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Survey of Phytophagous Mites, its Associated Natural Enemies on Brinjal and its Management Through Acaricides in North Bihar

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ABSTRACT

Background: Brinjal is an important vegetable crop grown throughout the country and a number of insect and non- insect pest are reported causing loss in quality and quantity of this crop. *Tetranychus urticae* (Koch) the two spotted mite is the most notorious non insect pest responsible for significant yield losses in brinjal crops next to shoot and fruit borer. Phytophagous mites are minute and not easily visible by naked eye making it very important create awareness among farmers of its occurrence and management practices. The present work was undertaken to understand status of phytophagous mites and associated natural enemies in brinjal farmers field along with to develop economically feasible management strategy.

Methods: Survey was conducted in four villages each of two district of North Bihar Samastipur and Muzaffarpur on presence of phytophagous mites, natural enemies in farmers brinjal field and efficacy of novel acaricides was also evaluated against these phytophagous mites. The survey on phytophagous mites and their natural enemies on brinjal crops was carried out in 31 farmers' field of Chandauli, Harpur, Naranyanpur and Gopalpur Thara villages of Samastipur and Lautan, Mirapur, Ittha and Muraul villages of Muzaffarpur district at fortnightly interval from January to June 2022.

Result: In our study we found wide spread presence of two species of tetranychid mites, predatory mites and six predatory insects *viz., Tetranychus urticae*, *T. neocaedelonicus*, *Amblyseius indicus*, *A. tetranychivorous*, Coccinellids, green lacewing, anthocorid bugs, mirid bugs, scolothrips and black ants. Efficacy of various acaricides resulted in lowest population in plot sprayed with chlofenapyr 10SC and spiromesifen 240EC and highest active mites were found in azadirachtin 1.9 EC treated plots. The highest per cent reduction over control was observed in plots treated with spiromesifen and the lowest per cent reduction over control was observed in plot treated with azadirachtin. This study has helped in understanding increase in mites infestation in changing climate scenario strategy for management.

Key words: Acaricides, Natural enemies, Phytophagous mites, Survey, Tetranychid.

INTRODUCTION

Brinjal commonly known as eggplant is an economically significant vegetable that grows over an area of 753 thousand hectares with productivity of 17.29 MT/ha and estimated annual production 13,023 thousand MT (Ministry of Agriculture and Family Welfare, (2021-2022) throughout India in Bihar, it is grown over an area of 58.2 thousand hectare with an annual production of 1241.7MT and a productivity of 21.3MT/ha (Directorate of Horticulture, Bihar, 2018).

Brinjal is being grown throughout the year, it is subjected to attack by number of insect and non-insect pests from nursery stage to harvest which reduce yield and spoil the quality of brinjal fruits. The major pest reported are shoot and fruit borer, leaf roller, stem borer, blister beetle, spotted beetles, *etc.* Among the non-insect pests, mites are probably the most notorious ones and gaining tremendous importance in the recent years due to their devastating nature. Especially two spotted spider mite, *Tetranychus urticae* (Koch) is the most notorious one which takes responsible for significant yield losses in brinjal crops next to shoot and fruit borer (Basu and Pramanik, 1968). Huffaker *et al.* (1969) proposed two main hypotheses concerned to mite outbreaks in recent decades which are general upsurge of mite due to simulative effects of pesticides and fertilizers promoting increased plant growth and better nutrition to mites. This has resulted in increased reproductive potentials of mites and detrimental effect of pesticides on natural enemies of mite.

In vegetables, spider mite damage causes 10 to 15 per cent loss in yield (Anonymous, 1991). There are 37 species of mites known to feed on vegetables. Among these, tetranychids are important ones attacking the brinjal, *viz.*, *Tetranychus cinnabarinus* (Boisduval) (=urticae Koch), *T. neocaledonicus* Andre, *T. ludeni* Zacher and *T. macfarlanei* Baker and Pritchard (Gupta, 1991).

