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Effect of Some Insecticides on the Population of Insect Pests and Predators on Okra

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Abstract: A field study was carried out to determine the efficacy of different insecticides against different insect pests and their predators on okra crop during the year 2005. The treatments included four insecticides i.e., Confidor, Sundaphos, Polo and Mospilan and their efficacy was checked by a control plot (unsprayed). Pre-treatments population of the jassid, thrips, whitefly, mites, spiders, ants and beetles was managed and post treatments observations were recorded after 24, 48, 72 h, 7 and 14 days of insecticidal spray. The results showed that in controlling jassid, all the insecticides were significantly ($p<0.01$) effective but Confidor proved to be more effective as compared to Sundaphos, Polo and Mospilan, where jassid mean population was 1.20 plant^{-1} as compared to pre-treatment population of 7.78 plant^{-1}, thrips 1.16 plant^{-1} as compared to pre-treatment population of 6.52 plant^{-1}, whitefly 1.18 plant^{-1} as compared to pre-treatment population of 8.31 plant^{-1}, mites controlled to the level of 2.42 plant^{-1} as compared 8.56 plant^{-1} (control). All the insecticides were almost equal in effects on the spiders and the mean spider population was 0.31, 0.30, 0.31, 0.38 plant^{-1} in plots sprayed with Confidor, Sundaphos, Polo and Mospilan, respectively and similar was the situation with population of ants where mean population was 0.33, 0.38, 0.35 and 0.35 plant^{-1} in plots sprayed with Confidor, Sundaphos, Polo and Mospilan, respectively. The insecticides sprayed all were harmful for the beetles and the mean population of beetles was 0.03, 0.06, 0.03 and 0.07 plant^{-1} in plots sprayed with Confidor, Sundaphos, Polo and Mospilan, respectively. However, Confidor and Polo were more harmful to beetles as compared to Sundaphos and Mospilan. All the insecticides were effective against jassid, thrips, whitefly and mites, but Confidor proved to be most effective equally against all the insect pests under study as compared to Sundaphos, Polo and Mospilan. Confidor also proved better than other insecticides, because the population of predators i.e., spiders, ants and beetles was less affected by Confidor application as compared to Sundaphos, Polo and Mospilan.

Key words: Population, predators, insecticides, insect pests, Okra

INTRODUCTION

Okra, *Abelmoschus esculentus* L., is grown in home gardens and for commercial markets in southern, central and northeast Arkansas. It is a warm season crop that belongs to the cotton (mallow) family. It is often referred to as gumbo. The cultivated okra is of old world origin and probably domesticated in the Ethiopian region (Jacquelyn, 1999). The plant of okra is erect, herbaceous annual, 1-2 meter tall, stem green, leaves alternate, broadly chordate, palmately 3-7 lobed, hirsute, serrate, flowers solitary, axillary with about 2 cm long peduncle; epicalyx upto 10, calyx split longitudinally (Henry, 2001).

It is rich in vitamins, calcium, potassium and other mineral matters. Its fruits can be cooked in a variety of ways. It can be fried in butter or oil and cooked with necessary ingredients (Yadav *et al*., 2001).

There are a number of insect pests which may attack okra like whitefly, American bollworm, stink bugs, rough bollworm, Looper, caterpillars and green vegetable bugs. Aphids and mites may also occur on okra crops. Aphids can be washed off with a steady stream of water or sprayed with soap spray. Stink bugs are more difficult to control. These can be hand picked and destroyed. Loopers can be controlled biologically with Bt *Bacillus thuringiensis* (Kumar, 2004). Mazumder *et al*. (2001) reported incidence of *Bemisia tabaci* in the Okra.

The damage of different insect pests varies from year to year depending upon weather conditions and the intensity of insect pest attack. About 145 species of insect pests are recorded on cotton plant and almost all of these attack okra plant also in Pakistan. However, only about a dozen of these are major pests and cause economic losses, six being the key insect pests: jassid *Amrasca devastans*, whitefly *Bemisia tabaci*, thrip *Thrips tabaci*, American bollworm *Helicoverpa armigera*, spotted bollworm *Earias* sp. and pink bollworm *Pectinophora gossypiella* (Kumar, 2004).

