak and destruction of natural enemies in the chilli ecosystem. The consumption of insecticides-containing green chilli may be severely hazardous for the consumers health as green chilli usually harvest at a regular interval from the field. The threat of using conventional insecticides can be minimized by adopting safer molecules like biorationals and new generation insecticides in the management strategies. Therefore, it becomes very crucial to select insecticides that are very selective in action as well as safer to different beneficial arthropods [6].

In the recent days, several biorational and new generation insecticides have been formulated which claimed to be relatively safer to the environment, less toxic to non-target organisms and less persistent in nature as compared to conventional insecticides [7,8]. Because of their good controlling ability at low rates or doses, high level of selectivity, greater specificity to target pests along with low toxicity to non-target organisms and the environment, these insecticides replaced many old/conventional compounds. Hence, the present study was undertaken to investigate the incidence of aphid and whitefly on chilli and their field management using different biorational and new generation insecticides.

2. MATERIALS AND METHODS

2.1 Experimental Site and Soil

The experiment was conducted at Entomology field laboratory, Bangladesh Agricultural University during rabi season of 2019-20 to investigate the incidence of aphid and whitefly on chilli and their management using different biorational and new generation insecticides. The soil of the field experiment area was under Old Brahmaputra Alluvial Tract under the Agro Ecological Zone 9 [9] with non-calcareous dark grey floodplain soil. Soil contains 10, 80 and 10%

sand, silt and clay respectively with the bulk density 1.3g cm^{-3}, total pore volume (TPV) of 50%, and pH of 6.7 at 0-15 cm depth.

2.2 Experimental Procedures

The experiment was laid out following randomized complete block design (RCBD) where eleven treatments were allocated including control. Each of the treatments was replicated thrice. The experimental field was about 20 m x 9 m size while each of the plot size was 4 m^2. The experimental field was prepared through ploughing and cross ploughing for several times to obtain desirable final tilts which were followed by laddering and spading. After making plots, all chemical fertilizers and manures were applied as recommended by Rashid [10] for chilli cultivation. After that healthy and disease free chilli seedlings of 30 days old were then transplanted in the experimental plots. Two adjacent unit plots and blocks were separated by 60 cm and 80 cm apart, respectively. The variety, BARI Morich-2 was used in this experiment.

2.3 Biorational and New Generation Insecticides and their Spray Schedule

A total of five biorational and new generation insecticides with two concentrations of each were evaluated against aphid and whiteflies in field condition. The insecticides and their concentrations are; Biotrin 0.5% (Matrine) @ 1.0 & 1.5 ml/L; Lumectin 10 WDG (Lufenuron + Emamectin Benzoate) @ 1.0 & 1.5 g/L; Gain 20 SL (Imidacloprid) @ 0.25 & 0.50 ml/L; Imixam 70 WDG (Imidacloprid + Thiamethoxam) @ 0.20 & 0.30 g/L and Shurter 505EC (Cypermethrin + Chlorpyriphos) @ 1.20 & 1.50 ml/L. A control treatment was also kept along with insecticidal treatment for comparison. All the selected insecticides were sprayed at 10 days intervals following the selected concentrations once insect population density rose above the threshold level. Spraying of insecticides were done in the morning using a high clearance sprayer equipped with a compressed air charged spray system calibrated to deliver 10 gpa through TX-6 hollow cone nozzles (2/row).

2.4 Data Collection

To measure the pest incidence, three chilli plants were randomly selected from each plot and marked them using color thread. After that three leaves were randomly selected from each plant and counted aphid and whitefly populations from nine leaves of an experimental plot. Finally, data were expressed as mean number of aphids or whitefly per leaf of that experimental plot. Control plots were always kept from insecticides spray or any drift residues from neighboring plots. In case of insecticide experiment, a total of four sprays was given at 7 days interval and insects were counted at 1, 3 and 7DAT (days after treatment) application following the same counting procedures followed for incidence data. Finally, data were expressed as mean number of aphids or whitefly/leaf. For estimating the mean number of curled leaves, nine plants were randomly selected from three plots and finally mean value was calculated as mean number of curled leaf/plant. Moreover, green chillies were harvested at 7 days intervals from each plot and final yield was calculated as ton/ha.

