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Infestation of *Earias* spp. on Cotton and Okra Grown as Mono and Mix Crops

G.H. Abro, A.J. Memon, T.S. Syed and A.A. Shaikh
Department of Entomology, Sindh Agriculture University, Tandojam, Pakistan

Abstract: Studies were carried out to investigate the effect of growing of cotton and okra as mono and mix crops or polycultures on percent infestation of *Earias* spp. on cotton and okra under field conditions. The results revealed that *Earias* spp. infestation on okra appeared about 45 days after sowing of the crop; whereas, on cotton the pest appeared atleast one month later than it appeared on okra. Two years data indicated a highly significant ($F=14.36$; $DF = 6, 3$, $P<0.01$) difference in percent infestation of *Earias* spp. on different mono and mix crops of cotton and okra. The highest *Earias* spp. infestation (18.45%) was recorded on okra grown as mono crop followed by okra mix, cotton mono crop and cotton mix crop with percent infestation of 10.29, 5.97 and 3.90, respectively. It was concluded that okra could be used as a trap crop for the population management of *Earias* spp. in cotton crop.

Key words: *Earias* spp. Trap crop, mono crop, pest infestation

INTRODUCTION

The spotted bollworm, *Earias* spp. (Lepidoptera: Noctuidae) is a very serious and polyphagous pest attacking many plants of Malvaceae family. Cotton and okra are economically the most important crops attacked by this pest. Two species, that is, *Earias vittella* and *Earias inisulana* are widely distributed in North Africa, Indo-Pakistan sub-continent and other countries of the world^[1]. The pest is active almost throughout the year on its different host plants under field conditions^[2,3]. In cotton crop, its initial attack is noticed in June and July. The attack on the bolls is generally higher than buds. Maximum infestation is recorded during August and September^[4]. As a result of attack the quality and quantity of the cotton is reduced. A single larva can destroy several buds and bolls in its life. Among bollworms, *Earias* spp. are more abundant on cotton in Sindh as compared to other bollworm species^[5] and cause 3.8 to 12.6% damage^[6]. Whereas, Abro *et al.*^[3,2] have reported 1.79 to 2.38% infestation of cotton bolls due to *Earias* spp.

Earias spp. are also serious pests of okra, they attack growing points, but when fruiting bodies start to appear, feed mostly inside squares, flowers and fruits. A larva damages several fruiting bodies in its life span. The economic injury level of *Earias* spp. on okra is reported to be 5.3% damage^[7] and about 36% of harvestable fruits are damaged by *Earias* spp.^[8]. Various authors have reported the damage caused by *Earias* spp. to okra crop for example, Srinivanan and Krishnakumar^[9] reported 9.3% infestation of *E. vittella*. Dhawan and Sindhu^[10] observed maximum damage of 67.7% caused to fruits and 25.04% to

buds of okra by *Earias* spp. in late October. *Earias* spp. is more severer in Indo-Pakistan sub-continent than other countries of the world^[1]. The most common host plants of *Earias* spp. in Pakistan are okra, cotton, Gul-e-Khera, *Althea rosea* and a weed, *Abutilon indicum*.

Intercropping or mix cropping involving simultaneous growing of two or more crops on the same piece of land is known as polyculture^[11], creates plant diversity which affects the population dynamics of insect herbivores in agricultural and natural communities^[12-14]. In general, specialist insect herbivores exhibit lower population densities and damage in diverse habitats compared with simple habitats^[15,16]. Numerous studies on pest population density and crop yield losses indicated that 56% of herbivores had lower population densities, 16% had higher densities and 28% had similar or variable densities in polycultures compared with mono cultures^[11,13,17]. Since *Earias* spp. are major pests of cotton and okra in Sindh, Pakistan. No research work is reported on their comparative levels of infestation on cotton and okra and effect of mixed cropping with non-host crops on the level of infestation in cotton and okra. Therefore, present study were conducted to investigate the effect of mono and mix cropping on infestation of *Earias* spp. in cotton and okra. Such studies will help in the understanding of the ecology and population management of these pests under field conditions.

