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Effect of Three Plant Extracts on Some Biological Aspects of Cotton Leafworm, *Spodoptera littoralis* (Boisd.)

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ABSTRACT

Neonated second instar larvae of the Egyptian cotton leafworm were permitted to feed on castor bean leaves previously immersed in different concentrations of crude extracts from leaves of three plants (i.e. Damsissa, Camphor and Datura). The larvae fed on treated leaves for 24 hrs. then on untreated fresh leaves thereafter. The results showed that, at larval stage, there were reduction of feeding ratio and mean larval weight while larval mortality and antifeedant index increased compared to those of control. For pupal stage, pupal duration and pupal mortality increased while pupal average weight and percent adult emergence decreased compared to those of control. For adult stage, there were reductions in both fecundity and fertility while percent sterility increased compared to those of control. Moreover, the treatments had a latent effect as it reduced the progeny of first generation. Generally, there was a positive correlation between the magnitude of the above toxic effects and the concentrations of all plant extracts. Crude Damsissa extract showed more pronounced toxic effects followed by Datura and Camphor extracts. It could be concluded that once neonate 2nd instar larvae of cotton leafworm (CLW) were exposed to these extracts for 24 hrs. only its subsequent developmental stages suffered from toxic effects which give good evidence for using these extracts as an element for the integrated management of this pest.

Key words: Plant extracts, Cotton leafworm (*Spodoptera littoralis*), Toxicity, Biological aspects.

Introduction

The Egyptian cotton leafworm (CLW), *Spodoptera littoralis* (Boisduval) (Lepidoptera: Noctuidae) is one of the most destructive pests of several crops such as cotton, corn, peanut, clover, vegetables and various fruits in Africa, Asia and Europe (Smagghe and Degheele, 1997; El-Aswad *et al*., 2003 and Ragaei and Sabry, 2011). The cotton leafworm (CLW) is the destructive pest to about 112 host plants from different families in Egypt as well as in Mediterranean and Middle East countries (Kandil *et al*., 2003; El-Sinary *et al*., 2008 and El-Zoghby *et al*., 2011). In addition to its direct damage, reducing photosynthetic area and reduce the marketability of vegetables and ornamentals (Pluschkell *et al*., 1998).

The most effective control measure against cotton leafworm (CLW) has been achieved by using chemical insecticides. Over the past 40 years, the intensive use of broad spectrum insecticides against the cotton leafworm (CLW) had led to the development of resistance to many of them (Smagghe *et al*., 1999; Aydin and Gurkan, 2006 and Rizk *et al*., 2010). Also, the continuous and unwise use of insecticides to control agricultural pests usually lead to adverse effects on beneficial insects, fish and wildlife, hazards to man and animals by environmental pollution, residues in foods (Abdel-Rahim and Azab, 2008; Abdel-Hafez and Mohamed, 2009; Osman and Mahmoud, 2009 and Ehab, 2012).

Recently, research is concentrated on developing safer insecticides. The natural products of plant origin are receiving a considerable attention to avoid the different disadvantages of insecticides use, as they would be non-hazardous, easy to use and specific in their action (Koul, 1982). Previous researchers demonstrated that plants were considered one of the richest sources which could be used as pest control agents. They attended to use plant extracts as toxicants, repellents, synergists, growth regulators and Antifeedant for cotton leafworm (CLW) (Hashem *et al*., 1998; Mohamed and El-Gengaihi, 1998; Arivudainambi, 2001; El-Kholy and Shaheen, 2004; Selvamuthukumaran and Arivudainambi, 2008a&b; El-Sinary *et al*., 2008; Ragaei and Sabry, 2011 and El-Zoghby *et al*., 2011).

The objectives of the present study is to test the biological activity of three plant extracts on larval, pupal and adult stages of cotton leafworm (CLW) and their latent effect on the progeny of this pest (first generation).

