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Evaluating the effective density of *Chrysoperla larvae* against major sucking pests on tomato

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Abstract:

The experiment was carried out at the farmer's field to evaluate effective density of Chrysoperla larvae against major sucking pests on tomato. The results showed that minimum post-treatment observations were recorded in T3 plot ranged in between (1.44 – 2.45) per leaf, followed by T2 (2.26 - 3.77), T1 (3.08 - 4.28) and T4 (5.90 - 8.65), respectively. The overall maximum post-treatment population reductions for whitefly (2.16 ± 0.52, 3.32 ± 0.64, 3.66 ± 0.68 and 7.41 ±

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0.96) per leaf were recorded in T3 followed by T2, T1 and T4, respectively. Results for jassid depicted that overall maximum post-treatment population reductions (2.56 ± 0.57, 4.16 ± 0.72, 5.25 ± 0.81 and 6.63 ± 0.91) per leaf were also recorded in T3, followed by T2, T1 and T4, respectively. The same trend was recorded in aphid with overall maximum post-treatment population reductions in T3 (2.46 ± 0.55, 3.88 ± 0.70, 4.89 ± 0.78 and 6.73 ± 0.92) followed by followed by T2, T1 and T4, respectively. The overall maximum post-treatment populations reductions for thrip (4.47 ± 0.75) per leaf were also recorded T3 followed by T2 (6.69 ± 0.91), T1 (8.86 ± 1.05) and T4 (10.35 ± 1.14), respectively. The results further showed positive correlation between pre and post-treatment pest populations with temperature and Relative humidity, however the treatments were statistically significant at (P<0.05) level indicating variance among treatments.

Key words: *C. carnae,* Radiant, densities, sucking pests, Hybrid-1359, IPM and control plots.

Introduction

Tomato (*Lycopersicon esculentum* L.), a member of the Solanaceae family, is a widely grown delicious fruit vegetable crop adapted to wide range of soils and climates (Smith, 1994; Peralta and Spooner, 2001). The tomato is one of the most important "protective foods" both because of its special nutritive value and also because of its widespread production. It is the world's largest vegetable crop after potato and sweet potato, but it tops the list of canned vegetables.

They have an outstanding vitamin contents like ascorbic acid or vitamin C, vitamin A, thiamine or vitamin B_1 and riboflavin or vitamin B_2, in that order. Tomato is used in many ways. It is taken cooked, raw or is made into soups, salads, preserves, pickles, *chutneys,* ketchups, sauces and many other products (ikisan.com, 2000). Tomato is said to be the native of

tropical America, but nowadays it is grown almost in all over the world. In the world China is the largest producer of tomato about 50,000,000 (MT) followed by India, USA, Turkey, Egypt, etc, (FAOSTAT, 2012) (Table-1). Demand on tomato processing products increases by almost one million tons of raw material early (WPTC, 2009). The cultivation of tomato in Pakistan has been more intensified in the recent years. However, still the local production could not meet the domestic demand and sometimes tomato is imported. The instability in the tomato production is mainly associated with the high variation in area under tomato cultivation as well as other factors in relation to use of inputs and cultural practices (Khan *et al*., 2002). There are around 7,500 tomato varieties grown for various purposes (Allen, 2008). Tomatoes are subjected to attack by a large number of insect pests from the time plants first emerge in the seed bed until harvest. Aphids, whiteflies, thrips, flea beetles, leaf miners, cutworms and spider mites threaten young plant-bed tomatoes (Krishna *et al.,* 2003a). In the field, flea beetles, aphids, leaf miners, stinkbugs, and fruit worms cause minimal damage to the foliage. However, severe damage may result either from their feeding on the fruit or by spreading certain diseases. Among other insect pests of tomato that bore into fruits or buds include tomato fruit worm, tobacco budworm, tomato pinworm, leaf miners, blister beetles, stinkbug, western flower, cutworms, southern potato wireworm, etc. (Krishna *et al.,* 2003b; Gajanana *et al.,* 2006).

