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Influence of natural enemies on suppression of insect pests and yield of okra

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Abstract
The present experiment on influence of natural enemies on suppression of insect pests and yield of okra was conducted at Latif Farm, Sindh Agriculture University, Tandojam from July to October 2011. The results of study revealed that reduction of jassid, whitelfy, thrip mealy bug per leaf and spotted bollworm per plant were recorded before and after release of natural enemies. The overall mean population of jassid (7.61 ± 0.97), whitefly (5.89 ± 0.85), thrip (5.22 ± 0.80) and mealybug (1.85 ± 0.48) per leaf while spotted bollworm (0.76 ± 0.30) per plant was recorded before release of natural enemies. The results further showed that in control (T2) plot more population of pests was recorded population than treated plot (T1). The data showed significant effect of releasing natural enemies on population reduction of pests, biological control also increased the yield and income of okra almost five times compared with untreated control.

Keywords: Insect pests, Natural enemies, Okra, *Abelmoschus esculentus*, yield

1. Introduction

Okra (*Abelmoschus esculentus* L.), an annual herbaceous plant, belongs to the family Malvaceae and is more prevalent in the Indo-Pak subcontinent [1]. It is a main Kharif vegetable of Pakistan and being consumed with a great interest. The origin of okra remains unclear but centers of genetic diversity include West Africa, India and Southeast Asia [2, 3]. Okra also contains carbohydrates and vitamins [4], and plays a vital role in human diet [5]. Okra is a most important cash crop in Sindh [6]. A number of insect pests attack okra from germination stage till its harvest [7]. The vegetable is attacked by sucking insect pests at its premature stage and in its later stage, fruit borers cause extensive damage to fruits. Approximately 69 % yield is lost due to sucking insect pests i.e. whitelfly, aphid, jassid, thrip whereas among fruit borers namely American boll worm, spotted boll worm [8, 9], The extent of infestation plus the nature of injury vary greatly with the variety of plant, localities and seasons [10].

Despite the use of broad-spectrum pesticides, the natural enemies play a significant role in minimizing the level of infestation via inundative release of bio-control agents [11]. Biological control is a suitable alternative to insecticides in integrated pest management [12]. The success and failure of bio-control agents is reviewed extensively [13]. Several factors which influence the effectiveness of natural enemies include specificity (specialist or generalist), the kind of agent (predator, pathogen or parasitoid), the number plus method of releasing and timing, synchronization of bio-control agent to its host and field condition [14].

The use of *Trichogramma* species as biological agent is a recognized alternate of insecticides throughout the world. *Trichogramma chilonis* (Ishii) in Pakistan parasitizes the egg of *Acigona steniellu* (Hanps.), *Agrotis ipsilon* (Hfn.), *Autographa nigrisigna* (Walk.), *Chilo infuscatellus* (Sn.), *C. partellus* (Swinh.). *Emmalocera depressella* (Swinh.), *Heliothis armigera* (Hbn.), and *Spodeoptera litura* (F.) indicating its potential for biological control of these insect pests [15].

Green lacewings are known as proven bio-control agents, which can devour the eggs and neonate larvae of most caterpillar pests (bollworms, armyworms, cabbage loopers, budworms, borers, corn earworms, codling moths, etc.), flea beetles, Colorado potato beetles, aphids, psyllids, scales, mealy bugs, whiteflies, leafhoppers, thrips, spider mites and other pests (Tauber and [16]. *Chrysoperla carnea* and *C. rufilabris*. (Neuropteran: Chrysopidae), are efficient predators which feed on a variety of insect pests in the field crops [17]. They are commonly found in agricultural settings where the adult feeds on pollen, nectar, and honeydew; however the larvae of lacewing are voracious predators. *C. carnea* are found in widely in different habitats while *C. rufilabris* is more effective in areas of humidity which tends to be high as in irrigated crops and greenhouses [18]. The effectiveness of predator, *C. carnea*, in biological control is documented in the orchards, fields as well as in greenhouses [19]. The present study is undertaken on the effect of *Chrysoperla* and *Trichogramma* species as biological controlling agents against insect pests of okra were evaluated by releasing these natural enemies in okra crop.

2. Materials and Methods

The experiment was carried out in the Latif Farm of Sindh Agriculture University, Tandojam from July to November, 2011 for determining the influence of natural enemies on suppression of insect pests and yield of okra. The experiment was conducted in Randomized Complete Block Design (RCBD). The variety (sbzpari) of okra was sown on an area of 104 x 104 ft by drilling method in June 07, 2011 and agronomic practices were also carried out throughout the experiment. Observations on jassid, thrip, whitefly and spotted bollworm population were recorded weekly. *Trichogramma chilonis* (Ishii) cards were obtained from NIA Tando jam and were released in the okra crop at the rate of 2 cards per plot and *Chrysoperla carnea* (Stephens). Total eight releases of natural enemies were made of 3rd larval instars at the interval of 15 days with a rate of 375 per plot. Pre-treatment data was taken one day before the releases and post-treatment data were obtained weekly after the releases. The weekly observations were recorded from July 07 to November 07, 2011. The data on natural enemies and pests were also obtained from control plot. The data on yield of okra was also obtained from treated as well as control plots. The okra fruit yields of treated and control plot were recorded.