2.5 Statistical Analyses

The recorded data were compiled and tabulated for statistical analysis. Analysis of variance (ANOVA) was done with the help of computer package MSTAT. The mean differences among the treatments were adjudged with Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD) when necessary.

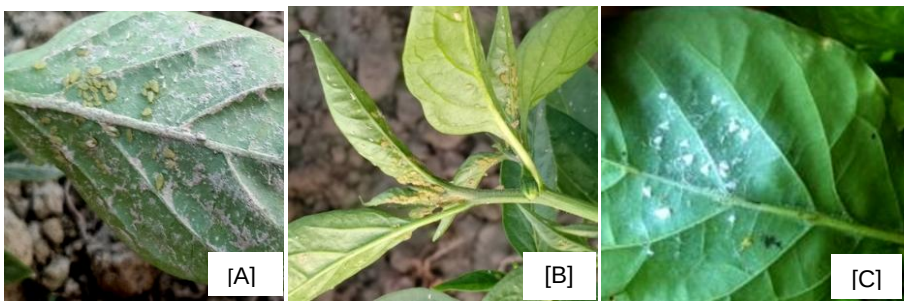

Plate 1. Infested leaves and twig of chilli caused by aphids and whiteflies. [A] Aphids are on the ventral sides of chilli leaf, [B] chilli leaves and twig are also severely infested by aphid[C] whiteflies on the ventral surface of the chilli leaf

3. RESULTS AND DISCUSSION

3.1 Incidence of Aphid and Whitefly on Chilli Crop

Incidence of two sucking insect pests namely aphid and whitefly on chilli crop were observed in experimental plots during the rabi season of 2019-2020. Incidence of these two pests has been shown in Fig. 1. The first incidence of aphids was recorded on 2nd week of January i.e. soon after the transplanting of chilli crop with the mean population of 2.34 aphids per leaf. After that a gradual increase and a subsequent decrease was observed in the aphid population. The highest population was observed in the 1st week of February with mean numbers of 16.69 per leaf. Just after one week later, the aphid populations declined to half (8.00/leaf) and thereafter decreased in a gradual manner. The aphid population was observed till fruiting stage of the crop i.e. at the end of the 3rd week of the March with the minimum populations (1.25/leaf). Almost similar trend but comparatively less population was observed in case of whitefly (Fig. 1). The first incidence of whitefly was observed on 23 January, two weeks later after initiation of aphid infestation with the mean number of 2.31 whitefly per leaf. After that a gradual increase was observed in its population followed by a decrease, while the peak population of whitefly was recorded on 6th February that persisted for next four weeks with more or less same populations. Thereafter a gradual decrease was observed and the lowest population (1.25/leaf) was recorded on 20th March i.e. flowering or fruiting stage of the chilli crop. Our present results are in agreement with the findings of Havanoor and Rafee [11] who reported that sucking insects mainly aphids and whitefly populations are reached in peak level by February and decline in the end of March. Ghose et al. [12], Bhatt and Karnatak [13] also found the similar findings regarding high and low incidence of aphids and whiteflies on chilli crop.

3.2 Effect of Different Biorational and New Generation Insecticides on the Abundances of Aphid and Whitefly on Chilli

Effect of different biorational and new generation insecticides on the abundances of aphid and whitefly on chilli crop has been shown in Table 1 and 2. All the selected insecticides except Shurter 505 EC had potential and significant effect on the reduction of aphid and whitefly populations compared to untreated control (Table 1 and 2). The highest infestation of aphid and whitefly was observed in untreated control plots (Plate-1). Counting of pre-treated data showed that there had almost a homogeneous distribution of aphids in all experimental plots with the range of 4.50 to 5.60 aphid per leaf. Following application of insecticides, aphid population was reduced significantly compared to untreated control (Table 1). After 1st spray, a significant result was found from all insecticides at 3 DAT compared to untreated control while further reduction was observed at 7 DAT. Data showed that Shurter 505 EC had comparatively less efficacy compared to the rest of the four insecticides although difference was found significant compared to control. Among rest of the four insecticides, the Imixam70 WDG @ 0.30g/L showed the best efficacy (1.00 aphid/leaf) than 0.20 g/L (1.75 aphids/leaf) or other insecticides regarding mean number of aphids per leaf. The mean number of aphids per leaf was further reduced in 2nd and 3rd spray while the lowest was recorded from 4th spray. It has been observed from the 4th spray that the insecticide Imixam70WDG @ 0.30 g/L has provided the best efficacy regarding the reduction of aphid populations (0.30 aphid/leaf) that was followed by lower dose i.e. 0.20 g/L (0.65 aphid/leaf). Almost similar result was also found from Gain 20 SL, Lumectin 70WDG and Biotrin 0.5% regarding the reduction of aphid populations. In all cases the highest number of aphids per leaf was recorded from untreated control plots.

