Efficacy of *Neoseiulus longispinosus* (Evans) (Mesostigmata: Phytoseiidae) for the management of *Tetranychus urticae* Koch (Prostigmata: Tetranychidae) on cucumber under protected cultivation

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ABSTRACT: Cucumber is one of the most preferred crops grown in polyhouses of Kerala. However, incidence of spider mite, *Tetranychus urticae* Koch, 1836 as emerged as an important limiting factor for cucumber cultivation in the polyhouses. Increasing concern over the abuse of acaricides for mite management in polyhouses has necessitated development of alternative strategy with emphasis on biological control. The phytoseiid mite, *Neoseiulus longispinosus* (Evans, 1952) which has a wide distribution and has the ability to adapt to warm temperatures can be a potent candidate against tetranychid mites. To identify the optimum predator: prey ratio of *N. longispinosus* to *T. urticae* for effective management of spider mites, experiments were conducted both in the laboratory as well as polyhouse using a range of ratios. In the laboratory, the experiment was carried out on excised cucumber leaves maintained on moist sponge in plastic trays. Gravid females of *N. longispinosus* were released to 100 mixed stages including eggs, nymphal stages and adults of prey on cucumber leaves at predator: prey ratios of 1:5, 1:10, 1:20, 1:25, 1:33, 1:50 and 1:100. In the polyhouse, hundred mixed stages of *T. urticae* were released on four leaf stage of twenty days old cucumber plants at the rate of 25 mites/leaf, followed by the release of gravid females of *N. longispinosus* at predator: prey ratios of 1: 20, 1: 25, 1: 33 and 1:50. Laboratory studies showed that, at ratios of 1:5 and 1:10, the prey population was significantly reduced by third day. The prey was completely eliminated by seventh and tenth day at ratios 1:5 and 1:10 respectively. Ten days after the release, the prey population at ratios, 1 20, 1:25 and 1:33 were on par with that of 1:5 and 1:10. In the polyhouse, the predator: prey ratios of 1:20 and 1:25 were significantly superior in reducing the population of *T. urticae* on cucumber. The present study has revealed the potential of the predatory mite, *N. longispinosus* as a biocontrol agent against *T. urticae* on cucumber in polyhouse.

Key words: Biocontrol agent, cucumber, polyhouse

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INTRODUCTION

The shrinking cultivable land area in Kerala due to high population and urbanization resulted in a decline in food production. With increase in living standards and purchasing power of people in the state, there is a growing demand for high quality food products. This necessitates production of high quality food in large quantities within the available area. In order to meet these demands, government has recently given thrust to hi - tech agricultural practice known as polyhouse cultivation. Cucumber, (*Cucumis sativus* L.) (Cucurbitaceae), is one of the most popular vegetable crops grown in polyhouses of Kerala. However, the incidence of insect pests and mites due to the favourable microclimate inside poses threat to the cultivation of cucumber in polyhouses. Among the various pests of cucumber in polyhouse, the two spotted spider mite, *Tetranychus urticae*

Koch, 1836 (Tetranychidae: Prostigmata) is considered to be the most destructive. Farmers routinely resort to application of synthetic acaricides for mite management in polyhouses, which results in resurgence and residue problems. However, they are becoming increasingly aware of the dangers of excessive use of chemicals inside polyhouses.

Biological control of phytophagous mites using predatory mites has been proven as a successful alternative to conventional chemical control, especially in green house crops (Gerson and Weintraub, 2006). Predatory mites of the family Phytoseiidae have been the most popular so far, as they have efficiently controlled mite pests in many crops around the world (Sabelis, 1981). The phytoseiid predator, *Neoseiulus* (=*Amblyseius*) *longispinosus* (Evans, 1952) (Mesostigmata: Phytoseiidae) has been identified as one of the most potent predator of tetranychid mite in tropics and

subtropics. It has a wide distribution and has the ability to adapt to warm temperatures inside polyhouses under South Indian conditions (Mallik *et al.,* 1998). It has been reported as an important native predator of spider mites from different agricultural ecosystems across the India (Arbabi and Singh, 2008; Thakur and Dinabandhoo, 2005; Karmakar and Gupta, 2010). Binisha and Bhaskar (2013) documented the predatory mite fauna in the vegetable ecosystems of Kerala and reported *N. longispinosus* as one of the predominant predatory mite species. It was also found associated with the tetranychid mites on cucumber in Thrissur district, Kerala (Maheswary, 2015).

