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Interaction between predatory mite, *Amblyseious alstoniae* Gupta (Acari : phytoseiidae) and yellow mite, *Polyphagotarsonemus latus* Banks (Acari: tarsonemidae)

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ABSTRACT

An experiment was carried out under polyhouse to investigate the interaction between the predatory mite, *A. alstoniae* and the prey, *P. latus*. It was found that at 1:10 ratio, *A. alstoniae* caused maximum reduction of *P. latus*. The predatory mite preferred to feed more upon eggs as compared to other mobile stages. It was also found that once the population of the prey *P. latus* was reduced, the population of predatory mite also declined.

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INTRODUCTION

Mites are microscopic and tiny creature, belonging to order Actenidida (Prostigmata), subclass Acari of the class Arachnida. They are biologically the most diverse and dominant group with worldwide distribution (Chillar *et al.*, 2007) and inhabiting on all types of terrestrial (plants, mountains, deserts, plains, pastures) and aquatic habitats (oceans, rivers, springs, streams, lakes, etc). Among the plant feeding mites the yellow mite, *Polyphagotarsonemus latus* (Banks) (Acari: Tarsonemidae), is a serious pest of several greenhouse crops worldwide, including pepper, cucumber and egg plants (Gerson, 1992 and Palevsky *et al.*, 2001). Because of their small size (0.1-0.3 mm long), broad mites are not initially noticed in crops, but are detected when plants show damage symptoms (Venzon *et al.*, 2008). Yellow mites attack young, growing plant parts and oviposit on the undersides of leaf surfaces (Gibson and Valenchia, 1978). In the recent past, the incidence of yellow mite on various vegetables, flowers and green house crops is severe in different parts of Gujarat and India, causing puckering of leaves, reddening and stunted growth (Hosamani *et al.*, 2009). Many pesticides were also tested against this pest but the problem of *P. latus* persists continuously. It was, therefore, felt necessary to study some biological control options of *P. latus* under polyhouse. A number of phytoseiid mites, such as *Neoseiulus californicus* (McGregor) and *Neoseiulus barkeri* (Hughes) have been described to offer good

control of *P. latus* in various parts of world (Fan and Petitt, 1994 and Pena and Osborne, 1996). *Neoseiulus cucumeris* (Oudemans) was also described to control broad mites on peppers when releasing individuals on each plant or every other plant (Weintraub *et al*., 2003). However, yellow mite is still one of the major pests on vegetables, flowers and greenhouse crops. This is mainly due to high temperatures and low humidity during summers in this region and the prevalence of whiteflies, the vector of yellow mites (Parker and Gerson, 1994). Considering the importance of *P. latus* as a serious pest of different crops, experiment was undertaken to know the interaction between *P. latus* and one of the commonly found predatory mite, *Amblyseius alstoniae* Gupta. Therefore, the present study was undertaken to know the interaction between the predatory and prey mite under the polyhouse condition.

MATERIAL AND METHODS

The details of the present study were as:

Nucleus culture of phytoseiid mite, *A. alstoniae*:

The field collected adults of phytoseiid mite, *A. alstoniae* was brought to the laboratory and these adults were sexed and released in the pair on french bean leaves already infested by *T. urticae*. After 48 hours, the eggs laid by the pairs were collected and placed separately and reared on french bean leaves already infested by *P. latus.* The adults thus, obtained were released and placed for mating and the next progeny obtained from this culture were used for further experiment.

Laboratory culture of prey mite, *P. latus*:

The laboratory culture of yellow mite, *P. latus* was maintained on french bean leaves as well as on potted plants of french bean in Polycarbonate house. In case of laboratory culture, the leaf bit method was used. In this a leaf bit of 2 cm^2 was placed on a cotton swab already saturated with the water for maintaining the turgidity of the leaves. The gravid females were placed on these leaf bits singly and after 24-hours these females were removed from these leaf bits. The eggs thus, laid by these females were used for the further multiplication and experiment.

Interaction between *A. alstoniae* and *P. latus*:

The role of phytoseiid predator in regulating the population of yellow mite has not been well documented. Therefore, the efforts were made to assess the capacity of the predator to control yellow mite, *P. latus* on frenchbean. The interaction between predator and prey were carried out under polyhouse condition following at predator- prey ratio of 1: 10, 1: 20, 1: 30 and 1: 50 along with predator free plants (Control). First the gravid female of prey was released on upper leaf region of the frenchbean 10-12 days prior to the release of predator so that sufficient numbers of prey were present on the leaf before the release of predator. The gravid female of *A. alstoniae* then was released on the upper leaf of frenchbean. The predatory mites were released on top leaves of Frenchbean as per the ratios mentioned above. Three leaves from each plant were sampled and observations on predator and prey mites were recorded before the release and 4, 8, 12, 16, 20, 24, 28 and 32 days after release. The lead samples were collected in separate polythene bags and brought to the Acarology laboratory and the observations on eggs, nymphs and adult stages of both prey and predators were recorded.

