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Predator-prey interaction between *Amblyseius longispinosus* (Evans) (Acari : Phytoseiidae) and *Tetranychus macfarlanei* Baker and Pritchard (Acari : Tetranychidae)

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ABSTRACT : Interaction between the phytoseiid predator, *Amblyseius longispinosus* (Evans) and the red spider mite, *Tetranychus macfarlanei* Baker and Pritchard on cotton at ratios of 1:5, 1:10, 1:20 and 1:30 indicated that irrespective of prey ratios, the predator consumed sufficient numbers to counter the increasing prey population. The prey elimination was slightly prolonged at 1:10, 1:20 and 1:30 ratios whereas in case of 1:40 and 1:50 ratios, the prey population was not suppressed on potted cotton plants kept under green house condition, even after fifth week. The curves obtained by the functional and numerical responses between prey egg density and prey eggs destroyed and number of eggs laid by the predator, reached a plateau and the shape of the curves in both the responses is curvilinear.

KEY WORDS : *Amblyseius longispinosus*, functional and numerical responses, interaction, *Tetranychus macfarlanei*

Phytoseiid mites are the most efficient predatory mites and being easy to mass culture, are the most preferred natural enemies in biological control. Presently, a few phytoseiids are being used successfully in temperate countries against tetranychids (Chen, 1988). *Amblyseius longispinosus* (Evans) was found efficient against *Oligonychus indicus* Hirst (Manjunath, 1988) and was reported to be associated with *Tetranychus macfarlanei* (Baker and Pritchard) in Tunga Bhadra Project area (Thulsi Ram, 1991). Sandness and McMurtry (1970) studied the functional responses of *Amblyseius* spp. at different densities of *Oligonychus punicae* Hirst. Interaction studies between *A. longispinosus* and prey such as *Tetranychus urticae* Koch (Mori, 1969), *Tetranychus ludeni* Zacher (Mallik, 1974) and *O. indicus* (Manjunath, 1988; Anil, 1990) were reported earlier. The present study aims at generating information on the interaction between *A. longispinosus* and *T. macfarlanei* at different ratios under laboratory condition and also to test its efficacy under green house condition.

MATERIALS AND METHODS

Studies on the interaction between predator and prey were carried out under laboratory condition at predator prey ratios of 1:5, 1:10, 1:20, 1:30, 1:40 and 1:50. Excised cotton leaf bits were placed on wet cotton wool in petri dishes. Gravid females were released on leaf bits in the required ratios. Four replications for each ratio were maintained and observations were taken daily. In the initial stages of the experiment, smaller leaf bits (5 x 4 cms) were used and as the mites increased in number, they were transferred to large and fresh leaf bits. Efficacy ascertained from the laboratory study was tested on potted cotton plants (MCU-5 variety). The mites were released on top leaves of the cotton plants in the same ratio, as mentioned above. The mite population was observed daily. The potted cotton plants were kept in green house. Only mobile stages were observed with the help of a hand lens.

To study the number of prey eggs destroyed (functional response) and number of eggs laid (numerical response) by the predator at densities of 10, 20, 30, 40 and 50 prey eggs simultaneously, one gravid female was released for each ratio as followed by Mallik (1974) and Anil (1990).

RESULTS AND DISCUSSION

The laboratory investigation on the interaction between predator, *A. longispinosus* and prey, *T. macfarlanei* showed a definite trend in fluctuation of population. The peak in the prey population was on

fourth day at 1:5 predatory-prey ratio (Table 1). The prey population reached a peak after fourth (123.75), fifth (185.0), sixth (285.75), seventh (341.5) and fourth (446.5) day of rearing in 1:10, 1:20, 1:30, 1:40 and 1:50 ratios, respectively (Table 2-6).