Spider mite belongs to the family Tetranychidae which comprises of more than 1270 spider mite species under

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95 genera and two subfamilies, Bryobinae and Tetranychinae (Zeity, 2015). Members of this family range in size from 0.20 to 0.90 mm are soft bodied and brightly coloured (red, green, yellow and orange). These mites are called spider mites because member species in the subfamily, Tetranychinae produces silk from glands which opens on the tarsus of pedipalps. Division of tetranychids into subfamilies, tribes and genera is mainly based on the empodial character (structure located between the tarsi) of females. The shape of male aedeagus, chaetotaxy of legs, shape of peritreme and shape of structure(s) on the palpal tarsus (used for spinning web) are taxonomically important characters (Zeity, 2015).

The two spotted spider mite, *T. urtiace* has a worldwide distribution. This most abundant species may be species complex because of its distinct population with variation in biological attributes. In view of global importance of Tetranychidae mite family, "Spider Mites Web" is provides comprehensive current information on every documented species under Tetranychidae including taxonomy, distribution, host plants, reference literature since 1758 *etc*. (Migeon *et al.,* 2010).

Many reports indicates that mites suck the sap usually from the lower surface of leaves producing small white specks, which gradually dry and drop off. The decreased vitality and leaf drop adversely affect plant growth, flowering and fruiting. In sever infestation, tetranychid mites web profusely and may form a thick sheath of webbing that covers the entire plant (Grandjean, 1948 and Jeppson *et al.,* 1975). These webs become filled with soil particles in windy weather and inhibit the photosynthetic activity of the plant. Thus the mite has been proved as an indirect pest causing loss in quality and quantity of the yield (Butani and Mittal, 1992). To manage mites whitefly and thrips on Chilli Neem oil @ 1.5 ml/L water, Omite 57 EC @ 2.0 ml/L water, Vertimec 018 EC @ 1.25 ml/L water, Liquor 1.8 EC @ 2.0 ml/L water and Confidor 20% SL @ 1.5 ml/L water were applied The efficacy of the botanical and synthetic pesticide reduced the abundance of mite, thrips , whiteflies and Omite showed the lowest abundance of mite (Nasrin *et al.,* 2021).

This study was undertaken to survey the status of phytophagous mites and associated natural enemies in brinjal ecosystem of brinjal growers field along with to develop economically feasible management strategy.

METHODS AND MATERIALS

This research work was carried on in Post Graduate College of Agriculture, Dr Rajendra Prasad Central Agricultural University, Pusa in 2022. The survey on phytophagous mites and their natural enemies on brinjal crops was carried out in the farmers' field of Chandauli, Harpur, Naranyanpur and Gopalpur Thara village of Samastipur and Lautan, Mirapur, Ittha and Muraul village of Muzaffarpur district at fortnightly interval from January to June 2022. Total 31 farmers' brinjal field were surveyed. During the survey the brinjal crops frequently produced in these regions were found infested by phytophagous mites and their leaf samples were collected for further study. In each field, 5 plants were randomly chosen for sampling and six leaves (2 from upper, 2 from middle and 2 from bottom) were plucked to examine the presence of mites with the help of hand lens (20×). The mite infested leaves collected in polythene bags separately with labels indicating the host, date and village name. These samples were brought to the laboratory and numbers of mites were counted in 2.5 cm^2 leaf area under stereoscopic microscope in the Department of Entomology, RPCAU, Pusa. The predatory phytoseiid mites which are fast moving in nature and of bigger size were collected directly from the plant with the help of fine camel hair brush and then preserved in 70% alcohol. The arthropods were collected using net, counted and photographed. Mites from the samples were individually removed using a fine brush and observed under a stereo-binocular microscope before being transferred to glass vials with 70% alcohol. The different phytophagous mites were identified with the help of key given by Krantz and Walter (2009).

