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Seasonal Incidence of *Raoiella indica* Hirst and its Natural Enemies on Arecanut

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A B S T R A C T

Study on seasonal incidence on *Raoiella indica* Hirst and its natural enemies were carried out at Sominkoppa, Shivamogga taluk during May 2016 to April 2018. The pooled analysis revealed that, the *R. indica* population was highest during first fortnight of March (39.42 / cm^2 of leaflet), while the lowest mites of 1.69 / cm^2 of leaflet were recorded during first fortnight of November. The natural enemies population viz., *Stethorous keralicus and Scolothrips* spp was highest during first fortnight of march coinciding with peak density of *R. indica*. Whereas, the predatory mite, *A. largoensis* was highest in the month of January, May and November months. Correlation studies revealed a significant positive association with maximum temperature (r = 0.636**) while negative non-significant correlation with morning relative humidity (r = - 0.700**), evening relative humidity (r = - 0.468*) and Rainfall (r = -0.306).

Introduction

Areca catechu L. is commonly known as arecanut or betel nut is a very widely cultivated plant in Eastern countries like India, Bangladesh, Sri Lanka, Malaysia, the Philippines and Japan. The importance of this nut is due to its use for chewing purposes. It is a common masticatory nut, consumed by all sections of the population, cutting across caste, class, region, religion, age and gender in India. Arecanut is an important cash crop forms a major source of income along with other agricultural crops. However, the farmers encountered considerable crop losses intermittently, owing to lack of knowledge on the bionomics, relative distribution pattern and ecological aspects of the pests.

Arecanut is attacked by an array of insect and non-insect pests. The pests infest all parts of the palm *viz.*, stem, leaves, inflorescence, root and nuts. As many as 102 insect and non-insect pests have been reported to be

associated with arecanut palm (Nair and Daniel, 1982), among which *Raoiella indica* is serious pest, which feeds on the underside of palm fronds of various hosts in the orders Arecales and Zingiberales. It was reported as a serious pest of economically important fruit-producing trees like the coconut, *Cocos nucifera* and banana, *Musa* spp (Nagesha Chandra and Channabasavanna, 1984; Welbourn, 2006) and it formed the first mite species in which feeding was observed through the stomata of its host plants (Ochoa *et al.,* 2011). Through this specialized feeding habit, *R. indica* interfere with the photosynthesis and respiration processes of its host plants. Mite infested palms displayed stunted growth and withering of leaves.

Materials and Methods

The study on seasonal incidence of *Raoiella indica* and its natural enemies was carried out in Shivamogga taluk from May 2016 to April 2018. For this study areca garden consisting of four to five years old palm was selected and in each garden, five palms were selected randomly of which three leaflets are selected each from top, middle and basal fronds. Mites were counted in square cm area using hand lens (10X) at fortnightly intervals. The incidence of natural enemies *viz.*, predatory coccinellids, thrips and phytoseiid mites were recorded as per leaflet and correlated with weather parameters *viz.*, temperature, humidity and rainfall.

Results and Discussion

During 2016-17

The *Raoiella indica* occurred throughout the study period (May 2016 to April 2017), the population varied from 1.78 to 37.03 mites/cm^2 of leaflet (Table 1) and there was a gradual increase in mite population from the second fortnight of December with the rise in environmental temperature and continued to reach its peak during February second fortnight. The mite population reduced gradually in subsequent months with the fall in temperature, increased relative humidity and rainfall.

Seasonal incidence of natural enemies indicated that the predatory coccinellid, *Stethorus keralicus* (Kapur) and predatory thrips, *Scolothrips* spp. maintained a very thin population at the initial stage of mite infestation but the population build up acquired a high momentum with rolling on months (Table 1). The peak population of *S. keralicus* (16.60/leaflet) and *Scolothrips* spp. (9.32/leaflet) were found during second fortnight of February coinciding with those of their host.

The *S. keralicus* and *Scolothrips* spp. the population showed a decrease in trend with reduction of mite population in the months of September, October, November and December. Whereas, the predatory mite, *Ambylesius largoensis* population was very low (1.08/leaflet) during peak incidence period of mites, while it attained to maximum density during January, May and November month.

Correlation studies of mite with weather parameter revealed that maximum temperature (r= 0.498**) and evening relative humidity (r= 0.528**) had highly significant, positive association (Table 4) while minimum temperature (r= -0.007), morning relative humidity (r= -0.330) and rainfall (r= -0.06) were negatively correlated.