The initial increase in prey number was mainly because of the proportionate increase in the number of eggs and secondly due to the emergence of prey nymphs. The total prey population decreased later as the rate of predation increased due to buildup of predator population. The peak population of the predator was recorded in case of 1:5 (14.25± 1.6), 1:10 (22.00 ± 1.8), 1:20 (33.25 ± 3.4), 1:30 (43.75 ± 2.5), 1:40 (47.25 ± 0.5) and 1:50 (51.0 ± 1.8) categories on 7th (Table 1), 10th (Table 2), 9th (Table 3), 10th (Table 4), 11th (Table 5) and 14th (Table 6) day, respectively. The prey elimination was found on 9th (Table 1), 12th (Table 2), 13th (Table 3) and 15th (Table 4) day in 1:5, 1:10, 1:20 and 1:30 ratios, respectively,whereas in case of 1:40 (Table 5) ratio the prey population (20.25 ± 3.75) was still present even up to 15th day. The variation at 1:50 ratio might be due to error caused during handling of large population from old leaves to fresh leaves. Further, the extensive web produced by the prey might be another factor responsible for reducing the predatory potential. At such high density of prey population, predators preferred to feed mainly on eggs which enable adult prey to be free from attack making elimination difficult. The present findings are in line with the report of Anil (1990) who concluded that *A. longispinosus* prefers to feed on eggs of the prey. The findings of Mori (1969), Sandness and McMurtry (1970) and Manjunath (1988) corroborated with the present observation on prey elimination by predators at different predator-prey ratios. They opined that at higher prey densities there will be abandonment of captured prey due to disturbance to the predator.

The elimination of the prey on potted cotton plants under green house condition took 10 to 12 days, 17 to 20 days, 20 to 24 days and 28 to 35 days at 1:5, 1:10, 1:20, 1:30 predator prey ratios, respectively. Elimination of the prey at 1:5 ratio was similar to the report of Mallik (1974), but at higher ratios of 1:10, 1:20 and 1:30 it prolonged slightly. This might be due to inherent difference in host plant, prey, and climatic factors. The predator failed to eliminate the prey at 1:40 and 1:50 ratios within five weeks after release on potted cotton plants. This might be due to the presence of large number of prey and hence prey multiplication rate outclassed the prey elimination rate.

Table 1. Population build up of the predator, *A. longispinosus* and its prey, *T. macfarlanei* at 1:5 ratio

Day of Observation	Population / leaf bit (± S.D.)							
	Prey				Predator			
	Egg	Nymph	Adult	Total	Egg	Nymph	Adult	Total
1.	-	-	10.00±0.0	10.00±0.0	-	-	2.00±0.0	2.00±0.0
2.	24.75±0.7	-	8.75±0.6	33.50±1.29	-	-	2.00±0.0	2.00±0.0
3.	46.25±2.6	-	7.75±0.8	54.00±4.5	2.00±0.0	-	2.00±0.0	4.00±0.8
4.	58.25±3.3	-	7.00±0.8	65.25±4.5	4.25±1.0	-	2.00±0.0	6.25±1.0
5.	40.50±1.9	-	5.00±0.6	45.50±2.1	5.75±1.3	1.75±0.5	2.00±0.0	9.50±1.1
6.	29.50±2.1	1.25±0.9	4.75±0.9	35.50±1.7	4.50±0.6	3.75±0.5	2.00±0.0	10.25±0.5
7.	14.50±1.3	4.25±1.0	4.00±0.8	22.75±2.1	5.00±1.2	7.25±1.9	2.00±0.0	14.25±1.6
8.	2.5±0.6	1.50±0.2	3.00±1.2	7.5±2.1	4.75±1.0	5.75±1.0	3.25±0.5	13.75±1.0
9.	-	-	-	-	-	1.00±0.8	2.00±0.6	3.00±0.8

Table 2. Population of the predator, *A. longispinosus* and its prey, *T. macfarlanei* at 1:10 ratio

