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Survival capability and effect of selected insecticides against pumpkin caterpillar, *Diaphania indica* on watermelon

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Abstract
The particular study was conducted in laboratory condition at Khanzada Agriculture Farm, Tando Allahyar, during 2019. The moths frequently can be seen holding their brushes above the body level and slowly waving them in a circular fashion. Longetivity of male and female lasted for 6.8 days and 8.6 days, respectively on watermelon and 6.2 days and 7.8 days respectively on pointed gourd Post spray observations were recorded with an interval of 24, 48 and 72 hours after spraying. Treatments T1 (Emamectin benzoate), T6 (Triazophos) and T7 (Cartap hydrochloride) showed 100 percent mortality at 24 hrs after spraying and all these treatments were at par with each other. At 48 hrs of spraying, the treatments T3 (Dimethoate) and T4 (Profenophos) recorded 100 % mortality and both these treatments were at par with each other.

Keywords: Insecticides, watermelon, longetivity, pre-oviposition

Introduction
Watermelon (*Citrulluslanatus*) Family: Cucurbitaceae) is the major commercial crop in Pakistan. Watermelon is a staple food item in every household during summer days. It is a vegetable like cucumber, squash, pumpkin and cantaloupe, the watermelon really a member of the gourd family. Therefore, horticulturist treat watermelons are to be vegetable's. Worldwide production of watermelon was 95,211,432 MT in 2016. Watermelon produced commercially with the top five countries in the order of decrease in the production are China (72,953 MT), Iran (3,947,067MT), Turkey (7,887,324 MT), Brazil (4,163,501MT) and Egypt (6,894,738MT) [1]. Watermelon is attacked by more than a dozen of insect pests, important ones are *Bactrocera cucurbitae*, *Thrips tabaci*, *Bemisia tabaci*, *Aphis gossypii*, Leaf eating caterpillar; *D. indica* Saunders. The cucumber moth, *D. indica* (Saunders), also known as cotton caterpillar or pumpkin caterpillar, is a destructive pest on a wide range of crops. The larvae of *D. indica* attack leaves, flowers and fruit of their host plants [2, 3, 4, 5]. Cucumber moth, *D.indica* is one of the serious Pest of plants under cucurbitaceae. *D. indica*was first reported on cotton leaves from Iran [6]. Subsequently, [7, 5, 2] reported *Margaronia indica* as one of the major pests that cause substantial damage to cucurbits. Host record of *D. indica* includes a number of cucurbits [8, 9]. Though *D. indica* often feeds on leaves, its attack on fruits can lead to marketable loss [10]. Newly hatched *D. indica* larvae lack color, but are pale yellow green in the second instar stage and mature *D. indica* larvae are of dark green color. The larva may feed on the surface of the fruit and cause scars on the surface of melons or even burrow into the fruit. Watermelon is a short term crop. It gives good earning to farmers within 90 days. Even if it is done in small acreage, a farmer can earn a good profit. Watermelon is becoming a very important source of income for small scale farmers of the semi-arid tropics of West Africa [10].

Materials and Methods
Site and location of experiment
The particular study was conducted in laboratory condition at Khanzada Agriculture Farm, Tando Allahyar, during 2019. Simultaneously biology of Pumpkin caterpillar *D. indica* on watermelon and pointed gourd was carried out. The details of the material used and methodology adopted during the course of investigation are given in this chapter under the following headings.

Culture of Pumpkin caterpillar *D. indica*.

To obtain initial culture, pre-pupa and pupa from leaves were collected from farmer field and kept them into small plastic bottles for emergence of adults. The adults thus obtained were released in small bottles in the laboratory for egg laying. The top of glass jar was covered with muslin cloth secured firmly with a rubber band.

Experimental details

A laboratory experiment was conducted in completely Randomized Design (CRD), with three replication and eight treatments.

Sr. No.	Insecticides	%Conc.	Dose
T1	Emamectin benzoate	0.0013%	0.4g/l
T2	Acetamiprid	0.002%	0.2g/l
T3	Dimethoate	0.02%	1m3/l
T4	Profenophos	0.079%	1.6 ml/l
T5	Azadirachtin	0.004%	2ml/l
T6	Triazophos	0.09%	1m7/l
T7	Cartap hydrochloride	0.065%	1.8g/l
T8 (Control)	Water Spray	-	-

Method of application

Fresh leaves of watermelon were collected from potted plants and sprayed with the different insecticidal solutions of mentioned concentration. Then these leaves were thorough dried. These leaves were placed in separate Petri dish individually. Then ten larvae of third instars of pumpkin caterpillar were released in each Petri plate.