RESULTS AND DISCUSSION

The interaction between predator and prey mite was presented under the following headings:

Eggs:

During the year 2014-15, before release of the gravid female of *A. alstoniae,* the number of eggs of *P. latus* was 20.75 per leaf at the ratio 1:10 and the prey elimination was observed on 24 DAR, at 1:20 ratio prey elimination was observed at 28 DAR, while, at 1:30 ratio the prey elimination was observed at 32 DAR (Table 1). Initial numbers of eggs at ratio 1:40 and 1:50 were 21.75 per leaf and 21.50 per leaf, respectively which were reduced to 8.25 per leaf and 11.00 per leaf, respectively on 32 DAR. In year 2015-16, the initial number of eggs at the ratio 1:10 was 101.00 per leaf and the prey elimination was noticed after 28 DAR while, at 1:20 and 1:30 ratio the prey elimination was observed after 28 and 32 DAR, respectively. In case of predator : prey ratios 1:40 and 1:50 the initial number of eggs of *P. latus* were 25.75 and 25.75 per leaf, respectively which was reduced to 7.50 and 11.25 per leaf, respectively (Table 1). Pooled analysis over two years revealed that interaction (Y x T) between year of observation (Y) and treatment (T) was found to be non significant exhibiting similar response of the predator to

prey over years (Table 2). At predator : prey ratio 1:10 the initial number of eggs of *P. latus* before release of predator was 23.12 per leaf where prey elimination was observed at 28 DAR while, at ratios 1:20 and 1:30 prey elimination was observed at 28 and 32 DAR, respectively. While, at ratios 1:40 and 1:50 the initial number of eggs were 23.75 and 23.63 per leaf, respectively, which was reduced to 7.88 and 11.13 per

Table 1: Interaction of *A. alstoniae* with *P. latus* (Eggs)

Ratio	2014-15								
	Pre-treatment	4 DAR	8 DAR	12 DAR	16 DAR	20 DAR	24 DAR	28 DAR	32 DAR
1:10	20.75(4.55)	17.75(4.21)	13.75(3.71)	10.50(3.24)	6.75(2.59)	3.50(1.87)	0.00(0.71)	0.00(0.71)	0.00(0.71)
1:20	21.25(4.61)	20.25(4.50)	15.75(3.97)	13.75(3.71)	10.75(3.28)	8.50(2.91)	2.50(1.73)	0.00(0.71)	0.00(0.71)
1:30	20.75(4.55)	20.00(4.47)	18.00(4.24)	16.00(4.00)	14.00(3.74)	14.25(3.77)	7.75(2.87)	6.50(2.64)	0.00(0.71)
1:40	21.75(4.66)	21.50(4.64)	20.50(4.53)	19.00(4.36)	17.50(4.18)	15.25(3.90)	12.00(3.53)	10.50(3.31)	8.25(2.95)
1:50	21.50(4.64)	21.75(4.66)	21.50(4.64)	20.50(4.53)	19.75(4.44)	17.75(4.21)	15.25(3.97)	13.00(3.97)	11.00(3.39)
Control	21.50(4.64)	21.50(4.64)	22.00(4.69)	21.50(4.64)	22.00(4.69)	21.75(4.66)	21.75(4.72)	22.00(4.72)	21.50(4.69)
S.E.±	0.043	0.061	0.051	0.052	0.076	0.081	0.065	0.069	0.050
C.D. (P=0.05)	0.121	0.174	0.144	0.149	0.217	0.231	0.185	0.196	0.142
C.V. (%)	1.846	2.708	2.358	2.575	3.995	4.564	4.452	5.244	4.552
	2015-16								
1:10	25.50(5.05)	22.25(4.72)	17.75(4.21)	13.25(3.64)	10.00(3.16)	6.00(2.45)	0.50(0.97)	0.00(0.80)	0.00(0.73)
1:20	25.50(5.05)	23.75(4.87)	21.00(4.58)	15.50(3.94)	14.00(3.74)	12.25(3.49)	5.00(2.33)	0.00(0.80)	0.00(0.73)
1:30	25.75(5.07)	25.25(5.02)	23.50(4.84)	18.75(4.33)	17.25(4.15)	15.75(3.97)	12.25(3.57)	9.50(3.06)	0.00(0.73)
1:40	25.75(5.07)	25.25(5.02)	24.75(4.98)	22.25(4.72)	21.00(4.58)	18.25(4.27)	14.75(3.90)	12.25(3.57)	7.50(2.92)
1:50	25.75(5.07)	25.25(5.02)	25.50(5.05)	24.00(4.90)	23.25(4.82)	21.75(4.66)	19.75(4.50)	16.50(4.05)	11.25(3.43)
Control	25.75(5.07)	25.75(5.07)	25.75(5.08)	25.25(5.02)	25.00(5.00)	25.50(5.05)	25.00(5.05)	25.25(5.05)	25.25(4.90)
S.E.±	0.026	0.035	0.037	0.040	0.050	0.083	0.095	0.057	0.022
C.D. (P=0.05)	0.074	0.098	0.104	0.114	0.142	0.237	0.270	0.162	0.062
C.V.(%)	1.030	1.394	1.526	1.811	2.357	4.187	5.614	3.935	1.951

