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RESEARCH ARTICLE

Biological activity of *Datura metel* L. on diamond back moth, *Plutella xylostella* L. infesting Brassicaceous vegetables

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ABSTRACT

Datura metel seed extracts in water and methanol were assayed for their activity against diamond back moth, *Plutella xylostella*. Aqueous extract was found more ovicidal with 74 per cent at 10 per cent concentration methanol compared to the aqueous extract (81 % mortality at 40% concentration). Repellent effect of methanol extract to fourth instar larvae was more evident up to 18 hours, while aqueous extract was repellent up to 12 hours only. Antifeedant activity was weak on fourth instar larvae as the maximum feeding inhibition by these extracts was only 14 - 21 per cent. Cumulative mortality (mortality of treated II or IV instar larvae + mortality in the succeeding stages) was similar (28-29%) when larvae were fed on the leaves treated with datura seed extracts in methanol or water. Aqueous and methanol extracts adversely affected oviposition of female moths as maximum oviposition deterrence observed was 55 per cent and 35 per cent, respectively. Thus, it is inferred that active principle (s) present in aqueous and methanol extracts of *Datura metel* seeds are insecticidal possessing diverse activities like repellence, feeding and oviposition deterrence, killing effect etc. against diamond back moth.

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INTRODUCTION

Many plant species are known to possess an array of chemicals with multiple modes of action on insects and at the same are believed to be safe to non-target organisms (Schmutterer, 1995). *Datura*, a genus of poisonous herbs (Kurian and Sankar, 2007) found in tropical and warm regions comprises of 15 species. Extracts from all the species of *Datura* are toxic, however, *D. fastuosa* (=*D. metel*) possesses more toxic properties (Nasir, 1985). In India, *Datura* grows wild in the hills of Uttar Pradesh, Himachal Pradesh, and Kashmir valley and in the plain lands of Karnataka.

Datura plant contains 0.3 to 0.5 per cent of tropane alkaloids, chiefly hyoscyamine 0.3 to 0.8 per cent, small quantities of atropine and hyoscine (scopolamine), flavonoids, withanolides, coumarins and tannins (Sharma, 2004). Total alkaloid content of leaves is 0.426 per cent, which is mainly atropine; the seeds also contain 0.426 per cent alkaloids, which is mainly hyoscyamine (Chopra *et al*., 1986). Hyoscyamine (isomeric with atropine) $C_{17}H_{23}O_3N$ is poisonous, slightly soluble in water, soluble in alcohol, ether and dilute acid, while atropine (daturine) $C_{17}H_{23}NO_3$ is poisonous, soluble in alcohol, ether, chloroform and glycerol, slightly soluble in water (Arthur and Elizabeth, 1961). Hyoscyamine is anticholinergic, specifically antimuscarinic, acts by blocking the action of acetylcholine on parasympathetic sites in smooth muscles, and central nervous system.

Diamond back moth, *Plutella xylostella* L. (Lepidoptera: Yponomeutidae), sometimes called cabbage moth, is one of the most important pests of Brassicaceous crops in the world and usually feed on plants that produce glucosinolates (Talekar and Shelton, 1993). Some plant products such as neem seed kernel extract (Narabenchi, 1998), *Annona squamosa*

(Isman and Leatemia, 2004), *Hedera nepalensis, Berberis lycium, Acorus calamus, Valeriana jatamansi, Zanthoxylum armatum* (Tewary *et al.*, 2005) were recorded to cause mortality in DBM larvae. The present study evaluated *D. metel* seed extracts for insecticidal activity against diamond back moth.

MATERIAL AND METHODS

Preparation of *Datura metel* seeds and seed extracts :

The matured fruits of *D. metel* were collected from wild plants and seeds obtained were allowed to dry in shade. Dried seeds were ground to coarse powder using a waring blender and the powder was used for extraction using water and methanol.

Aqueous and methanol extracts :

Known quantity of *Datura* seeds coarse powder was soaked in water over-night and filtered repeatedly using a fine white muslin cloth. The volume of the filtrate was made up using ordinary tap water to get the desired concentrations. Methanol extract was prepared with 100g of *Datura* seed powder and 250ml methanol using Soxhlet apparatus, run for 10-12 hours till the solvent in the extraction jar appeared almost clear. The extract was evaporated in a flash evaporator to obtain a semi solid extract, which was then air dried to near dryness and stored at 8 to 10^0C in a refrigerator for further use.