Predatory coccinellid *S. keralicus* has exhibited, a Positive correlation with maximum temperature (r= 0.519**) and minimum temperature (r= 0.088), while evening relative humidity showed highly significant negative relationship (r= -0.568**). The morning relative humidity (r= -

0.261) and rainfall (r= -0.019) were negatively correlated (Table 4). There was a highly significant positive association observed between *Scolothrips* spp. with evening relative humidity (r= 0.057**) and maximum temperature (r= 0.505*). While rainfall (r= -0.115), minimum temperature (r= -0.022) and morning relative humidity (r= -0.266) were negatively correlated (Table 4). *A. largoensis* showed positive correlation with maximum temperature (r= 0.342), while minimum temperature (r= -0.141), morning relative humidity (r= -0.359), evening relative humidity (r= -0.155) and rainfall (r= -0.133) had negative relationship.

During 2017-18

R. indica mite population remained active around the year and gradually increased during various months of the year (Table 2). It increased at a faster rate from the first fortnight of March (46.87/cm^2 of leaflet). The population has started to decline in the following months with changes in environmental conditions. The natural enemies *viz., Scolothrips* spp. and *S. keralicus* population was highest during first fortnight of March (12.34 and 16.80 per leaflet) coinciding with the maximum incidence period of mites (Table 2). Lowest counts of *S. keralicus* (0.28 / leaflet) and *Scolothrips* spp. (0.10/leaflet) were recorded in the month of December. The *A. largoensis* was lowest during first and second fortnight (0.06 and 0.08/leaflet respectively) of August and during peak mite incidence period it was 1.92 per leaflet.

Correlation study revealed that there was a highly significant positive relationship noticed between maximum temperature (r= 0.775**) and mite population, whereas minimum temperature (r= 0.055) had a positive non-significant association (Table 4). Morning relative humidity (r= -0.777**) and rainfall (r= -0.306) were negatively correlated.

S. keralicus had positive, highly significant correlation with maximum temperature (r= 0.721**) whereas, minimum temperature (r= 0.183) showed positive non-significant association. The morning relative humidity (r= -0.703**) and evening relative humidity (r= -0.684**) had highly significant negative correlation. While rainfall (r= -0.166) exhibited non-significant negative relationship. Similarly, *Scolothrips* spp. had highly significant negative association with morning (r= -0.761**) and evening (r= -0.740**) relative humidity. While, rainfall (r= -0.208) is negatively correlated (Table 4). There was positive non-significant relationship observed with minimum temperature (r= - 0.100).

From all the above results it was evident that abiotic factors were found to exert a profound influence in determining the population size of *R. indica*. Increase in the temperature along with fairly low relative humidity enhanced the mite population. Similarly, *R. indica* population declined in an inconsistent manner as the atmospheric relative humidity increased.

Pooled data

Pooled data indicated that the *R. indica* persisted on arecanut palm throughout the year with notable fluctuations in the population, which varied from 1.11 to 39.42 mites per cm^2 of leaflet (Table 3). Highest mites counts were recorded during first fortnight of March (39.42 / cm^2 of leaflet), while the lowest mites of 1.69 / cm^2 of leaflet were recorded during first fortnight of November. The natural enemies *viz.*, *Scolothrips* spp. and *S. keralicus* population was highest during first fortnight of March (12.91 and 17.89 per leaflet) coinciding with the maximum incidence of mites.

Table.1 Seasonal incidence of *Raoiella indica* and its natural enemies on areca palms in Sominakoppa, Shivamogga taluk during 2016-17