The effectiveness of different acaricides against the phytophagous mites on brinjal crop was evaluated in a field trial during the crop period of summer 2022. Seedlings of Kashi Taru variety of brinjal crops were grown in the nursery of the Birauli Farm, KVK. In the first week of January 2022, healthy 40 days seedlings having uniform development were transplanted into the main field with a spacing of 75 cm × 60 cm and a shallow depth of 2 to 2.5 cm in 2 × 3 meters plot. The first spray was done at the flowering stage and after 14 days interval second spray was done. One day prior to spraying, observations were made along with 1, 3, 7 and 14 days after spray. Seedlings of Kashi Taru variety of brinjal crops was grown in the nursery of the Birauli Farm, KVK and 45 days old seedlings were transplanted in RBD at a plant spacing of 75 cm × 60 cm and grown following all the recommended agronomic practices. Knapsack sprayer was used in spraying and the six acaricides, including the control plot (water), were first sprayed in the month of June when the population of mites was highest and cloth fabric screen were utilized to prevent drifting of spray from one plot to other. Thirty leaves from each plot, or six leaves from the tagged plant's upper, middle and lower portions, were collected and placed in polythene bags for laboratory counting. The total mite population was counted from four different area on 2.5 cm^2 each using a stereo binocular microscope. The mite population was counted before and after treatment at 1, 3, 7 and 14 days after spraying and the percentage of population reduction was calculated.

Before analysing variance to determine the treatment impact, the per cent reduction values were converted to arc sine values and C.D. To determine the importance of the differences between the treatments, C.D. was used at a 5% level of significance.

RESULTS AND DISCUSSION

In the Samastipur district, four villages were surveyed *viz.,* Chandauli, Gopalpur Thara, Harpur and Narayanpur. Besides, the other district covered was Muzaffarpur, where also four villages, *viz.,* Lautan, Muraul, Mirapur and Ittha, were surveyed. Among the four villages surveyed in Samastipur district, a maximum of 26.21 tetranychid mites/ 2.5 square cm area of leaf was observed in Harpur followed by Gopalpur Thara (24.25 mites/2.5 square cm area of leaf), Chandauli (17.54 mites/2.5 square cm area of leaf) and Narayanpur (16.11 mites/2.5 square cm area of leaf). In the case of natural enemies (predatory insects), Chadauli village registered the largest number of natural enemies, where five different natural enemies were observed in each visit *viz.,* coccinellids, green lacewing, anthocorid bugs, mirid bugs and black ants, followed by Narayanpur village, where four natural enemies were observed in each visit *i.e*., chrysoperla *carnea*, anthocorid bugs, mirid bugs and black ants. The predatory mites found in all four villages were Amblyseius indicus and Amblyseius tetranychivorous (Table 1).

In Muzaffarpur district, the tetranychid mite's occurrence trend were Ittha (21.20 mites/2.5 square cm area of leaf) > Mirapur (19.52 mites/2.5 square cm area of leaf) > Lautan (15.58 mites/2.5 square cm area of leaf) > Muraul (15.10 mites/2.5 square cm area of leaf). In terms of natural enemies (predatory insects), Muraul village had the highest number of natural enemies (5 types per visit), namely green lacewing, coccinellids, anthocorid bugs, mirid bugs black ants scolothrips while Mirapur village had the lowest natural enemies (2 types per visit) *viz*., green lacewing and anthocorid bugs. In the case of predatory mites, *Amblyseius indicus* and *Amblyseius tetranychivorous* were observed in all the villages (Table 1).