MATERIALS AND METHODS

The study on the effect of mono and mix cropping on level of infestation of *Earias* spp. in cotton and okra crops was carried out at the Latif Experimental Farm, Sindh

Agriculture University, Tandojam, Pakistan during early and late summer 1997 and early summer 1998 seasons. Cotton, *Gossypium hirsutum* (cv. NIAB-78); okra, *Abelmoschus esculentus* (cv. Pusa Sawami), guar, *Cyamopsis psoraloides*, mung, *Phaseolus aureus*, till, *Sesamum indicum* and maize, *Zea mays* were selected for the study. The criterion for selection of crops was that crops selected must belong to different taxonomic categories and should have almost the same plant height so that they should not cause shade on neighbouring crop plants. The crops were planted on March 11, 1997. The second late summer experiment was carried out on August 11, 1997, while the third experiment was sown on March 10, 1998.

Experimental design: All the experiments were laid out in a completely randomized block design with four replications. The treatment size was 20x40 ft. All agronomic practices were carried out as usual. The experimental plots did not receive any insecticide sprays. A constant row to row space of 75 cm was maintained in all the treatment plots.

The mono crop treatments were maintained by growing either cotton or okra in a pure stand, while intercrop combinations were obtained by planting complete rows of different crop plants at random.

Sampling: *Earias* spp. infestation in mono and mix crops cotton and okra was assessed by estimating the damage caused by borer. The percentage fruit damaged by larvae of *Earias* spp. was evaluated by counting the total and attacked number of fruits in a sample of five plants selected at random per treatment. The observations were taken in the morning hours at weekly intervals. The data were recorded from 45 days after sowing of seeds in the field till harvest of the crop.

All the data obtained were subjected to the analysis of variance (ANOVA) and standard error of the mean (SEM) was calculated. Means were separated by LSD range test^[13].

RESULTS AND DISCUSSION

Cotton: The results of *Earias* spp., infestation in cotton grown as mono and mix crops are shown in Table 1. The results show that pest appearance in cotton grown as mono crop was recorded in the second week of July with 1.09% infestation. The pest infestation in cotton remained fluctuating throughout the season. The infestation of *Earias* spp. in case of cotton grown as a mix crop started in the first week of June (Table 1) and remained fluctuating erratically throughout the season. The highest infestation (17.08%) was recorded in the fourth week of September.

Table 1: Percent infestation of *Earias* spp. on cotton and okra fruits grown as mono and mixed crops under field conditions during early summer 1997 (X±SE)

Date	Cotton (NIAB-78)		Okra (Faisalabad M-1)	
	Mono crop	Mix crop	Mono crop	Mix crop
April 26	0.00	0.00	2.52	0.86
May 1	0.00	0.00	9.30	0.00
May 9	0.00	0.00	2.19	1.09
May 17	0.00	0.00	3.14	1.20
May 24	0.00	0.00	10.30	5.17
May 31	0.00	0.00	14.47	1.02
June 7	0.00	0.50	8.13	15.38
June 15	0.00	0.54	5.00	6.09
June 21	0.00	0.00	6.09	12.32
June 29	0.00	0.00	5.68	4.54
July 6	0.00	0.47	11.25	18.00
July 13	1.09	5.09	6.31	12.98
July 21	1.41	0.59	9.69	6.09
July 27	2.91	0.98	16.92	6.06
August 5	1.28	3.57	18.64	13.04
August 14	8.87	2.60	28.26	10.14
August 23	5.76	3.45	18.64	13.04
September 01	7.32	3.66	21.81	22.38
Sept. 09	5.17	2.90	21.31	15.27
Sept. 18	9.44	14.88	29.16	2.91
Sept. 22	7.18	17.08	36.95	2.53
X SE	2.40±0.73a	2.71±1.03a	13.61±2.12c	8.10±1.43b

Means followed by same letter(s) are not significantly different from each other (P<0.05) by LSD method.