Month / Year	Fortnight	Mean mite population per cm^2 of leaflet[#]				Natural enemies per leaflet		
		Top	Middle	Bottom	Mean	*Stethorus keralicus*	*Scolothrips* spp	*Amblyseius largoensis*
May 2016	I	14.82±2.02	16.95±1.23	20.70±1.68	17.49±1.71	9.50±0.46	6.48±0.31	4.30±0.21
	II	15.24±1.20	16.75±1.04	20.07±1.34	17.35±1.42	7.64±0.37	5.45±0.26	4.68±0.23
June	I	14.36±0.96	13.13±0.94	19.36±0.82	15.62±1.90	6.96±0.34	5.56±0.27	1.36±0.07
	II	9.65±0.55	11.70±077	14.11±0.59	11.82±1.28	5.89±0.28	3.46±0.17	1.78±0.09
July	I	5.04±0.56	5.54±0.35	10.70±0.44	7.09±1.80	5.02±0.24	2.58±0.12	1.08±0.05
	II	4.73±0.57	6.40±0.59	6.88±0.63	6.00±0.65	4.56±0.22	3.59±0.17	0.32±0.02
August	I	4.40±0.93	5.44±0.26	5.52±0.39	5.12±0.36	3.76±0.18	3.47±0.17	0.06±0.00
	II	4.41±0.44	5.36±0.36	6.76±0.42	5.51±0.68	4.06±0.20	2.59±0.12	0.04±0.00
September	I	2.47±0.55	2.35±0.48	2.57±0.39	2.46±0.06	3.21±015	2.34±0.11	0.20±0.01
	II	1.76±0.31	1.64±0.19	1.93±0.31	1.78±0.08	2.73±0.13	1.98±0.10	0.30±0.01
October	I	0.32±0.10	6.96±0.45	7.79±0.67	4.92±2.36	4.60±0.22	1.03±0.05	1.09±0.05
	II	3.21±0.74	4.68±0.41	6.89±0.80	4.93±1.06	5.08±0.24	0.84±0.04	2.28±0.11
November	I	1.58±0.20	3.68±0.27	4.28±0.51	3.24±0.81	2.52±0.12	0.74±0.04	3.06±0.15
	II	1.08±0.12	1.92±0.26	3.42±0.32	2.14±0.68	3.36±0.16	0.32±0.02	3.80±0.18
December	I	0.40±0.17	1.03±0.25	6.13±0.54	2.52±1.81	2.14±0.10	0.18±0.01	1.08±0.05
	II	5.40±1.10	7.46±0.67	10.19±0.66	7.68±1.38	2.44±0.12	1.82±0.09	0.84±0.04
January 2017	I	12.16±0.53	19.22±0.66	20.61±0.63	17.33±2.61	9.82±0.47	5.84±0.28	2.88±0.14
	II	17.72±085	21.79±1.36	20.84±1.33	20.12±1.22	10.24±0.49	6.20±0.30	4.92±0.24
February	I	26.23±2.37	27.92±1.50	31.23±1.72	28.46±1.46	14.78±0.71	7.23±035	1.32±0.06
	II	35.09±1.63	37.26±1.83	38.74±1.29	37.03±1.05	16.60±0.80	9.32±045	1.08±0.05
March	I	30.14±1.95	32.04±1.17	33.69±1.04	31.96±1.02	12.44±0.60	8.02±039	0.98±0.05
	II	20.04±069	20.48±0.58	22.77±1.14	21.10±0.84	9.40±0.45	6.31±0.30	0.64±0.03
April	I	22.04±1.32	23.87±1.20	27.28±1.48	24.40±1.53	10.34±0.50	10.21±0.49	0.92±0.04
	II	15.01±0.30	18.00±0.46	20.70±1.01	17.90±1.64	10.50±0.51	6.80±0.33	1.32±0.06

Mean ± SEm; n= Observation of 45 leaflets

Table.2 Seasonal incidence of *Raoiella indica* and its natural enemies on areca palms in Sominakoppa, Shivamogga taluk during 2017-18