Mass rearing of diamond back moth :

The late instar larvae of *Plutella xylostella* were collected from infested cabbage and radish fields around Bangalore and were reared in the laboratory on mustard seedlings raised in plastic Petri dishes (10cm × 1.5cm diameter) with vermiculite. After pupation, the pupae were placed in the oviposition cage (35cm × 10cm × 35cm) for moth emergence. The moths were provided with 10 per cent honey on cotton wads and 3 to 4 days old mustard seedlings for oviposition. After 24 hours, seedlings with DBM eggs were transferred and reared in plastic trays till pupation and moth emergence.

Bioassay for different activities :

Repellent activity against fourth instar larvae :

The repellent activity of *Datura* seed extracts (aqueous extract @ 10, 20 and 40 % concentrations and methanol extract @ 2.5, 5 and 10 % concentrations) on diamond back moth was studied by employing the method of "free choice test". Water with 0.5 per cent methanol served as control. Four centimetre diameter mustard leaf discs treated with desired concentrations of extracts were used for "leaf disc dip" bioassay method. The treated leaf discs were placed alternatively with untreated leaf discs in a circular fashion at equal distances in a plastic tray. Thirty IV instar larvae (with 3 replications) were released at the centre of the plastic tray to settle on the leaf discs of their choice. The repellency, if any was recorded by counting the number of larvae settled on treated and untreated leaf discs 6, 12 and 18 hours after release and per cent repellency was calculated using the formula :

$$\textbf{Per cent repellency} \quad Z\left(\frac{\mathbf{A \; J \; B}}{\mathbf{A}}\right)\grave{o}\,\mathbf{100}$$

where, A: Mean number of larvae recorded on untreated leaf discs.

B: Mean number of larvae present on treated leaf discs.

Repellency data were categorized into five classes as suggested by Rahman *et al*. (2007) :

Repellency	Class
Up to 1%	0
1-20%	I
21-40%	II
41-60%	III
61-80%	IV
81-100%	V

Anti-feedant activity :

The antifeedant activity on fourth instar larvae was determined following leaf disc bioassay method of Wada and Muna (1968) with minor modifications, based on the weight of treated leaf area consumed in 48 hours. Leaf bits of mustard leaves measuring 4 cm × 7 cm were prepared and dipped in desired concentrations of extracts (aqueous extract @10, 20 and 40 % and methanol extract @ 2.5, 5 and 10%) for ten seconds and air dried. These leaf bits were weighed and used for feeding 15 IV instar larvae in plastic boxes (15 cm × 6 cm). Leaf bits treated with water and water with methanol 0.5 per cent served as controls and three replications were maintained for each treatment.

Reduction in the weight of treated leaf bits due to feeding by larvae was recorded after 48 hours and corrected as below:

$$= (T_0 - T_1) - (C_0 - C_1)$$

where, T_0: Treated leaf weight at 0 hour (along with larvae).

T_1: Treated leaf weight after 48 hours (along with larvae).

C_0: Leaf weight at 0 hour in control (without larvae).

C_1: Leaf weight after 48 hours in control (without larvae).

The per cent antifeedant activity was calculated based on feeding ratio calculated as below :

$$\left(\frac{\textbf{Leaf weight consumed in treatment}}{\textbf{Leaf weight consumed in control}}\right)\grave{o}\,\mathbf{100}$$

The anti-feedant activity was then rated using inhibition scale suggested by Wada and Muna (1968) :

Scale	Extent of feeding
High antifeedant activity (++++)	Below 20%
Medium antifeedant activity (+++)	20 to 50%
Weak antifeedant activity (++)	51 to 80%
Insignificant antifeedant activity (+)	> 80%

Development of larvae fed on treated leaf :

The growth disruptive activity of *Datura* seed extracts on *P. xylostella* was investigated under laboratory conditions. Fresh and clean mustard leaf bits (measuring approximately 4 cm × 7 cm) were dipped in the desired concentrations of extracts (aqueous extract @ 10, 20 and 40 % and methanol extract @ 2.5, 5 and 10%) for 10 seconds and air dried. Leaf bits treated with water only and water with methanol 0.5 per cent served as controls and three replications were maintained for each treatment. Treated leaf bits were offered to fifteen IV instar larvae in clean plastic boxes (15 cm × 6 cm) kept at room temperature. After 72 hours, untreated fresh leaf bits were used for further feeding of the larvae. Larval mortality was recorded at 24 hours interval. The larvae were probed individually with a fine camel hair brush to ascertain their death and those larvae which did not move or respond were considered dead. Observations were continued till the larvae developed into adults, by recording the mortality or morphogenic effects, if any in the further developmental stages like pupa and adult.