Biological control of spider mites using predators in polyhouses though had proven successful in several states, has not yet been exploited in Kerala. In this context, a study was conducted to evaluate the performance of *N. longispinosus* for the biological control of *T. urticae* infesting cucumber, the predominant vegetable grown under protected cultivation in Kerala.

MATERIALS AND METHODS

In order to recommend *Neoseiulus longispinosus* for field application, the optimum number of predators required for controlling the prey mites need to be standardized. To estimate the optimum predator: prey ratio, experiments were conducted separately in the laboratory as well as in polyhouse conditions.

The experiment to estimate the optimum predator: prey ratio was laid out in a completely randomized design by maintaining eight treatments and three replications in the Acarology laboratory, AINPAA, KAU Centre, Thrissur during November, 2015 under the controlled laboratory conditions (Temperature 28.45 ± 0.63ºC; relative humidity 69.79 ± 5.99%). Hundred mixed stages of *Tetranychus urticae* were released on cucumber leaves maintained on moist sponge in plastic trays (40×28 cm^2). To prevent the movement of mites among the leaves in a tray, a thin lining of wet cotton was provided all around the leaf margin. Using a moist hair brush, gravid females of *N. longispinosus* were released to at densities of 1, 2, 3, 4, 5, 10 and 20, separately. Cucumber leaf with hundred mixed stages of the prey without predator served as control. The number of eggs and active stages of both the prey and the predator was counted on 3rd, 7th and 10th day after release of the predator. The data were subjected to one way ANOVA and the means were compared using CD at 1% level of significance.

An experiment was conducted to evaluate the efficacy of *N. longispinosus* against *T. urticae* at four different predator: prey ratio (1:20, 1:25, 1:33 and 1:50) on cucumber (Variety Hilton) in the polyhouse of AINPAA during March to May, 2016. The crop was raised in the polyhouse as per the package of practices recommendations (KAU, 2014) at spacing of 60×30 cm in plots of 1.6×1.3 m. The experiment was laid out in completely randomized design with five treatments and four replications. Hundred mixed stages of *T. urticae* were released on four leaves of twenty days old cucumber plants at the rate of 25 mites/leaf. This was followed by the release of gravid females of *N. longispinosus* at densities of five, four, three and two to obtain predator: prey ratios of 1:20, 1:25, 1:33 and 1:50. A control treatment was maintained without the release of the predatory mite. Fifteen days after the first release, a second release of the predator was done at the same density. Observations were recorded on mite population on 5, 10 and 15 days after the first and second release of the predator. The mite counts were recorded from three randomly selected mite infested leaves per plant. The number of mites/cm^2 leaf area was recorded *in situ* from five loci/leaf using a hand lens of $10 \times$ magnification and average number of mites/cm^2 leaf area was derived. The obtained data on average number of mites per leaf were subjected to square root transformation and analyzed by using one way ANOVA.

RESULTS AND DISCUSSION

The results of the experiment to estimate the optimum predator: prey ratio of *Neoseiulus longispinosus* to *Tetranychus urticae* in laboratory are presented in Table 1.Three days after the release of the predator, the mean number of prey mites recorded were 277.00, 230.67, 282.67, 243.66, 262.33, 49.00 and 5.67 at predator densities of 1, 2, 3, 4, 5, 10 and 20, respectively whereas, in the control 609.00 prey mites were recorded on the third day. On third day after the release of the predatory mites 8.33, 9.00, 26.00, 23.67, 34.67, 23.67 and 96.33 predatory mites were recorded at prey densities of 1, 2, 3, 4, 5, 10 and 20, respectively.