Incase of whitefly, 2-3 whiteflies were counted per chilli leaf before treatment application but these numbers were significantly reduced when different biorational and new generation insecticides were sprayed on chilli plants. From Table 2, it has been shown that all the selected insecticides except Shurter 505EC had significant effect on the reduction of whiteflies populations in different sprays. Like as aphids, similar reduction trends was also observed in case of whiteflies. A total of four sprays were given at 7 days interval and a gradual reduction was observed from 1st to 4th sprays. The minimum reduction was observed from 4th sprays. Specifically, 0.31 whiteflies per leaf was counted when chilli plants were treated with Imixam 70 WDG @ 0.30g/L that was significantly followed by Imixam @ 0.20g/L (0.70 whitefly per leaf). Similar trend was found from Gain 20 SL treated plots where 0.40 and 0.80 whitefly per

leaf was counted when chilli plants were sprayed with 0.50 and 0.25 ml/L of water respectively. Lumectin 10 WDG and Biotrin 0.5% were also found effective against whiteflies compared to untreated control. The insecticide, Shurter 505 EC was found less effective than rest of the four insecticides but difference was found significant in comparison with that in the control (Table 2).

Till now different chemical insecticides have been evaluated against sucking insects pests of chilli and most of them showed high efficacy. In this study, five biorationals and new generation insecticides have been evaluated against aphid and whiteflies on chilli and they showed moderate to very high efficacy. Among the tested insecticides, Imixam 70 WDG (Imidacloprid + Thiamethoxam) @ 0.3g/L showed maximum reduction that was followed by Gain 20 SL (Imidacloprid), Lumectin 10WDG (Lufenuron +Emamectin Benzoate) and Biotrin 0.5% (Matrine) compared to Shurter 505EC and untreated control. Our findings have conformity with several researchers who evaluated various chemical insecticides against aphids and whiteflies (Parhyar et al., 2019; Khanzada et al., 2018; Sangle et al., 2017; Priyadorshini et al., 2019). On the other hand, Shurter 505 EC (Cypermethrin + Chlorpyriphos) was found very less effective against sucking insects and this result was found to be similar with Jain et al. [14] and Mandi and Senapati [5].

3.3 Effect of Biorational and New Generation Insecticides on the Development of Curled Leaves

Curled leaves are usually developed when different sucking insects suck the cell sap from the leaf and also insert some kinds of toxin in leaf tissues. Development of curled leaves is one of the striking indicators of infestation of sucking insects. In the present study, number of curled leaves were counted in control and treated plots to know the efficacy of selected insecticides. Data were shown in Fig. 2. It has been clearly observed that all the selected insecticides significantly reduced curled leaf formation compared to untreated control although Shurter 505EC showed less efficacy compared to the rest of the four insecticides. The highest number of curled leaves was counted from control plots. Number of curled leaves were gradually reduced with increasing number of sprays and the lowest curled leaves were counted after given 4th sprays. Similar results were also found from the study of Priyadarshini et al. [15] who reported that Imidacloprid alone or its cocktail form is highly effective against sucking insects and thus reduce curled leaf formation. Sangle et al. [4] also found the similar results when they used few new generation insecticides against sucking insects. In our study, the Imixam 70WDG (Imidacloprid + Thiamethoxam) and Gain 20 SL (Imidacloprid) showed the maximum efficacy compared to others regarding curled leaf reduction.