This study partially concurs with that of Bala and Karmakar, (2021) who reported 1885 mite specimens from various agro-horticulture crops in the Bihar districts of Muzaffarpur, Darbhanga, Madhubani and Sitamarhi. They reported predatory mite, *Amblyseius largoensis*, in the brinjal fields and found it most common species among the others. These results unequivocally demonstrated the significance of phytoseiids in the environment of the brinjal for tetranychid mite natural control. Additionally, two phytophagous mite from the family Tetranychidae, *Tetranychus urticae* and *Eutetranychus orientalis*, were identified and considered as the main mite pest on brinjal. Choudhury *et al.* (2015) observed lady bird beetle in brinjal fields during summer season (March to August) and kumar *et al.* (2008) reported several natural enemies associated with brinjal crop. The incidence of phytophagous mites is common in farmer's brinjal field.

The initial population of tetranychid mites before the treatments ranged from 26.92 to 30 mites per leaf, which were on par with each other. At one day after spray (1 DAS), spiromesifen 240SC @ 0.8 ml/l recorded the lowest number of mites (7.32 mites/ plant), at par with chlofenapyr 10SC @ 1.5 ml/l (8.21 mites/leaf). Highest number of active

Table 1: Survey of phytophagous mites and its associated natural enemies.

District	Village	Tetranychid mites	No. of mites/2.5 square cm area of leaf	Natural enemies	
				Predatory mites	Insect predators
Samastipur	Chandauli	*Tetranychus urticae* *Tetranychus neocaeledonicus*	17.54	*Amblyseius indicus*	Coccienellids, Green lacewing, Anthocorid bugs, Mirid bugs, Black ants
	Gopalpur Thara	*T. urticae*	24.25	*A. tetranychivorous*	Coccienellids, Scolothrips, Black ants
	Narayanpur	*T. neocaeledonicus* *T. urticae*	16.11	*A. tetranychivorous*	Green lacewing, Anthocorid bugs, Mirid bugs, Black ants
	Harpur	*T. urticae*	26.21	*A. indicus*	Coccienellids, Green lacewing
Muzaffarpur	Lautan	*T. neocaedelonicus* *T. urticae*	15.58	*A. indicus*	Coccienellids, Mirid bugs, Black ants
	Muraul	*T. urticae*	15.10	*A. tetranychivorous*	Coccienellids, Green lacewing, Anthocorid bugs, Miridbugs, Black ants, Scolothrips
	Mirapur	*T. urticae*	19.52	*A. tetranychivorous*	Green lacewing, Anthocorid bugs,
	Ittha	*T. neocaeledonicus*	21.20	*A. tetranychivorous*	Coccienellids, Black ants, Scolothrips

Note 1: Sampling methods - 6 leaves per plant; 25 plants per location.

mites were found in azadirachtin 0.15 EC @ 5 ml/l treated plots at 17.27 mites per leaf, followed by propargite 57EC @ 2ml/l (15.26 mites per leaf). However, all the treatments were superior over the control plots (28.40 mites/leaf).

In azadirachtin plots highest mean mites activity was recorded at 16.80 mites/leaf followed by 13.66 mites/leaf in in fenpyroximate plots as compared to 34.06 mites/leaf in control plots and the lowest population of 5.94 mites/leaf followed by 6.55 mites/leaf was present on spiromesifen and chlofenapyr plots respectively. The highest per cent reduction over control was observed in plots treated with Spiromesifen 240 SC which was at par with hlofenpyr 10SC and Abamectin 1.9 EC *viz.*, 88.60%, 88.00% and 85.75%, respectively. The lowest percent reduction over control was observed in plots treated with Azadirachtin at 57.25%, followed by Fenpyroximate at 62.95%.

The initial population of tetranychid mites before 2nd spray ranged between 8.24 to 34.83 mites/leaf (Table 2). The highest mean mites activity was observed in azadirachtin plots at 15.49 mites/leaf, followed by fenpyroximate treated plot at 7.39 mites/leaf and the least number of mites on average was observed in spiromesifen plots at 3.69 mites/leaf, followed by chlofenapyr treated plot at 5.29 mites/leaf, as compared to control plots at 44.87 mites/leaf. The highest percent reduction over control was observed in plots treated with spiromesifen at par with chlofenpyr followed by abamectin, *viz.*, 85.09%, 83.02% and 79.03%, respectively. The lowest percent reduction over control was observed in plots treated with azadirachtin at 64.92%, followed by fenpyroximate at 69.06%.