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Materials and Methods

A. Insects:

Insects were obtained from a colony of the Egyptian cotton leaf worm (*Spodoptera littoralis*) maintained during 10 generations (≈ one year) in the Central Laboratory of Pesticides, ARC, Dokki, Giza, Egypt that had no history of pesticides. The larvae were reared in laboratories of Department of Plant Protection, Faculty of Agriculture, Cairo, Al-Azhar University, Egypt where they maintained on clean fresh castor bean leaves, *Ricinus communis* L., in a controlled environmental chamber at 25±2ºC and 65±5% R.H. and a photoperiod of 12:12 hrs. (L:D) as described by El-Defrawi *et al*. (1964)

B. The plants and Extraction:

Leaves of three plants Damsissa (*Ambrosia maritima* L.), Camphor (*Eucalyptus globules*) and Datura (*Datura stramonium*) were used in this study. The fresh leaves of these plants were collected and their characteristics are shown in Table (1).

The extraction method of El-Torky (2008) was followed with some modifications. The leaves were cleaned from the dust and debris then dried separately under room temperature. The leaves were grounded in electric mill then soaked in ethanol for 7 days (every day, the soaked leaves were shacked for one hour using an electric shaker). The extracts were filtered over anhydrous sodium sulphate. The solvent was evaporated under vacuum using a rotary evaporator and hot water bath.

Table 1: General characteristics of the used plants.

Vernacular name	English name	Scientific name	Family	Sources of plant material	Crude extracted yield g/250g material
Damsissa	Sea ambrosia	*Ambrosia maritima* L.	Compositae	Farm of Fac. of Agric. Mostorod Kalubiah Gov.	28.22
Cafoor	Camphor	*Eucalyptus globules*	Myrtaceae	Fac. of Agric. Cairo Al-Azhar Univ.	19.85
Datoora	Thorn apple or Worm wood	*Datura stramonium*	Solanaceae	Fac. of Agric. Cairo Al-Azhar Univ.	23.36

In all cases, the crude extracts were weighted then kept in the refrigerator until use. Seven concentrations of each extract were diluted with ethanol to be 10, 100, 250, 500, 1000, 2500 and 5000ppm.

C. Treatments:

By leaf dipping technique, the leaves of castor bean leaves (*R. communis*) were dipped in the abovementioned concentrations for each plant extract, for 15 seconds, placed in dryness on toilet papers at room temperature, then placed in glass jars (1 liter) with toilet paper on the bottom and covered with muslin. For each extract, the initial weight of larvae of the second instar (one day old) was (11.0 ± 2mg) and they starved for 3 hrs. before they were placed in the jars. Ten replicates (each containing 10 larvae) were used and the larvae were fed on treated leaves for 24 hrs. then, on fresh untreated leaves until the termination of the experiment.

The larval mortality was observed daily, larvae were considered dead if they gave no response to stimulation by touch (Osman and Mahmoud, 2009) and feces were discarded. Uneaten leaves and new fresh leaves were weighted daily after taking the natural loss of moisture in consideration.

At the end of larval stage, the consumed fresh leaves was corrected according to, Ghanema (2002) by the following formula:

Corrected weight of the consumed leaves= Cb / Ca X Ta.

Where:
Cb= Initial weight of castor bean leaves before larval exposure.
Ca= Final weight (after exposure to natural dryness for 24 hrs.) of leaves without larvae.
Ta= Final weight of treated leaves after feeding the larvae for 24 hrs.
Daily weight (fresh basis) of consumed treated leaves/larva= **A – B / C.**
Where:
A= Initial fresh weight of treated leaves before feeding the larvae.
B= Corrected fresh weight of treated leaves after feeding the larvae.
C= Number of survived larvae.
At the end of larval stage, the following parameters were recorded:

- Mean weight of consumed leave larva^{-1} (g).
- Feeding ratio (Wada and Manukata, 1968) = b / a X 100

Where:
a= Amount of fresh weight of leaves consumed in the control.
b= Amount of fresh weight of leaves consumed in treatment.