Day of observation	Population / leaf bit (± S.D.)							
	Prey				Predator			
	Egg	Nymph	Adult	Total	Egg	Nymph	Adult	Total
1.	-	-	20.00±0.0	20.00±0.0	-	-	2.00±0.0	2.00±0.0
2.	36.25±2.2	-	18.75±0.5	55.00±2.4	-	-	2.00±0.0	2.50±0.0
3.	76.75±1.8	-	17.50±0.5	94.25±2.3	2.50±0.6	-	2.00±0.0	4.50±0.6
4.	107.25±8.7	-	16.25±0.5	123.50±8.1	3.75±0.5	-	2.00±0.0	5.75±0.5
5.	92.75±8.0	-	15.75±0.5	108.50±7.7	5.25±0.5	-	2.00±0.0	7.25±0.5
6.	78.25±5.5	3.25±0.5	14.75±0.5	96.25±6.9	7.75±1.0	2.00±0.8	2.00±0.0	11.75±1.0
7.	54.75±4.9	7.50±1.2	14.50±0.5	76.75±6.2	7.50±0.6	2.75±0.5	2.00±0.0	12.25±1.0
8.	32.75±2.2	12.25±2.9	14.00±0.8	59.00±4.5	6.75±0.5	4.25±0.5	2.00±0.0	13.00±0.6
9.	21.50±2.7	14.25±0.9	9.25±0.5	45.00±2.5	6.25±0.5	7.00±0.8	3.50±0.6	16.75±0.6
10.	14.25±0.9	8.75±0.9	7.25±0.5	30.25±1.2	5.50±0.6	10.25±0.8	6.25±0.5	22.00±1.8
11.	6.50±0.5	4.25±0.9	4.75±0.5	15.50±1.3	3.25±0.5	6.75±0.5	7.50±2.0	17.50±2.5
12.	-	-	-	-	2.00±0.8	3.75±0.5	5.25±1.0	11.00±0.8
13.	-	-	-	-	-	1.50±0.5	2.50±0.6	4.00±0.8
14.	-	-	-	-	-	-	0.25±0.5	0.25±0.5

Table 3. Population of the predator, *A. longispinosus* and its prey, *T. macfarlanei* at 1:20 ratio

Day of observation	Population / leaf bit (± S.D.)							
	Prey				Predator			
	Egg	Nymph	Adult	Total	Egg	Nymph	Adult	Total
1.	-	-	40.00±0.0	40.00±0.0	-	-	2.00±0.0	2.00±0.0
2.	48.25±0.5	-	37.50±0.6	85.75±0.5	-	-	2.00±0.0	2.00±0.0
3.	104.25±6.3	-	36.25±0.5	140.50±6.6	3.00±0.8	-	2.00±0.0	5.00±0.8
4.	136.50±4.7	-	33.75±0.5	170.20±3.7	4.25±0.5	-	2.00±0.0	6.25±0.5
5.	156.75±5.7	-	28.25±3.3	185.00±5.0	5.75±0.5	2.75±1.0	2.00±0.0	10.50±1.3
6.	150.25±5.7	5.25±0.5	26.75±2.4	182.25±7.6	9.25±1.7	5.75±1.0	2.00±0.0	17.00±2.2
7.	120.25±4.9	12.75±1.3	24.25±2.5	157.50±8.1	11.75±0.6	10.25±0.5	2.00±0.0	24.00±0.8
8.	126.25±4.0	16.25±1.3	20.75±2.9	163.25±6.2	14.25±1.0	9.75±3.4	5.25±0.8	29.25±2.9
9.	84.50±3.4	14.25±0.5	16.50±2.1	115.25±1.9	12.50±0.5	13.25±1.0	7.50±1.0	33.25±3.4
10.	46.75±2.6	15.75±2.7	10.50±1.4	73.00±5.3	11.25±1.7	12.00±2.2	9.25±1.0	32.50±3.4
11.	17.25±3.3	12.25±1.7	7.25±2.2	36.75±5.2	8.75±1.0	6.75±0.5	11.75±1.0	27.25±2.6
12.	4.75±1.7	3.25±1.0	2.75±1.9	10.75±1.7	4.25±2.1	5.75±1.3	9.50±1.0	19.50±4.4
13.	-	-	-	-	-	3.25±1.7	4.25±1.0	7.50±1.7
14.	-	-	-	-	-	-	2.00±0.8	2.00±1.4

Table 4. Population of the predator, *A. longispinosus* and its prey, *T. macfarlanei* at 1:30 ratio