Jassid adult is tinny insect oval in shape, green in colour with four wings. Adult male is smaller in size than female. The pest usually rests under side of the leaves during day hours. The female lays eggs singly inside the

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prominent veins of mature leaves and eggs hatch in about four days. The newly hatched nymph measures 2.28 mm in length and is green in colour. The lifecycle of insect is completed in about 14-15 days (Bhatti and Soomro, 1996). Hormchan *et al*. (2001) recorded Jassid infesting cotton and okra plants and observed considerable yield losses.

The adult whitefly is small insect having four white membranous wings. The nymphs are oval and light yellow in colour and remain in clusters on the under surface of leaves. It breeds all the year, the eggs hatch in 3-6 days. The lifecycle is completed in 13 to 21 days. Whitefly eggs are generally laid on the underside of leaves.

Different measures are adopted to control the insect pests in okra such as for whitefly control seed treatment before planting could be effective or some cultural practices are adopted to prevent the damage of insect pests, but still no method has been devised to control these devastating insects. Although, chemical control yet has been the most effective tool to control these insect pests (Jech and Husman, 1998).

While considering the economic injury levels of different insects pests such as; Jassid *Amrasca devastans* that is 1 adult or nymph per leaf (Gowri *et al*., 2002), white fly *Bemisia tabaci* 5 adults/nymphs or both per leaf (Aslam and Gebara, 1995), Thrips *Thrip tabaci* 8-10 insects per leaf, Aphids 15 insect per leaf, mites 10-15 per leaf or spray on visible damage and spotted bollworm 3 larvae per 25 plants. Whitefly can be effectively controlled by using seed dressing insecticides. In chemical control, high volume of water is more effective. The use of pyrethroids and their mixtures should be avoided early in the season. The spraying should be done early in the morning for effective control of whitefly. For the management of spotted bollworm, Pyrethroids were identified as effective insecticides, while for pink bollworm management in okra two consecutive sprays of pyrethroids were found effective at week interval (Kumar, 2004). Bifenthrin 10 EC, Fenpropathrin 30 EC, Cypermethrin 10 EC, Deltamethrin 10 EC, Beta-cyfluthrin 25 EC, Lambda-cyhalothrin 2.5 EC were sprayed against whitefly, jassid, thrips and mites and found good control during all four sprays (Jech and Husman, 1998).

Keeping in view the economic importance of okra and losses caused by its insect pests, the present research work was carried out to investigate the efficacy of different pesticides against different insect pests and their predators under agro-ecological conditions of Tanodjam, Sindh Pakistan.

MATERIALS AND METHODS

The present study was carried out to investigate the efficacy of different pesticides against different insect pests and their predators in the experimental field of Entomology Section, Agriculture Research Institute, Tandojam, Sindh during kharif season 2005.

The seed of okra variety Sabz Pari was sown on April 19, 2005. The sowing was done by hand-drill in the direction from east to west. The experiment will be conducted in a Randomized Complete Block Design (RCBD), the size of sub plot maintained as 30×40 ft. The experimental plots had five treatments (control) and each treatment was replicated three times. The crop was sown on 60 cm apart ridges, keeping plant to plant distance of 30 cm. The first two irrigations were given frequently after emergence of seed. Normal agronomic practices were carried out throughout the growing season of the crop and no pesticides were sprayed in the experimental field.

Four insecticides i.e., Confidor, Sundaphos, Polo and Mospilan were used to observe their efficacy on the insect pests and predators on okra. The incidence of insect pests was recorded on 20 plants in each treatment. Pre-treatment observations of insect pests were taken on three leaves, i.e., each one from top, middle and bottom. Pre-treatment observation for predators was taken on whole plant. The post-treatment observations were taken at the intervals of 24 h, 48 h, 72 h, 7 days and 14 days after spray. The observations on the incidence of jassid, thrips, whitefly and mites were recorded and among predators, spiders, ants and beetles were observed for assessment of the insecticide effect on their population. The insecticidal application was carried out either in the morning or in the evening and observations were recorded at morning hours (8-10 am) the population of the insects was examined carefully. The number of jassid, thrips, whiteflies, mites, spiders, ants and beetles were counted.

The population of jassid, thrips, whiteflies, mites, spiders, ants and beetle was observed separately in each replication (plot) and their efficacy was analysed. The observations were started in third week of May when insect abundance was observed and the observation process lasted until the end of September.