- Feeding inhibition %, mean larval weight (g), mean larval duration (days) from 2nd instar larvae to pupation, larval mortality %, pupation %,
- Antifeedant index % according to Pavela *et al*. (2008):

AFI={(C-T)/(C+T)} X 100 (in %).
Where:
C= Weight of leaves consumed in control.
T= Weight of leaves consumed in treatment.

At pupal stage, the following data were recorded as follow:

- Mean pupal weight (mg) 48 hrs. old, mean pupal duration (days) from pupation to adult emergence, pupal mortality %, adult emergence %.

At the adult stage, pairs of 2 males and 2 females resulted from each concentration were placed in glass jar (1 liter) containing *N. oleander* leaves as a site of egg laying. The glass jar were provided with pads of cotton soaked with a 15 % honey solution and covered with muslin. Honey solutions were replaced daily to prevent fungal growth. Five replicates were used per concentration plus a control. The effect of plant extracts on adults were recorded as follow**:**

- Longevity (days) for males and females and reduction %, fecundity (number of deposited eggs female^{-1}), fertility (egg hatchability %).
- Sterility % (Toppozada *et al*., 1966)= **100 - (a X b / A x B) X 100**.

Where:
A= Number of eggs laid female^{-1} in the untreated.
B= Percent of hatchability in the untreated.

The latent effect of these plant extracts on the progeny (1st generation) was recorded as % of larval mortality, % of pupal mortality, % of adult mortality, % of accumulative mortality.

Percentages of mortality were corrected when needed according to Abbott's formula (Abbott, 1925).

Statistical analysis:

Statistical analysis was conducted by ANOVA and compared by L.S.D. test at 5% and 1% level of probability in all experiments according to Gomez and Gomez (1984).

Results and Discussion

The results in Table (2) show the effect of three crude plant extracts at different concentrations on average fresh weight of consumed leaves larva^{-1}, feeding ratio, feeding inhibition and antifeedant index (AFI), respectively. All data were recorded at the end of larval instar.

Data indicate that, all the tested plant extracts significantly (*p=0.05*) reduced the weight of consumed leaves larva^{-1} comparing with that of control. There is a gradual decrease in consumption with increasing extract concentration. Damsissa extract (at any concentration used) gave better results followed by Datura and camphor extracts. The same trend was observed with the reduction of feeding ratio, feeding inhibition and AFI. These results clearly indicate that these plants extracts show antifeedant properties. The present results are in agreement with those obtained by several authors. For example, Smagghe and Degheele (1997) cited that larvae of cotton leafworm (CLW) treated with plant extracts could suffer gut alterations, suggesting that such larvae stopped feeding and consequently lost weight. Swidan (1994) indicated that *A. maritima* extract gave better result as antifeedant against cotton leafworm (CLW) than *Eucalyptus* extract, when used at 2% concentration, after 24 hrs. Aly *et al*. (2000) demonstrated that the percent food consumption of the fourth larval instar of cotton leafworm (CLW) was reduced with increasing the concentration of extracts from leaves and seeds of *Eucalyptus* plants.

Data in Table (3) show the effect of plant extracts on weight of larvae, larval duration, larval mortality and the pupation percent. All plant extracts significantly (*p=0.05*) reduced larval weight, and Damsissa extract shows higher effect followed by Datura and camphor extracts. The same trend was also observed for larval duration and larval mortality. These results are in accordance with those obtained by Smagghe and Degheele (1997). Hashem *et al.* (1998) demonstrated that ethanolic extract of Damsissa leaves caused mortality percentage to cotton leafworm (CLW) approximately equal to Neem and Zanzlacht. They suggested that Damsissa extract might act as stomach poison. Zidan *et al*. (2000) reported that extracts from *Eucalyptus* species caused a great reduction in AChE activity of the larvae of cotton leafworm. Khalil and Ismail (2001) mentioned that *A. maritima* extracts caused antifeedant and growth retardant on larvae of *Agrotis ipsilon*.

Table 2: Effect of three crude plant extracts on consumption, feeding, antifeedant index (AFI) during the larval stage of cotton leafworm.