2.1 Statistical analysis

The software SPSS (SPSS Inc, Chicago, IL, USA) was used for data analysis. The one-way analysis of variance was used for the analysis of data and the entire means were compared using paired T-test at probability level of P=< 0.05.

3. Results

In the present study, the jassid population on okra ranged between (4.52 - 9.49) per leaf in pre-treatment observations, i.e. before the releases of natural enemies from 3rd week of July to last week of October, 2011. While the overall mean population of jassid (7.61 ± 0.97) per leaf was recorded before release of natural enemies. The whitefly population on okra ranged between (4.32-7.45) per leaf in pre-treatment observations from 3rd week of July up to 2nd week of October, 2011before release of natural enemies. Whereas the overall mean population of whitefly (5.89 ± 0.85) was recorded before release of natural enemies. Similarly, the thrip population on okra ranged between (4.43 ± 5.84) per leaf in pre-treatment observations before release of natural enemies from 1st week of August upto last week of October, 2011. Although, the overall mean population of thrip (5.22 ± 0.80) was recorded before release of natural enemies. The mealybug population on okra ranged between (0.03 – 3.35) per leaf in pre-treatment observations, i.e. before release of natural enemies from 3rd week of July until last week of October, 2011. Thus, the overall mean population of mealy bug (1.85 ± 0.48) was recorded before release of natural enemies. The data of spotted bollworm population on okra ranged between (0.00 ± 1.25) larvae per plant in the pre-treatment observations, i.e. before release of natural enemies from 3rd week of July until last week of October, 2011 and the overall mean population of spotted bollworm was (0.76 ± 0.30) larvae per plant before release of natural enemies as given in (Table-1).

The overall mean population of jassid (4.73 ± 0.76) per leaf was recorded in treated plot (T1) where natural enemies were released. Whereas, in the control (T2) plot higher population (10.81 ± 1.16) per leaf was recorded than treated plot (T1) with (4.73 ± 0.76) per leaf throughout the study period. The overall minimum mean population of whitefly (2.02 ± 0.50) per leaf was recorded in treated plot (T1) where natural enemies were released. The control (T2) plot had a higher mean number of whitefly (8.93 ± 1.05) per leaf compared with treated plot (T1) with (2.02 ± 0.50) per leaf. The overall mean population of thrip (0.74 ± 0.30) per leaf was recorded in treated plot (T1) where natural enemies were released. The control (T2) plot showed a higher mean population (7.14 ± 0.94) per leaf than treated plot (T1) with (0.74 ± 0.30) per leaf. The overall mean minimum population of mealybug (0.68 ± 0.29) per leaf was recorded in treated plot (T1) where natural enemies were released. Whereas, the control (T2) plot received a higher mean number of population (2.63 ± 0.57) per leaf than treated plot (T1) with (0.68 ± 0.29) per leaf throughout the period under study. The overall mean population of spotted bollworm (0.02 ± 0.04) larvae per plant was recorded in treated plot (T1) where natural enemies were released. The control (T2) plot showed a higher mean number of spotted bollworm (0.96 ± 0.34) per plant than treated plot (T1) with (0.02 ± 0.04) per plant throughout the period under study as indicated in Table 2.

Table 3 shows the okra crop yield obtained from natural enemies released okra compared with control plot. The yield of okra recorded from natural enemies released crop was 3112 kgs per acre compared with 640 kgs from control plot. There was almost five times increase in yield of okra where natural enemies were applied for population management of insect pests. Similarly, there was almost five times increase in net return from okra crop where biological control was applied compared with okra crop cultivated without the use of control measures.

Table 1: Pretreatment pest population on okra crop at Latif Farm, SAU, Tandojam.

No. of release	Observation dates	Jassid	Whitefly	Thrip	Mealybug	Spotted bollworm
1	21/07/2011	4.52	4.32	4.92	0.03	0
2	04/08/2011	5.62	5.08	4.43	1.32	0.85
3	18/08/2011	6.48	5.26	5.61	1.98	0.58
4	01/09/2011	7.76	6.04	5.33	1.45	0.68
5	15/09/2011	8.20	6.28	5.05	1.56	0.80
6	29/09/2011	9.29	5.84	5.41	2.02	1.05
7	13/10/2011	9.49	7.45	5.19	3.05	1.20
8	30/10/2011	9.48	6.86	5.84	3.35	1.25
Mean ±S.E		7.61 ± 0.97	5.89 ± 0.85	5.22 ± 0.80	1.85 ± 0.48	0.76 ± 0.30

The analysis of data through paired t-test revealed that treatments were statistically significant at (P=< 0.05).

