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Integrated Pest Management of Cotton's Spiny Bollworm (*Earias insulana*) with Spray of Diazinon and Relaese of Green Lacewings

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Abstract: Cotton (*Gossypium hirsutum*) was planted, in a Complete Randomized Block Design (CRBD) in an experimental field of Agricultural faculty of Razi University in Kermanshah, Iran, for a two years period. Four treatments applied, 3 different concentrations of an organophosphorous insecticide, Diazinon, plus control (without spraying of any insecticide). One month after spray of insecticide, release of 2nd instar larvae and or eggs of green lacewing *Chrysoperla lucasina* was done. The number and weight of attacked, blind, or blossomed bolls, was considered as index of efficacity, of certain insecticide concentration, together with release of lacewing.

Key words: IPM, *Earias insulana*, cotton, diazinon, *Chrysoperla lucasina*

INTRODUCTION

Cotton, as a major fiber crop, is subject, to damage, by different kind of insect pests, most important between them, are whiteflies and Lepidopteran pests. Although, in recent years, many researchers focused, to organic practice, without use of chemical insecticides, but this sort of practice was not successful, at least, in Cotton production. For example, in California, cost of production per bale of cotton, were on average, 37% higher, for organic, than for conventional cotton (Swezey *et al*., 2007).

As an alternative to treating pests, exclusively with insecticides, Integrated Pest Management (IPM), by the use of one organophosphorous, Diazinon, with long persistence, together with release of eggs and or larvae of green lacewing *Chrysoperla lucasina*, was used in this experiment. Egypt is one of the big producers of cotton in the world and spiny bollworm, together with *Pectinophora gosypiella* and *Spodoptera littoralis*, are three major pests of cotton there. Integrated control of these pests, by the use of three sprayings of Bt (Agreen) and Spinosad, together with three release of *Trichogramma evanescens* lead to a 79-91% reduction of above mentioned pests (Amin and Gergis, 2006).

Spiny bollworm (*Earias insulana* Boisduval), belongs to the Noctuidae family and the larvae of which are considered one of the important pests of cotton in many parts of the world. In Iran, distribution area of the pest, is in Khorrasan Kermanshah, Kurdistan, Khuzestan, Darab Fars, Gorgan, Gonbad, Veramin and in Khorrasan and Kurdistan, the pest attains 6 generations (Mirmoayedi, 2006).

Cotton (*Gosypium hirsutum*) is a preferred plant for Spiny Boll Worm (SBW), Saini and Ram (1999), in India, used adults (SBW) in laboratory to test their oviposition and found that, they prefered cotton to other plants. Fruits of cotton were favored more for oviposition than leaves or squares. Concerning predatism of *Chrysoperla carnea* on aphids, Reddy (2002) found that odor emitting from different plants should plays a role and odors from eggplant, Okra and pepper are attractive to the adults of *Chrysoperla carnea*, while odors from tomato, are not. Although, different methods of

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IPM, in cotton, are used by researchers, in different countries, but in this experiment, the green lacewings, together with insecticide, as an integrated control method, was used to cope with one of the major pests of cotton and will discuss the success and drawbacks of such an integrated pest control.

MATERIALS AND METHODS

In a two years study period, between 2005 and 2007, cotton variety Veramin were used for present experiments. Before planting the seeds in small holes in soil by hand, they were disinfected by fungicide Vitavax®. The plots were a 4×4 RCBD (Randomized Complete Block Design), each plot, 4×2.5 m and irrigated weekly, during 16 weeks. Planting ground was an experimental field of Agricultural faculty of Razi university. Four treatments, each with four replicas, consisted of the first three, spraying of Diazinon, 85% EC, successively, with work solutions of 0.5/1000, 1/1000 and 1.5/1000 and the last treatment, control, without any spraying of Diazinon. One month later, green lacewing *Chrysoperla lucasina*, were released in each treatment, with exception of control, according the following procedure. First treatment, twenty, 2nd instar larvae, second treatment, ten, 2nd instar larvae, third treatment, twenty eggs. A female gravid adult of green lacewing, *Chrysoperla lucasina*, was collected and reared in laboratory, according the method used by Mirmoayedi and Kharazi (1993). In the end of vegetative phase, when the maximum of bolls were opened, ten plants in each treatment, were chosen randomly and the weights and quantities of healthy and attacked bolls, weighed and counted. Statistical software MSTAT-C, was used, for analysis of variance and Duncan's DMRT, was utilised for comparison of means. Data of quantities and weights of healthy and damaged bolls, in years 2005 and 2007, are respectively mentioned in Table 1 and 2.