Day of observation	Population / leaf bit (± S.D.)							
	Prey				Predator			
	Egg	Nymph	Adult	Total	Egg	Nymph	Adult	Total
1.	-	-	60.00±0.0	60.00±0.0	-	-	2.00±0.0	2.00±0.0
2.	72.25±5.5	-	58.25±1.0	130.50±5.0	0.25±0.5	-	2.00±0.0	2.25±0.5
3.	125.25±7.5	-	55.25±1.0	180.25±6.8	7.50±1.3	-	2.00±0.0	9.50±1.3
4.	182.50±6.5	-	53.75±0.5	236.25±6.3	7.50±1.3	-	2.00±0.0	9.50±1.3
5.	224.25±3.8	-	50.25±1.7	274.50±5.5	11.75±1.0	3.75±0.5	2.00±0.0	17.50±1.4
6.	230.25±4.0	6.75±1.0	48.75±3.6	285.75±6.5	10.25±1.3	5.75±1.0	2.00±0.0	18.00±0.6
7.	223.50±4.0	14.25±1.0	45.25±3.6	283.00±2.1	14.75±1.4	7.25±1.0	2.00±0.0	24.00±1.4
8.	176.25±7.5	21.50±2.1	44.50±3.8	242.25±7.2	12.50±1.7	8.75±0.5	4.50±0.6	25.75±1.9
9.	142.50±2.7	29.75±1.0	41.75±2.6	214.00±5.2	14.50±1.0	12.50±0.6	8.25±1.0	35.25±1.0
10.	116.50±6.1	34.25±3.1	36.25±2.4	187.00±4.4	17.75±1.3	15.50±1.3	10.50±0.6	43.75±2.5
11.	69.75±2.2	26.75±2.1	30.75±1.0	127.25±1.5	16.25±1.0	14.75±0.5	11.75±0.5	41.75±1.3
12.	18.25±1.0	18.25±1.0	23.25±2.4	59.75±2.6	14.75±1.5	14.50±0.6	12.00±1.0	41.25±1.0
13.	2.75±1.0	5.50±1.9	16.50±2.6	24.75±6.5	12.75±1.0	12.50±1.3	13.50±0.6	38.75±1.5
14.	-	0.75±1.0	7.25±1.5	6.00±1.4	8.25±1.0	10.25±1.0	8.75±0.5	27.25±0.5
15.	-	-	0.25±0.5	0.25±0.5	2.25±0.5	5.75±1.0	6.25±0.5	14.25±1.3

Table 5. Population of the predator, *A. longispinosus* and its prey, *T. macfarlanei* at 1:40 ratio

Day of observation	Population / leaf bit (± S.D.)							
	Prey				Predator			
	Egg	Nymph	Adult	Total	Egg	Nymph	Adult	Total
1.	-	-	80.00±0.0	80.00±0.0	-	-	2.00±0.0	2.00±0.0
2.	97.50±2.1	-	77.50±1.3	175.00±1.4	-	-	2.00±0.0	2.00±0.0
3.	182.50±10.1	-	76.25±0.5	258.25±10.3	4.25±0.5	-	2.00±0.0	6.25±0.5
4.	256.75±4.6	-	75.50±0.6	332.25±4.2	7.25±0.5	-	2.00±0.0	9.25±0.5
5.	251.25±7.5	-	73.75±1.0	325.00±7.3	12.75±1.2	4.00±0.8	2.00±0.0	18.75±2.1
6.	256.75±3.8	9.25±0.5	72.50±0.5	332.50±3.3	14.25±0.5	6.50±1.3	2.00±0.0	22.75±1.5
7.	254.50±3.2	16.75±1.7	70.25±0.5	341.50±6.6	10.25±1.3	8.25±1.3	2.00±0.0	20.50±4.3
8.	211.75±6.3	27.25±2.2	69.75±0.5	308.75±4.6	13.75±1.0	12.75±0.8	3.25±0.5	29.75±0.8
9.	181.50±5.1	36.25±1.7	62.50±2.4	280.25±6.4	12.25±1.0	14.50±0.5	6.75±0.8	33.50±1.3
10.	163.75±4.5	42.02±2.6	56.25±0.5	262.00±3.6	16.50±0.6	14.25±0.5	9.25±0.5	40.00±1.5
11.	141.25±5.8	40.75±4.4	47.50±0.5	238.50±4.8	19.25±1.3	15.75±0.8	11.75±0.9	46.75±1.8
12.	100.50±6.4	30.25±2.2	31.50±2.3	162.25±5.4	17.50±1.3	16.25±0.5	13.50±0.6	47.25±2.1
13.	72.25±1.7	19.75±0.1	23.25±4.5	116.25±5.7	14.50±1.3	14.50±0.8	15.75±1.0	44.75±1.8
14.	46.75±1.7	11.75±2.6	16.50±1.3	85.00±4.3	10.75±2.2	13.75±0.9	14.75±0.5	37.25±3.4
15.	6.50±2.7	5.5±1.3	8.25±1.7	20.25±3.7	6.25±1.7	9.25±0.5	10.00±0.6	25.50±2.9