Table 2: Percent infestation of *Earias* spp. on cotton and okra fruits grown as mono and mixed crops under field conditions during late summer 1997 (X±S.E.)

Date	Cotton (NIAB-78)		Okra (Desi)	
	Mono crop	Mix crop	Mono crop	Mix crop
Sep 27, 1997	0.00±0.00	0.00±0.00	72.73±0.00	0.00±0.00
Oct 04, 1997	0.00±0.00	0.00±0.00	34.61±0.01	0.00±0.00
Oct 11, 1997	0.00±0.00	0.00±0.00	44.83±0.01	23.10±0.01
Oct 18, 1997	0.00±0.00	0.00±0.00	41.18±0.01	15.00±0.02
Oct 25, 1997	0.00±0.00	0.00±0.00	34.04±0.02	22.73±0.01
Nov 1, 1997	33.33±0.01	14.10±0.04	33.34±0.03	29.16±0.01
Nov 8, 1997	18.18±0.02	15.94±0.10	19.51±0.06	17.14±0.02
Nov 15, 1997	16.67±0.02	13.26±0.15	17.50±0.05	18.18±0.02
Nov 22, 1997	09.52±0.04	14.70±0.19	10.75±0.05	10.34±0.04
Nov 29, 1997	09.61±0.04	08.99±0.25	09.64±0.06	10.94±0.04
Dec 06, 1997	03.70±0.08	11.66±0.08	06.49±0.03	06.66±0.05
Dec 13, 1997	0.00±0.00	0.00±0.00	11.36±0.03	06.66±0.04
Dec 19, 1997	0.00±0.00	0.00±0.00	05.00±0.06	09.50±0.03
Dec 27, 1997	0.00±0.00	0.00±0.00	08.33±0.03	0.00±0.00
Mean±S.E.	06.50±0.72b	05.61±0.89b	24.95±1.39a	12.10±0.06b

Mean followed by the same letter(s) are not significantly different from each other (P<0.05) by LSD method.

The overall seasonal mean infestation of *Earias* spp. in cotton grown as mono and mix crops was 2.40 and 2.71%, respectively. *Earias* spp. appeared approximately 15 days later on cotton as monocrop than it appeared on cotton grown as a mix crop under field (Table 1). Comparison of seasonal infestation means of *Earias* spp. on cotton grown as mix crops and mono crop by t-test indicated that differences between infestation means were non-significant.

A further analysis of data in Table 1 indicated that the seasonal infestation means of *Earias* spp. on okra grown as mono crop was significantly higher (P<0.001)

than on cotton mono crop and okra grown as mix crops also had infestation significantly ($P < 0.01$) higher than it was on cotton mix crop (Table 1).

Earias spp. infestation in cotton grown as mono and mix crops during late summer crop is shown in Table 2 indicated that pest infestation occurred on November 01, 1997 and disappeared in the second week of December in both crops. The highest overall percent infestation was observed in okra grown as mono crop (24.95%) followed by okra mixed crop (12.10%), cotton mix crops (6.50% and cotton mono crop (5.61%).

Infestation of *Earias* spp. in cotton grown as mono and mix crop during 1998 are shown in Table 3. Pest appeared first in cotton grown as mono crop in the fourth week of May, whereas, it appeared almost four weeks later in cotton grown as mix crop. Pest infestation in cotton grown as mono crop was higher than in cotton grown as mix crop. Seasonal mean infestation of *Earias* spp. in cotton grown as mono crop was significantly ($P < 0.05$) higher than in cotton grown as mix crop. The results also showed that *Earias* spp., appeared on okra grown as mono and mix crops during fourth week of April, whereas in cotton mono crop it appeared a month later, that is, on May 24 and in cotton mix crop on June 21, 1998. There is a time gap of more than one month in pest appearance on okra and cotton. On overall mean basis, maximum infestation (16.80%) was found on okra grown as mono crop, followed by okra mix crop (10.67%), cotton mono crop (9.89%) and cotton mix crop (2.50%).