RESULTS AND DISCUSSION

Analysis of variance, by MSTAT-C showed that mean Quantity of Healthy Blind Bolls (QHBB) and mean Weight of Healthy Blind Bolls (WHBB), had a significantly difference ($p<0.05$) in different treatments, reciprocal effects of treatment×year had also the same significantly difference. There was also a significantly difference, between mean number of attacked blind bolls (QABB), but statistically speaking, no significantly difference existed, between mean Weight of Attacked Blind Bolls (WABB), in different treatments, i.e., equal effect was seen, in different treatments during two years, 2005 and 2007 (Table 3).

Table 1: Blocks and treatments, weights and quantities of healthy and attacked bolls of cotton, in the year 2005

Blocks and replications	Healthy blind dry bolls		Attacked blind dry bolls		Blossomed healthy bolls		Blossomed attacked bolls	
	Quantity	Weight	Quantity	Weight	Quantity	Weight	Quantity	Weight
1-1	8	43.6	45	152.0	19	30.7	82	163.1
1-2	2	4.8	37	145.8	34	56.6	70	138.2
1-3	4	16.1	53	170.7	18	29.5	60	105.0
1-4	3	3.7	54	120.8	9	9.3	96	140.3
2-1	19	64.5	41	151.2	67	125.4	98	204.5
2-2	4	13.2	46	125.1	9	17.8	90	174.0
2-3	7	18.9	71	194.2	47	65.5	130	217.7
2-4	3	7.4	42	119.9	15	21.3	131	214.0
3-1	3	8.5	35	99.0	41	59.5	58	108.8
3-2	7	22.4	44	133.5	34	63.2	43	90.6
3-3	3	13.1	41	140.7	26	46.5	56	127.5
3-4	4	9.2	36	107.2	38	73.6	59	105.7
4-1	3	9.2	32	125.9	16	30.0	46	88.0
4-2	13	36.5	44	135.9	15	34.2	46	166.3
4-3	4	15.0	23	113.9	35	62.1	55	110.9
4-4	5	18.7	35	123.2	25	62.6	72	193.5

Table 2: Blocks and treatments, weights and quantities of healthy and attacked bolls of cotton, in the year 2007

Blocks and replications	Healthy blind dry bolls		Attacked blind dry bolls		Blossomed healthy bolls		Blossomed attacked bolls	
	Quantity	Weight	Quantity	Weight	Quantity	Weight	Quantity	Weight
1-1	10	39.3	19	60.0	38	276.4	15	97.4
1-2	7	32.7	20	71.4	52	347.0	15	86.2
1-3	14	61.1	23	91.0	49	335.4	9	45.7
1-4	15	56.4	29	104.7	50	366.3	26	177.3
2-1	28	110.8	31	119.4	71	503.9	23	118.9
2-2	9	35.3	11	35.6	48	295.5	15	97.7
2-3	7	23.1	13	57.0	64	435.0	13	65.0
2-4	11	40.4	18	51.7	33	219.9	23	126.3
3-1	15	50.4	27	109.2	52	278.7	16	105.6
3-2	19	95.7	20	75.8	48	393.0	5	36.1
3-3	9	33.9	11	38.9	47	296.1	31	191.8
3-4	10	33.3	33	111.2	22	318.3	56	351.4
4-1	6	25.1	40	151.5	28	160.2	21	130.5
4-2	12	51.9	22	81.1	32	219.1	20	113.6
4-3	6	33.0	30	144.1	14	101.2	17	131.5
4-4	12	48.8	33	130.3	22	145.4	16	97.1

Table 3: Combined analysis of variance, during 2005/2007, by MSTAT-C

Quantity or weight	Years 2005/2007 MS	Treatment MS	Year×treatment MS
QHBB	957.00ns	304.33ns	156.53*
WHBB	7024.08*	555.50ns	106.1 *
QABB	2793.78*	28.78*	157.78ns
WABB	16475.20*	721.74ns	1705.17ns
QBHB	1540.12ns	313.45ns	60.125ns
WBHB	476185.51*	1486.10ns	841.15*
QBAB	23707.53*	670.28*	49.44*
WBAB	4418.00*	6391.87*	2439.02*

*: p<0.05, **: p<0.01; ns: Non significant; QHBB: Quantity of Healthy Blind Bolls; WHBB: Weight of Healthy Blind Bolls; QABB: Quantity of Attacked Blind Bolls; WABB: Weight of Attacked Blind Bolls; QBHB: Quantity of Blossomed Healthy Bolls; WBHB: Weight of Blossomed Healthy Bolls; QBAB: Quantity of Blossomed Attacked Bolls; WBAB: Weight of Blossomed Attacked Bolls