Treatments	Concn. (ppm)	Average weight of consumed leaves/ larva (g) ± SE*	Feeding ratio	Feeding inhibition	Antifeedant index % (AFI)
Untreated	**0.00**	03.13±0.51	00.00	00.00	00.00
Datura extract	**10**	02.25±0.07	71.88	28.12	16.36
	100	01.92±0.05	61.34	38.67	23.96
	250	01.66±0.12	53.03	46.97	30.69
	500	01.41±0.03	45.05	54.95	37.88
	1000	01.20±0.03	38.34	61.66	44.57
	2500	01.16±0.05	37.06	62.94	45.92
	5000	00.79±0.07	25.24	74.76	59.69
Camphor extract	**10**	02.85±0.06	91.05	08.95	04.68
	100	02.76±0.04	88.18	11.82	06.28
	250	02.63±0.14	85.62	14.38	07.74
	500	02.35±0.05	75.08	24.20	14.23
	1000	02.30±0.07	73.48	26.52	15.28
	2500	02.10±0.07	67.09	32.91	19.69
	5000	01.45±0.07	46.32	53.68	36.68
Damsissa extract	**10**	01.83±0.07	58.47	41.53	26.21
	100	01.60±0.07	51.11	48.89	32.35
	250	01.36±0.10	43.45	56.55	39.42
	500	01.13±0.05	36.10	63.90	46.95
	1000	01.06±0.06	33.86	66.14	49.40
	2500	00.86±0.11	27.48	72.52	56.89
	5000	00.61±0.04	19.48	80.52	67.38

*** SE=** Standard Error

L.S.D. at	**5%**	**1%**
Treatments (T.)=	0.03	0.05
Concentrations (C.)=	0.06	0.08
T. X C.=	0.04	0.06

Table 3: Effect of three crude plant extracts on weight, duration, and mortality of larvae of cotton leafworm (CLW) and percent of pupation.

Treatments	Concn. (ppm)	Mean larval weight (g) ± SE*	Mean larval duration (days) ± SE*	Larval mortality %	Pupation %
Untreated	**0.00**	00.98±0.01	18.16±0.41	00.00	99.00
Datura extract	**10**	00.95±0.01	18.18±0.39	13.25	86.75
	100	00.82±0.01	18.68±0.82	21.19	78.81
	250	00.75±0.02	18.96±0.72	37.53	62.47
	500	00.72±0.01	19.26±0.25	42.66	57.34
	1000	00.64±0.01	20.00±0.21	46.17	53.83
	2500	00.56±0.03	20.24±0.21	56.69	43.31
	5000	00.34±0.03	20.34±0.37	68.22	31.78
Camphor extract	**10**	00.97±0.01	18.80±0.24	07.15	92.85
	100	00.85±0.02	18.96±0.48	18.22	81.78
	250	00.77±0.02	18.32±0.19	33.17	66.83
	500	00.73±0.01	18.70±0.29	40.33	59.67
	1000	00.65±0.02	19.06±0.32	44.19	55.81
	2500	00.61±0.01	19.78±0.24	53.41	46.59
	5000	00.46±0.01	20.16±0.19	64.15	35.85
Damsissa extract	**10**	00.94±0.01	19.20±0.22	22.11	77.89
	100	00.85±0.02	19.64±0.35	29.26	70.74
	250	00.74±0.01	19.88±0.24	39.17	60.83
	500	00.71±0.01	19.90±0.26	45.16	54.84
	1000	00.62±0.01	20.22±0.31	53.71	46.29
	2500	00.44±0.01	20.32±0.39	66.22	33.78
	5000	00.26±0.01	20.86±0.27	81.19	18.81

*** SE=** Standard Error

L.S.D. at	**5%**	**1%**	**5%**	**1%**
Treatments (T.)=	0.01	0.02	0.14	0.20
Concentrations (C.)=	0.01	0.03	0.33	0.44
T. X C.=	0.04	0.06	0.18	0.26