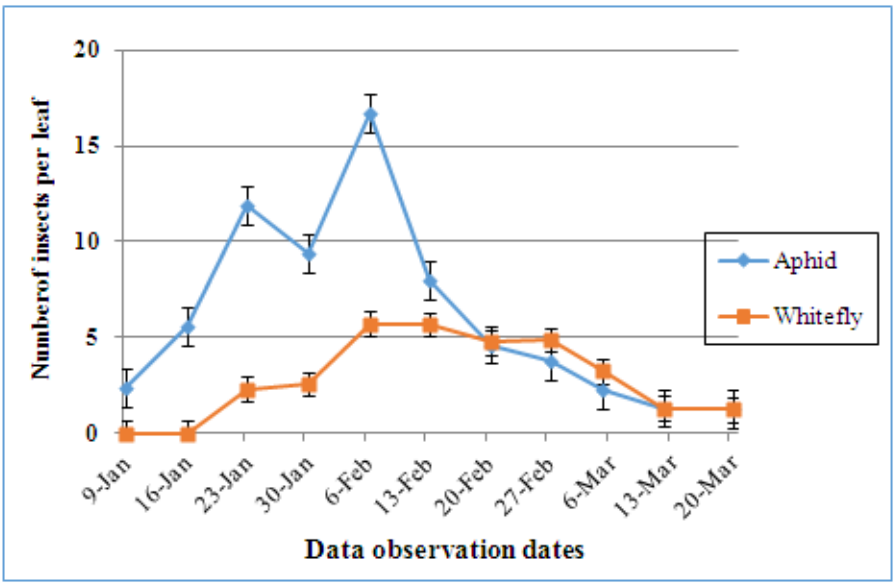

Fig. 1. Incidence of aphid and whitefly in chilli-ecosystem at different time of months. line graph indicate the mean ± SEM

Table 1. Effect of different biorational and new generation insecticides on the abundances of aphid populations in chilli-ecosystem

Insecticides	Dose (mg or ml/L)	Mean number of aphids per leaf											
		Pre- treatment	Post-treatment (at different DAT after given each spray)										
			1st spray			2nd spray			3rd spray			4th spray		
			1	3	7	1	3	7	1	3	7	1	3	7
Biotrin 0.5%	1.00 ml/L	5.00	5.38a	2.38a	2.31a	2.25a	2.13a	2.38a	1.63a	1.38a	2.13a	1.63a	1.00a	1.00a
	1.50 ml/L	4.80	4.63a	2.88a	2.00a	2.00a	2.03a	2.13a	1.23b	1.28b	1.38b	1.38a	0.80a	0.70b
Lumectin10WDG	1.00 g/L	5.10	4.63a	2.50a	3.75b	4.13b	2.75b	3.38b	1.88a	1.68c	1.50b	1.00a	1.00a	1.00a
	1.50 g/L	4.59	4.00a	2.38a	2.38a	3.38b	2.10a	1.75a	1.38b	1.35a	0.88c	0.77a	0.70a	0.80a
Gain 20SL	0.25ml/L	4.00	3.75b	2.63a	1.38c	2.25a	1.50c	1.75a	1.38b	1.88c	0.75d	1.75a	0.50c	0.60b
	0.50 ml/L	5.11	3.25b	1.88b	1.10d	1.38c	1.00d	1.08c	0.63c	1.13b	1.13b	0.80c	0.38c	0.51b
Imixam70WDG	0.20g/L	5.60	5.75a	2.75a	1.75a	1.88a	1.38c	1.30c	1.13b	1.25b	1.00d	1.00b	0.65c	0.65c
	0.30 g/L	4.90	4.00b	1.50b	1.00d	0.75d	0.80e	0.75d	0.63c	0.50d	0.13e	0.25d	0.30d	0.30d
Shurter 550EC	1.20 ml/L	4.78	5.38a	4.00c	5.88e	5.50e	6.13f	7.88e	4.50d	5.00e	5.50f	4.38e	4.88e	5.38e
	1.50 ml/L	5.01	5.40a	3.88c	5.75e	5.13e	4.50g	5.75f	4.00d	5.38e	4.13g	4.75e	4.38e	4.38f
Control	---	5.50	5.00a	7.63d	8.69f	8.00f	9.32h	8.62g	8.75e	7.75f	5.32f	6.82f	5.00f	6.25g
$LSD_{0.05}$	---	NS	1.11	1.02	1.14	0.95	1.42	1.66	1.60	1.47	0.77	1.12	0.51	0.30
CV(%)			18.12	23.34	19.98	13.44	17.88	20.22	19.44	20.12	15.66	16.77	22.13	18.90