Table 2: Interaction of *A. alstoniae* with *P. latus* (Egg)

Ratio		Pooled								
		Pre-treatment	4 DAR	8 DAR	12 DAR	16 DAR	20 DAR	24 DAR	28 DAR	32 DAR
1:10		23.13(4.80)	20.00(4.46)	15.75(3.96)	11.88(3.44)	8.38 (2.88)	4.75(2.16)	0.25(0.84)	0.00(0.76)	0.00(0.72)
1:20		23.38(4.83)	22.00(4.69)	18.38(4.27)	14.63(3.82)	12.38(3.51)	10.38(3.20)	3.75(2.03)	0.00(0.76)	0.00(0.72)
1:30		23.25(4.81)	22.63(4.75)	20.75(4.54)	17.38(4.16)	15.63(3.95)	15.00(3.87)	10.00(3.22)	8.00(2.85)	0.00(0.72)
1:40		23.75(4.87)	23.38(4.83)	22.63(4.75)	20.63(4.54)	19.25(4.38)	16.75(4.09)	13.38(3.72)	11.38(3.44)	7.88(2.94)
1:50		23.63(4.86)	23.50(4.84)	23.50(4.85)	22.25(4.71)	21.50(4.63)	19.75(4.44)	17.50(4.23)	14.75(3.86)	11.13(3.41)
Control		23.63(4.86)	23.63(4.85)	23.88(4.88)	23.38(4.83)	23.50(4.84)	23.63(4.86)	23.38(4.88)	23.63(4.90)	23.38(4.80)
Y	S.E.±	0.014	0.020	0.018	0.019	0.026	0.034	0.033	0.026	0.016
	C.D. (P=0.05)	0.041	0.058	0.051	0.054	0.075	0.095	0.094	0.073	0.045
T	S.E.±	0.025	0.035	0.031	0.033	0.046	0.058	0.058	0.045	0.027
	C.D. (P=0.05)	0.071	0.100	0.089	0.094	0.130	0.165	0.164	0.127	0.077
Y x T	S.E.±	0.035	0.050	0.044	0.047	0.065	0.082	0.081	0.063	0.039
	C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
	C.V. (%)	1.46	2.098	1.945	2.197	3.200	4.365	5.165	4.580	3.475

Figures in the parentheses are square root transformed values. DAR= Days after release NS= Non-significant

leaf, respectively after 32 DAR (Table 2).

Nymphs:

During 2014-15, the nymphal population of *P. latus* nymphs before release of predator at 1:10 ratio was 19.50 per leaf the prey elimination was achieved after 32 DAR by *A. alstoniae* (Table 3). At 1:20 ratio also prey elimination was observed at 32 DAR while at the ratios of 1:30, 1:40 and 1:50 the population of *P. latus* nymphs before release of the *A. alstoniae* was 20.25, 21.00 and 21.50 per leaf, respectively which was gradually reduced at different time intervals and reached to 2.00, 6.50 and 7.25 nymphs per leaf, respectively at 32 DAR. Similarly, in the next year 2015-16 the initial population of *P. latus* nymphs in 1:10 ratio was 19.75 per leaf and prey elimination was noticed after 32 DAR. At the ratio of 1:20 the prey elimination was achieved at 32 DAR, while at 1:30, 1:40 and 1:50 ratios initial nymph population of *P. latus* was 19.25, 20.25 and 21.00 per leaf, respectively which was reduced to 2.50, 7.00 and 7.50, respectively at 32 DAR (Table 3). Pooled data revealed that interaction (Y x T) was found non significant exhibiting similar response of predator to prey population over years (Table 4). The initial population of *P. latus* nymphs at predator: prey ratio 1:10 was 19.63 per leaf where prey elimination was observed at 32 DAR. Similarly, at 1:20 ratio also the prey elimination was noticed at 32 DAR. At 1:30, 1:40 and 1:50 ratios the initial nymphal population was 19.75, 20.63 and 21.25 per leaf, respectively which was reduced and reached to 2.25, 6.75 and 7.38 per leaf, respectively after 32 DAR.