Month /Year	Fortnight	Mean mite population per cm^2 of leaflet[#]				Natural enemies per leaflet		
		Top	Middle	Bottom	Mean	*Stethorus keralicus*	*Scolothrips* spp	*Amblyseius largoensis*
May 2017	I	13.42±1.25	16.95±1.22	14.70±0.96	15.02±1.03	10.64±0.41	5.76±0.24	3.40±0.14
	II	18.29±1.01	13.13±1.49	12.29±1.06	14.57±1.87	9.26±0.49	4.56±0.18	4.18±0.17
June	I	14.67±0.66	15.85±1.38	17.10±1.01	15.87±0.70	7.80±0.36	4.46±0.30	2.36±0.20
	II	6.90±0.98	7.82±0.64	9.07±0.34	7.93±0.62	5.80±0.33	3.58±0.20	1.76±0.10
July	I	7.57±0.51	9.40±0.51	9.03±0.82	8.67±0.55	13.56±0.53	7.59±0.39	1.72±0.07
	II	0.00±0.00	2.20±0.25	2.80±0.32	1.67±0.85	8.76±0.56	4.47±0.20	0.48±0.09
August	I	0.00±0.00	1.40±0.49	0.80±0.27	0.73±0.40	4.28±0.27	3.24±0.13	0.06±0.00
	II	0.23±0.05	1.64±0.41	1.93±0.25	1.27±0.52	6.20±0.35	6.98±0.28	0.08±0.00
September	I	0.00±0.00	0.00±0.00	0.00±0.00	0.55±0.00	4.76±0.19	4.32±0.17	0.46±0.02
	II	0.00±0.00	0.89±0.16	1.26±0.29	0.72±0.37	2.84±0.15	2.20±0.09	0.64±0.03
October	I	0.00±0.00	0.34±0.18	0.77±0.08	0.37±0.22	1.56±0.08	1.32±0.09	2.56±0.12
	II	0.00±0.00	0.40±0.17	0.12±0.06	0.17±0.11	0.71±0.10	0.80±0.22	3.28±0.15
November	I	0.00±0.00	0.04±0.04	0.40±0.15	0.15±0.12	0.72±0.03	0.42±0.14	2.28±0.21
	II	0.00±0.00	0.00±0.00	0.23±0.07	0.08±0.07	0.48±0.02	0.40±0.16	3.16±0.11
December	I	0.90±0.29	1.42±0.41	2.52±0.40	1.61±0.47	0.28±0.08	0.20±0.06	0.16±0.07
	II	1.02±0.30	2.20±0.54	3.65±0.35	2.29±0.76	0.28±0.02	0.10±0.06	0.80±0.04
January 2018	I	3.41±0.42	4.66±0.85	5.20±0.57	4.42±0.53	2.60±0.18	1.97±0.17	4.80±0.24
	II	5.12±0.38	9.18±1.16	11.45±0.50	8.58±1.85	6.20±0.25	5.84±0.30	5.20±0.25
February	I	19.95±1.12	27.61±1.49	33.57±1.09	27.04±3.94	12.26±0.70	9.59±0.50	2.52±024
	II	29.03±2.05	36.55±1.93	40.28±2.49	35.29±3.30	14.21±0.68	10.46±0.57	1.36±0.12
March	I	47.64±4.88	49.33±2.14	43.65±2.74	46.87±1.68	16.80±0.66	12.34±0.49	1.92±0.17
	II	40.50±0.93	44.35±1.60	45.27±1.88	43.37±1.46	13.12±0.58	10.32±0.41	0.98±0.25
April	I	29.80±1.11	30.60±1.36	32.40±1.46	30.93±0.76	12.24±0.53	9.23±0.36	0.61±0.03
	II	19.00±1.05	19.80±0.35	20.60±1.21	19.80±0.46	10.02±0.55	7.00±0.39	1.76±0.08

Mean ± S. Em ; n= Observation of 45 leaflets.

Table.3 Seasonal incidence of *Raoiella indica* and its natural enemies on areca palms in Sominakoppa, Shivamogga taluk (Pooled data of 2016-17 and 2017-18)