The use of insecticides provided temporary relief from insect pests but disrupted the ecological balance by eliminating natural enemies. The potential use of bio-control agents are yet to be fully explored and evaluated in most pest control strategies (Carvalho *et al.,* 2002). In the recent past, chrysopids are one among the few insect predators, which attracted the attention of scientific community working in the field of biological control in India and elsewhere. This polyphagous nature has made them to emerge as potential and important

component of Integrated Pest Management (IPM) strategy against various dreaded crop pests (Dhandapani *et al.* 2003). *C. carnae*, known as the common green lacewing, belongs to Chrysopidae family. Larvae of lacewings eat preferably aphids, but may eat other sucking insects and mites and even beneficial insects. Adult lacewings feed on pollen, nectar and honeydew. The larvae are mostly active at night and shelter under the plant. They grab the prey and inject saliva that transforms the inner body into a liquid. Then they suck on their prey. It has been used in the biological control of insect pests on different crops (Henry *et al.,* 2002). They prey mostly from the order Homoptera and are predominant eaters of aphids on low growing vegetation (Bellows and Fisher, 1999). On crops, the larvae have been reported as attacking several species of aphids, red spider mites, thrips, whitefly, leafhoppers and neonates of budworm. They are also considered to be important predators of the long-tailed mealybug under glass (Hoffmann and Frodsham, 1993). The presence of the larvae on the foliage was found to inhibit visitation and oviposition by *B. tabaci* which suggests the larvae may produce a volatile semiochemical which repels the whitefly (Bellows and Fisher, 1999). In view of the facts stated above, we carried out new method of IPM strategy in the local grower's tomato field to evaluate effects of different release densities of *C. carnae* larvae against sucking insect pests.

Materials and Methods

Insect material, survey methods, data observation and Analytical methods

The natural enemies, *C. carnae* larvae (second stage) were provided by Dr. Raza Muhammad Memon, Senior Scientific Officer (Nuclear Institute of Agriculture, Tandojam, Sindh-Pakistan).

***C. carnae* release management and survey time selection**.

(i) ***Experimental field*:** The present experiment was conducted at Muhammad Hanif Jamali Farm, Tajpur; district Tando Allahyar, Sindh-Pakistan, during January - May, 2012 (sowing till harvesting), poor agronomical management, different vegetable crops practiced like tomato, onion, cabbage, brinjal, etc; use pesticides 12 times a year , mainly abamectin, imidacloprid, chemical pesticide chlorpyrifos, etc.;

(ii) ***Survey and C. carnae management methods***

Tomato "Hybrid-1359" variety was grown, Randomized Complete Block Design (RCBD) survey method, on area of 2 acres. The plot was divided into four different sub-plots, such as T1, T2, T3 and T4. Each comprised of ½ (Half) acre. Three different release densities i.e. 250 (T1), 500 (T2) and 750 (T3) larvae of *C. carnae* were randomly released on the bottom, mid and top of the tomato plants in three sub-plots, while the fourth one (T4) kept as control (Sprayed Pesticide). This IPM management strategy was repeated after every 15 days till the harvest time of crop. Thus total eight (8) numbers of releases from 3rd week of February till 2nd week of April were managed carried till the crop harvest. Whereas, the pesticide with common name "Radiant", trade name "Spinetorm 120% SC" of "Spinocid" group of pesticide manufactured by Arysta Life Science Company was used against sucking pests in Non-IPM plot. Three applications of insecticide were made at interval of 21 days. The dates of sprays were 25/2/2012, 18/3/2012 and 10/4/2012.

Data observation

We used visual estimation and sweeping net to investigate sucking insect pests like whitefly, jassid, aphid and thrip. Data were taken as (a) Pre-treatment observation (before the release of *C. carnae*) and (b) Post-treatment observation (after the release of *C. carnae*) throughout the study. The pre-treatment

observations were taken 24 hours before the release of *C. carnae*. Whereas, post-treatment observations were taken at weekly basis but then were compiled on fortnight basis. The numbers of sucking insects were counted from top, middle and bottom parts of the twenty five (25) randomly selected plants from those IPM plots (*C. carnae* release) and pesticide plot (control). Further the data for environmental factors like temperature and relative humidity were taken by hygrometer containing thermometer weekly at the time of each post observation which were then compiled into fortnightly basis. Moreover, photography was also done by Sony Company digital camera 8.1 Mega Pixels throughout the study.

Analytical methods

Raw data management

All the raw data from IPM plots and pesticide plot along with temperature and relative humidity were processed into mean data with Mean ± S.E by Microsoft Office Excel 2007, Microsoft Office Word 2007.