Method of recording mortality observation of *D. indica*

Observations were recorded each after 24, 48 and 72 hrs regarding the mortality of larvae in different insecticidal treatments. Data thus collected was be statistically analyzed to judge the effective insecticide.

Results and Discussion

The female usually laid eggs singly or in clusters of two or more during night time mostly on tender leaves, stalks and vines in the field, however, eggs were also observed on the glass jar and muslin cloth. The results are in conformity with the findings of the [11] who reported that eggs *D. indica* were laid singly or in small clusters on the lower surface of snake gourd leaves while [12] also reported that eggs were noticed on leaves and muslin cloth. The freshly laid eggs were white to yellowish in colour and elongated in shape. The eggs measured 0.85 to 0.95 mm in length with an average of 0.87 mm and 0.54 to 0.58mm in 49 breaths with an average of 0.57 mm (Table 1). At the hatching egg became orange in color. Similar observation was made by [13] who reported that freshly laid eggs were very small, and yellow in color, measured from 0.73 to 0.95mm in length and 0.30 to 0.45 mm in breadth. Furthermore, the present study find out that the pre-oviposition, oviposition and post-oviposition period were recorded and the results are presented in (Table 2). It was revealed that the pre-oviposition period varied from 2 to 3 days with an average of 2.2 days. The oviposition period ranged between 4 to 5 days with an average 4.4 days. The post-oviposition period was recorded only for 1 to 2 days with a mean of 1.6 days. These observations are in close conformity with the findings of the [12] who reported that the pre-oviposition, oviposition and post-oviposition period of 2, 5.1and1.5 days, respectively on watermelon. Another researcher [14] studied the biology of *D. nitidalis*. They found Oviposition occurred at night, chiefly after fruiting began, and very few adults were seen in cultivated fields during the day, they probably shelter on trees and high bushes near the fields. The larval and pupal stages and complete development lasted 9-28, 6-31 and 22-53 days, respectively, in field cages. The data recorded on fecundity of Pumpkin caterpillar, *D. indica* revealed that the total number of eggs laid by female in her life span varied from 116 to 308 with an average of 193.4 (Table 1).The observations are in accordance with [15] who reported that the female of *D. indica* laid 93 to 306 eggs with an average of 187.1. It was evident from the data that the incubation period ranged from 4 to 4.5 days with a mean of 4.3days. Hatching percentage ranged from 100 per cent with an average of 100 % (Table 2). On the other hand, present result differ from the observation of [12], they recorded incubatation period was 3.7 days at 30˚C and [16] reported that incubatation period ranged from 4 to 6 days with a mean of 4.75 days with 90.4 percent hatching.

Furthermore, results summarized in the Table-3 showed that the first and second instar lasted for 2 days but third instar lasted for 2 days with mean of 2 days. Newly hatched larva was tiny, active and creamy white. Larva was polypod, slender and had a black spot on each side of the head and dark brown tubercles on each body segment which occurred in transverse rows on first larva. Larva measured 1.0 to 1.2mm in length with an average of 1.1mm and 0.12 to 0.14mm in head width with an average of 0.13 mm. Results were corroborated with the results of [17] who reported 0.187 to 0.262 mm of head capsule width with an average of 1.0 to 1.3 mm and length of larvae 1.650 to 2.250 mm with an average of 1.893 mm. Second instar was yellowish green, head hypognathous, smaller in size than rest of body. There were nine pairs of spiracles, the first on prothorasic segment and remaining eight on each of abdominal segment, Legs fleshy and yellowish. Abdomen ten segmented the fifth, sixth, and tenth segment hadprolegs. Larva measured 6.90 to 7.49mm in length with an average of 7.22mm and 0.55-0.61mm in head width with an average of 0.59mm on watermelon (Table 3). The present observations are in close conformity with [18] who reported 0.600 to 0.712 mm of head capsule width with an average of 0.648 mm and length of larvae 5.50 to 7.00 mm with an average of 6.30 mm on watermelon. The third instar larva was yellowish green. A row of black tubercles bearing setae were seen on thoracic and abdominal segment. Furthermore, the fourth and fifth instar lasted for 3 days with mean of 3 days larva was green during fourth instar but green with whitish head during fifth instar and a row of black tubercles bearing setae were seen on thoracic and abdominal segment. Larva measured 10.31 to 11.35 mm in length with an average of 11.00 mm and 0.88 to 1.08 mm in head width with an average of 0.97 mm on fourth instar. On the other hand, larva measurements increase during fifth instar 14.10 to 16.91mm in length with an average of 15.92mm and 1.55 to 1.71mm in head width with an average of 1.63 mm. A similar finding of [16] who reported 0.900 to 11.87 mm of head capsule width with an average of 10.87 mm and length of larvae 10.00 to 12.00 mm with an average of 11.12 mm on watermelon. Another investigation find out by [24, 25] whom agreed with present studies that length of larvae was 14.20 to 18.50 mm with an average of 18.04 mm and head width was 2.01 to 2.36mm with an average of 1.21 mm.