On seventh day, 398.67, 182.67, 148.00, 161.66, 127.33 and 1.33 prey mites were recorded at the predator densities of 1, 2, 3, 4, 5 and 10, respectively. The predatory mite count recorded on the same day was 33.00, 31.67, 45.00, 68.33, 85.33 and 39.33, respectively. At a release rate of 20 predators for 100 prey mites, no prey and predator were recorded in the experimental arena on the seventh day, whereas in control, 756.00 prey mites were recorded. A drastic reduction in the number of prey mites was recorded in all the treatments after ten days of predator release. At predator densities of 1, 2, 3, 4 and 5, prey mite counts recorded were 171.00, 45.00, 17.33, 6.33 and 2.66, respectively. However, at densities of 10 and 20, no any prey mites were observed. In control, 561.00 prey mites were recorded on tenth day. The predators recorded a population of 67.33, 35.33, 41.33, 47.33, 67.00 and 23.66 at densities of 1, 2, 3, 4, 5 and 10, respectively.

Table 1. **Influence of predator: prey ratio on the population of *Tetranychus urticae* and *Neoseiulus longispinosus* on cucumber (*in vitro* study)**

Predato: prey ratio	No. of predators released/100 prey	*No. of prey			*No. of predator		
		3rd day	7th day	10th day	3rd day	7th day	10th day
1: 100	1	277.00[b] (16.65)	398.67[b] (19.97)	171.00[b] (13.09)	8.33[d] (2.97)	33.00[cd] (5.78)	67.33[a] (8.23)
1: 50	2	230.67[b] (15.20)	182.67[c] (13.53)	45.00[c] (6.74)	9.00[d] (3.08)	31.67[cd] (5.67)	35.33[d] (5.98)
1: 33	3	282.67[b] (16.82)	148.00[cd] (12.18)	17.33[d] (4.22)	26.00[c] (5.14)	45.00[c] (6.74)	41.33[c] (6.46)
1: 25	4	243.66[b] (15.62)	161.66[cd] (12.73)	6.33[d] (2.61)	23.67[c] (4.91)	68.33[b] (8.29)	47.33[b] (6.91)
1: 20	5	262.33b[b] (16.21)	127.33[d] (11.30)	2.66[d] (1.77)	34.67[b] (5.93)	85.33[a] (9.26)	67.00[a] (8.21)
1: 10	10	49.00[c] (7.03)	1.33[e] (1.35)	0.00[d] (0.70)	23.67[c] (4.91)	39.33[c] (6.31)	23.66[e] (4.91)
1: 5	20	5.67[c] (2.48)	0.00[e] (0.70)	0.00[d] (0.70)	96.33[a] (9.84)	0.00 (0.70)	0.00 (0.70)
Control		609.00[a] (24.68)	756.00[a] (27.50)	561.00[a] (16.65)	-	-	-
CD (1%)		78.88	38.25	25.91	5.01	8.55	4.85

*Mean of three observations
DAR –Days after Release
Figures followed by the same alphabets did not differ significantly (P=0.01)
Figures in parentheses are square root transformed values

To optimize the optimum predator: prey ratio of *N. longispinosus* to *T. urticae* required for effective suppression of spider mites in the polyhouse conditions, predators were released at four different predator: prey ratios of 1:20, 1:25, 1:33 and 1:50 on cucumber plant. The population of *T. urticae* at different predator and prey ratio on 5, 10 and 15 days after first and second release of the predator on cucumber is furnished in Table 2.

The prey counts at five days after the first release of the predator were significantly lower at the ratios of 1:20 (1.86 mites/cm²) and 1:25 (1.91 mites/cm²) without any significant difference among the treatment. However, the prey population recorded at 1:33 (4.21 mites/cm²) was significantly higher compared to 1:50 (3.34 mites/cm²). In the control, an average of 8.24 prey mites per cm² was recorded.

The prey count at ten days after the first release of the predator were significantly lower at the ratios of 1:20 (3.36 mites/cm²) and 1:25 (3.31 mites/cm²) indicating no significant difference in the treatment. The prey mite count at the ratios 1:33 (4.83 mites/cm²) and 1:50 (4.81 mites/cm²) were showed almost similar population of prey mites. However, prey mite count in the control was 12.89 mites per cm² leaf area which was significantly higher than all other treatments.