Sabbour and Abd El-Aziz (2002) mentioned that *Eucalyptus* oil was the most effective as a feeding deterrent causing 60.03% and 52.58% antifeedant activities in case of 3rd larval instar of *A. ipsilon* and *S. littoralis,* respectively. They added that *Eucalyptus* oil caused 35% larval mortality in *A. ipsilon* and 43% in *Spodoptera littoralis,* respectively, which, retarded larval development. El-Doksh *et al*. (1984) indicated that the crude alkaloids from *D. stramonium* exhibited toxic action to *Spodoptera* larvae. Mahmoud (2002) recorded an increase in the larval duration of *A. ipsilon* as a result of treated fourth larval instar with *A. maritima* extracts by a contact method. Abdel-Rahim *et al*. (2007) isolated 5,6-dihydroxy-3,4-7 trimethoxy flavone from *A. maritima*

which was found to be toxic to 2nd and 4th instar larvae of cotton leafworm (CLW). It increased larval duration to 20 days as compared to 14.5 days of the check.

Data in Table (4) indicate that all the tested plant extracts significantly (*p=0.05*) reduced pupal weight and % of adult emergence, increased pupal duration, pupal mortality. The Damsissa extracts gave better results followed by Datura and camphor. These results are in agreement with those obtained by previous researchers. For example, Osman (1999) found an increase in the pupal duration when the larvae of cotton leafworm (CLW) were treated with chloroform extract of *A. maritima* by a contact method. Mahmoud (2002) recorded an increase in pupal period of *A. ipsilon* as a result of treatment of 4th instar larvae with *A. maritima* extracts by a contact method. He found that the treatment induced the highest reduction in adult emergence. Emara *et al*. (2002) demonstrated that treatment of 2nd larval instar of cotton leafworm (CLW) with certain botanical extracts inhibited adult emergence. Abdel-Rahim *et al*. (2007) found that treatment of 2nd instar larvae of cotton leafworm (CLW) with compound isolated from *Eucalyptus* plants caused highly significant reduction in moth emergence. Similar results were recorded by Khalil and Ismail (2001).

Table 4: Effect of three crude plant extracts on weight, duration, and mortality of cotton leafworm pupae and percentage of adult emergence.

Treatments	Concn. (ppm)	Mean pupal weight (mg) ± SE*	Mean pupal duration (days) ± SE*	Pupal mortality %	Adult emergence %
Untreated	**0.00**	390.6±28.05	11.04±0.44	00.00	99.00
Datura extract	**10**	338.4±05.02	12.42±0.34	02.13	97.87
	100	322.4±04.97	13.66±0.64	03.19	96.81
	250	278.4±08.64	15.20±0.21	04.11	95.89
	500	223.8±04.76	15.68±0.23	04.23	95.77
	1000	192.2±05.89	16.52±0.35	06.67	93.77
	2500	164.4±05.81	17.56±0.28	08.50	91.50
	5000	137.8±03.42	18.16±0.16	10.34	89.66
Camphor extract	**10**	379.2±32.46	11.74±0.26	01.29	98.00
	100	335.2±08.84	12.40±0.51	02.16	97.84
	250	319.6±09.96	13.50±0.29	03.22	96.78
	500	284.4±08.53	15.12±0.14	03.67	96.33
	1000	259.8±38.20	15.46±0.31	04.22	95.78
	2500	186.6±11.37	16.38±0.29	05.67	94.33
	5000	173.6±06.54	17.30±0.29	06.82	93.18
Damsissa extract	**10**	334.2±05.63	12.46±0.27	03.19	96.81
	100	317.6±04.61	13.72±0.34	03.96	96.04
	250	260.0±11.26	15.52±0.16	04.80	95.20
	500	210.8±07.62	16.26±0.27	04.95	95.05
	1000	179.4±11.26	17.52±0.28	07.63	92.37
	2500	157.0±06.20	18.22±0.21	09.66	90.34
	5000	117.4±07.40	19.21±0.35	12.91	87.09