Table 2: Effect of release of natural enemies on population of insect pests on okra crop.

Pests	Pest population in treated and control treatments				
	T1	T2	T	DF	P
Jassid	4.73	10.81	9.49	7	0.001
Whitefly	2.02	8.93	18.32	7	0.001
Thrip	0.74	7.14	27.75	7	0.001
Mealybug	0.68	2.63	3.95	7	0.001
Spotted bollworm	0.02	0.96	4.73	7	0.001

The analysis of data through paired t-test revealed that treatments were statistically significant at (P=< 0.05).
T1= Natural enemies released treatment
T2= Control treatment

Table 3: Yield obtained from treated and untreated plots of okra crop at Latif Farm.

Date of okra picking	Treated	Untreated
22/07/2011	32	20
29/07/2011	45	16
05/08/2011	55	8
12/08/2011	65	12
19/08/2011	62	24
02/09/2011	68	4
09/09/2011	65	8
16/09/2011	66	10
23/09/2011	55	12
30/09/2011	52	4
07/10/2011	50	6
14/10/2011	46	6
21/10/2011	40	8
31/10/2011	38	10
07/11/2011	39	12
Total	778	160
Yield/acre	3112	640
Income/acre	Rs.124480.00	Rs.25600
Crop protection expenses	Rs.1024	---
Net return	Rs.123356	Rs.25600

4. Discussion

The study showed that there was a significant effect of *Chrysoperla* larvae and *Trichogramma* eggs against jassid, whitefly, thrip, mealybug and spotted bollworm. The study further revealed that release of natural enemies showed the maximum effect on population reduction of sucking insect pests was higher than control throughout the study period. The results partially agree with the findings of [20] who studied the potential of *C. carnea* larvae against aphid and whitelfy. The present study is also in agreement with the findings of [21] who reported that release rates did not affect the rate of predation by the *C. carnea*, but was affected by the timing and method of application. However, releases of lacewing larvae at densities from 6, 175 to 1,235,000 eggs or larvae per hectare provided similar control level. When, releases that were timed to approximately 50 to 70 % leafhopper eggs hatch showed greater effect against densities than release timed to peak leaf hopper nymphal densities. Moreover, the releases of lacewing larvae were more effective than the release of lacewing eggs. The results of present study also agree with those of [22, 23] who investigated that the seasonal incidence of jassid, *Amrasca biguttula*, *buguttula* and population of whitelfy, *Bemisa tabaci* on okra and found that the infestation of jassid and whitelfy started in the 4th week of July and reached at its peaks in 2nd and 4th week of September. The results of present study are in partial agreement with those of [24] who determined the effect of prey density on pre-imago development and predation of *C. carnea*, different number of *B. tabacci* and *Thrip tabaci* fed with. The duration of *C. carnea* larvae were significantly different among the number of larvae when fed on *T. tabaci* and *B. tabaci*. The shortest duration of larva (10.25 days) was recorded against *B. tabaci* (35 nymphs), followed by *T. tabaci* (14.50 days, 25 nymphs). Longest duration of larvae was with 5 and 10 nymphs of *B. tabaci* and *T. tabaci*, respectively. Maximum consumption by *C. carnea* on the nymphs of *B. tabaci* (200.5 nymphs) in comparison to *T. tabaci* (171.8 nymphs) the results of this study are also in agreement with the findings of [25] who evaluated by releasing native stains of predator *C. carnea* on whiteflies, mealy bug and aphids, respectively. *C. carnea* larvae were found to be effective with a release ratio of 1 / 5 whitelfy and 1 / 20 - 40 / mealybug, respectively on okra, but ineffective on egg plants. *C. carnea* was not able to control aphids. The findings of this study also agree with the findings of [26] who investigated the response of *T. chilonis* preying upon eggs and first instar larvae of the okra bollworm, *Heliocoverpa armigera* Hubner. The 1st and 2nd instar larvae of *T. chilonis* showed less response against both prey stages. However, the egg stage of *T. chilonis* showed a type III functional response to the eggs of *H. armigera*. The highest predation rate was recorded on the eggs of *T. chilonis* on *H. armigera* eggs. Results of the present study revealed that the eggs of *T. chilonis* had a good predatory potential in controlling both eggs and larvae of *H. armigera.* However, for a comprehensive estimation of the bio-control potential of *T. chilonis* toward *H. armigera*, further studies related to the field are needed.

5. Conclusion

It is concluded from the present study that release of natural enemies influenced the maximum mean population reduction of sucking and spotted bollworms on okra. Eight released of *Chrysoperla carnea* larvae at 15 days interval gave better control of sucking pests of okra. The release of *Trichogramma chilonis* gave better control of bollworms (*E. vittela*). Control (T2) plot received a higher mean number of pest population than treated plot (T1) throughout the period under study. The population of insect pests increased gradually up to harvest in control plot. Maximum mean yield (kgs) was recorded in released natural enemies than control. More studies on stages of *Chrysoperla carnea* need to be investigated.

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