The present study was comparable with Patel and Patel, 2017 reporting most efficient treatments for mites both fenazaquin 0.01% and spiromesifen 0.02% as spiromesifen 0.02% (37.91 tonnes/ha) and fenazaquin 0.01% (36.95 tonnes/ha) resulted in better fruit yields and fenazaquin recording the lowest percentage of preventable losses (2.52%), followed by diafenthiuron 0.05% (11.76%). Kavya *et al.* (2015) tested different acaricide against *T. urticae* reported that within three days of application, propargite (0.78 mites/leaf) and spiromesifen (1.05 mites/leaf) considerably reduced the overall mite population more than other acaricides resulting in a proportional increase in fruit output. They also mentioned predatory mite population was safe on plots treated with buprofezin, spiromesifen and HMO, with more than 85% reductions on moving stages of *T. urticae* on cowpea. The present study was supported by the mortality caused by spiromesifen at par with abamectin as both falls under same class of insecticide. In her study Roopa (2005) reported spiromesifen (0.024%), difenthiuron (0.075%) and dicofol (0.046%) outperformed the other pesticides when it came to killing spider mites at all stages, while dimethoate (0.05%), endosulfan (0.07%), methyl demeton (0.025%), monocrotophos (0.036%) and phosalone (0.07%) were ineffective, also both spiromesifen and difenthiuron gave highest fruit yields.

Overall pooled data (Table 2) for the two sprays showed that spiromesifen 240 EC was much more effective than the other treatments at reducing the population of the mite *T. urticae*, followed by chlofenapyr 10EC. These two treatments showed the mite incidence to be much lower (4.78 to 5.92 mites/2.5 cm^2 leaf area). However, it was also determined that propargite 57EC and abamectin 1.9 EC were the next best treatments fenpyroximate 5EC was moderately effective in treating brinjal mites, with a 10.52 mite count per 2.5 cm^2 of leaf area. Moreover, the azadirachtin-treated plot recorded fewer mites per 2.5 cm^2 of leaf area (21.27) than the control plot (39.46 mites/2.5 cm^2 leaf area). Parveen *et al.* (2021) reported use of entomopathogenic fungi in the field conditions as an alternate control method in combating the insect pests and other arthropod pests as they are natural mortality agents and environmentally safe.

The current study's observation of spiromesifen's excellent effectiveness against brinjal mite is consistent with those reported by Roopa (2005), noted under laboratory and greenhouse conditions, the acaricide spiromesifen 0.02% a greater mortality of the cucumber mite, *T. urticae*.

Table 2: Effect of different acaricides against brinjal mite, *T. urticae* after two sprays.

Treatments	*Number of mites/leaf (2.5cm^2 leaf area)		
	1st spray	2nd spray	Pooled
Propargite 57% EC	9.76(3.17)	6.94(2.82)	8.35(3.05)
Spiromesifen 240% EC	5.94(2.63)	3.69(2.17)	4.86(2.41)
Fenpyroximate 5% EC	13.66(3.28)	7.39(2.90)	10.52(3.39)
Abamectin 1.9% EC	9.02(3.17)	5.91(2.63)	7.45(2.89)
Chlofenapyr 10% SC	6.55(2.75)	5.29(2.51)	5.92(2.13)
Azadirachtin 0.15% EC	16.80(4.22)	15.49(4.06)	16.15(4.02)
Control	34.06(5.92)	44.87(6.77)	39.46(5.76)
S.Em(±)	0.23	0.25	
C.D at 5%	0.25	0.33	
CV(%)	7.60	7.80	

*Figures were transformed by square root transformation.

Table 3: Effect of different acaricides on brinjal fruit yield during crop period 2022.