Correlation analysis

For correlation analysis, we performed linear regression between pre-treatment population with temperature and relative humidity; also post-treatment population with temperature and relative humidity. For this we first compiled horizontal means of pre and post-treatment populations of all four pests separately then we took horizontal means pre and post-treatment observations of all pests together (Table-6) and then first correlation was taken between pre-treatment pest population with temperature and relative humidity and second between post-treatment pest population with temperature and relative humidity (Fig. 2, 3, 4, 5).

Analysis of Variance (ANOVA)

Finally all the data were statistically analyzed and LSD at 0.05% was also tested by using Statix-8.1 computer software program.

Results

Whitefly, *Bemisia tabaci* (Genn):

The data in Table-1 shows fortnight pre and post-treatments whitefly population/leaf in both IPM (*C. carnae* released) and control (Pesticide applied) plots. The pre-treatment data show that almost same trend of whitefly per leaf population was found in all treatments ranged in between (3.18 – 5.38). Whereas, minimum post-treatment observations were recorded in T3 plot ranged in between (1.44 – 2.45) per leaf, followed by T2 (2.26 - 3.77), T1 (3.08 - 4.28) and T4 (5.90 - 8.65), respectively. The overall post-treatment maximum mean population reduction of whitefly (2.16 ± 0.52) per leaf was also recorded T3 followed by T2 (3.32 ± 0.64), T1 (3.66 ± 0.68) and T4 (7.41 ± 0.96), respectively. Comparatively T3 treatment showed best results throughout all eight releases.

JASSID, *Amrasca bigutella bigutella* (Ishida)

The data in Table-1 shows fortnight pre and post-treatments jassid population/leaf in both IPM (*C. carnae* released) and control (Pesticide applied) plots. The pre-treatment data show that almost same trend of jassid per leaf population was found in all treatments ranged in between (4.12 – 6.36). Whereas, minimum post-treatment observations were recorded in T3 plot ranged in between (1.28 – 3.05) per leaf, followed by T2 (2.37 - 4.77), T1 (4.67 - 5.69) and T4 (6.00 – 7.06), respectively. The overall post-treatment maximum mean population reduction of jassid (2.56 ± 0.57) per leaf was also recorded T3 followed by T2 (4.16 ± 0.72), T1 (5.25 ± 0.81) and T4 (6.63 ± 0.91), respectively. Comparatively T3 treatment showed best results throughout all eight releases.

Aphid, *Aphis gossypii* Glover

The data in Table-1 shows fortnight pre and post-treatments aphid population/leaf in both IPM (*C. carnae* released) and

control (Pesticide applied) plots. The pre-treatment data show that almost same trend of aphid per leaf population was found in all treatments ranged in between (4.08 – 6.42). Whereas, minimum post-treatment observations were recorded in T3 plot ranged in between (1.07 – 3.05) per leaf, followed by T2 (2.24 - 4.32), T1 (3.87 - 5.65) and T4 (6.23 - 7.25), respectively. The overall post-treatment maximum mean population reduction of aphid (2.46 ± 0.55) per leaf was also recorded T3 followed by T2 (3.88 ± 0.70), T1 (4.89 ± 0.78) and T4 (6.73 ± 0.92), respectively. Comparatively T3 treatment showed best results throughout all eight releases.

Thrip, *Thrips tabaci* (Lindeman):

The data in Table-1 shows fortnight pre and post-treatments thrip population/leaf in both IPM (*C. carnae* released) and control (Pesticide applied) plots. The pre-treatment data show that almost same trend of thrip population was found in all treatments ranged in between (8.20 – 10.46). Whereas, minimum post-treatment observations were recorded in T3 plot ranged in between (2.91– 5.08) per leaf, followed by T2 (5.80 - 7.18), T1 (7.55 - 9.39) and T4 (9.46 - 11.06), respectively. The overall post-treatment maximum mean population reduction of thrip (4.47 ± 0.75) per leaf was also recorded T3 followed by T2 (6.69 ± 0.91), T1 (8.86 ± 1.05) and T4 (10.35 ± 1.14), respectively. Comparatively T3 treatment showed best results throughout all eight releases.

The regression analysis found positive correlation between pre and post-treatment pest populations with temperature and Relative humidity (Fig. 2, 3, 4, 5). The ANOVA results for fortnight mean post-treatment populations of whitefly, jassid, aphid and thrip in both IPM and Control plots showed that treatments were statistically significant at ($P<0.05$) level indicating variance among treatments. The LSD further confirmed that 1 to 4 separate groups (A, B, C, and D) were formed indicating variance among treatments.

