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RESEARCH ARTICLE

Bionomics and evaluation of different biocides against anar butterfly, *Virachola isocrates* (Fabricius) infesting pomegranate

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ABSTRACT

The present investigation was carried out in laboratory condition at Department of Entomology and field condition at Horticulture Farm, B.A. College of Agriculture, Anand Agricultural University, Anand during 2011-12. The female laid eggs on flowers, fruits and leaves singly. The freshly laid eggs were shiny white in colour. The length and breadth of eggs, first, second, third, fourth and fifth instar larvae were 0.49 ± 0.78 and 0.51 ± 0.08 mm, 1.56 ± 0.28 and 0.98 ± 0.08, 6.95 ± 1.28 and 2.45 ± 1.01, 12.4 ± 0.95 and 3.80 ± 0.53, 17.4 ± 1.95 and 4.6 ± 0.52, 22.5 ± 1.90 and 5.78 ± 1.20 mm, respectively. The duration of first, second, third, fourth, fifth, pre-pupal and pupal stages were 4.8 ± 1.10, 5.8 ± 0.78, 7.8 ± 0.65, 6.3 ± 0.62, 5.22 ± 1.02, 2.4 ± 0.48 and 10.8 ± 2.20 days, respectively. The pre-ovipositor, oviposition and post oviposition period were 1.20 ± 0.42, 3.5 ± 0.95 and 6.0 ± 0.79 days, respectively. Among the nine biocides evaluated against *V. isocrates* on pomegranate, neem oil @ 0.5 per cent, neem seed kernel extract @ 5 per cent and *Bacillus thuringiensis* @ 0.15 per cent were found more effective. The application cost of the respective biocides were 1670, 2420 and 3337 Rs./ha, respectively.

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INTRODUCTION

Pomegranate (*Punica granatum* Linnaeus) is an ancient favourite table fruit of tropical and sub tropical regions of world. The fruit is symbolic of plentifulness and it is very much liked for its cool refreshing juice. The roots, rind and seeds are medicinally important especially against diarrhoea. In Gujarat, it is cultivated in Dholka, Bhavnagar, Ahmedabad, Sabarkantha and Banaskantha districts. Cultivation of high yielding varieties of pomegranate with intensive care and management in the recent past under irrigated condition with early stage exploitation of plant has lead to certain severe insect pests problems *i.e*. Anar butterfly [*Virachola isocrates* (Fabricius)], pomegranate borer [*Deudorics epijarbas* (Moore)], bark eating caterpillars [*Indarbela tetraonis* (Moore) and *Indarbela quadrinotata* (Walker)], mealy bug [*Drosicha magiferae* (Green) and *Planococcus lilacinus* (Cockerell)], thrips [*Retithrips syriacus* (Mayet) and *Rhipiphorothrips cruentatus* (Hood)] and fruitfly [*Bactrocera dorsalis* (Hendel)]. Among them, *V. isocrates* is serious pest of pomegranate having a wide host ranges including, apple, ber, citrus, guava, pear, aonla etc. This pest has been reported to cause 40-90 per cent damage to pomegranate fruits (Atwal, 1986). Avoidable losses in pomegranate caused by *V. isocrates* was about 13.23 per cent in the Rajasthan (Kanwat and Kumawat, 1995).

MATERIAL AND METHODS

The investigation was carried out at Horticulture farm for evaluation of biocides while bionomics was carried out under laboratory conditions at Department of Entomology, Anand Agricultural University, Anand during 2011-2012. Larvae of *V. isocrates* were collected from the pomegranate orchards planted at Horticulture Farm and reared in the laboratory of Department of Entomology. The male and female adults emerged out from pupae were collected with the help