The data thus recorded were subjected to analysis of variance to record the level of significance for variation and the mean values were compared by using LSD test as suggested by Gomez and Gomez in 1984. The means from the statistically analysed data were derived to form the final tables for each insect pest separately to facilitate the comparison of the effects of insecticides on insect pests and their predators on okra plants.

RESULTS

The present research work was carried out to investigate the efficacy of different pesticides against different insect pests and their predators (Table 1) on okra

Table 1: Insecticides and their formations used in the experiment

Treatments	Trade name	Common name	Dose/acre	Chemical group	Dose/plot
T_1	Confidor 200 SL	Imidachoprid	250 mL	New chemistry	6.88 mL
T_2	Sundaphos 60 SL	Methamediphos	500 mL	OP	13.77 mL
T_3	Polo 500 SC	Diafenthiuron	200 mL	New chemistry	5.50 mL
T_4	Mospilan 20 SP	Accetemaprid	125 g	New chemistry	3.44 mg
T_5	Control -	-	-	-	-

Table 2: Population average of jassid on okra crop after application of insecticides

		Post-treatment intervals					
Treatments	Pre-treatment	24 h	48 h	72 h	7 days	14 days	Mean
Confidor	7.08	1.52	0.88	0.36	1.39	2.36	1.30e
Sundphas	7.11	1.58	1.07	1.21	1.98	2.96	1.76d
Polo	7.25	2.57	2.09	2.50	1.38	4.34	2.78b
Mospilan	7.53	2.43	1.89	2.05	2.34	3.19	2.34c
Control	7.25	7.23	7.31	7.55	8.04	8.76	7.78a
Mean	7.24	3.03b	2.65c	2.74c	3.23b	4.32a	-

Mean values with different alphabetic are significantly different at p<0.04

Table 3: Population average of thrips on okra crop after application of insecticides

		Post-treatment intervals					
Treatments	Pre-treatment	24 h	48 h	72 h	7 days	14 days	Mean
Confidor	6.39	1.17	0.71	0.69	1.25	1.98	1.16e
Sundphas	6.60	1.37	0.73	1.17	1.76	2.47	1.50d
Polo	6.65	2.13	1.78	2.02	2.62	3.14	2.34b
Mospilan	6.63	1.77	1.63	1.58	2.35	2.76	2.02c
Control	6.50	6.49	6.45	6.55	6.62	6.51	6.52a
Mean	6.54	1.79c	1.43	1.57d	2.21b	2.81a	-

Mean values with different letters are significantly different at p<0.04

crop during the year 2005. The observations were recorded after 24, 48, 72 h, 7 and 14 days of insecticidal spray. The efficacy of the insecticides were recorded against jassid, thrips, whitefly, mites, spiders, ants and beetles.

Jassid, *Amrasca devatans* (Dist.): All the insecticides were significantly ($p<0.01$) effective against the jassid but Confidor proved to be more effective where jassid mean population was 1.20 plant^{-1} as compared to jassid population of 1.76, 2.34 and 2.78 plant^{-1} recorded in plots sprayed with Sundaphos, Mospilan and Polo, respectively while jassid presence was significantly high (7.78 plant^{-1}) in plots left unsprayed (Table 2).

The periodical observations showed that jassid population was maximally declined to the level of 0.36 plant^{-1} in plots sprayed with Confidor after 72 h of spray and later jassid population again started increasing. Sundaphos suppressed the jassid maximally to the level of 1.07 plant^{-1} after 48 h of its spray, while Polo showed its maximum efficacy after 7 days of spray with jassid population of 1.38 plant^{-1}. The Mospilon remained effective in controlling jassid upto 48 h of its spray and later jassid population gradually increased. The jassid population in control plots remained almost static and was found to a maximum level of 8.76 plant^{-1} after 14 days of sprayed plots. The results were statistically highly significant ($p<0.01$) for observation intervals, insecticides as well as interactions.