Adult:

During the year 2014-15, the population of adult *P. latus* at predator : prey ratio of 1:10 was 15.50 per leaf before release of gravid females of *A. alstoniae* (Table 5). At this ratio the prey elimination was observed after 28 DAR whereas at 1:20 and 1:30 ratios the prey elimination was observed at 32 DAR. During the year 2015-16 the initial prey population at 1:10 ratio was 15.50 per leaf where prey elimination was observed at 28 days

Table 3: Interaction of *A. alstoniae* with *P. latus* (Nymphs)

Ratio	2014-15								
	Pre-treatment	4 DAR	8 DAR	12 DAR	16 DAR	20 DAR	24 DAR	28 DAR	32 DAR
1:10	19.50(4.42)	18.75(4.33)	15.50(3.94)	12.50(3.53)	8.50(2.91)	3.75(1.93)	2.00(1.39)	0.25(0.84)	0.00(0.71)
1:20	20.50(4.53)	20.25(4.50)	18.50(4.30)	17.00(4.12)	13.00(3.60)	8.75(2.95)	5.50(2.33)	3.00(1.86)	0.00(0.71)
1:30	20.25(4.50)	20.25(4.50)	19.75(4.44)	18.25(4.27)	15.00(3.87)	10.50(3.24)	7.75(2.78)	4.00(2.11)	2.00(1.56)
1:40	21.00(4.58)	21.25(4.61)	21.00(4.58)	20.00(4.47)	18.00(4.24)	15.50(3.94)	12.00(3.46)	9.25(3.12)	6.50(2.64)
1:50	21.50(4.64)	21.50(4.64)	21.75(4.66)	21.00(4.58)	19.75(4.44)	17.00(4.12)	13.25(3.64)	10.25(3.28)	7.25(2.78)
Control	21.50(4.64)	21.75(4.66)	22.25(4.72)	22.00(4.69)	21.75(4.66)	21.75(4.66)	20.75(4.55)	22.25(4.77)	23.50(4.90)
S.E.±	0.050	0.038	0.038	0.054	0.064	0.068	0.100	0.098	0.083
C.D. (P=0.05)	0.142	0.109	0.108	0.154	0.181	0.193	0.283	0.279	0.235
C.V. (%)	2.198	1.696	1.704	2.534	3.215	3.910	6.591	7.381	7.465
	2015-16								
1:10	19.75(4.44)	18.50(4.30)	14.50(3.81)	12.25(3.50)	8.25(2.87)	3.00(1.72)	2.00(1.39)	0.50(0.97)	0.00(0.71)
1:20	20.50(4.53)	19.00(4.36)	18.00(4.24)	16.00(4.00)	12.25(3.50)	8.00(2.83)	5.25(2.29)	3.00(1.86)	0.00(0.71)
1:30	19.25(4.39)	18.75(4.33)	18.50(4.30)	17.75(4.21)	14.75(3.84)	9.75(3.12)	7.75(2.78)	4.00(2.11)	2.50(1.73)
1:40	20.25(4.50)	20.75(4.55)	20.25(4.50)	19.50(4.42)	17.50(4.18)	14.50(3.81)	11.75(3.42)	9.75(3.20)	7.00(2.74)
1:50	21.00(4.58)	20.25(4.50)	21.00(4.58)	20.25(4.50)	18.75(4.33)	16.50(4.06)	13.00(3.60)	10.25(3.28)	7.50(2.82)
Control	20.00(4.66)	21.75(4.66)	22.25(4.72)	22.00(4.69)	21.75(4.66)	21.75(4.66)	21.25(4.61)	21.50(4.69)	23.50(4.90)
S.E.±	0.040	0.038	0.050	0.045	0.071	0.069	0.089	0.096	0.067
C.D. (P=0.05)	0.113	0.109	0.141	0.127	0.201	0.197	0.252	0.274	0.189
C.V. (%)	1.779	1.717	2.275	2.119	3.630	4.115	5.885	7.175	5.875