of plastic bottle and released in pair in rearing cage (1.25 × 1.25 × 1.25 m^3) for mating and egg laying. Tender terminal shoots of pomegranate with fresh fruits and calyx were wrapped with cotton lint soaked in water at cut end to keep the leaves and fruit fresh and turgid for longer period. The bouquet of tender shoots with fruit and calyx held erect in flask was placed inside the cage for egg laying. Absorbent cotton dipped in 5% honey solution was serving as food to adults. Observations on twenty pairs were recorded on duration of pre-mating, mating, pre-oviposition, oviposition, post-oviposition behaviour and fecundity. Detailed observations on eggs and larvae of each instar, pre-pupa, pupa and adults were also made. Moulting and stage of the larvae was determined by locating the exuviae cast out side of the fruits and also by measuring head capsule as suggested by Dyar (1890). The data on morphometrics *viz.*, the size of eggs, larva, pre-pupa, pupa with help of Magnus-Pro software while male and female adults body length were measured with the help of millimeter scale. In order to study the effect of different biocides against anar butterfly, *V. isocrates*, the experiment was laid out in a Completely Randomized Design with three repetitions. Thirty plants were randomly selected for each experiment from the field having uniform size and growth of trees. The respective biocides were sprayed on three randomly selected and tagged plants. One plant was considered as one repetition. For recording the observations, *V. isocrates* infested and total fruits were counted before one day and after 1, 2, 3 and 4 weeks of application from five branches of each plant.

Method of application :

First spray application of respective biocides was given in the month of March. Second spray was given after 30 days of first spray using manually operated knapsack sprayer having duromist nozzle with slight runoff stage. Leaf extract of respective botanical treatments were made by grinding the sufficient quantity of leaves using grinder. To prepare neem seed kernel extract, the required quantity of kernels was weighed (250 g) on electric balance and grinded in electric grinder. The powder was kept in muslin cloth and soaked into 2 litre of water for overnight and thereafter, the bag was squeezed repeatedly until the out flowing fluid turned light brownish in colour. Finally, the required volume (5 litre) was prepared by addition of water. For making of Nafatia, Ardusa and Neem leaf extract required quantity of leaves were weighed (500 g) on electric balance and grinded in electric grinder. The paste was kept in muslin cloth and soaked into 2 litre of water and thereafter, the muslin cloth was squeezed repeatedly and added extra water to make finally required volume (5 litre).

Cost of treatment :

In order to know the economics of different treatments evaluated against *V. isocrates* infesting pomegranate trees, the plant protection cost of each treatment was worked out. For the purpose, total cost of biocides application per hectare was calculated for each treatment based on the prevailing market price.

RESULTS AND DISCUSSION

The female laid eggs on flowers, fruits (base, middle, top and calyx cup) and on leaves singly. The freshly laid eggs were shiny white in colour and more or less round in shape. The length and breadth of eggs ranged from 0.44 to 0.55 mm with an average of 0.49 ± 0.78 mm and 0.49 to 0.56 mm with an average of 0.51 $\pm$ 0.08 mm, respectively (Table 1). The incubation period varied from 6 to 10 days with an average of 8.76 ± 0.49 days. The minimum and maximum hatching percentage was 70 and 90, respectively with an average of 81.85 ± 7.65. Present results are tally with the reports of Tiwari and Mishra (2007) and Singh and Singh (2001).

In laboratory, the newly hatched first and second instar larvae fed initially on seed. The third instar larva bore hole was bigger in size and posterior end of the abdomen was seen through the bore hole. The fourth instar fed voraciously on seeds and excreta was pushed out of the entry holes as dry pellets or wet faecal matter which stunk around the holes. This could create an offensive smell. The fifth instar larva was creating lot of mess and offensive smelling fluid oozed out from the entrance hole. Sometimes, the holes could be plugged with the anal end of larva. The larvae were found to pass through five instars on pomegranate fruits in the laboratory. These findings are well supported by Thirumurugan (1992), Karuppuchamy *et al.* (1998), Singh and Singh (2001) and Tiwari and Mishra (2007) who noticed five instars of this pest in contrast to Kabre and Moholkar (1992) who observed only four instars of *V. isocrates* on pomegranate.

The freshly hatched larva was cylindrical and creamy white in colour except head and last abdominal segments being black. The body of larva covered with scattered white hairs. The length and breadth of first instar larva varied from 1.30 to 1.80 mm with an average of 1.56 ± 0.28 mm and 0.70 to 1.00 mm with an average of 0.98 ± 0.08 mm, respectively. The width of head capsule varied from 0.18 to 0.25 mm with an average 0.20 ± 0.03. The duration of first instar larvae varied from 4 to 7 days with an average 4.8 ± 1.10 days (Table 1).