Thrips, *Thrips tabaci* (Linn.): The insecticides showed a significant ($p<0.01$) efficacy against the thrips when compared with control plots, where thrips population was high (Table 3). In plots where Confidor was sprayed the thrips population was minimum (1.16 plant^{-1}), while thrips population among treated plots was relatively higher (2.34 plant^{-1}) in case of Polo as compared to the mean thrips population of 6.52 plant^{-1} in control plots. The mean thrips population in plots sprayed with Confidor, Sundaphos, Polo and Mospilan was 1.16, 1.50, 2.34 and 2.02 plant^{-1} as compared to thrips population of 6.52 plant^{-1} under control.

The periodical observations showed that thrips population was maximally declined from 6.39 to the level of 0.69 plant^{-1} in plots sprayed with Confidor after 72 h of spray and later insect population again started increasing. Sundaphos killed thrips maximally and its pretreatment population (6.50 plant^{-1}) declined to the level of 0.73 plant^{-1} after 48 h of spray, while Polo showed its maximum efficacy also after 48 h of spray decreasing thrips population from 6.65-1.78 plant^{-1}. The Mospilon was effective in controlling thrips upto 72 h of its spray and thrips population was 1.58 plant^{-1} against pre-treatment counts of 6.63 plant^{-1}. Later, thrips population started increasing gradually. It was observed that all the insecticides remained effective in controlling thrips even upto 14 days after spray and thrips population was well in control as compared to untreated plots. The differences in the efficacy of different insecticides were statistically significant ($p<0.01$), while differences for intervals were highly significant ($p<0.01$).

Whitefly, *Bemisia tabaci* (Genn.): Whitefly has been the major threat for a number of crops, it not only sucks the sap from crop leaves, but also considered as vector species for different viral diseases. All the insecticides demonstrated a significant control ($p<0.01$) of whitefly when compared with control plots, where whitefly population was significantly high (Table 4). The plots where okra crop was sprayed with Confidor suffered with lowest whitefly population of 1.18 plant^{-1}, while insect population among treated plots was relatively higher (2.66 plant^{-1}) in plots sprayed with Polo as

Table 4: Population average of whitefly on okra crop after application of insecticides

Treatments	Pre-treatment	Post-treatment intervals 24 h	48 h	72 h	7 days	14 days	Mean
Confidor	7.36	1.06	0.20	0.78	1.17	2.06	1.18e
Sundphas	7.31	1.67	1.53	1.46	2.31	4.23	2.24c
Polo	7.34	2.35	2.10	2.25	2.69	3.91	2.66b
Mospilan	7.33	1.23	0.80	1.39	1.71	2.30	1.49d
Control	7.37	7.55	7.54	8.14	8.79	9.55	8.31a
Mean	7.34	2.77c	2.56d	2.80c	3.34b	4.41a	-

Mean values with different letters are significantly different at p<0.04

Table 5: Population average of mite on okra crop after application of insecticides

Treatments	Pre-treatment	Post-treatment intervals 24 h	48 h	72 h	7 days	14 days	Mean
Confidor	7.70	2.28	2.04	1.88	2.47	3.35	2.42 c
Sundphas	7.76	2.22	1.63	2.23	3.08	3.53	2.54 c
Polo	7.70	2.26	2.13	2.53	3.24	4.27	2.89 b
Mospilan	7.73	2.98	2.06	2.28	3.08	3.81	2.84 b
Control	7.76	7.87	8.03	8.38	8.86	9.67	8.56 a
Mean	7.73	3.52 c	3.18 d	3.46 c	4.42 b	4.94 a	-

Mean values with different letters are significantly different at p<0.04

compared control plots (8.31 plant^{-1}). The mean whitefly population in plots sprayed with Confidor, Sundaphos, Polo and Mospilan was 1.18, 2.24, 2.66 and 1.49 plant^{-1} as compared to insect population of 8.31 plant^{-1} in control.

The periodical observations showed that whitefly population was maximally decreased from 7.36 to the level of 0.20 plant^{-1} in plots sprayed with Confidor after 48 h of spray and later insect population again started increasing. Sundaphos damaged whitefly to the level of and its pretreatment population (6.50 plant^{-1}) declined to the level of 0.73 plant^{-1} after 48 h of spray, while Polo showed its maximum efficacy also after 48 h of spray decreasing whitefly population from 7.34 to 2.10 plant^{-1}. The Mospilan was most effective in controlling whitefly upto 48 h of its spray and population was 0.80 plant^{-1} against pre-treatment counts of 7.33 plant^{-1}. Later on, whitefly population started increasing gradually. It was noted that Confidor was more effective insecticide against whitefly as compared to rest of the insecticides. However, all the insecticidal treatments remained effective in controlling whitefly, even after 15 days of spray the population of whitefly was in control. Differences in the efficacy of different insecticides as well as observation periods were highly significant (p<0.01).