The data in Table 4 indicated the overall position of infestation of *Earias* spp. on okra and cotton grown as mono and mix crops during different seasons and years. The highest infestation (18.45%) was recorded on okra grown as mono crop and the minimum (3.90%) on cotton grown as a mix crop. The *Earias* spp. infestation on different crops was highly significant ($F=14.36$, $DF=6,3$ $P < 0.01$).

Okra: The results of early summer crop shown in Table 1 which indicated the effect of mono and mix cropping on the infestation of *Earias* spp., in cotton and okra. Infestation of *Earias* spp. started its occurrence in okra both as mono and mix crops in the fourth week of April. In okra, grown as mono crop infestation started with 2.52% and kept on increasing, although erratically. The first peak of infestation of 14.47% was observed in the fourth week of May, infestation then declined and the second peak was observed as high as 28.25% in the second week of August. The infestation again declined there after. The final infestation peak of 36.95% was recorded in the fourth week of September and then crop was harvested.

Table 3: Percent infestation of *Earias* spp., on cotton and okra fruits grown as mono and mixed crops under field conditions during 1998 (X±S.E)

Dates	Cotton (NIAB-78)		Okra (Faisalabad M-1)	
	Mono crop	Mix crop	Mono crop	Mix crop
April 25, 1998	0.00±0.00	0.00±0.00	5.26±0.04	2.2±0.06
May 3, 1998	0.00±0.00	0.00±0.00	8.69±0.03	2.95±0.10
May 10, 1998	0.00±0.00	0.00±0.00	10.34±0.03	3.40±0.08
May 17, 1998	0.00±0.00	0.00±0.00	8.57±0.04	4.20±0.01
May 24, 1998	4.23±0.08	0.00±0.00	10.00±0.04	4.55±0.07
May 31, 1998	2.42±0.18	0.00±0.00	10.86±0.04	5.60±0.14
Jun 6, 1998	2.81±0.17	0.00±0.00	9.83±0.05	6.20±0.10
Jun 14, 1998	4.10±2.23	0.00±0.00	12.12±0.04	7.0±0.12
Jun 21, 1998	5.35±0.16	1.66±0.66	12.32±0.05	7.40±0.12
Jun 28, 1998	6.79±0.13	2.70±0.43	13.75±0.05	8.25±0.08
July 5, 1998	8.19±0.08	2.70±0.43	15.38±0.04	9.40±0.11
July 12, 1998	8.23±0.24	2.94±0.40	17.64±0.04	9.60±0.11
July 19, 1998	9.67±0.23	2.94±0.40	18.10±0.04	10.30±0.06
July 26, 1998	10.32±0.12	2.79±0.40	17.55±0.05	10.60±0.11
August 2, 1998	10.92±0.06	2.97±0.42	18.18±0.06	11.40±0.10
August 9, 1998	11.65±0.18	3.60±0.37	20.39±0.07	11.65±0.10
August 16, 1998	12.24±0.13	3.82±0.30	20.18±0.05	12.20±0.08
August 21, 1998	13.05±0.12	3.53±2.92	20.78±0.04	12.90±0.10
August 30, 1998	13.94±0.12	3.65±0.31	20.53±0.05	13.10±0.08
Sep 6, 1998	14.70±0.10	3.93±0.30	20.68±0.06	13.80±0.09
Sep 13, 1998	15.40±0.20	3.70±0.30	20.54±0.07	13.85±0.09
Sep 20, 1998	15.98±0.18	3.91±0.25	20.67±0.07	13.95±0.09
Sep 27, 1998	16.74±0.12	4.02±0.23	20.54±0.04	14.05±0.11
Oct 4, 1998	17.22±0.16	4.36±0.29	20.93±0.05	14.20±0.11
Oct 11, 1998	17.73±0.13	4.31±0.30	21.40±0.06	14.80±0.13
Oct 18, 1998	18.42±0.13	4.64±0.28	21.47±0.07	14.90±0.13
Oct 25, 1998	18.10±0.14	4.89±0.27	12.15±0.06	14.95±0.11
Nov 1, 1998	15.69±0.13	4.05±0.25	22.28±0.07	15.40±0.14
Nov 8, 1998	14.62±0.12	3.39±0.30	23.53±0.08	15.90±0.14
Nov 15, 1998	13.49±0.15	3.01±0.32	25.31±0.09	15.95±0.14
Nov 22, 1998	11.96±0.19	2.92±0.29	23.55±0.09	14.90±0.13
Nov 29, 1998	11.82±0.15	2.64±0.43	18.76±0.06	13.20±0.10
Dec 6, 1998	9.76±0.14	1.76±0.32	17.56±0.10	11.80±0.11
Dec 13, 1998	6.76±0.17	1.55±0.64	15.94±0.08	10.25±0.15
Dec 20, 1998	5.28±0.28	1.32±0.86	12.35±0.12	8.90±0.15
Mean±S.E	9.89±0.16b	2.50±0.04c	16.80±0.14a	10.67±0.20b