Table 6. Population of the predator, *A. longispinosus* and its prey, *T. macfarlanei* at 1:50 ratio

Day of observation	Population / leaf bit (± S.D.)							
	Prey				Predator			
	Egg	Nymph	Adult	Total	Egg	Nymph	Adult	Total
1.	-	-	100.00±0.0	100.00±0.0	-	-	2.00±0.0	2.00±0.0
2.	156.50±6.9	-	98.75±0.5	255.25±7.1	2.25±0.5	-	2.00±0.0	4.25±0.5
3.	274.75±8.1	-	95.50±1.3	370.25±8.1	5.75±0.5	-	2.00±0.0	7.75±0.5
4.	352.25±1.2	-	94.25±1.0	446.50±11.0	6.25±0.5	1.75±0.5	2.00±0.0	10.00±1.0
5.	326.50±12.6	-	92.75±1.0	419.25±12.2	10.75±1.0	4.25±0.5	2.00±0.0	17.00±0.6
6.	318.75±9.4	10.50±1.3	91.50±1.3	420.75±10.8	13.25±0.5	6.25±0.5	2.00±0.0	21.50±0.6
7.	298.50±8.7	20.50±2.6	87.50±1.7	406.75±11.1	12.75±0.5	10.75±1.0	3.50±0.6	27.00±1.0
8.	304.50±7.1	36.25±3.2	82.75±1.0	423.50±0.6	14.25±0.5	8.75±0.5	5.75±0.5	28.75±0.5
9.	275.75±9.4	48.50±1.7	78.75±1.3	402.75±11.2	16.25±1.0	13.25±0.5	8.50±1.0	38.00±0.5
10.	25.50±5.0	32.75±2.5	70.25±1.0	360.25±7.4	17.75±1.2	16.25±1.6	12.50±0.6	46.50±1.3
11.	216.25±7.1	40.50±1.9	67.50±1.3	324.25±8.3	16.50±0.6	14.25±1.0	13.75±0.5	44.50±1.3
12.	191.75±9.4	38.75±1.3	60.75±1.7	290.75±10.4	20.50±1.6	15.25±0.5	15.25±1.0	51.00±2.2
13.	158.25±12.2	34.25±1.7	51.25±1.3	243.75±13.0	18.25±1.0	13.25±1.0	17.50±0.6	49.00±1.8
14.	133.75±8.8	32.75±2.8	43.75±1.0	210.25±10.7	17.50±1.3	15.75±1.9	17.75±1.9	51.00±1.8
15.	109.50±5.3	28.25±2.1	38.25±1.0	176.00±6.9	15.50±0.5	14.50±0.5	16.25±0.5	47.25±1.6