The analysis of variance showed, also, that, there were neither, a significantly difference, between mean Quantities, of Blossomed Healthy Bolls (QBHB), in different treatments, or different years, nor between effect of treatment×year (Table 3), but there was a significantly difference between means of Weight of Blossomed Healthy Bolls (WBHB), in different years and a significantly difference for reciprocal effect of treatment×year, in years 2005 and 2007. There was a significantly difference ($p<0.05$), between means of Quantities of Attacked Blossomed Bolls (QABB) in different treatments and also, a significantly difference, ($p<0.05$), between, means of Weight of Attacked Blossomed Bolls (WABB). DMRT (Duncan's Multiple Range Test), was used to compare, means of quantities and weights of blind healthy and attacked bolls (Table 4). There was no significantly difference, neither between means of quantities, nor between means of weight of such bolls in different treatments. When means of quantities of attacked blind bolls, in treatments 2 and 3, in years, 2005 and 2007, were compared, by the use of Duncan's test ($p<0.05$), there was a significantly difference between means of quantities of attacked bolls, in two years (Table 4). In year 2005, the quantities and weights of attacked bolls (Table 4), in both treatments of 2 and 3, were significantly more, statistically speaking, than, in year 2007 (effect of year), the cause of this was due to a more hot weather, in year 2007, so the increase of the mortality rate of larvae of spiny bollworm, with an impact of less attack, to the bolls, than in year 2005. As in Table 5, comparison of weights of healthy blossomed bolls, between two years, there is a significantly difference ($p<0.05$). Mean weights of healthy blossomed bolls, in different treatments, in 2007, were significantly more, than in 2005 (effect of year). In year 2005, treatment 2, spray of Diazinon 1/1000, with release of 10, 2nd instar larvae of green lacewings, had a

Table 4: Comparison of means of quantities and weights of healthy and attacked blind bolls, in different treatments, in two years 2005/2007, using DMRT

	Healthy				Attacked			
	Quantity		Weight		Quantity		Weight	
Treatment	2005	2007	2005	2007	2005	2007	2005	2007
1	8.25AB	32.25A	31.45AB	56.33A	38.25ABC	29.25BCD	132.00AB	110.00BC
2	6.50AB	13.5AB	19.23AB	55.90A	42.75A	18.25D	135.10AB	65.98D
3	4.50AB	9.0AB	15.77B	37.78AB	47.00A	19.25D	154.90A	82.75CD
4	3.75B	12.0AB	9.75B	44.72AB	41.75AB	28.25CD	117.80ABC	99.57BCD

Mean values with different letter(s) are significantly different

Table 5: Comparison of means of quantities and weights of healthy and attacked blossomed bolls, in different treatments, in two years 2005/2007, using DMRT

	Healthy				Attacked			
	Quantity		Weight		Quantity		Weight	
Treatment	2005	2007	2005	2007	2005	2007	2005	2007
1	35.75AB	47.25A	61.40B	304.8A	71.00AB	18.75C	141.10AB	113.10AB
2	23.00AB	45.00AB	42.95B	313.6A	62.25B	13.75C	142.30AB	83.40A
3	31.5AB	43.50AB	50.90B	291.9A	75.25AB	17.50C	140.30AB	108.50AB
4	21.75B	31.75AB	41.70B	262.5A	89.50A	30.25C	163.40AB	188.00A

Mean values with different letter(s) are significantly different

significantly lower mean quantities, of attacked blossomed bolls, when compared to control treatment (without spray of insecticide, or release of lacewings) (Table 5). In Turkey, Unlu and Efil (2004) measured infestation ratio of (SBW) in blind bolls of cotton and found a different percentage, in Harran plains, compared with other regions of Turkey. This ratio, proved to play an important role, in reducing cotton's yield (Unlu and Bilgic, 2004). Variety of cotton and date of sowing, should both also, have an important role on reduction of infestation ratio (Unlu and Yildiz, 2003). Although the replacement of chemical insecticides with biopesticides is a new approach in plant protection, which is taken into account by many countries in the world, but even such insecticides are not completely safe for predators and parasites. For example, although, some authors indicated of Pyriproxiphen and Tebufenzoide to be harmless to survival of adults of *Chrysoperla carnea* (Medina *et al*., 2001), but, some others, like, Liu and Chen (2001) found that Fenoxycarb as an insect growth regulator, is more toxic to the 3rd instar larvae of *Chrysoperla rufilabris*, in laboratory condition, than to other larval instars, or pupae. Finally other studies indicated, that, Spinosad, another bioinsecticide, to be moderately harmful, for *Chrysoperla carnea* (Cisneros *et al*., 2002). Nowadays, for control of pests of cotton, less and less insecticides are used and more and more, transgenic cotton are planted, in many countries of the world.