*** SE=** Standard Error

	L.S.D. at	**5%**	**1%**	**5%**	**1%**
Treatments (T.)=	6.12	08.91	0.15	0.21
Concentrations (C.)=	9.69	12.87	0.23	0.31
T. X C.=	7.90	11.50	0.19	0.28

The results of Table (5) indicate that all the plant extracts significantly (*p=0.05*) reduced fecundity (eggs female^{-1}) and fertility (egg hatching) and increased the sterility % compared to those of check. Damsissa extract gave better results followed by Datura and camphor extracts. A gradual decrease in reproductive parameters and sterility % with increasing the extract concentration. These results are in accordance with those obtained previously. For example, Mogahed *et al*. (1997) reported that alcoholic extracts from different plants caused a clear reduction in the rate of egg laying/female. They suggested that, the effect might be due to physiological disturbance in hormonal systems of adults. Inhibition of egg hatchability might be due to disturbance in the embryonic development.

Osman (1999) found a decrease in the percent egg hatching of *A. ipsilon* treated with chloroform extracts of *A. maritima*. Khalil and Ismail (2001) mentioned that *A. maritima* caused reduction of fecundity and fertility of *A. ipsilon* adults when larvae were treated with the extracts from *A. maritima* and so increased the longevity of moths. Emara *et al*. (2002) demonstrated that when 2nd larval instar of cotton leafworm (CLW) treated with high concentration of certain plant extracts, they inhibited adult emergence and caused higher sterility as well as significant reduction in fecundity.

Table 5: Effect of three crude plant extracts on reproductive parameters and percent sterility of cotton leafworm.

Plant Extract	Concn. (ppm)	Reproductive parameters		Sterility %
		Fecundity (eggs/female) ± SE*	Fertility (egg hatching %)	
Untreated	**0.00**	817.4±33.3	93.56	0.00
Datura extract	**10**	808.4±10.70	86.10	08.89
	100	746.2±28.20	80.54	21.43
	250	645.4±17.90	75.74	36.61
	500	552.8±12.20	69.62	49.68
	1000	474.3±08.80	61.22	62.04
	2500	389.5±06.70	55.04	71.97
	5000	341.9±07.10	41.48	81.45
Camphor extract	**10**	800.7±16.40	88.22	07.64
	100	765.5±41.80	86.00	13.92
	250	688.1±0.14	80.18	27.86
	500	637.8±18.8	78.22	34.77
	1000	547.4±11.90	75.32	46.09
	2500	357.8±26.10	62.80	65.80
	5000	352.3±06.10	51.42	75.95
Damsissa extract	**10**	752.4±06.10	85.82	15.57
	100	712.5±10.10	80.84	24.69
	250	611.4±05.10	70.70	43.48
	500	589.1±07.70	64.20	50.55
	1000	480.1±08.60	49.32	66.53
	2500	361.7±07.40	46.78	77.87
	5000	235.6±15.10	33.10	89.81

*** SE=** Standard Error

L.S.D. at	**5%**	**1%**
Treatments (T.)=	09.03	13.14
Concentrations (C.)=	14.69	19.50
T. X C.=	11.65	16.96

The results of Table (6) clearly indicate that all plant extracts significantly (*p=0.05*) reduced moth longevity compared to the control. Similar results were obtained by Mahmoud (2002) and Abdel-Rahim *et al*. (2007) who found a significant reduction in adult longevity when larvae of cotton leafworm (CLW) were treated with *A. maritima* extracts.

Table 6: Longevity and reduction percentage of cotton leafworm adults when their 2nd larval instar were treated with three crude plant extracts.