Table 4: Interaction of *A. alstoniae* with *P. latus* (Nymphs)

Ratio		Pooled								
		Pre treatment	4 DAR	8 DAR	12 DAR	16 DAR	20 DAR	24 DAR	28 DAR	32 DAR
1:10		19.63(4.43)	18.63(4.31)	15.00(3.87)	12.38(3.51)	8.38(2.89)	3.38(1.82)	2.00(1.39)	0.38(0.90)	0.00(0.71)
1:20		20.50(4.53)	19.63(4.43)	18.25(4.27)	16.50(4.06)	12.63(3.55)	8.38(2.89)	5.38(2.31)	3.00(1.86)	0.00(0.71)
1:30		19.75(4.44)	19.50(4.41)	19.13(4.37)	18.00(4.24)	14.88(3.86)	10.13(3.18)	7.75(2.78)	4.00(2.11)	2.25(1.65)
1:40		20.63(4.54)	21.00(4.58)	20.63(4.54)	17.50(4.06)	17.75(4.21)	15.00(3.87)	11.88(3.44)	9.50(3.16)	6.75(2.69)
1:50		21.25(4.61)	20.88(4.57)	21.38(4.62)	20.63(4.54)	19.25(4.39)	16.75(4.09)	13.13(3.62)	10.25(3.28)	7.38(2.80)
Control		20.75(4.55)	21.75(4.66)	22.25(4.72)	22.00(4.69)	21.75(4.66)	21.75(4.66)	21.00(4.58)	21.88(4.73)	23.50(4.90)
Y	S.E.±	0.018	0.016	0.018	0.020	0.027	0.028	0.039	0.040	0.031
	C.D. (P=0.05)	0.052	0.045	0.051	0.058	0.078	0.080	0.110	0.113	0.087
T	S.E.±	0.032	0.027	0.031	0.035	0.048	0.048	0.067	0.069	0.053
	C.D. (P=0.05)	0.091	0.077	0.089	0.100	0.135	0.138	0.190	0.196	0.151
Y x T	S.E.±	0.045	0.038	0.044	0.050	0.067	0.069	0.094	0.097	0.075
	C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
	C.V. (%)	2.003	1.710	2.004	2.339	3.426	4.011	6.249	7.278	6.700

Figures in the parentheses are square root transformed values. DAR= Days after release NS= Non-significant

Table 5: Interaction of *A. alstoniae* with *P. latus* (Adult)

Ratio	2014-15								
	Pre-treatment	4 DAR	8 DAR	12 DAR	16 DAR	20 DAR	24 DAR	28 DAR	32 DAR
1:10	15.50(3.94)	13.50(3.67)	11.25(3.35)	8.75(2.95)	6.50(2.55)	3.50(1.87)	1.75(1.31)	0.00(0.73)	0.00(0.71)
1:20	15.75(3.97)	14.75(3.84)	13.25(3.64)	10.25(3.20)	9.00(3.00)	9.00(3.00)	5.00(2.23)	2.25(1.59)	0.00(0.71)
1:30	15.25(3.90)	14.50(3.81)	13.50(3.67)	13.00(3.60)	12.00(3.46)	10.00(3.16)	8.00(2.83)	6.25(2.49)	0.00(0.71)
1:40	15.50(3.94)	15.00(3.87)	14.25(3.77)	13.25(3.64)	12.50(3.53)	11.00(3.31)	8.75(2.96)	6.75(2.70)	4.75(2.29)
1:50	16.00(4.00)	15.75(3.97)	15.25(3.90)	14.50(3.81)	13.75(3.70)	12.25(3.50)	9.75(3.12)	8.75(3.18)	7.75(2.87)
Control	15.75(3.97)	15.75(3.97)	15.50(3.94)	15.25(3.90)	15.50(3.94)	15.75(3.97)	15.50(3.94)	16.00(4.06)	15.75(4.03)
S.E.±	0.031	0.049	0.063	0.058	0.068	0.068	0.070	0.083	0.038
C.D. (P=0.05)	0.088	0.139	0.179	0.166	0.192	0.192	0.198	0.237	0.107
C.V. (%)	1.562	2.541	3.389	3.322	4.016	4.320	5.111	6.780	4.010
	2015-16								
1:10	15.50(3.94)	13.50(3.67)	11.75(3.43)	9.00(3.00)	5.50(2.33)	3.00(1.72)	1.50(1.22)	0.00(0.71)	0.00(0.71)
1:20	15.25(3.90)	14.00(3.74)	13.75(3.70)	11.50(3.39)	8.50(2.91)	6.75(2.63)	4.25(2.10)	1.50(1.40)	0.00(0.71)
1:30	15.50(3.94)	15.50(3.94)	14.75(3.84)	13.25(3.64)	11.50(3.39)	8.25(2.89)	5.50(2.54)	4.50(2.23)	0.00(0.71)
1:40	15.75(3.97)	15.50(3.94)	15.00(3.87)	13.50(3.67)	12.00(3.46)	9.25(3.06)	7.50(2.80)	6.50(2.64)	4.75(2.28)
1:50	15.25(3.90)	15.75(3.97)	15.50(3.94)	15.00(3.87)	14.50(3.81)	13.50(3.61)	12.75(3.31)	11.00(3.39)	8.50(3.00)
Control	15.75(3.97)	15.25(3.90)	15.50(3.94)	15.75(3.97)	15.50(3.94)	15.50(3.91)	15.75(3.91)	15.50(4.00)	15.75(4.03)
S.E.±	0.033	0.032	0.059	0.063	0.099	0.087	0.073	0.061	0.052
C.D. (P=0.05)	0.095	0.092	0.168	0.178	0.282	0.248	0.207	0.175	0.149
C.V. (%)	1.701	1.672	3.120	3.485	5.999	5.876	5.511	5.131	5.487