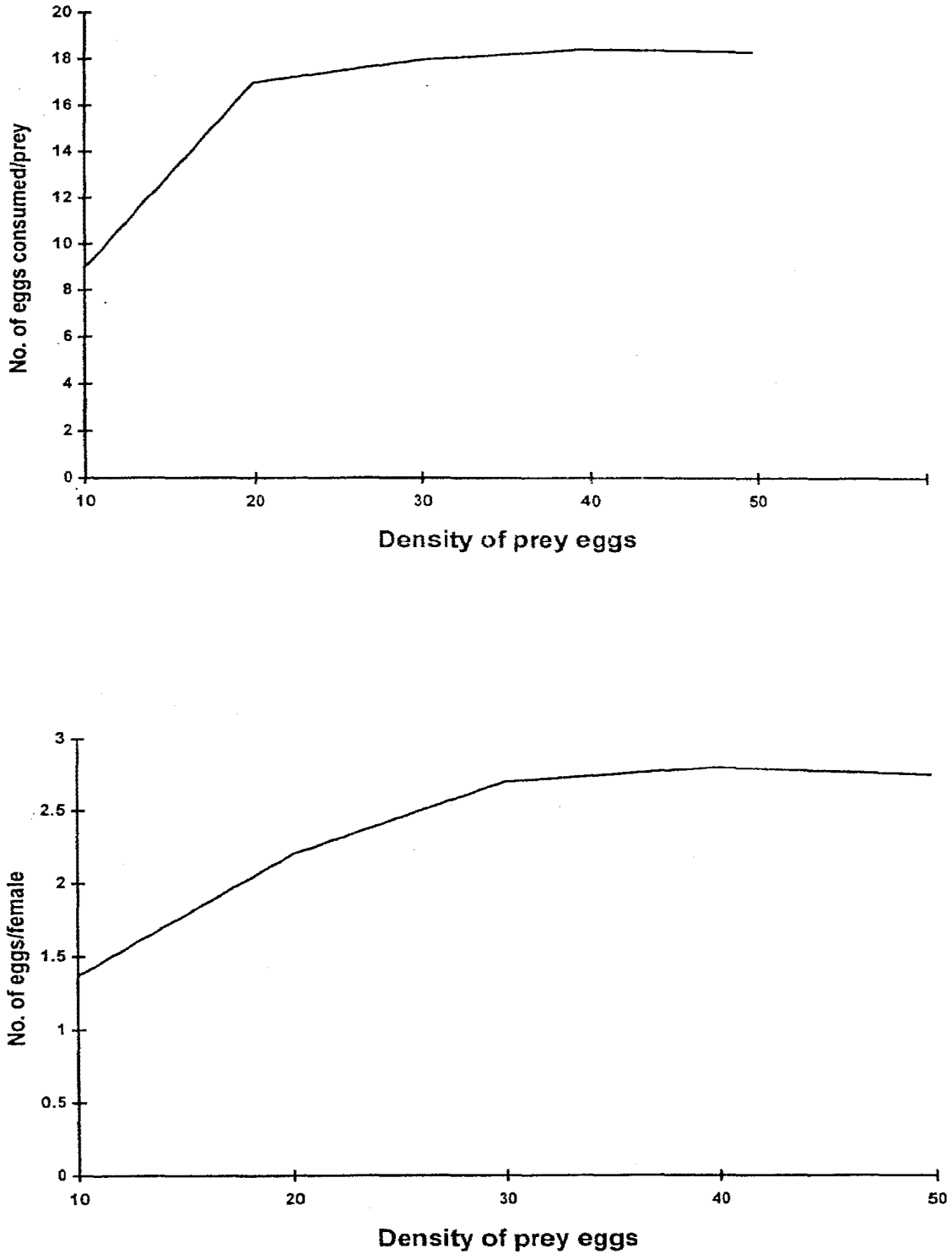

Fig. 1. Functional and numerical response of *Amblyseius longispinosus* to *Tetranychus macfarlanei*

The functional response rose from 9.8 at a density of 10 eggs/leaf bit to 19.7 at a density of 40 eggs per leaf bit. It was clear that the predator followed Hollings type-2 response. The numerical response curve rose from 1.2 at a density of 10 eggs to 3.2 at a density of 40 eggs. Further, increase in the prey egg density did not result in increased predator eggs within the period of observation and the numerical response levelled off after the density of 40 eggs. This was in agreement with the findings of Santos (1975). The curves (Figure 1) obtained by two responses are similar and in accordance with those described by Sandness and McMurtry (1970), Laing and Osborn (1974) and Anil (1990) for different species of *Amblyseius* and their prey.

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