In a column, means followed by similar letter(s) are not significantly different at 5% level of probability. NS: Not Significant

Table 2. Effect of different insecticides on the abundances of whitefly populations in chilli-ecosystem

Insecticides	Dose (mg or ml/L)	Mean number of whiteflies per leaf											
		Pre- treatment	Post-treatment (at different DAT after given each spray)										
			1st spray			2nd spray			3rd spray			4th spray		
			1	3	7	1	3	7	1	3	7	1	3	7
Biotrin 0.5%	1.00 ml/L	3.00	3.63b	2.00d	3.75b	2.50ef	2.00d	1.25bc	1.38e	1.23d	1.25ef	1.00c	0.90ef	0.80e
	1.50 ml/L	2.80	3.25b	1.88d	2.00c	2.00d	2.18d	1.10b	1.13ef	1.13d	1.13e	0.80b	0.80ef	0.68e
Lumectin 10 WDG	1.00 g/L	3.10	3.38b	2.75e	3.13b	2.88e	2.75e	1.63bc	1.50e	1.88e	1.83d	1.00c	1.10e	0.99e
	1.50 g/L	2.78	3.00b	1.38c	2.00c	1.75d	2.00d	1.00b	1.00d	1.13d	0.80b	0.78b	1.00e	0.60d
Gain 20SL	0.25ml/L	3.00	2.63c	1.88d	2.00c	1.33c	1.38c	1.25bc	1.00d	1.13d	0.70b	0.67b	0.80d	0.80d
	0.50 ml/L	2.00	2.50c	1.25c	1.63d	1.13c	1.18c	1.00b	0.89d	0.75c	0.56b	0.56b	0.40c	0.40cf
Imixam 70WDG	0.20g/L	2.50	2.25c	1.44d	1.38e	1.13c	1.11c	1.11b	0.38c	0.55b	0.40b	0.40b	0.70d	0.70c
	0.30 g/L	2.80	2.75c	1.25c	1.35e	1.00c	1.10c	0.88b	0.25c	0.33b	0.65b	0.50b	0.30c	0.31f
Shurter 550EC	1.20 ml/L	3.00	3.50b	3.50b	3.75b	3.75b	4.38b	4.38a	5.13b	4.13a	5.90a	5.00a	5.13a	4.00b
	1.50 ml/L	2.56	3.13b	3.13b	3.13b	3.75b	3.88a	4.63a	4.50b	5.13a	5.00b	5.09a	3.56b	4.13b
Control	---	3.00	5.50a	4.00a	5.38a	5.69a	3.88a	4.75a	5.00a	4.88a	6.13a	4.88a	5.82a	5.25a
$LSD_{0.05}$	---	NS	0.69	0.77	1.03	0.80	1.14	0.90	1.01	1.02	0.50	0.82	0.32	0.30
CV(%)			15.67	18.90	12.34	15.60	21.09	22.11	18.22	14.55	20.11	14.44	15.55	14.66

In a column, means followed by similar letter(s) are not significantly different at 5% level of probability. NS: Not Significant