Discussion

The present study showed almost same trends of whitefly, jassid, aphid and thrip populations per leaf were found in both IPM and control plots. Minimum post-populations were found in T3 plot where we released 750 number of *C. carnae*, followed by 500, 200 and control. This proved that increasing the number of *C. carnae* (Second instar) of natural enemies can have significant effect on decreasing the pest population. The experiment further resulted positive correlation between pest populations and environmental factors. The results of present study agree with those of Lagaspi *et al.* (1994) who evaluated different lace wing release rates for the control of silver leaf whitefly, *Bemisia argentifolii* inside cages in organically grown water melon. Second instar of C*hrysoperla rufllaberis* 10, 25 and 50 per cage (0.37 m^2) sized. The results revealed that control had 35% more whiteflies over the entire season as compared to the predator treatments with the highest whitefly counts (25 lacewings per plant). The effects of predator releases were most evident during second half of the season. The results also agree with those of Singh and Varma (1994) who reported that *C. carnae* is a beneficial predator could manage whiteflies and aphids. The results also agree with those (Khuram *et al.* 2008) who investigated effectiveness of *C. carnae* on the population of *B. tabaci* in different cotton genotypes and should that use of *C. carnae* as biological intensive IPM program reduced the use of insecticides. The results of present study also agree with those of Khan and Morse, (1999) who evaluated predatory effect of two species of *C. carnae* against thrips *Sciroto thrips* citrus (Moulton) population during spring, 1995 at the University of California Lind cover research and Extension Center. The results revealed that 6 of the 11 releases were found to result in significantly less fruit scaring by citrus thrips than the level observed in untreated control. The reduction in thrip number (immature + adults) was evident

after 13-14 post-release. Present results partially agree with those of Campbell and Lilley (1999) evaluated that release rates did not affect the rate of predation by the *C. carnae*, but was affected by the method and timing of application. Releases of green lacewings at densities from 6,175 to 1,235,000 eggs or larvae per ha provided similar levels of control. However, releases that were timed to approximately 50–70% leafhopper egg hatch had a greater effect on densities than releases timed to peak leafhopper nymphal densities. In addition, releases of green lacewing larvae were more effective than releases of lacewing eggs. Releases of the predatory insects early in the season to control the two-spotted spider mite, *Tetranychus urticae* (Koch), on dwarf hops maintained populations at lower densities than releases later in the year regardless of the release rate. The results of present study agree with those of Hoddle and Robinson (2004) who reported that only 2nd and 3rd instar stage of *C. carnae* managed the thrips *Scirtothrips perseae.* Alvarez *et al.,* (2010) compared the functional response of *C. carnae* and *Chrysoperla nipponensis against aphis gossypii* and found that *C. carnae* ate more aphids at high densities than *C. nipponensis* which could be considered a prospective candidate for use as commercial bio-control agents against aphids in Japan. The results also agree with Sattar (2010) who recorded 83.70 and 76.07% population reduction of jassid, 37. 59 and 60.32% for thrips and 51.84 and 44.05% for white fly during 2005 and 2006, respectively.

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Conflict of interest declaration: The authors have declared that no conflicts of interests exist.

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Table-1 The top ten tomatoes producers of the world (in tonnes) in 2012

Rank	Country	Production (MT)
1	China	50,000,000
2	India	17,500,000
3	United States	13,206,950
4	Turkey	11,350,000
5	Egypt	8,625,219
6	Iran	6,000,000
7	Italy	5,131,977
8	Spain	4,007,000
9	Brazil	3,873,985
10	Mexico	3,433,567

Table-2 Mean fortnight pre and post-treatments whitefly population/leaf at different *C. carnae* release densities along with temp and R.H% in tomato.