Mites *Tetrarychus urticae*: The insecticides demonstrated a significant control (p<0.01) of mites when compared with control plots, where mites population was significantly high (Table 5). The plots where okra crop was sprayed with Confidor had lowest mites population (2.42 plant^{-1}), while insect population among treated plots was significantly higher (2.89 plant^{-1}) in plots sprayed with Polo as compared control plots (8.56 plant^{-1}). The

Table 6: Population average of spider on okra crop after application of insecticides

Treatments	Pre-treatment	Post-treatment intervals 24 h	48 h	72 h	7 days	14 days	Mean
Confidor	0.35	0.23	0.14	0.26	0.50	0.42	0.31
Sundphas	0.43	0.25	0.16	0.41	0.33	0.35	0.30
Polo	0.40	0.20	0.30	0.37	0.30	0.36	0.30
Mospilan	0.51	0.47	0.30	0.35	0.43	0.37	0.38
Control	0.50	0.48	0.64	0.47	0.73	0.47	0.55
Mean	0.44	0.32	0.30	0.37	0.46	0.39	-

mean population of mites in plots sprayed with Confidor, Sundaphos, Polo and Mospilan was 2.42, 2.54, 2.88 and 2.84 plant^{-1} as compared to insect population of 8.562 plant^{-1} in control.

The periodical observations showed that mites population was decreased from 7.77 to its minimum (1.66 plant^{-1}) in plots sprayed with Sundaphos after 48 h of spray and later insect population started rising. Confidor ranked second after Sundaphos and kept mites population to the level of 1.88 plant^{-1} over pre-treatment population of 7.70 plant^{-1} after 48 h of spray, while Mospilan was also considerably satisfying in controlling mites with minimum insect population of 2.06 after 48 h of spray as compared to its pretreatment counts of 7.73 plant^{-1}. The Polo remained relatively least in controlling mites with its lowest mites population of 2.13 after 48 h of spray as compared to pretreatment population of 7.70 plant^{-1}. It was observed that the efficacy of all the insecticides started decreasing after 48 to 74 h of spray. However, their effects were still enough to control mites even upto 2 weeks after spray. The results were statistically highly significant (p<0.01) for observation periods, insecticidal treatments as well as for their interaction.

Spider sp. *Pholcus phallangiodes*: Spiders are considered as the predators of different insect pests and the insecticides which are less harmful for the predators are preferably applied and suggested by the scientists for growers. All the insecticides were almost equal in effects on the spiders and the mean spider population was 0.31, 0.30, 0.30 0.38 plant^{-1} in plots sprayed with Confidor, Sundaphos, Polo and Mospilan, respectively (Table 6). The differences however, between the population of spiders in plots sprayed with different insecticides were statistically non-significant (p>0.05).

The periodical observations showed that all the insecticides were harmful maximally upto 48 h after spray, later on the spiders population started increasing and the level of pretreatment counts. Furthermore, the spiders population increased considerably after 7 and 14 days of spray, might have they returned to same fields they quit after spray. However, it was observed

Table 7: Population average of ant on okra crop after application of insecticides

Treatments	Pre-treatment	Post-treatment intervals 24 h	48 h	72 h	7 days	14 days	Mean
Confidor	0.73	0.26	0.23	0.15	0.33	0.67	0.33b
Sundphas	0.46	0.47	0.25	0.33	0.43	0.44	0.38b
Polo	0.60	0.25	0.33	0.15	0.40	0.60	0.35b
Mospilan	0.58	0.38	0.24	0.20	0.47	0.45	0.35b
Control	0.74	0.53	0.70	0.55	0.68	0.60	0.61a
Mean	0.62	0.38	0.35	0.28	0.46	0.55	-

Mean value with different letters in rowviz are significantly different at p<0.01

Table 8: Population average of beetle on okra crop after application of insecticides