Ovicidal activity of extracts:

Four days old mustard seedlings were placed in oviposition cage and two-days old moths were released (50 individuals) for egg laying. After 12 hours, the seedlings were taken out of oviposition cages and then dipped in the desired concentrations of the extracts (aqueous extract @ 10, 20 and 40 % and methanol extract @ 2.5, 5 and 10%) and the treated seedlings were air dried. Seedlings treated with water only and water with methanol 0.5 per cent served as controls and four replications were maintained for each treatment. The number of eggs treated and hatched (after 4 days) was recorded using a stereobinocular microscope. The ovicidal activity was computed as :

$$Z \frac{\text{Number of eggs unhatched}}{\text{Total number of eggs treated}} \grave{o} 100$$

Oviposition deterrence :

Four days old mustard seedlings dipped in the desired concentrations of the extracts and air dried were offered for egg laying by two days old moths released in the oviposition cage @ 50 moths per cage. Seedlings treated with water only and water with methanol 0.5 per cent served as controls and four replications were maintained for each treatment. Seedlings were taken out of the oviposition cage after 12 hours and the numbers of eggs laid were recorded using a stereobinocular microscope.

Statistical analysis:

Data on the mortality of eggs, larvae, pupae, adults and morphogenic effects at the pupal/ adult stages were corrected using Abbott's (1925) formula, considering such effects noticed in the untreated control. Percentage data were subjected to arc-sine transformation, while the number data were subjected to $\sqrt{x+0.5}$ and analyzed statistically following analysis of variance technique for Completely Randomized Design (CRD) to interpret the results at 5 per cent level of significance.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Effect of *Datura* extracts on DBM eggs :

Data with respect to the effect of *D. metel* seed extracts on eggs of diamond back moth are presented in Table 1. The extent of egg mortality ranged from 36 per cent with water extract @10 per cent to a maximum of 81 per cent with very a high concentration of water extract @ 40 per cent. Methanol extract from seeds was significantly more ovicidal than the aqueous extract. Maximum egg mortality observed was 74 per cent with methanol extract @ 10 per cent, while mortality effected by methanol extract @ 2.5 and 5 was 38 and 60 per cent, respectively.

Table 1 : Effect of *Datura metel* seed extracts on diamond back moth eggs

Treatments	Mortality (%)
Methanol extract @ 2.5%	38.46 (38.31)^{cd}
Methanol extract @ 5%	60.29 (50.95)^{b}
Methanol extract @ 10%	74.07 (59.94)^{a}
Aqueous extract @ 10%	36.14 (36.78)^{d}
Aqueous extract @ 20%	51.37 (45.79)^{bc}
Aqueous extract @ 40%	81.38 (65.11)^{a}
Control (water/methanol 0.5%)	0.00 (0.00)^{e}
F-test	**
SEM ±	(3.95)
C.D. at (P=0.05)	(8.93)

Figures in parentheses are angular transformed values
** indicate significance of value at P = 0.01 respectively
Means followed by same alphabetical superscript are statistically at par.

Effect on second instar larvae :

Concentrations of extracts which were used for treating the eggs were tested for their effects on second instar larvae. The larval mortality observed three days after treatment was 11.6 to 18.6 per cent with methanol extract compared to 4.6 to 16.2 per

cent mortality noticed with aqueous extract. The larvae which survived in these treatments beyond 3 days were however killed before pupation and the extent of additional mortality before pupation ranged from 3 to 5 per cent with aqueous extracts and 5 to 6 per cent with methanol extracts (Table 2). Also with methanol extract treatments mortality at the pupal stage ranged from 5.8 to 6.4 per cent, while it was 7.7 to 9.1 per cent with the aqueous extract. However, cumulative mortality caused by higher concentrations of water extract @ 20 per cent and 40 per cent was comparable to that of the higher concentrations of methanol extract @ 5 per cent and 10 per cent. Thus, it is evident that methanol extract was more insecticidal to second instar larvae than the aqueous extract (Fig. 1, 2 and 3). Exposure of second instar larvae to either water or methanol extracts from datura seeds, besides causing the death of the larvae, it also resulted in the death of developing pupae and thus the cumulative mortality (which includes the mortality of exposed larvae and mortality in the successive developmental stages) due to methanol extract @10 per cent and aqueous extract @40 per cent was comparable *i.e.* 29 per cent.