Treatments	Concn. (ppm)	Male longevity (days) ± SE*	Reduction %	Female longevity (days) ± SE*	Reduction %
Untreated	**0.00**	12.20±0.38	00.00	11.70±0.18	0.00
Datura extract	**10**	11.92±0.30	02.29	11.32±0.22	03.25
	100	11.84±0.18	02.95	10.84±0.89	07.35
	250	11.68±0.14	04.26	10.28±4.38	12.14
	500	11.10±0.18	09.02	09.96±0.65	14.87
	1000	10.52±0.44	13.77	09.78±0.60	16.41
	2500	09.96±0.28	18.36	08.98±0.38	23.25
	5000	09.04±0.24	25.90	08.54±0.36	27.00
Camphor extract	**10**	12.16±0.36	00.33	11.40±0.33	2.56
	100	12.02±0.19	01.47	10.94±0.61	6.49
	250	11.86±0.18	02.79	10.78±0.54	7.86
	500	11.50±0.24	05.74	10.06±0.68	14.02
	1000	10.86±0.35	10.98	09.44±0.23	19.32
	2500	10.26±0.43	15.90	09.06±0.20	22.56
	5000	09.44±0.20	22.62	08.56±0.27	26.84
Damsissa extract	**10**	11.74±0.30	03.77	11.18±0.30	04.44
	100	11.50±0.15	8305.	10.46±0.42	10.59
	250	11.10±0.24	09.18	09.88±0.31	15.55
	500	10.74±0.48	11.97	09.42±0.17	19.49
	1000	09.82±0.35	19.51	09.00±0.26	23.08
	2500	09.04±0.43	25.90	08.64±0.18	26.15
	5000	08.76±0.61	28.20	08.34±0.28	28.72

*** SE=** Standard Error

L.S.D. at	**5%**	**1%**	**5%**	**1%**
Treatments (T.)=	0.16	0.23	0.46	0.67
Concentrations (C.)=	0.24	0.31	0.78	1.04
T. X C.=	0.21	0.31	0.59	0.86

The results of Table (7) show that these plant extracts reduced all the progeny of cotton leafworm (CLW) (first generation). These results are in agreement with those obtained by previous researchers. For larval

mortality (El-Doksh *et al*., 1984; Hashem *et al*., 1998; Huseein *et al*., 2002; Sabbour and Abd El-Aziz, 2002 and Abdel-Rahim *et al*., 2007). For pupal mortality (El-Kholy and Shaheen, 2004; Hashem *et al*., 1998 and Abdel-Rahim *et al*., 2007). For adult mortality (Khalil and Ismail, 2001; Mahmoud, 2002; Emara *et al*., 2002; El-Kholy and Shaheen, 2004; Hashem *et al*., 1998 and Abdel-Rahim *et al*., 2007).

Generally, the present results clearly indicate that these plant extracts exhibit insecticidal and antifeedant activities against cotton leafworm (CLW) insect. The point to be made is, these biologically active natural products may serve as suitable prototypes for the development of commercial insecticides.

Table 7: Mortality percentages of the developmental stages of the first generation previously exposed the 2nd instar larvae of cotton leafworm to crude extracts.

Treatments	Concn. (ppm)	Larval mortality %	Pupal mortality %	Adult mortality %	Accumulative mortality
Datura extract	**10**	02.15	03.07	03.11	08.33
	100	03.26	05.22	05.92	14.40
	250	06.19	07.11	08.17	21.47
	500	09.22	10.71	10.11	30.04
	1000	13.16	15.12	12.82	41.10
	2500	15.23	18.61	20.11	53.95
	5000	18.17	20.22	22.17	60.56
Camphor extract	**10**	01.17	02.11	02.26	05.54
	100	02.81	03.19	04.23	10.23
	250	05.13	05.22	07.61	17.96
	500	07.26	08.17	08.17	23.60
	1000	08.12	12.26	12.56	32.94
	2500	12.17	15.23	17.33	44.73
	5000	15.23	17.61	19.75	52.59
Damsissa extract	**10**	02.23	03.15	03.24	08.62
	100	04.16	06.17	06.17	16.50
	250	07.16	08.22	09.12	24.50
	500	10.23	12.75	12.25	35.23
	1000	15.62	18.91	23.14	57.67
	2500	17.91	20.23	26.12	64.26
	5000	21.62	25.17	28.13	74.92

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