Treatments	Pre-treatment	Post-treatment intervals 24 h	48 h	72 h	7 days	14 days	Mean
Confidor	0.10	0.03	0.02	0.03	0.02	0.05	0.03
Sundphas	0.35	0.03	0.08	0.05	0.03	0.10	0.06
Polo	0.20	0.03	0.02	0.02	0.05	0.05	0.03
Mospilan	0.20	0.03	0.07	0.07	0.08	0.10	0.07
Control	0.20	0.03	0.03	0.08	0.02	0.04	0.04
Mean	0.20	0.03	0.04	0.05	0.04	0.07	-

that Sundaphos was relatively less harmful to spiders, followed by Polo and Confidor, while Mospilan was found more harmful for the spiders in the field.

Ants sp., *Formica rufa*: Ants are also considered as the predators of different insect pests and are equally important like spiders and beetles. All the insecticides were almost equal in effects on the ants and the mean population of ants was 0.33, 0.38, 0.35 and 0.35 plant^{-1} in plots sprayed with Confidor, Sundaphos, Polo and Mospilan, respectively (Table 7). The differences between the population of ants in plots sprayed with different insectides were statistically significant ($p<0.01$), while non-significant differences in ant population were noted between periods after spray ($p>0.05$).

The periodical observations showed that Confidor, Polo and Mospilan were actively harmful to ants upto 72 h of their spray with mean ant population of 0.15, 0.15 and 0.20 plant^{-1}. Lateron, the population of ants started increasing and reached ulmost to the same level of pretreatmentr counts. Similarly, Sundaphos was harmful only upto 24 h after spray (0.25 plant^{-1}), lateron the population of ants increased gradually and reached to the maximum counts after 2 weeks of spray. It was observed that Confidor was relatively less harmful to the predating ants, followed by Polo, Mospilan and Sundaphos. It was assumed that predators keep better system to sense the harmful effects and most of them quit the sprayed fields and returned after the toxic effects are declined.

Beetles, *Brumus suturalis*: Beetles are popular predators of aphids and a number of other insect pests. Naturally, beeltes and specially female beetles are slow moving as compared to spiders and ants. The insecticides sprayed all were harmful for the beetles (Table 8) and the mean population of beetles was 0.03, 0.06, 0.03 and 0.07 plant^{-1} in plots sprayed with Confidor, Sundaphos, Polo and Mospilan, respectively. The differences between the population of beetles in plots sprayed with different insectides and observation periods after insecticidal spray were statistically non-significant ($p>0.05$).

The periodical observations showed that Confidor and Polo were relatively more harmful to beetles upto 7 days and 72 h of their spray with mean beetles population of 0.03 and 0.03 plant^{-1}, respectively. While, Sundaphos and Mospilan were relatively more harmful for predators upto 24 h of spray with mean beetle population of 0.03 and 0.03 plant^{-1}, respectively. However, it was transparent that beetles were drastically killed by all the insecticides sprayed, but the non-significant differences happened because of bigger variation in populations within the same treatments. However, Confidor and Polo were more harmful to beetles as compared to Sundaphos and Mospilan.

DISCUSSION

The present experiment was conducted to determine the effect of some insecticides on the population of insect pests and predators on okra crop during the year 2005.

It was observed that all the insecticides were significantly ($p<0.01$) effective against the jassid but Confidor proved to be more effective as compared to Sundaphos, Polo and Mospilan. The results were statistically highly significant ($p<0.01$) for observation intervals, insecticides as well as interactions. Similar results have been reported by Mahal *et al.* (1994a), who reported that jassid was the major pest of okra and among predators spiders, ants and beetles played significant role in balancing population of harmful insects in the crop. Misra (2002), Mishra and Mishra (2002), Ravi Kumar *et al.* (2003) and Rajpal and Joshi (2003) also reported that jassid was the major okra pest and spiders and beetles were the main defenders. They also reported that methamidaphos controlled the harmful insects and predator population was not affected.

The insecticides showed a significant ($p<0.01$) efficacy against the thrips when compared with control plots, where thrips population was alarmingly high. It was observed that all the insecticides remained effective in controlling thrips even upto 14 days after spray and thrips population was well in control as compared to untreated plots. The differences in the efficacy of different insecticides and intervals were highly significant ($p<0.01$).