Month / Year	Fortnight	Mean mite population per cm^2 of leaflet#				Natural enemies per leaflet		
		Top	Middle	Bottom	Mean	*Stethorus keralicus*	*Scolothrips* spp	*Amblyseius largoensis*
May	I	14.12±1.24	16.95±0.79	17.70±0.97	16.26±1.09	13.57±0.42	8.12±0.27	3.85±0.16
	II	16.77±0.87	14.94±0.63	16.18±0.64	15.96±0.53	10.80±0.42	6.01±0.21	4.43±0.19
June	I	14.52±0.61	14.49±0.27	18.23±0.83	15.75±1.24	8.88±0.34	5.01±0.28	1.86±0.08
	II	8.28±0.60	9.76±0.60	11.59±0.17	9.88±0.95	7.35±0.29	3.52±0.18	1.77±0.07
July	I	6.31±0.38	7.47±0.31	9.87±0.27	7.88±1.04	9.79±0.36	4.84±0.25	1.40±0.06
	II	2.37±0.71	4.30±0.38	2.80±0.24	2.69±0.58	7.66±0.39	4.03±0.18	0.40±0.05
August	I	2.20±1.16	3.42±0.33	3.16±0.30	2.93±0.37	4.52±0.21	3.36±0.14	0.06±0.00
	II	2.32±0.20	3.50±0.25	4.35±0.29	3.39±0.58	5.13±0.26	4.79±0.19	0.06±0.00
September	I	1.24±0.61	2.00±0.21	1.29±0.19	1.51±0.24	3.99±0.16	3.33±0.14	0.33±0.02
	II	0.88±0.21	1.27±0.16	1.60±0.12	1.25±0.20	2.79±0.14	2.09±0.09	0.47±0.02
October	I	0.00±0.10	3.65±0.16	4.28±0.33	2.64±1.33	3.08±0.15	1.18±0.07	1.83±0.09
	II	1.61±0.88	2.54±0.23	3.51±0.38	2.55±0.54	2.90±0.16	0.82±0.09	2.78±0.13
November	I	0.79±0.25	1.95±0.12	2.34±0.23	1.69±0.46	1.62±0.08	0.58±0.08	2.67±0.12
	II	0.54±0.20	0.96±0.26	1.83±0.17	1.11±0.37	1.92±0.09	0.36±0.07	3.48±0.14
December	I	0.65±0.15	1.23±0.27	4.33±0.41	2.07±1.14	1.21±0.09	0.19±0.03	0.62±0.04
	II	3.21±0.66	4.83±0.50	6.92±0.44	4.99±1.07	1.36±0.07	0.96±0.07	0.82±0.04
January	I	7.79±0.29	11.94±0.64	12.91±0.55	10.88±1.57	6.21±0.32	5.41±0.20	3.84±0.19
	II	11.42±0.45	15.49±0.51	16.15±0.74	14.35±1.47	9.22±0.35	7.52±0.29	5.06±0.24
February	I	23.09±1.62	27.77±1.13	32.40±0.90	27.75±2.68	19.03±0.69	12.41±0.42	1.92±0.15
	II	32.06±1.56	36.91±1.73	39.51±1.74	36.16±2.18	21.62±0.60	15.68±0.41	1.22±0.08
March	I	38.89±2.45	40.69±0.91	38.67±1.57	39.42±0.63	21.91±0.74	17.89±0.50	1.45±0.10
	II	30.27±0.58	32.42±1.00	34.02±1.04	32.24±1.08	16.28±0.50	12.82±0.33	0.81±0.13
April	I	25.92±1.08	27.24±1.20	29.84±1.04	27.67±1.15	18.79±0.47	14.22±0.41	0.77±0.04
	II	17.01±0.51	18.90±0.22	20.65±1.01	18.85±1.05	15.26±0.47	9.40±0.36	1.54±0.07

Mean ± S. Em ; n= Observation of 45 leaflets.

Table.4 Correlation and multiple regression coefficient of *Raoiella indica* and its natural enemies with weather parameters in Sominakoppa, Shivamogga

Year	Particulars	Temperature (^{0}C)		Relative humidity (%)		Rainfall (mm)	R^2	Regression Equation
		Max (X_1)	Min (X_2)	Morning (X_4)	Evening (X_5)	(X_3)		
2016-17	*Raoiella indica*	0.498*	-0.007	-0.330	0.528**	-0.610	0.675	$Y=-44.275+1.868X_1-0.286X_2-0.002X_3-0.354X_4+0.493X_5$
	Stethorus keralicus	0.519**	0.088	-0.261	-0.568**	-0.019	0.717	$Y=-35.680+1.227X_1+0.004X_2-0.04X_3-0.179X_4+0.315X_5$
	Scolothrips spp.	0.505*	-0.022	-0.266	0.576**	-0.115	0.204	$Y=-33.137+0.987X_1-0.209X_2-0.019X_3-0.087X_4+0.284X_5$
	Amblyseius largoensis	0.342	-0.141	-0.359	-0.155	-0.133	0.759	$Y=3.408+0.136X_1+0.0204X_2+0.009X_3-0.062X_4-0.016X_5$
2017-18	*Raoiella indica*	0.775**	0.055	-0.777**	-0.775**	-0.306	0.759	$Y=17.249+0.608X_1-0.005X_2+0.207X_3-0.210X_4+0.001X_5$
	Stethorus keralicus	0.721**	0.183	-0.703**	-0.684**	-0.166	0.830	$Y=5.131+0.984X_1+1.379X_2+0.003X_3-0.735X_4+0.106X_5$
	Scolothrips spp	0.701**	0.100	-0.761**	-0.740**	-0.208	0.831	$Y=12.021+0.552X_1+0.963X_2+0.006X_3-0.546X_4+0.059X_5$
	Amblyseius largoensis	0.214	-0.292	-0.158	-0.260	-0.381	0.250	$Y=-5.101+0.086+X_1-0.178X_2-0.006X_3-0.155X_4+0.087X_5$
Pooled	*Raoiella indica*	0.656**	0.026	-0.700**	-0.468*	-0.254	0.808	$Y=48.19+1.210X_1+2.356X_2-0.012X_3-1.437X_4+1.685X_5$
	Stethorus keralicus	0.636**	0.168	-0.633**	-0.319	-0.116	0.845	$Y=26.52+0.667X_1+1.581X_2+0.006X_3-0.831X_4+9.323X_5$
	Scolothrips spp	0.625**	0.059	-0.692**	-0.380	-0.171	0.811	$Y=23.727+0.513X_1+1.007X_2+0.004X_3-0.645X_4+0.077X_5$
	Amblyseius largoensis	0.288	-0.227	-0.229	-0.247	-0.381	0.250	$Y=-5.101+0.086X_1-0.178X_2-0.006X_3+0.155X_4-0.087X_5$