Weeks of Observation	No. of Releases	Pre-treatment				Post-treatment				Temp: ^{0}C	R.H%
		T1	T2	T3	T4	T1	T2	T3	T4		
Feb, 3rd	First	5.12	4.76	4.84	4.96	4.28	3.33	2.45	5.90	21.25	45.00
Feb, 4th	Second	5.08	4.72	4.48	5.88	4.20	3.57	2.32	6.45	23.50	53.00
Mar, 1st	Third	5.38	5.06	4.68	4.84	4.15	3.77	2.31	7.16	20.25	49.00
Mar, 2nd	Fourth	4.28	4.16	4.02	3.24	3.14	3.45	2.14	7.77	26.50	55.00
Mar, 3rd	Fifth	4.62	4.28	4.18	4.32	3.33	3.46	2.23	7.55	30.50	40.00
Mar, 4th	Sixth	4.80	4.44	4.36	4.66	3.86	3.48	2.20	7.82	32.00	38.00
Apr, 1st	Seventh	4.94	4.74	4.62	3.86	3.24	3.26	2.16	8.00	29.75	47.00
Apr, 2nd	Eighth	4.10	4.04	4.02	3.18	3.08	2.26	1.44	8.65	30.00	50.00
Mean ±S.E		**4.79 ± 0.77**	**4.53 ± 0.75**	**4.40 ± 0.74**	**4.36 ± 0.73**	**3.66 ± 0.68**	**3.32 ± 0.64**	**2.16 ± 0.52**	**7.41 ± 0.96**	**26.72 ± 1.83**	**47.13 ± 2.43**

T1=250 Larvae, T2=500, T3=750, T4= Control Plot

Table-3 Mean fortnight pre and post-treatments jassid population/leaf at different *C. carnae* release densities along with temp and R.H% in tomato.

Weeks of Observation	No. of Releases	Pre-treatment				Post-treatment				Temp: ^{0}C	R.H%
		T1	T2	T3	T4	T1	T2	T3	T4		
Feb, 3rd	First	5.16	4.88	4.96	5.08	5.20	4.29	3.05	6.00	21.25	45.00
Feb, 4th	Second	5.38	5.24	5.02	4.12	5.41	4.77	2.90	6.12	23.50	53.00
Mar, 1st	Third	5.68	5.46	5.26	5.52	5.24	4.65	2.89	6.88	20.25	49.00
Mar, 2nd	Fourth	5.36	5.24	5.12	5.36	5.38	4.43	2.83	6.90	26.50	55.00
Mar, 3rd	Fifth	5.74	5.32	5.22	5.56	5.34	4.36	2.86	6.48	30.50	40.00
Mar, 4th	Sixth	5.56	5.36	5.28	5.92	5.69	4.44	2.76	6.78	32.00	38.00
Apr, 1st	Seventh	6.36	5.56	5.38	5.18	5.08	4.00	1.94	6.78	29.75	47.00
Apr, 2nd	Eighth	5.14	4.68	4.54	5.48	4.67	2.37	1.28	7.06	30.00	50.00
Mean ±S.E		**5.55 ± 0.83**	**5.22 ± 0.80**	**5.10 ± 0.79**	**5.27 ± 0.81**	**5.25 ± 0.81**	**4.16 ± 0.72**	**2.56 ± 0.57**	**6.63 ± 0.91**	**26.72 ± 1.83**	**47.13 ± 2.43**

T1=250 Larvae, T2=500, T3=750, T4= Control Plot

Table-4 Mean fortnight pre and post-treatments aphid population/leaf at different *C. carnae* release densities along with temp and R.H% in tomato.

Weeks of Observation	No. of Releases	Pre-treatment				Post-treatment				Temp: ^{0}C	R.H%
		T1	T2	T3	T4	T1	T2	T3	T4		
Feb, 3rd	First	4.84	4.64	4.80	4.85	4.72	3.89	2.73	6.23	21.25	45.00
Feb, 4th	Second	4.98	4.68	4.08	4.28	5.30	4.19	2.85	7.15	23.50	53.00
Mar, 1st	Third	5.92	5.26	4.58	5.64	5.15	4.28	2.89	6.46	20.25	49.00
Mar, 2nd	Fourth	5.08	4.88	4.72	5.18	5.08	4.32	3.05	7.11	26.50	55.00
Mar, 3rd	Fifth	5.38	5.12	4.98	5.32	5.07	4.19	2.57	6.31	30.50	40.00
Mar, 4th	Sixth	5.48	5.16	5.06	5.10	5.65	4.30	2.60	6.44	32.00	38.00
Apr, 1st	Seventh	6.42	5.32	5.12	5.34	4.28	3.65	1.93	6.90	29.75	47.00
Apr, 2nd	Eighth	4.34	4.28	4.18	4.44	3.87	2.24	1.07	7.25	30.00	50.00
Mean ±S.E		**5.31 ± 0.81**	**4.92 ± 0.78**	**4.69 ± 0.76**	**5.02 ± 0.79**	**4.89 ± 0.78**	**3.88 ± 0.70**	**2.46 ± 0.55**	**6.73 ± 0.92**	**26.72 ± 1.83**	**47.13 ± 2.43**

T1=250 Larvae, T2=500, T3=750, T4= Control Plot

Table-5 Mean fortnight pre and post-treatments thrip population/leaf at different *C. carnae* release densities along with temp and R.H% in tomato.