Kapadia and Mittal (1995) and Verma and Harsha (1997), found thrips as one of the major pests of okra and they have reported good control of this pest by the application of monocrotophos. They also reported that the population of spiders and ants was less affected by application of this insecticide and controlled the harmful insects in okra.

Whitefly has been the major threat for a number of crops, it not only suck the sap from crop leaves, but also considered as vector species for different viral diseases. All the insecticides demonstrated a significant control ($p<0.01$) of whitefly when compared with control plots, where whitefly population was significantly high. It was noted that Confidor was more effective insecticide against whitefly as compared to rest of the insecticides. However, all the insecticidal treatments remained effective in controlling whitefly, even after 15 days of spray the population of whitefly was in control. Differences in the efficacy of different insecticides as well as observation periods were highly significant ($p<0.01$). Kapadia and Mittal (1995), Singh and Gupta (1996) and Verma and Harsha (1997) found whitefly the most disaster for the okra crop and considered as the causal organism for most of the diseases also.

The insecticides demonstrated a significant control ($p<0.01$) of mites when compared with control plots, where mites population was significantly high. It was observed that the efficacy of all the insecticides started decreasing after 48 to 74 h of spray. However, their effects were still enough to control mites even upto 2 weeks after spray. The results were statistically highly significant ($p<0.01$) for observation periods, insecticidal treatments as well as for their interaction. Similar results have also been reported by Kaur (2002) and Rao and Rajendran (2002) who reported mites damaging okra leaves and fruits considerably and they applied different insecticides for its control and the recorded good control of mites by Cypermethrin application.

Spiders are considered as the predators of different insect pests and the insecticides which are less harmful for the predators are preferably applied and suggested by the scientists for growers. All the insecticides were almost equal in effects on the spiders. All the insecticides were harmful maximally upto 48 h after spray, later on the spiders population started increasing and it was more or less reached to the level of pretreatment counts. Similar was the situation regarding population of spiders in control plots. It was assumed that spiders were more sensible and after insecticidal application they might tried to quit the toxic plantation. Furthermore, the spiders population increased considerably after 7 days and 14 days of spray, might have they returned to same fields they quit after spray. However, it was observed that Sundaphos was relatively less harmful to spiders, followed by Polo and Confidor, while Mospilan was found more harmful for the spiders in the field. It was observed that Confidor was relatively less harmful to the predating ants, followed by Polo, Mospilan and Sundaphos. It was assumed that predators keep better system to sense the harmful effects and most of them quit the sprayed fields and returned after the toxic effects are declined. Similar findings have also been reported by Mahal *et al*. (1994b), who found spiders, ants and beetles as the main defenders, while Ravi Kumar *et al*. (2003) found Malathion, methamidophos and monocrotophos as economical insecticides because of less damage to predators after their application and economically controlled the harmful insects.

Beetle are popular predators of aphids and a number of other insect pests. Naturally, beeltes and specially female beetles are slow moving as compared to spiders and ants. However, it was transparent that beetles were drastically killed by all the insecticides sprayed, but the non-significant differences happened because of bigger variation in populations within the same treatments. However, Confidor and Polo were more harmful to beetles as compared to Sundaphos and Mospilan. Kapadia and Mittal (1995) have reported similar results and reported that beetles were the major predators of aphids and jassids and Verma and Harsha (1997) found monocrotophos as an effective insecticide against jassid, thrips, whitefly and predators were less affected by this group of insecticides.

CONCLUSIONS

- All the insecticides were effective against jassids, thrips, whitefly and mites, but Confidor proved to be most effective equally against all the insect pests as compared to Sundaphos, Polo and Mospilan.
- Confidor also proved better than other insecticides, because the population of predators i.e., spiders, ants and beetles was less affected by Confidor application as compared to Sundaphos, Polo and Mospilan.

REFERENCES

Aslam, M. and F. Gebara, 1995. Host plant preference of vegetables by cotton whitefly, *Bemisia tabaci* (Genn.). Pak. J. Zool., 27: 269-272.

Bhatti, I.M. and A.H. Soomro, 1996. Agricultural Inputs and Field Crop Production in Sindh 2nd Rev. Edn. Direct. Gen. Agric. Res. Sindh, Hyd. Sindh, Pak., pp: 95-107.