The colour of second instar larva varied from creamy white to greenish brown with scattered hairs. Length of second instar larva ranged from 5 to 8 mm with an average 6.95 ± 1.28 mm, while the breadth ranged from 2 to 4 mm with an average 2.45 ± 1.01 mm. The width of head capsule varied from 0.28 to 0.40 mm with an average 0.33 ± 0.07 mm and duration of second instar larvae varied from 5 to 8 days with an average 5.8 ± 0.78 days.

Third instar larva was similar to preceding instar but dark in colour with larger yellowish and boat shaped spots on abdomen. The length, width and head capsule width of third instar larva ranged from 9.0 to 16 mm with an average of 12.4 ± 0.95 mm, 3.5 to 5.5 mm with an average of 3.80 ± 0.53 mm and 0.48 to 0.59 mm with an average of 0.54 ± 0.76 mm, respectively The duration of third instar larvae varied from 6 to 10 days with an average of 7.8 ± 0.65 days. The yellowish boat shaped spots disappeared in the stout fourth instar larva. The colour changed greenish to light brown. The length, width and head capsule width of fourth instar larva ranged from 14 to 19 mm with an average of 17.4 ± 1.95 mm, 4.0 to 6.0 mm with an average of 4.6 ± 0.72 mm and 0.69 to 0.82 mm with an average of 0.80 ± 0.07 mm, respectively. While, duration of fourth instar larvae varied from 5 to 8 days with an average of 6.3 ± 0.62 days.

The full grown larva was dark brown with pale yellowish patches and short hairs on the body. The length, width and head capsule width of fifth instar larva ranged from 20.0 to 25.0 mm with an average of 22.5 ± 1.90 mm, 5.5 to 7.0 mm with an average of 5.78 ± 0.95 mm and 1.20 to 1.4 mm with an average of 1.18 ± 0.08 mm, respectively. The duration of fifth instar larvae varied from 4 to 8 days with an average of 5.22 ± 1.02 days.

The total larval period varied from 27 to 32 days with an average 29.2 ± 2.20 days. Butani (1976) noted total larval period ranged from 18 to 47 days. Karuppuchamy *et al.* (1998) mentioned total larval period ranged from 19 to 25 days.

Fully grown larva suspended its feeding, became motionless, reduced in size and turned into pre-pupal stage. Their colour changed to dark bluish on dorsal side and dirty white on ventral side. The length of pre-pupa ranged from 14.00 to 18.00 mm with an average of 16.20 ± 1.20 mm, while breadth ranged from 6.10 to 7.6 mm with an average 7.0 ± 1.50

Table 1 : Measurement of different stages and duration of *V. isocrates*

Stage	Particulars	Measurement (mm)			Periods (days)		
		Min.	Max.	Mean ± S.D.	Min.	Max.	Mean ± S.D.
Egg	Length	0.44	0.55	0.49 ± 0.78	6	10	8.76 ± 0.49
	Breadth	0.49	0.56	0.51 ± 0.08			
Larva							
I Instar	Length	1.30	1.80	1.56 ± 0.28	4	7	4.8 ± 1.10
	Breadth	0.70	1.00	0.98 ± 0.08			
	Head capsule	0.18	0.25	0.20 ± 0.03			
II Instar	Length	5.00	8.00	6.95 ± 1.28	5	8	5.8 ± 0.78
	Breadth	2.00	4.00	2.45 ± 1.01			
	Head capsule	0.28	0.40	0.33 ± 0.07			
III Instar	Length	9.00	16.0	12.4 ± 0.95	6	10	7.8 ± 0.65
	Breadth	3.5	5.50	3.80 ± 0.53			
	Head capsule	0.48	0.59	0.54 ± 0.76			
IV Instar	Length	14.0	19.0	17.4 ± 1.95	5	8	6.3 ± 0.62
	Breadth	4.0	6.0	4.6 ± 0.52			
	Head capsule	0.69	0.82	0.80 ± 0.07			
V Instar	Length	20.0	25.0	22.5 ± 1.90	4	8	5.22 ± 1.02
	Breadth	5.50	7.00	5.78 ± 1.20			
	Head capsule	0.95	1.4	1.18 ± 0.08			
Total larval period					27	32	29.2 ± 2.20
Pre-pupa	Length	14.0	18.0	16.20 ± 1.20	2	4	2.4 ± 0.48
	Breadth	6.10	7.6	7.0 ± 1.50			
Pupa	Length	10.0	15.0	13.80 ± 1.74	8	14	10.8 ± 2.20
	Breadth	5.00	7.00	6.0 ± 0.08			
Adult							
Male	Length	20.0	25.0	23.6 ± 1.50	30	40	37.6 ± 2.74
	Breadth (wing expanded)	38.0	49.0	43.8 ± 2.40			
Female	Length	20.0	27.4	25.7 ± 1.80	35	44	40.5 ± 3.20
	Breadth (wing expanded)	44.0	52.0	45.8 ± 2.15			