Weeks of Observation	Releases of *C. carnae*	Pre-treatment				Post-treatment				Temp: ^{0}C	R.H%
		T1	T2	T3	T4	T1	T2	T3	T4		
Feb, 3rd	First	9.32	9.04	9.64	9.84	9.09	6.84	5.08	10.54	21.25	45.00
Feb, 4th	Second	9.14	8.52	8.20	9.80	9.20	6.74	4.99	10.48	23.50	53.00
Mar, 1st	Third	9.88	9.06	8.34	9.76	9.20	6.75	4.85	10.90	20.25	49.00
Mar, 2nd	Fourth	9.68	9.48	9.24	9.84	9.39	6.59	4.68	11.06	26.50	55.00
Mar, 3rd	Fifth	9.82	9.56	9.32	9.04	8.14	7.18	4.63	10.29	30.50	40.00
Mar, 4th	Sixth	10.16	9.72	9.52	9.18	9.06	7.09	4.65	9.86	32.00	38.00
Apr, 1st	Seventh	10.46	9.84	9.64	9.38	9.24	6.54	4.00	10.18	29.75	47.00
Apr, 2nd	Eighth	9.42	9.26	9.12	9.98	7.55	5.80	2.91	9.46	30.00	50.00
Mean ±S.E		**9.74 ± 1.10**	**9.31 ± 1.07**	**9.13 ± 1.06**	**9.60 ± 1.09**	**8.86 ± 1.05**	**6.69 ± 0.91**	**4.47 ± 0.75**	**10.35 ± 1.14**	**26.72 ± 1.83**	**47.13 ± 2.43**

T1=250 Larvae, T2=500, T3=750, T4= Control Plot

Table-6 Mean fortnight pre and post-treatments populations/leaf of all pests together along with temp and R.H% in tomato.

No. of Releases	Pre-treatment				Mean	Post-treatment				Mean	Temp: ^{0}C	R.H%
	W.Fly	Jassid	Aphid	Thrip		W.Fly	Jassid	Aphid	Thrip			
First	4.92	5.02	4.78	9.46	6.05	3.99	4.64	4.39	7.89	5.23	21.25	45.00
Second	5.04	4.94	4.51	8.92	5.85	4.14	4.80	4.87	7.85	5.42	23.50	53.00
Third	4.99	5.48	5.35	9.26	6.27	4.35	4.92	4.70	7.93	5.48	20.25	49.00
Fourth	3.93	5.27	4.97	9.56	5.93	4.13	4.89	4.89	7.93	5.46	26.50	55.00
Fifth	4.35	5.46	5.20	9.44	6.11	4.14	4.76	4.54	7.56	5.25	30.50	40.00
Sixth	4.57	5.53	5.20	9.65	6.24	4.34	4.92	4.75	7.67	5.42	32.00	38.00
Seventh	4.54	5.62	5.55	9.83	6.39	4.17	4.45	4.19	7.49	5.08	29.75	47.00
Eighth	3.84	4.96	4.31	9.45	5.64	3.86	3.85	3.61	6.43	4.44	30.00	50.00

Fig-1 Photographs showing different activities along with P.I. of the project during the study period.