Means followed by the same letter(s) are not significantly different from each other ($p < 0.05$)

Table 4: Overall percent infestation of *Earias* spp., on cotton and okra fruits grown as mono and mix crops during 1997 and 1998

Year	Cotton		Okra	
	Mono crop	Mix crop	Mono crop	Mix crop
Early Summer 1997	2.40	2.71	13.61	8.10
Late summer 1997	5.61	6.50	24.95	12.10
Summer 1998	9.89	2.50	16.80	10.67
Mean± S.E	5.97±2.17ab	3.90±1.30a	18.45±3.38d	10.28±1.17bc

Means followed by the same letter(s) are not significantly different from each other ($P < 0.05$)

The infestation of *Earias* spp. on okra grown as mixed crop along with other crop plants started its occurrence in the fourth week of April with 0.86% infestation. The infestation remained erratic and the first peak of infestation was recorded in the first week of June as 15.38% infestation. The infestation decreased after that and remained fluctuating till the first week of September when the second peak of infestation was recorded (22.38%), infestation remained declining in the subsequent observations till harvest of crop.

The overall seasonal mean infestation of *Earias* spp. in okra grown as mono and mix crop was 13.61 and 8.10%, respectively. The infestation of *Earias* spp. in okra grown as mono crop was higher than on okra grown as mix crop, the infestation differences were statistically highly significant ($P < 0.001$).

The results of late summer crop shown in Table 2 revealed that *Earias* spp. appeared first in okra grown as mono crop during fourth week of September with a maximum infestation of 72.73%. Pest infestation in mix crop was recorded two weeks later. The highest peak in okra grown as mix crop was 29.16% recorded on November, 01. *Earias* spp., infestation in okra grown as mono crop remained higher than in okra grown as mix crop. The overall seasonal mean infestation of *Earias* spp., in okra grown as mono and mix crops was 24.95 and 12.10%, respectively. The infestation difference between seasonal means of okra grown as mono and mix crop was statistically significant ($P < 0.05$).

Earias spp. infestation on okra grown as mono and mix crops during 1998 is shown in Table 3. The results showed that *Earias* spp. appeared on okra grown as mono and mix crops during fourth week of April. The pest remained active in the crop till December, when crop was harvested. Pest infestation was higher on okra grown as mono crop compared with mix crop. The seasonal mean infestation of *Earias* spp., on okra grown as mono crop was 16.80% which was significantly ($P < 0.05$) higher than on okra grown as mix crop.