Table 2. **Influence of predator: prey ratio on the population of *Tetranychus urticae* on cucumber in polyhouse after the release of predator**

Predator: prey ratio (No. of predators/100 prey)	*No. of prey mites/ cm²					
	First release			Second release		
	5DAR	10 DAR	15 DAR	5DAR	10 DAR	15 DAR
1:20 (5)	1.86[d] (1.53)	3.36[c] (1.96)	4.99[d] (2.34)	3.53[d] (2.00)	2.32[d] (1.67)	1.03[d] (1.23)
1:25 (4)	1.91[d] (1.55)	3.31[c] (1.95)	5.61[d] (2.47)	3.96[d] (2.11)	2.38[d] (1.69)	1.11[d] (1.26)
1:33 (3)	4.21[b] (2.17)	4.83[b] (2.30)	11.12[c] (3.40)	6.93[c] (2.72)	8.33[c] (2.97)	7.14[c] (2.76)
1:50 (2)	3.34[c] (1.95)	4.81[b] (2.30)	12.05[b] (3.54)	7.67[b] (2.85)	11.37[b] (3.44)	9.92[b] (3.22)
Control (0)	8.24[a] (2.95)	12.89[a] (3.65)	13.86[a] (3.78)	15.36[a] (3.98)	19.79[a] (4.50)	20.60[a] (4.59)
CD (1%)	0.44	0.82	0.88	0.58	0.54	0.60

*Mean of 45 observations (All life stages)
DAR –Days after Release
Figures followed by the same alphabets did not differ significantly (P=0.01)
Figures in parentheses are square root transformed values

On fifteenth day after the first release of the predator, 4.99 and 5.61 prey mites were recorded per cm² leaf area at the ratios 1:20 and 1:25 showed similar rate of predation

by *N. longispinosus*. The ratio of 1:33 (11.12 mites/cm²) recorded significantly higher prey mite population compared to the ratio 1:50 (12.05 mites/cm²). However, all these ratios were significantly superior to the control (13.86 mites/cm²) in reducing prey the mite population.

Five days after the second release of the predator *N. longispinosus*, 3.53 and 3.96 prey mites were recorded per cm² leaf area at ratios of 1:20 and 1:25, respectively. These ratios were found to be significantly superior to other treatments. At ratios of 1:33 and 1: 50, 6.93 and 7.67 prey mites were recorded per cm² leaf area, respectively. A lower prey population was recorded at the ratio 1:33 compared to the ratio of 1:50. However, in the control, significantly higher prey count of 15.36 mites per cm² leaf area were recorded.

Ten days after the second release of the predator, significantly lower prey mite populations were recorded in 1:20 (2.32 mites/cm²) and 1:25 (2.38 mites/cm²). This was followed by the ratios of 1:33 (8.33 mites/cm²) and 1:50 (11.37 mites/cm²) which differed from each other significantly. In the control, 19.79 mites per cm² leaf area were recorded.

Significant reduction in prey mite population was recorded fifteen days after the second release of the predator with a record of 1.03 and 1.11 mites per cm² leaf area at ratios of 1:20 and 1:25, respectively. These ratios were found to be significantly superior to other ratios. Fifteen days after the second release, 7.14 prey mites/cm² was recorded in the ratio 1:33 which were superior to the mite count at 1: 50 (9.92 mites/cm²). In the control, significantly higher mite count of 20.60 was recorded.

The present study indicated that at a narrower predator: prey ratio of 1:5 and 1:10, the predator could eliminate the prey population in seven and ten days, respectively. However, at these ratios, a drastic decline in the predator population was also noticed, probably due to the insufficiency of food to sustain the predator population (Fig. 1). At wider ratios (1:20 to 1:100), total elimination of prey population could not be effected up to ten days after predator release. At a narrow predator:prey ratio, the predator density is higher than that at a wider ratio and at higher predator density faster elimination of prey population is expected. Considerable reduction in prey population after the release of predator at narrow predator:prey ratio might have hindered the development of predator due to the non availability of prey. This might the reason for the drastic reduction in predator population from seventh day onwards at the lower ratios. On the tenth day, though the prey population was not completely eliminated at the ratios 1:20, 1:25 and 1:33, there was a significant reduction in the prey population. The predator population was also available in good numbers. Hence it
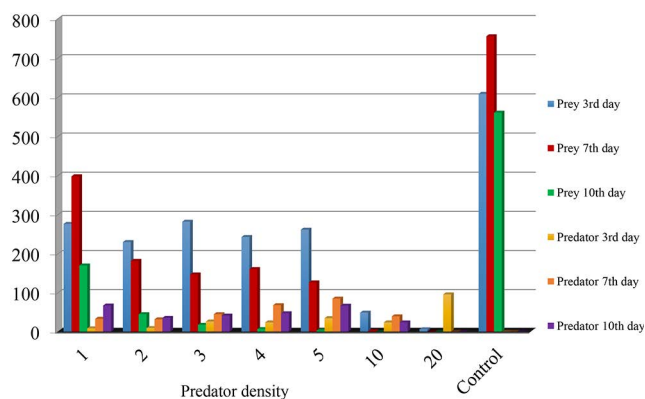