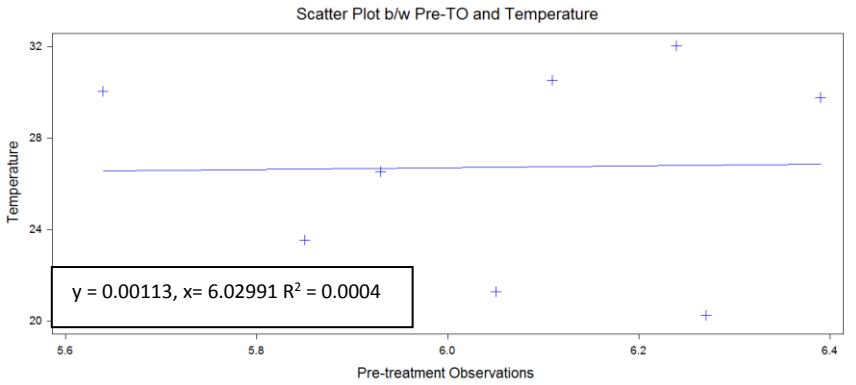

Figure-2 Regression analysis between Pre-treatment pest population & temperature ^{0}C

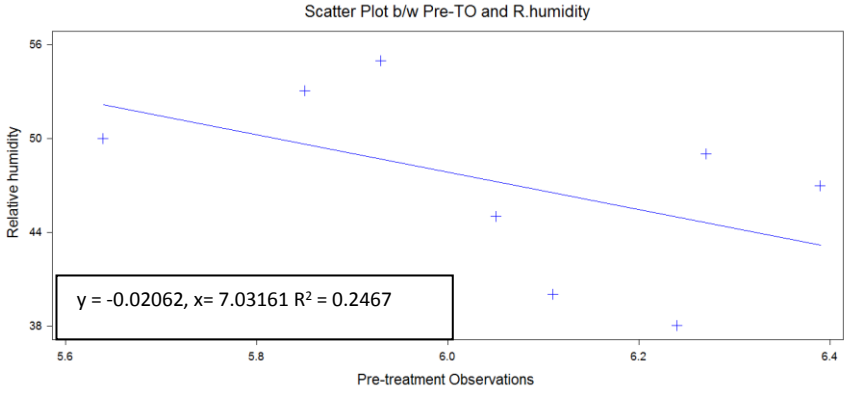

Figure-3 Regression analysis between Pre-treatment pest population & Relative humidity%

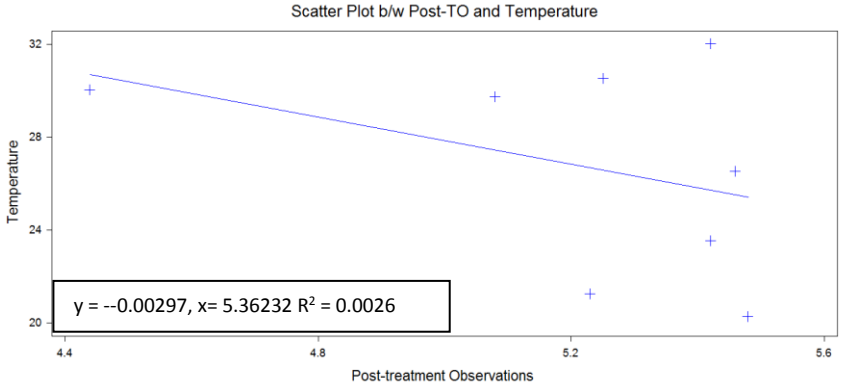

Figure-4 Regression analysis between Post-treatment pest population & Temperature ^{0}C

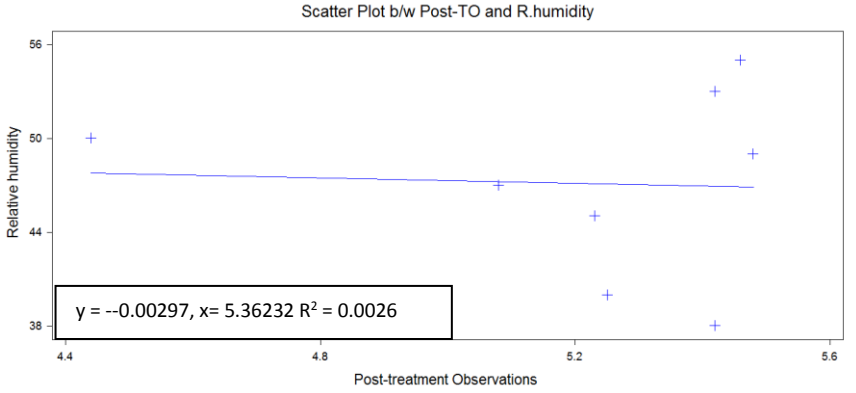

Figure-5 Regression analysis between Post-treatment pest population & Relative humidity%