3.4 Yield of Green Chilli (t/ha)

Effect of different biorational and new generation insecticides on the yield of green chilli (t/ha) has been shown in Fig. 3. All the selected insecticides significantly increased the yield of green chilli compared to an untreated control although Shurter 505EC showed the least efficacy regarding chilli yield. Green chilli was harvested at 7 days interval and weight was taken based on treatment specifications. The lowest yield (9.00 t/ha) was found from untreated control plot. The highest yield was recorded from Imixam treated plots that was very closely followed by Gain 20 SL, Lumectin 10 WDG and Biotrin 0.5% respectively. 15 t/ha yield was recorded from Imixam 70 WDG @ 0.30g/L that was followed by 0.20g/L (13.5 t/ha). On the other hand, 14.9 and 14.3 t/ha chilli was yielded when plots were sprayed with Gain 20 SL @ 0.50 ml/L & 0.25 ml/L respectively. This result was followed by Lumectin 10 WDG and Biotrin 0.5% respectively. Our present results are in close agreement with the findings of Parhyar et al. [16] Khanzada et al. [17] and Sangle et al., [4] who found that Imidacloprid and Thiamethoxam are very effective to reduce sucking insect infestation and thereby increasing high yield of green chilli. On the other hand, Shurter 505EC (Cypermethrin + Chlorpyriphos) was not found effective in increasing yield of green chilli and this result was found to be similar with Jain et al. [14] and Mandi and Senapati [5].

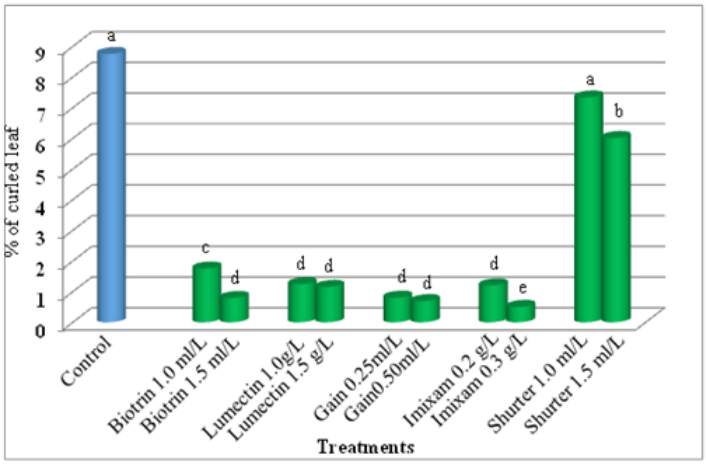

Fig. 2. Effect of different biorational and new generation insecticides on the percent reduction of curled leaf of chilli. A total of four consecutive sprays were given at 7 days interval and data represented here that was collected at 7 days after 4th spray. Bar containing different letters are significantly different from each other at 5% level of probability

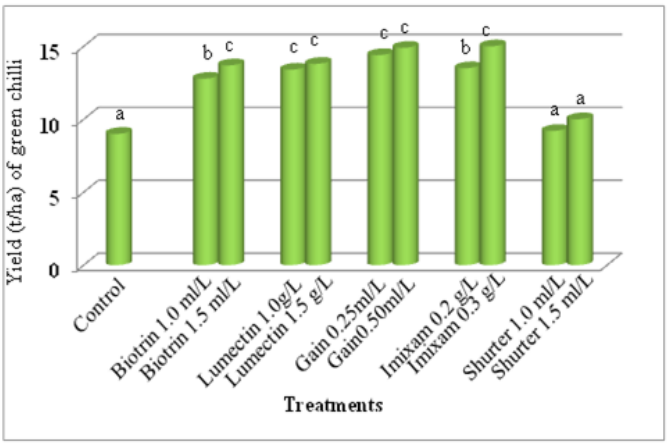

Fig. 3. Effect of different biorational and new generation insecticides on the yield of green chilli (t/ha)

Bar containing different letters are significantly different from each other at 5% level of probability

4. CONCLUSION

The results of the present study depicted that the insect pests viz. aphids and whitefly were recorded on chilli crop on just after transplanting, reached to the peak level by the mid of February and declined to minimum level in the 3rd of week of March. The fluctuation of insect population density might be influenced by various abiotic factors. On the other hand, Imixam 70 WDG (Imidacloprid + Thiamethixam), Gain 20SL (Imidacloprid), Lumectin 10WDG (Lufenuron + Emamectin Benzoate) and Biotrin 0.5% (Matrine) were found very effective against aphids and whiteflies on chilli and in contrast Shurter 505EC (Cypermethrin + Chlorpyriphos) showed less efficacy. Chilli growers can use above mentioned insecticides, except Shurter 505EC for effective control of aphids and whiteflies and thereby getting higher chilli yield.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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