Fig 1. **Influence of predator: prey ratio on the population build up of *Tetranychus urticae* and *Neoseiulus longispinosus* on cucumber in the laboratory**
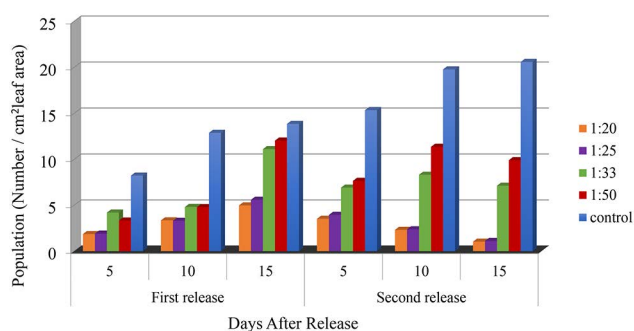

Fig. 2. **Influence of predator: prey ratio on the population of *Tetranychus urticae* on cucumber in polyhouse condition.**

is expected that the predators would consume the available prey mite and bring about further reduction in population. The ratios between 1:20 and 1:33 are found ideal as indicated by the present study. Studies by Kongchuensin *et al.* (2006) showed that the optimum predator prey ratio effective in the field was 1:20 - 1:40. The results of Rahman *et al.* (2012 a) also indicated 1:33 and 1:50 as the best ratios in the laboratory for *N. longispinosus* on *Oligonychus coffeae*.

In the present study though narrow ratios were found to be effective and fast in controlling the prey mites, it is not economically viable to use predators at high densities for biocontrol programme in the field. In the polyhouse, the best predator:prey ratio identified were 1:20 and 1:25 to suppress the pest population (Fig. 2). Fifteen days after the second release of the predator, a considerable reduction in prey mite population was effected at these ratios. There was also an increase in predator population at ratios of 1:20 and 1:25. Further reduction in population of *T. urticae* is expected on cucumber in polyhouse by the action of these predators. Greenhouse studies conducted by Rahman *et al.* (2012 a) revealed 1:25 as a suitable predator prey ratio to suppress *O. coffeae* on tea by *N. longispinosus*. Rajashekharappa (2010) also suggested ratios of 1:25 or lower as the effective and

economical to control spider mites on rose and carnation.

The present study suggests that predatory mite, *N. longispinosus* can be an efficient biocontrol agent against spider mites due to several positive traits identified in the biology and predation efficiency. The predator completes its life cycle in a span as short as 4.2 days for females and 3.91 day for males compared to the longer duration of 6.75 and 7.15 days for male and female *T. urticae*, respectively. Female biased sex ratio (1:3.31) and longer oviposition period (19.91 days) along with shorter life cycle in *N. longispinosus* would result in faster multiplication of the predator. In addition, longer life span of the adults of *N. longispinosus* (19.66 days for male and 22.75 days for female) would influence the predation efficiency as the study revealed that adults are more potent than nymphal stages. Also the preference shown by *N. longispinosus* towards the egg stage of the prey would help prevent the proliferation of the pest, thereby bringing about effective management. Above all, the density dependant nature of the prey predator relationship, brought out in the present study could provide a platform for viable biocontrol strategy based on *N. longispinosus* for management of spider mites under protected cultivation in Kerala.

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