mm. While, duration of pre-pupal stage varied from 2 to 4 days with an average of 2.4 ± 0.48 days. The larvae pupated inside the damaged fruit or in tunnel made by the larva in laboratory as well as field condition.

The pupa of *V. isocrates* was light brown in colour and obtect, adecticous in shape. The length of pupal stage ranged from 10 to 15 mm with an average of 13.80 ± 1.74 mm, while breadth ranged from 5.00 to 7.00 mm with an average 6.0 ± 0.08 mm. The duration of pupal stage varied from 8 to 14 days with an average of 10.8 ± 2.20 days. Freshly emerged butterflies remained immobile for 5 to 10 minute, set in slanting position by keeping their head upward and abdomen downwards for proper wings development. Adult butterflies were dull brown (males) to dark brown (females). The fore wings of both sexes covered with brownish scales were large in size and dark in colour as compared to hind wings which had 4 to 5 mm long tail like structure on its anal margin. The thorax was fairly large and covered with brownish hairs. Male butterfly had three bluish spots in the anterior region of each hind wing. The female butterflies had an orange patch on the apical region of each forewing.

The length of male butterfly ranged from 20 to 25 mm with an average of 23.6 ± 1.50 mm, while breadth with wing expanded varied from 38 to 49 mm with an average of 43.8 ± 2.4 mm. The length of female butterfly ranged from 20.00 to 27.4 mm with an average 25.7 ± 1.80 mm, while breadth with wing expanded varied from 42.00 to 52.00 mm with an average 45.8 ± 2.15 mm (Table 1).

The pre-oviposition, oviposition and post-oviposition period of female butterfly varied from 1 to 2 days with an average of 1.20 ± 0.42 days, 2 to 5 days with an average of 3.5 ± 0.95 days and 5 to 7 days with an average of 6.0 ± 0.79 days, respectively (Table 2). The egg laying capacity of female varied from 25 to 34 eggs with an average of 30.8 ± 2.24 eggs.

The longevity of female and male butterfly ranged from 10 to 15 days with an average of 11.4 ± 2.20 days and 5 to 11 days with an average of 8.2 ± 2.1 days. The sex ratio of male : female was found to be 1 : 2.11 under laboratory condition (Table 2). The total life cycle of *V. isocrates* occupied on an average 37.6 ± 2.74 days ranging from 30 to 40 days in case of male, while in case of female 40.5 ± 3.20 days ranging from 35 to 44 days. Similar observations reported by Karuppuchamy *et al.* (1998) and Shevale (2003).

All the tested biocides were found significantly superior to reducing the fruit damage up to second week of spray. Fruit damage after first spray (Table 3) showed that the lowest (14.19%) fruit damage was noticed in plants treated with neem oil and it was at par with NSKE and B*t*. Vanguard, neem leaf extract and naffatia leaf extract registered 18.70, 19.73 and 21.49 per cent fruit damage and they were at par with each other in reducing the damage caused by *V. isocrates*. The highest (25.09%) fruit damage was recorded in plants treated with ardusa leaf extract and it was at par with *Ll* and *Bb*.