while, at 1:20 and 1:30 ratio the prey elimination was observed at 32 DAR. The initial population of adult *P. latus* at 1:40 and 1:50 ratios during the year 2014-15 was 15.50 and 16.00 per leaf, respectively which was reduced to 4.75 and 7.75 per leaf, respectively at 32 DAR whereas in the year 2015-16 the initial population of adult *P. latus* at 1:40 and 1:50 ratios was 15.75 and 15.25 per leaf, respectively which was reduced to 4.75 and 8.50 per leaf, respectively at 32 DAR (Table 5). Pooled data revealed that interaction (Y x T) was found non significant, exhibiting similar response of predator to prey population over years (Table 6). At 1:10 ratio the population of adult *P. latus* adults was 15.50 per leaf where in prey elimination was noticed at 28 DAR while in the case of 1:20 and 1:30 ratio the prey elimination occurred at 32 DAR. The initial population of adult prey at 1:40 and 1:50 ratios was 15.63 and 15.63 per leaf, respectively which was reduced to 4.75 and 8.13 per leaf, respectively at 32 DAR.

Total population:

During the year 2014-15 total population *i.e.* eggs + nymphs + adult of *P. latus* at 1:10 ratio before release of gravid females of *A. alstoniae* was 55.75 per leaf (Table 7). The prey elimination was recorded at 32 DAR while, in the year 2015-16, the initial population was 60.75 per leaf where the prey elimination was noticed at 32 DAR at 1:10 ratio. At 1:20 ratio during the both the years prey elimination was observed at 32 DAR. The initial population in the year 2014-15 at 1:30, 1:40 and 1:50 ratios was 56.25, 58.25 and 59.00 per leaf, respectively which was reduced to 2.00,19.50 and 26.00 per leaf, respectively at 32 DAR. Whereas, in the year 2015-16 the initial population of *P. latus* at 1:30, 1:40 and 1:50 was 60.50, 61.75 and 62.00 per leaf, respectively which was reduced to 2.50, 19.25 and 27.25 per leaf, respectively at 32 DAR (Table 7). The pooled data revealed that interaction (Y x T) was found non-significant, exhibiting similar response of predator to prey population over years (Table 8). The initial population at 1:10 ratio was 58.25 per leaf wherein prey elimination was recorded at 32 DAR. At 1:20 ratio also prey elimination was recorded at 32 DAR while, at 1:30, 1:40 and 1:50 ratios the total population of *P. latus* before release of the gravid females of *A. alstoniae* was 58.38, 60.00 and 60.50 per leaf, respectively which was gradually decreased by predator and reached to 2.25, 19.38 and 26.63 per leaf, respectively at 32 DAR. Dhooria (1981) studied the interaction between *A. alstoniae* and *E. orientalis* on citrus and found that at different predator prey ratios, *A. alstoniae* effectively reduced the prey population. Shah and Shukla (2014) reported that at 1:10 ratio, *A. longispinosus* caused

Table 6: Interaction of *A. alstoniae* with *P. latus* (Adult)