In the year 2000, 1.4 136 million ha of Bollgard cotton, was sown, in the USA, representing 25-30% of cotton's acreage of that country. Moar *et al*. (2002) did not seen any adverse effect of this transgenic cotton, versus non target arthropods, including *Chrysoperla carnea*. In Brazil, in a three years experiment, on Bt and non-Bt cotton, population dynamics of important predators, including, green lacewing, *Chrysoperla rufilabris* was not impaired by Bt-cotton (Torres and Rubersun, 2006). But as the planting of transgenic cotton is not yet adapted, by many countries, between them, Iran, so integrated control, for the time being, is the best way to control, pests of cotton, in these countries. West Africa, as a whole, ranks as the sixth largest cotton producer and the third largest exporter, in the world.

Two types of threshold based pest control schemes, for cotton have been introduced by CIRAD (Centre Internationale de Recherche Agronomique et de developement) in collaboration, with national research institutions, to escape, traditional calendar based spraying programme. In the first type (in

Benin, Cameroon and Guinea), insecticides are still applied, according to a calendar (5 or 6 sprayings at a fortnightly intervals), but formulations and dosages depend on the pests observed, on the day before spraying. In the second type (Borkina Faso, Mali, Senegal and Togo), insecticide is applied in a lower dosage than, the usual calendar based programme and scouting is performed, 6 days after spraying. The benefit of application of second type, is a 40-50%, reduction, in insecticide consumption and therefore, a reduction, in cost of cotton production, from US $ 50 ha^{-1}, to less than US $ 30 ha^{-1} (Silvie *et al*., 2001).

Green lacewings (Neuroptera, Chrysopidae) are generalist predators, on aphids, scale insects, mealybugs, thrips, as well as to the eggs and larvae of lepidopterans. Costa *et al*. (2003) found that in greenhouse condition, when different insecticides were tested to evaluate, their toxicity toward the 2nd instar larvae of *Chrysoperla extensa*, released on the leaves of cotton, Fenpropathrin and Chlorpirifos, preserved their persistence, with 30% mortality, up to 25 days. We used in our experiment, an interval of 30 days after spray of Diazinon, for release of *Chrysoperla lucasina* larvae, an interval, safe enough for the larvae of lacewing, not to be intoxicated by the insecticide. Population fluctuations of the common lacewing, *Chrysoperla carnea* Stephens and those of *Bemisia tabaci* (Gennadius) were followed during four years, in cotton, *Gossypium hirsutum*, in Israel. Samples were taken and insecticidal control were applied to determine the importance of *Chrysoperla carnea* as a controlling factor of *Bemisia*, in cotton. The results showed that *C. carnea* was not an efficient controlling agent of *Bemisia tabaci*, in cotton (Gerling *et al*., 1997). Release of *Chrysoperla carnea* as a biological control agent, without use of any insecticide was not successful, for control of spiny boll worm, in cotton (Mirmoayedi, 2001). But in our present experiment, of integrated, pest control, it was found that use of *Chrysoperla lucasina*, together, with spray of Diazinon, more successful, to control (SBW) in cotton. In addition, we agree with Silvie *et al*. (2001), for utilizing low dose of insecticide and disagree with, high dose proposed by Khan and Zahidullah (1999).

CONCLUSION

Although in recent years, many countries of the world have chosen, Bt-cotton, as an ultimate way to control, lepidopterous pests of cotton, but due to many questions, not answered, regarding, this scheme of control, so, there are yet, other countries, including Iran, which do not use Bt-cotton and utilise chemical control, to control pests of cotton. In one aspect, Chemical control, is effective, not only for controlling, lepidopterous pests, but equally for control of other pests of cotton, but in another aspect, it should produce, environmental challenges, such as killing of non target insects and animals and air, soil and water pollutions. So, now, many entomologists, consider, IPM, the only way, to reduce, intense use of insecticides, in agriculture. We used, release of green lacewings, *Chrysoperla lucasina*, together, with one spray of an organophosphorous insecticide, i.e., Diazinon, as an effective way, to reduce multiple use of insecticide spraying in cotton and propose it as an effective way, to control, pests of cotton.

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