Morphometrics of Adults Male and Female

Female Moth was medium sized, stoutly built with white

wings which have an iridescent purplish reflection and brownish border. At rest the wings held like a flat over the body.Wing expansion ranged from 22.95 to 23.90 mm with an average of 23.58mm. Mouth parts well developed with a long and coiled proboscis. Head width ranged from 1.90 to 2.10 mm with an average 2.10 mm of on watermelon. Body width ranged from 3.07 to 3.38mm with an average of 3.23 mm. The present observations are in close conformity with [19] who reported that male and female Wing expanse ranged from 24.00 to 26.00 mm with an average of 25.20 mm, Head width ranged from 1.50 to 2.50 mm with an average1.95, body width ranged from 2.50 to 3.00 mm with an average of 2.75 mm, the body length ranged from 13.00 to 14.00mm with an average of 13.52 mm. On the other hand, male Wing expansion ranged from 21.98 to 22.94mm with an average of 22.39mm on watermelon and from 21.84 to 22.21 mm with an average of 22.06 mm on pointed gourd. Head small, hypognathous and brown. Compound eyes were reddish and large. Antenna was filli-form with numerous segments. Mouth parts well developed with a long and coiled proboscis. Present data also showing that Female Abdomen elongated, conical, eight segmented, tapering posterior having a yellowish orange brush at the anal end. Abdomen was relatively bigger in size and broad as compared to male moth. Head width ranged 65 from 1.90 to 2.23mm with an average 2.06 mm. Body width ranged from 2.57 to 2.96mm with an average of 2.70 mm. Legs slender, pale white. The results are also examined by [20] who reported Wing expanse ranged from 23.00 to 25.00 mm with an average of 24.150 mm, Head width ranged from 1.50 to 2.50 mm with an average 1.875, Body width ranged from 2.50 to 3.00 mm with an average of 2.675, the body length ranged from 13.00 to 15.00mm with an average of 13.97mm. Abdomen elongated, conical, eight segmented, tapering posteriorly having a yellowish orange brush at the anal end. Abdomen was relatively smaller in size and longer as compared to female moth. The body length ranged from 13.19 to 14.10 mm with an average of 13.7 mm. Furthermore, result revealed about lifecycle that egg period varied from 4 to 4.5 days, (mean 4.25 days), larval period was 13 days with an average of 13 days on watermelon. Prepupal period was varied from 2.08 days to 2.25 days with an average of 2.16 days. Pupal period was varied from 6.03 days to 7.21 days with an average of 6.62 days. Adult stages varied from 6.00 to 9.00 days with an average of 7.5 days. One generation was completed in 31.11 to 35.96 days with an average of 33.53 days. The present observations are in close conformity with [21] who reported one generation was completed in 31 to 44 days with an average of 36.075 days.

To know the efficacy of insecticides against Pumpkin caterpillar, *D. indi*ca on Watermelon under laboratory conditions