Much of the variability in abundance patterns of herbivorous and their natural enemies with respect to vegetational diversity may be a consequent of their range of resource needs. Comparative studies of generalist and specialist herbivores showed that incorporation of nonhosts in the system can result in reduced densities of herbivores. Thus, generalists would be expected to be less sensitive to plant diversity, on an average, than are specialists^[19-21]. As such *Earias* spp. is an specialist herbivore feeding on the host plants which belong to Malvaceae family. It is expected that *Earias* spp. infestation will be greater on cotton and okra when grown as mono crops compared to mix crops, as has been observed in the present study. Similar results are reported by many workers such as, Letourneau^[21] observed *Empoasca* leaf hoppers more abundant on squash in monoculture than in polyculture. Matteosn^[22] sampled insect pests and their natural enemies on cowpea in mono crop and cereal-inter crop plots and found that population of flower thrips, *Megalunothrips ajostedti* (Trybom) were reduced by 42% and predators mostly *Orius* spp. by 23% on cowpea in maize intercrop plots. Dash *et al.*^[23] conducted experiments on the effect of mixed and

intercropping on the occurrence of some pests in arhar and cotton crops and observed that the incidence of important insect pests in pure cropping situation was higher than in the mixed and intercropping systems. Similarly, Mole *et al.*^[24] reported that cotton cowpea intercropping system recorded minimum incidence of bollworm complex.

Afifi and Hayer^[33] studied the effect of intercropping systems on onion and garlic infestation with *Thrip tabaci* Lind. The *T. tabaci* numbers were highest on onion alone compared to garlic alone and numbers found in tomato + onion and tomato + onion + garlic plots were significantly lower than in plots of onion and garlic alone. Ofuya^[25] made observations on insect infestation and damage in cowpea intercropped with tomato and found that intercropping reduced infestation of cowpea by *Empoasca dolichi*. Damage by *Helicoverpa armigera* and pod sucking bugs, *Riptortus* spp. was also reduced and seed yield was increased in the intercropped cowpeas. Aliyageen and Alghali^[26] conducted experiments on the intercropping as a component in insect pest management for grain cowpea production. Intercropping reduced the number of flower thrips and pod sucking bugs but made no difference to the number of pod borers. While, Picano *et al.*^[27] found intercropping tomato with maize reduced the level of attack by *Tuta absoluta* to stem apices and the leaves and caused greater attack by *H. zea* to tomato.

The results of presents study indicated that infestation of *Earias* spp. on okra grown as mono crop appeared earlier than its appearance on cotton. Kumar and Urs^[28] also reported infestation of shoots and fruits of okra by *E. vittella* started in second and sixth week after germination of crop. Infestation of *Earias* spp. on okra in present study was more severe compared with cotton when sown as mono crops indicating that okra is preferred host of *Earias* spp. Similar observations are also reported by Dongre and Rahalkar^[29] who examined the relative food plant preference and induction of preference for feeding in larvae of *Earias vittella* and found that out of five food plants okra was the most preferred food plant. Similarly, Hirmath^[30] observed the suitability of common food plants of *Earias* spp. and observed that under laboratory, the growth of *Earias* spp. was fastest on okra followed by cotton and hollyhock. In free choice experiments okra was the most preferred host plant for ovoiposition. Thimmalah and Raju^[31] conducted experiments on the possibilities of using okra as a trap crop in cotton bollworm management and showed that on an average 1.49 to 4.91 and 0.75 to 3.65 eggs of *E. vittella* per okra fruit were trapped during two year study which constituted 60-70% of eggs. Tomato intercropped with

pigeon pea, okra, field bean, sunflower and maize registered 21.9, 16.3, 17.9, 39.3 and 34.3% reductions in fruit borer, *H. armigera* incidence, respectively, as compared with tomato as mono crop. The reduction in fruit borer incidence was at a maximum (93.5%) when tomato was intercropped with marigold^[34]. It could be concluded from the results of present study that okra is a preferred host of *Earias* spp. Okra could be used as a trap crop for the population management of *Earias* spp., in cotton.

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