Gowri, S., G. Ramachandrarao and B. Nagalingam, 2002. Impact of neem formulations on coccinellid predators of okra pest complex. Pest. Res. J., 14: 242-243.

Henry, E., 2001. Commercial okra production. University of Arkansas Cooperative Extension Program, University of Arkansas at Pine Bluff, United States Department of Agriculture and County Governments Cooperating, pp: 1-3.

Hormchan, P., A. Wongpiyasatid and S. Piyapuntawanon, 2001. Observation of gamma irradiated cotton populations on trend of cotton leafhopper resistance using hopperburn index. Kasetsart J. (Nat. Sci.), 35: 386-391.

Jacquelyn, W., 1999. Agriculture Businesses Communities Families Home and Garden Kids Ar Us Natural. University of Arkansas Cooperative Extension Program, University of Arkansas at Pine Bluff, United States Department of Agriculture and County Governments Cooperating, Arkansas, USA., pp: 1-3.

Jech, L.E. and S.H. Husman, 1998. Improved areawide whitefly management through industry and extension partnership. Proc. Beltwide Cotton Conf. San Diego, California, USA., 5-9 Jan., 2: 1081-1083.

Kapadia, M.N. and V.P. Mittal, 1995. Record of two egg parasitoids of the okra jassid *Amrasca devastans* (Dist.). Gujrat Agric. Univ. Res. J., 20: 180-181.

Kaur, S., 2002. Management of cotton jassid, *Amrasca devastans* (Dist.) and spotted bollworm, *Earias* sp. in okra. Veg. Sci., 29: 172-175.

Kumar, B.S., 2004. Okra, planting and propagation, problems and care. Web-India. Webindia123.com., pp: 2.

Mahal, M.S., L.S. Brar, R. Singh and B. Singh, 1994a. Effect of simulated initiation of cotton jassid, *Amrasca devastans* (Dist.) infestation at different crop ages on seed yield of okra. Pest Manag. Econ. Zool., 2: 27-30.

Mahal, M.S., L.S. Brar, R. Singh and B. Singh, 1994b. Influence of varying magnitude of jassid injury on seed yield of okra and economics of its control. J. Insect-Sci., 7: 129-132.

Mazumder, N., U. Borthakur and D. Chaudhury, 2001. Incidence of yellow vein mosaic virus of bhindi *Abelmoschus esculentus* L. Moench in relation to cultivar and vector population under different sowing dates. Indian. J. Virol., 12: 137-141.

Mishra, N.C. and S.N. Mishra, 2002. Impact of biopesticides on insect pests and defenders of okra. Indian J. Plant Prot., 30: 99-101.

Misra, H.P., 2002. Field evaluation of some newer insecticides against aphids (*Aphis gossypii*) and jassids *Amrasca devastans* (Dist.) (on okra. Indian J. Entomol., 64: 80-84.

Rao, N.S. and R. Rajendran, 2002. Joint action potential of neem with other plant extracts against the leafhopper, *Amrasca devastans* (Dist.) on okra. Pest Manage. Econ. Zool., 10: 131-136.

Rajpal, S. and A.K. Joshi, 2003. Pests of okra *Abelmoschus esculentus* (Moench). in Paonta Valley, Himachal Pradesh. Insect Environ., 9: 173-174.

Ravi Kumar, S.S., B.S. Chhillar and H.R. Rohilla, 2003. Toxicity of nitroguanidines/neonicotinoids and conventional insecticides against leafhopper *Amrasca devastans* devastans on okra under screen-house. Indian J. Entomol., 65: 268-272.

Singh, R. and G.P. Gupta, 1996. Effect of insecticidal schedules on intermittent population of jassid and whitefly and pod yield of okra. Pest. Res. J., 5: 179-185.

Verma, V.S. and D. Harsha, 1997. Toxicity of monocrotophos against jassid *Amrasca devastans* on okra *Abelmoschus esculentus* L. J. Maharashtra Agric. Univ., 16: 119-126.

Yadav, S.K., B.S. Dhankhar, D.P. Deswal and R.P.S. Tomer, 2001. Effect of sowing date and plant geometry on seed production and quality of okra, *Abelmoschus esculentus* L. (Moench) cv. Varsha Uphar. Seed Res., 29: 149-152.