The data pertaining to the relative efficacy of different insecticides against pumpkin caterpillar are presented in (Table 4). Post spray observations of larval mortality were recorded with an interval of 24, 48 and 72 hours after spraying. Present results also agreed with [22] who recorded that toxicity of these insecticides to the third instar larvae of *Diaphania indica* was evaluated for immediate toxicity on the basis of larval mortality in 24 hr on *Coccinia* leaves carrying fresh dry film of insecticides. Cypermethrin was found superior against the larvae of *Diaphania indica* followed closely by deltamethlrin. Triazophos, phosalone and carbaryl were equally good in persistence as well as initial toxicity. The present results of the insecticide spraying are discussed below. The results on relative efficacy of insecticides revealed that the treatments T1(Emamectin benzoate), T6(Triazophos) and T7 (Cartap hydrochloride) showed 100 % mortality at 24 hrs after spraying and all these treatments were at par with each other. The next best treatment were T2 (Acetamiprid) and T3 (Dimethoate) which recorded 73.33 percent mortality. No mortality was recorded in T8 (Control). Our results generally agrees with [23] reported with the help of Pooled mean analysis that Acetamiprid + Dimethoate 30 EC @ 2 ml lit-1 were superior over other treatments in checking pumpkin caterpillar population during both the seasons. In the present study at 48 hrs of spraying, the treatments T3 (Dimethoate) and T4 (Profenophos) recorded 100 percent mortality and both these treatments were at par with each other whereas the treatments *viz.*, T1 (Emamectin benzoate), T6 (Triazophos) and T7 (Cartap hydrochloride) which already recorded 100 % mortality at 24 hrs of spraying. The next best treatment was T2 (Acetamaprid) which showed 76.67 % mortality whereas no mortality was recorded in T8 (Control). Similar finding [24] reported that the leaf eating caterpillar, *Cricula trifenestrata* Helfer, a wild silk infests plant *Persea bomycina* Kost. Causing non-availability of quality leaves during commercial rearing seasons of muga silkworm. Efficacies of different chemical pesticides were evaluated and observed that Profenophos (0.05% and 0.1%) caused the highest larval mortality of *C. trifenestrata* besides rendering the highest residual toxic effect to silkworm. Deltamethrin (0.0014% and 0.0028%) and Azadirachtin (0.0015% and 0.003%) were found effective against *C. trifenestrata* with the lower residual effect to muga silkworm after 15 days of treatment. Data on present study relative efficacy of insecticides after 72 hrs spraying showed that the treatment T5 (Azadirachtin) recorded 79.99 percent mortality and which was found to be at par with treatment T2 (Acetamiprid) which showed 76.67 percent mortality. The treatment T8 (control) showed no mortality. The treatments *viz.*, T1 (Emamectin benzoate), T6 (Triazophos), T7 (Cartap hydrochloride), T3 (Dimethoate) and T4 (Profenophos) already showed 100 percent mortality up to 48 hrs of spraying (Table 6) But according to [25, 26] who noted evaluated the bio-efficacy of cypermethrin, dichlorvos, endosulfan, profenophos and quinalphos against *Spodoptera litura* infesting soybean. The treatment with profenofhos 0.1% gave maximum protection when recorded up to 7 days after application. The highest residual toxicity to tobacco caterpillar recorded at 24, 48, 72 hrs and one week after application was exhibited in the treatment of profenofhos 0.1% under laboratory to field weathered deposits. *S. litura* on groundnut, which revealed that emamectin benzoate 0.005%, chlorpyriphos 0.05, cypermethrin 0.016 and chlorantraniliprole 0.006% were found to be the most effective.

Table 1: Morphometrics of Egg stage, Pre-oviposition, oviposition and post-oviposition period of *Diaphania indica*

Sr. No.	Egg Length(mm)	Egg Breadth(mm)	Pre-oviposition period (days)	Oviposition period(days)	Post-oviposition period(days)	Fecundity
1	0.852	0.542	2	4	2	178
2	0.866	0.574	2	4	2	192
3	0.878	0.587	2	4	2	308

4	0.950	0.589	2	5	1	116
5	0.892	0.563	3	5	1	173
6	0.872	0.581	-	-	-	-
7	0.883	0.569	-	-	-	-
8	0.859	0.584	-	-	-	-
9	0.861	0.576	-	-	-	-
10	0.874	0.578	-	-	-	-
Range	0.852-0.950	0.542-589	Range	2-3	4-5	1-2
Mean	0.89	0.574	Mean	2.2	4.4	1.6
S.D. ±	0.028	0.014	S.D. ±	0.4472	0.548	0.548

Table 2: Incubatation period and Hatching percentage

Sr. No.	No. of eggs observed	No. of eggs hatched(days)				Total eggs hatched	Incubatation period	Per cent eggs hatched
		2	3	4	5			
1	10	_	_	8	2	10	4.5	100
2	10	_	1	8	1	10	4	100
3	10	_	_	8	2	10	4.5	100
4	10	_	_	9	1	10	4.5	100
5	10	_	1	6	3	10	4	100
6	10	_	_	8	2	10	4.5	100
7	10	_	1	8	1	10	4	100
8	10	_	_	7	3	10	4.5	100
9	10	_	_	8	2	10	4.5	100
10	10	_	1	7	2	10	4	100
Range	10					10	4-4.5	100

Table 3: Morphometrics of first, second, third, fourth and fifth instar larvae of *D.indica*