Ratio		Pooled								
		Pre-treatment	4 DAR	8 DAR	12 DAR	16 DAR	20 DAR	24 DAR	28 DAR	32 DAR
1:10		15.50(3.94)	13.50(3.67)	11.50(3.39)	8.88(2.98)	6.00(2.44)	3.25(1.79)	1.63(1.26)	0.00(0.72)	0.00(0.71)
1:20		15.50(3.94)	14.38(3.79)	13.50(3.67)	10.88(3.29)	8.75(2.95)	7.88(2.82)	4.63(2.17)	1.88(1.50)	0.00(0.71)
1:30		15.38(3.92)	15.00(3.87)	14.13(3.76)	13.13(3.62)	11.75(3.42)	9.13(3.03)	6.75(2.68)	5.38(2.36)	0.00(0.71)
1:40		15.63(3.95)	15.25(3.90)	14.63(3.82)	13.38(3.66)	12.25(3.50)	10.13(3.19)	8.13(2.88)	6.63(2.67)	4.75(2.29)
1:50		15.63(3.95)	15.75(3.97)	15.38(3.92)	14.75(3.84)	14.13(3.76)	12.88(3.55)	11.25(3.22)	9.88(3.28)	8.13(2.94)
Control		15.75(3.97)	15.50(3.94)	15.50(3.94)	15.50(3.94)	15.50(3.94)	15.63(3.94)	15.63(3.94)	15.75(4.03)	15.75(4.03)
Y	S.E.±	0.013	0.017	0.025	0.025	0.035	0.032	0.029	0.030	0.019
	C.D. (P=0.05)	0.037	0.048	0.071	0.070	0.098	0.091	0.083	0.085	0.053
T	S.E.±	0.023	0.029	0.043	0.043	0.060	0.055	0.050	0.052	0.032
	C.D. (P=0.05)	0.065	0.083	0.123	0.122	0.170	0.157	0.143	0.147	0.092
Y x T	S.E.±	0.032	0.041	0.061	0.061	0.085	0.078	0.071	0.073	0.046
	C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
	C.V. (%)	1.632	2.151	3.255	3.406	5.088	5.118	5.309	6.034	4.813

Figures in the parentheses are square root transformed values. DAR= Days after release NS= Non-significant

Table 7: Interaction of *A. alstoniae* with *P. latus* (All stages)

Ratio	Pre-treatment	4 DAR	8 DAR	12 DAR	16 DAR	20 DAR	24 DAR	28 DAR	32 DAR
				2014-15					
1:10	55.75(7.47)	50.00(7.07)	40.50(6.36)	31.75(5.63)	21.75(4.66)	10.75(3.27)	10.75(1.93)	0.25(0.84)	0.00(0.71)
1:20	57.50(7.58)	55.25(7.43)	47.50(6.89)	41.00(6.40)	32.75(5.72)	26.25(5.12)	26.25(3.60)	5.25(2.40)	0.00(0.71)
1:30	56.25(7.50)	54.75(7.40)	51.25(7.16)	47.25(6.87)	41.00(6.40)	34.75(5.89)	34.75(4.84)	16.75(4.15)	2.00(1.56)
1:40	58.25(7.63)	57.75(7.60)	55.75(7.47)	47.75(6.88)	48.00(6.93)	41.75(6.46)	41.75(5.72)	26.50(5.19)	19.50(4.47)
1:50	59.00(7.68)	59.00(7.68)	58.50(7.65)	56.00(7.48)	53.25(7.30)	47.00(6.85)	47.00(6.18)	32.00(5.70)	26.00(5.14)
Control	58.75(7.66)	59.00(7.68)	59.75(7.73)	58.75(7.66)	59.25(7.70)	59.25(7.70)	59.25(7.61)	60.25(7.79)	60.75(7.83)
S.E.±	0.043	0.056	0.051	0.154	0.079	0.078	0.106	0.100	0.083
C.D. (P=0.05)	0.121	0.160	0.146	0.439	0.224	0.223	0.303	0.284	0.235
C.V. (%)	1.125	1.509	1.424	4.526	2.443	2.668	4.274	4.602	4.857
				2015-16					
1:10	60.75(7.79)	54.25(7.37)	44.00(6.63)	34.50(5.87)	23.75(4.87)	12.00(3.46)	4.00(1.99)	0.50(0.97)	0.00(0.71)
1:20	61.25(7.83)	56.75(7.53)	52.75(7.26)	43.00(6.56)	34.75(5.89)	27.00(5.19)	14.50(3.80)	4.50(2.22)	0.00(0.71)
1:30	60.50(7.78)	59.50(7.71)	56.75(7.53)	49.75(7.05)	43.50(6.59)	33.75(5.81)	25.50(5.05)	18.00(4.30)	2.50(1.73)
1:40	61.75(7.86)	61.50(7.84)	60.00(7.75)	55.25(7.43)	50.50(7.10)	42.00(6.48)	34.00(5.83)	28.50(5.38)	19.25(4.44)
1:50	62.00(7.87)	61.25(7.83)	62.00(7.87)	59.25(7.70)	56.50(7.52)	51.75(7.19)	45.50(6.75)	37.75(6.18)	27.25(5.27)
Control	61.50(7.84)	62.75(7.92)	63.50(7.97)	63.00(7.94)	62.25(7.89)	62.75(7.92)	62.00(7.87)	62.25(7.92)	64.50(8.06)
S.E.±	0.034	0.038	0.048	0.048	0.089	0.084	0.085	0.097	0.056
C.D. (P=0.05)	0.096	0.109	0.137	0.137	0.253	0.238	0.242	0.276	0.160
C.V. (%)	0.866	0.994	1.287	1.357	2.679	2.784	3.265	4.313	3.221