Treatment	Acaricides	Dose (ml /ha)	Fruit yield (t/ha)	Yield increase over control (t/ ha)	% increase over control
T1	Propargite 57% EC	1000	20.11	5.81	40.6
T2	Spiromesifen 240% EC	400	27.21	12.91	90.2
T3	Fenpyroximate 5% EC	500	18.45	4.15	29.0
T4	Abamectin 1.9% EC	400	23.14	8.84	61.8
T5	Chlofenapyr 10% EC	750	25.10	10.80	75.52
T6	Azadirachtin 0.15% EC	2500	17.20	2.9	20.27
T7	Control	-	14.30	-	

Varghese and Mathew's (2013) reported, spiromesifen 45 SC @ 100 g a.i./ha successful in lowering the number of chilli mites and Kavitha *et al.* (2006) found spiromesifen at 120 g a.i./ha to be more effective at controlling the chilli mite.

After two sprays, the yield of brinjal fruits was calculated and the results showed that the maximum output (12.91 tonnes/ha) was significantly higher than the control plot when the fruit was harvested from the plots treated with spiromesifen 240EC and 90.20% higher than the control, plot sprayed with abamectin 1.9EC was the next-highest compound with an yield of 8.84 tonnes/ha after chlofenapyr10SC (10.80 tonnes/ha). The plots sprayed with propargite 57% EC and fenpyroximate 5% EC yielded more than the control plot (5.81 and 4.15 tonnes/ha, respectively). The azadirachtin 0.15% EC treatment increased the fruits yield by 2.9 tonnes per hectare over the control plot (Table 3).

This result is consistent with Roopa's earlier study from 2005, which found that the highest fruit yields were obtained with spiromesifen 0.02% and diafenthiuron 0.05%,which gave, respectively, 240.74 and 248.97 q/ha during the second and 176.33 and 163.99 q/ha during the third season trials that the highest fruit yields were achieved with spiromesifen 0.02% and diafenthiuron 0.05%, which gave, respectively, 240.74 and 248.97 q/ha during the second and 176.33 and 163.99 q/ha during the third season trials.

CONCLUSION

In the study, two species of tetranychid mites, two species of predatory mites and seven predatory insects were recorded *viz., Tetranychus urticae*, *T. neocaedelonicus*, *Amblyseius indicus*, *A. tetranychivorous*, Coccinellids, green lacewing, Anthocorid bugs, Mirid bugs, Scolothrips and Black ants. In the Samastipur district Harpur village had the highest number of tetranychid mites' population while in Chandauli most natural enemies with maximum tetranychid mites/2.5 square cm area of leaf was observed in Harpur village. When it comes to natural enemies, Chadauli village reported the highest number of them, where five different natural enemies were observed on each visit. In Muzaffarpur, four villages, *viz.*, Lautan, Muraul, Mirapur and Ittha, were surveyed and the tetranychid mite's occurrence trend observed were Ittha (21.20 mites/2.5 square cm area of leaf) > Mirapur (19.52 mites/2.5 square cm area of 245 leaf) >Lautan (15.58 mites/2.5 square cm area of leaf leaf) >Muraul (15.10 mites/2.5 246 246 square cm area of leaf). Highest six different types of natural enemies were observed in 247 Muraul village.

The study pertaining to the efficacy of various acaricides chlofenapyr10SC and spiromesifen 240EC observed the lowest number of mites. On the other hand, the most number of active mites was present in azadirachtin 1.9EC treated plots in both the sprays. The highest per cent reduction over control was observed in plots treated with spiromesifen and the lowest per cent reduction over control was observed in plot treated with azadirachtin. The comparative order of acaricides against the phytophagous mite based on field efficacy, fruit yield and gross income over contol were as spiromesifen > chlofenapyr > abamectin > propargite > fenpyroximate > azadirachtin.

Conflict of interest

All authors declare that they have no conflicts of interest.

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