Sr. No.	First instar		Second instar		Thrid instar		Fourth instar		Fifth instar	
	Body length (mm)	Head width (mm)	Body length (mm)	Body length (mm)	Head width (mm)	Head width (mm)	Body length (mm)	Head width (mm)	Body length (mm)	Head width (mm)
1	1.2	0.14	4.96	0.31	7.41	0.60	11.35	0.88	16.91	1.71
2	1.0	0.12	4.84	0.36	7.29	0.59	11.02	0.91	15.73	1.56
3	1.2	0.14	4.90	0.28	6.99	0.59	10.31	0.98	14.10	1.55
4	1.0	0.13	4.50	0.33	6.90	0.55	11.10	1.08	16.04	1.63
5	1.0	0.13	3.97	0.37	7.49	0.61	11.25	1.00	16.81	1.71
Range	1.0-1.2	0.12-0.14	3.97-4.96	0.28-0.37	6.90-7.49	0.55-0.61	10.31-11.35	0.88-1.08	14.10-16.91	1.55-1.71
Mean	1.1	0.13	4.63	0.33	7.22	0.59	11.00	0.97	15.92	1.63
S.D.±	0.11	0.01	0.41	0.03	0.25	0.02	0.41	0.07	1.13	0.07

Table 4: Morphometrics of adult Male and female of *Diaphaniaindica*

Sr. No	Male				Female			
	Head width (mm)	Body width (mm)	Body length(mm)	Wing span(mm)	Head width (mm)	Body width (mm)	Body length(mm)	Wing span(mm)
1	1.90	2.57	13.19	22.94	2.07	3.25	12.45	23.90
2	2.07	2.62	13.42	22.89	2.10	3.07	12.31	23.68
3	2.23	2.78	13.78	21.98	1.98	3.38	12.40	22.95
4	2.10	2.96	14.00	22.16	1.90	3.19	12.39	23.60
5	2.00	2.60	14.10	22.00	2.00	3.30	12.90	23.78
Range	1.90-2.23	2.57-2.96	13.19-14.10	21.98-22.94	1.90-2.10	3.07-3.38	12.31-12.90	22.95-23.90
Mean	2.06	2.70	13.7	22.39	2.01	3.23	12.49	23.58
S.D.±	0.12	0.16	0.38	0.48	0.07	0.11	0.23	0.37

Table 5: Life cycle

Stage	Duration(days) on watermelon					
	Min	Max	Mean	Min	Max	Mean
Egg	4	4.5	4.25	4	4.5	4.25
First	2	2	2	2	2	2
Second	3	3	3	2	2	2
Third	2	2	2	2	2	2
Fourth	3	3	3	2	2	2
Fifth	3	3	3	3	3	3
Total larval period	13	13	13	11	11	11
Pre pupa	2.08	2.25	2.16	2.08	2.16	2.12
Pupa	6.03	7.21	6.62	6.02	6.57	6.29
Adult	6.00	9.00	7.5	6	8	7
Life cycle	31.11	35.96	33.53	29.1	32.23	30.66

Table 6: Efficacy of insecticides against Pumpkin caterpillar,*D. indi*ca on Watermelon under laboratory conditions

Treat.	24 hrs	48 hrs	72 hrs
T1	100.00 (89.19)	100.00 (89.19)	100.00 (89.19)
T2	73.33 (59.00)	76.67 (61.71)	76.67 (61.71)
T3	73.33 (59.00)	100 (89.19)	100.00 (89.19)
T4	30.00 (32.30)	100 (89.19)	100.00 (89.19)
T5	10.00 (18.43)	33.33 (35.22)	79.99 (67.59)
T6	100.00 (89.19)	100.00 (89.19)	100.00 (89.19)
T7	100.00 (89.19)	100.00 (89.19)	100.00 (89.19)
T8	0.00 (0.91)	0.00 (0.91)	0.00 (0.91)
SEm	2.69	1.88	4.20
CD at 5%	8.52	5.64	12.60

Conclusion

It was concluded the total number of eggs laid by female in her life span varied from 116 to 308 with an average of 193.4 and incubation period was 4.3 days with 100 % hatching. Freshly emerged larva measured 1.2 mm in length and 0.14 mm in breadth. Full grown larva measured 15.92 mm in length and 1.63 mm in head breadth on watermelon. In female there was a receiving organ at the centre of brush ventrally. The moths frequently can be seen holding their brushes above the body level and slowly waving them in a circular fashion. Sex ratio of male to female was 1:4 on watermelon Post spray observations were recorded with an interval of 24, 48 and 72 hours after spraying. Treatments T1 (Emamectin benzoate), T6 (Triazophos) and T7 (Cartap hydrochloride) showed 100 % mortality at 24 hrs after spraying and all these treatments were at par with each other. After 72 hrs spraying the treatment T5 (Azadirachtin) recorded 79.99 mortality and which was found to be at par with treatment T2 82 (Acetamiprid) which showed 76.67 mortality. The treatment T8 (control) showed no mortality.

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