Table 8: Interaction of *A. alstoniae* with *P. latus* (All Stages)

Ratio		Pre-Treatment	4 DAR	8 DAR	12 DAR	16 DAR	20 DAR	24 DAR	28 DAR	32 DAR
					Pooled					
1:10		58.25(7.63)	52.13(7.22)	42.25(6.50)	33.13(5.75)	22.75(4.76)	11.38(3.37)	3.88(1.96)	0.38(0.90)	0.00(0.71)
1:20		59.38(7.70)	56.00(7.48)	50.13(7.08)	42.00(6.48)	33.75(5.81)	26.63(5.16)	13.75(3.70)	4.88(2.31)	0.00(0.71)
1:30		58.38(7.64)	57.13(7.56)	54.00(7.35)	48.50(6.96)	42.25(6.50)	34.25(5.85)	24.50(4.95)	17.38(4.22)	2.25(1.65)
1:40		60.00(7.74)	59.63(7.72)	57.88(7.61)	51.50(7.16)	49.25(7.02)	41.88(6.47)	33.38(5.78)	27.50(5.29)	19.38(4.46)
1:50		60.50(7.78)	60.13(7.75)	60.25(7.76)	57.63(7.59)	54.88(7.41)	49.38(7.02)	41.88(6.46)	34.88(5.94)	26.63(5.21)
Control		60.13(7.75)	60.88(7.80)	61.63(7.85)	60.88(7.80)	60.75(7.79)	61.00(7.81)	60.00(7.74)	61.25(7.86)	62.63(7.94)
Y	S.E.±	0.016	0.020	0.020	0.047	0.034	0.033	0.039	0.040	0.029
	C.D. (P=0.05)	0.045	0.056	0.058	0.133	0.098	0.094	0.112	0.114	0.082
T	S.E.±	0.027	0.034	0.035	0.081	0.059	0.057	0.068	0.070	0.050
	C.D. (P=0.05)	0.077	0.097	0.100	0.230	0.169	0.163	0.194	0.198	0.142
Y x T	S.E.±	0.039	0.048	0.050	0.114	0.084	0.081	0.096	0.098	0.071
	C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
	C.V. (%)	1.000	1.270	1.355	3.287	2.567	2.728	3.781	4.455	4.102

Figures in the parentheses are square root transformed values. DAR= Days after release NS=Non-significant

maximum reduction of *T. urticae* within 20 days after release. Further, Mahendrakumar and Shukla (2016) also recorded similar results at 1:10 predator prey ratio and found *A. alstoniae* caused maximum reduction of prey mite on brinjal. Likewise Chauhan and Shukla (2016) recorded maximum reduction of *T. urticae* at 1:10 ratio within twenty days after release of predatory mite, *A. longispinosus*. Mandape *et al*. (2018) also reported the effectiveness of *A. alstoniae* against the sorghum mite, *O. indicus*. Wilson *et al*. (1983) reported that at 1:10 ratio the predatory mite, *M. occidentalis* reduced the population of tetranychid mite significantly and gave good control within two weeks. Kilincer *et al*. (1992) reported good control of *Tetranychus* sp. on rose by releasing 16, 16, 20 and 40 adults of *P. persimilis* per plant. These reports are more or less in accordance with the present research results. However, slight difference may be due to difference in the prey species, rearing technique and climatic conditions.

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