After second spray (Table 3) exposed that the lowest (15.65%) fruit damage was found in plants treated with neem oil and it was at par with NSKE and *Bt*. Vanguard, neem leaf extract and naffatia leaf extract noted 20.08, 21.49 and 23.00 per cent fruit damage, respectively and they were equally effective as Vanguard. The highest (26.60%) fruit damage was registered in plants treated with ardusa leaf extract and it was at par with nafatia leaf extract, *Ll* and *Bb*. Pooled over spray results revealed that the lowest (14.90%) fruit damage was noticed in plants treated with neem oil and it was at par with NSKE and *Bt.* Vanguard, neem leaf extract and naffatia leaf extract registered 19.38, 20.60 and 22.24 per cent fruit damage, respectively and they were statistically at par with each other. The highest (25.84%) fruit damage was observed in plants treated with ardusa leaf extract and it was at par with naffatia leaf extract, *Bb* and *Ll*.

As per the report of the Murugan and Thirumurugan (2001), spraying of neem oil at 3 per cent controlled *D. isocrates* infestation on pomegranate equal to that of three rounds of malathion spraying at 0.1 per cent. The dipel (*Bacillus thuringiensis*) noticed about 18.5 per cent reduction of *V. livia* incidence on date palm and exhibit 79 to 86 per cent successful larval penetration (Temerak and Saiyad, 2001). Above reports drawn by various research workers strongly support the present findings.

The cost of biocides application was calculated and revealed that naffatia leaf extract, neem leaf extract and ardusa leaf extract registered low cost (Rs. 1640 ha) of treatment. However, first two leaf extract were found mediocre and last one fell less effective group against *V. isocrates* on pomegranate. The NSKE, neem oil and Vanguard application costed 2420, 1670 and 2892 Rs/ha, respectively. Microbial insecticides, *Lecanicillium lecanii*, *Beauveria bassiana* and *Bacillus thuringinsis* costed 2060, 2060 and 3337 Rs/ha, respectively.

Table 2 : Pre-oviposition, oviposition, post-oviposition and sex ratio of *V. isocrates*

Particulars	Min.	Max.	Mean ± S.D.
Pre-oviposition	1	2	1.20 ± 0.42
Oviposition	2	5	3.5 ± 0.95
Post-oviposition	5	7	6.0 ± 0.79
Sex ratio (Male : Female)	1 : 1	1 : 2.60	1 : 2.11

Table 3 : Effectiveness different biocides on fruit damage caused by *V. isocrates* in pomegranate

Biocides	Before spray	Fruit damage (%) after spray		Pooled	Cost of two sprays (Rs./ha)
		*First	*Second		
Neem oil 0.5%	29.16 (23.74)	22.13 (14.19)	23.30 (15.65)	22.71 (14.90)	1670
NSKE 5.0%	27.01 (20.62)	22.43 (14.56)	23.59 (16.02)	23.01 (15.28)	2420
Vanguard 0.4%	31.79 (27.75)	25.62 (18.70)	26.62 (20.08)	26.12 (19.38)	2892
0.15% EC					
Nafatia leaf extract 10%	31.49 (30.61)	27.62 (21.49)	28.66 (23.00)	28.14 (22.24)	1640
Ardusa leaf extract 10%	33.59 (30.61)	30.06 (25.09)	31.05 (26.60)	30.55 (25.84)	1640
Neem leaf extract 10%	31.23 (26.88)	26.37 (19.73)	27.61 (21.48)	26.99 (20.60)	1640
Beauveria bassiana 2×10^8 CFU	33.13 (29.87)	29.30 (23.95)	30.30 (25.45)	29.80 (24.70)	2060
Lecanicillium lecanii 2×10^8 CFU	32.39 (28.70)	29.48 (24.22)	30.48 (25.73)	29.98 (24.97)	2060
Bacillus thuringinsis 5×10^7 spore/mg	26.88 (20.44)	23.29 (15.63)	24.45 (17.13)	23.87 (16.38)	3337
Control (water spray)	36.20 (34.88)	34.98 (32.87)	35.46 (33.66)	35.22 (33.26)	–
S. Em ± Treatment (T)	2.10	0.82	0.85	–	-
Period (P)	–	–	–	0.27	–
Spray (S)	–	–	–	0.19	–
T x P	–	–	–	0.61	–
T x S	–	–	–	0.38	–
S x P	–	–	–	0.86	–
T x P x S	–	–	–	1.21	–
C.D. at 5% T	NS	2.30	2.38	–	–
P	–	–	–	0.76	–
S	–	–	–	0.54	–
T x P	–	NS	NS	1.69	–
T x S	–	–	–	NS	–
S x P	–	–	–	NS	–
T x P x S	–	–	–	NS	–
C.V. %	11.64	10.01	10.11	7.60	–