** Significance at p= 0.01 level; * Significance at p=0.05 level; n= 24

The lowest of *S. keralicus* (1.21 / leaflet) and *Scolothrips* spp. (0.19 / leaflet) were recorded during first fortnight of December. The *A. largoensis* population was lowest during second fortnight of August (0.06 / leaflet), while it attained to maximum density during January, May and November months.

There was a significant positive relationship noticed between maximum temperature (r = 0.620**) and mite population, whereas minimum temperature (r = 0.026) had a positive non-significant association (Table 4). Morning relative humidity (r = - 0.700**), evening relative humidity (r = - 0.468*) and rainfall (r = -0.306) were negatively correlated

S. keralicus had significant positive correlation with maximum temperature (r = 0.636**) whereas, minimum temperature (r = 0.168) showed positive non-significant association. The morning relative humidity (r = -0.633**), evening relative humidity (r = - 0.319) and rainfall (r = - 0.166) exhibited negative relationship.

Similarly, *Scolothrips* spp. had negative association with morning relative humidity (r = - 0.692**), evening relative humidity (r = - 0.380) and rainfall (r = - 0.171) (Table 4). There was positive non-significant relationship observed with minimum temperature (r = 0.059). *A. largoensis* showed positive correlation with maximum temperature (r = 0.288), while minimum temperature (r = - 0.227), morning relative humidity (r = - 0.229), evening relative humidity (r = - 0.247) and rainfall (r = -0.381) had negative relationship (Table 4).

The multiple regression value depicted in table 4 indicated that combined and overall impact of all the abiotic factors on mites and natural enemies were to the extent of 25 to 84 per cent respectively.

The decline in mite population with the onset of monsoon and an increase in relative humidity are in conformity with Nair and Daniel (1982). Thus results of our study in all three locations showed that high temperature, low relative humidity and rainfall greatly influenced the incidence of *R. indica.*

Our results are in close conformity with Yadav Babu and Manjunatha (2007) reported that there was a positive correlation observed with mite population and temperature, while relative humidity and rainfall had a negative relationship with mite population.

Similarly, Hoy *et al*., (2010) reported that, In India, populations of *R. indica* are negatively affected by rainfall and high relative humidity while they are highest during hot, sunny, and dry conditions; Taylor *et al*., (2011); Prabheena and Ramani (2014) found that *R. indica* densities were significantly higher during hotter and drier periods.

Apart from Abiotic factors, the mite population would also have been checked in the field by natural enemies *viz*., predatory coccinellid, *S. keralicus* and predatory thrips *Scolothrips* spp. During the study period it was observed that their maximum population density coincided with the peak incidence of *R. indica*.

These results clearly indicated that natural enemies are density dependent and had a close association with mite *R. indica* population. Similar results findings were given by Nageshchandra (1980); Somachoudary and Sarkar (1987) who reported association of predatory coccinellid with peak population of *R. indica* are in conformity with present findings.

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