Figures in parenthesis are retransformed value, those outside are arcsine transformed value
*Pooled over 4 week, Labour charge : Rs. 170 per day for skilled labour, Rs. 100 ordinary labour
Number of labour required : 3, Water requirement for 1 ha : 650 litre.

On the basis of above results, it can be concluded that total life cycle of *V. isocrates* ranged from 30 to 40 days in case of male, while 35 to 44 days in female. Neem oil @ 0.5 per cent, NSKE @ 5.0 per cent and *Bt* @ 0.15 per cent were found more effective. The cost of application neem oil, neem seed kernel extract and *Bt* were higher but these biocides were found more effective against *V. isocrates* in pomegranate.

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REFERENCES

Atwal, A.S. (1986). Pests of tropical and sub tropical fruits. In : *Agricultural Pests of India and South East Asia*. Kalyani Publisher, NEW DELHI (INDIA) pp. 205–247.

Butani, D. K. (1976). Insect pests of fruit crops and their control, pomegranate. *Pesticides*, **10**(6) : 23-26.

Dyar, H. G. (1890). The number of moults in lepidopterous larvae. *Psche* (Cambridge Mass) **5**(2): 420-422.

Kabre, G. B. and Moholkar, P. R. (1992). Studies on life history of pomegranate fruit borer, *Virachola isocrate. J. Insect Sci.*, **5** (2) : 213-215.

Kanwant, P. M. and Kumawat, K. C. (1995). Assesment of loss in pomegranate due to anar butterfly, *Virachola isocrate*. *Annals Arid Zone*, **34** (4): 317-318.

Karuppuchamy, P., Balasubramanian, G. and Sundarababu, P.C. (1998). The biology of pomegranate fruit borer, *Deudorix isocrate. Madras Agric. J.*, **85** (5-6): 256-259.

Karuppuchamy, P., Balasubramanian, G. and Sundarababu, P.C. (2001). Use of neem products and biocontrol agents for management of pomegranate fruit borer, *Deudorix isocrates. Madras Agric. J.*, **88** (4-5): 334-336.

Murugan, M. and Thirumurugan, A. (2001). Studies on ecofriendly approaches to manage pomegranate fruit borer. *Plant Prot. Bull.*, **5** (3): 13-15.

Shevale, B.S. (2003). Studies on life fecundity table of pomegranate butterfly. *Ann. Plant Prot. Sci.*, **11** (3): 253-257.

Singh, H.B. and Singh, S.B. (2001). Biology of *Deudorix isocrates* on its new potential host, Aonla. *Indian J. Ent.*, **63** (1): 19-25.

Temerak, S.A. and Saiyad, A.A. (2001). Ovi larvicidal activity of spinosad in comparison to *Bacillus thuringiensis* for control of *Virachola livia* (Klug.) on date palm trees. *Assiut. J. Agric. Sci.* **32**(4) : 1-7.

Thirumurugan, A. (1992). Studies on insect pests of pomegranate and their control. M.Sc. (Ag.) Thesis, Agricultural College and Research Institute (T.N.A.U.), Killikulam T.N. (INDIA).

Tiwari, A.K. and Mishra, P. (2007). Biology of *Deudorix isocrates* Fabricius on aonla, *Emblica officinalis*. *Annals Plant Protec. Sci.*, **15**(2) : 335-337.