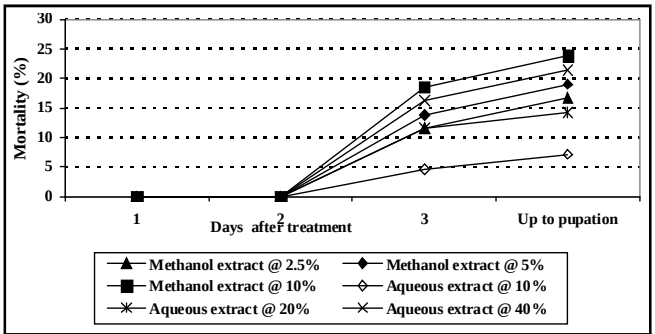

Fig. 1 : Effect of *Datura metel* seed extracts on second instar larvae of *Plutella xylostella*

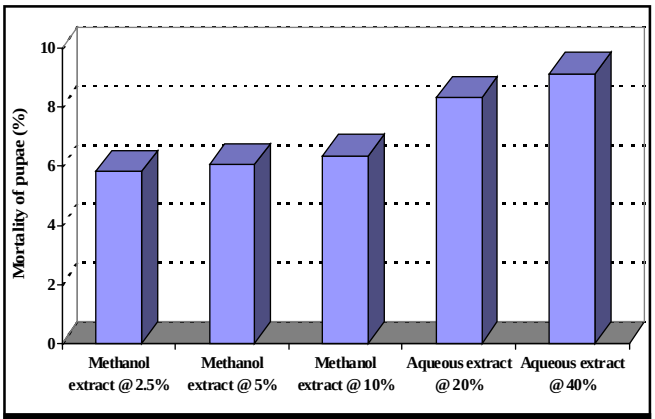

Fig. 2 : Pupal mortality in *Plutella xylostella* due to exposure of II instar larvae to *Datura* seed extracts

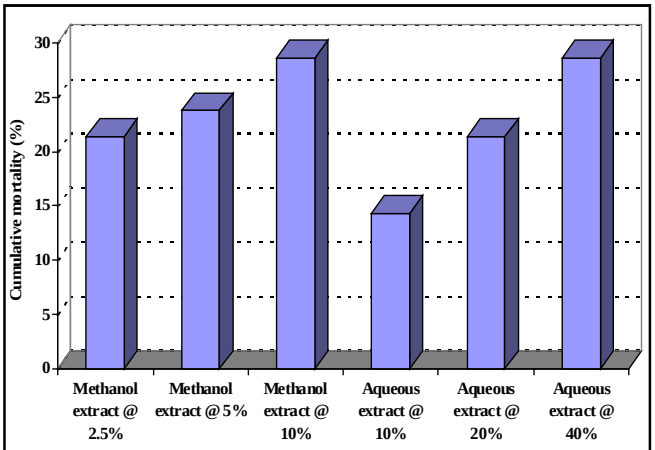

Fig. 3 : Cumulative mortality in *P. xylostella* due to exposure of II instar larvae to *Datura* seed extracts

Table 2 : Effect of *Datura metel* seed extracts on second instar DBM larvae

Treatments	Mortality of larvae (%)		Mortality of pupae (%)	Cumulative mortality (%)
	3 DAT	Up to Pupation		
Methanol extract @ 2.5%	11.58 (19.70)^{a}	16.66 (23.99)^{bc}	5.81 (11.44)	21.43 (27.36)^{ab}
Methanol extract @ 5%	13.81 (21.42)^{a}	19.05 (25.79)^{abc}	6.06 (11.70)	23.81 (28.94)^{a}
Methanol extract @ 10%	18.57 (25.45)^{a}	23.81 (29.16)^{a}	6.36 (11.99)	28.57 (32.20)^{a}
Aqueous extract @ 10%	4.60 (10.16)^{b}	7.14 (15.50)^{d}	7.69 (16.1)	14.28 (22.20)^{b}
Aqueous extract @ 20%	11.58 (19.70)^{a}	14.28 (22.20)^{c}	8.33 (16,78)	21.43 (27.58)^{ab}
Aqueous extract @ 40%	16.19 (23.66)^{a}	21.43 (27.36)^{ab}	9.14 (17.59)	28.57 (32.20)^{a}
Control (water/methanol)	0.00 (0.00)^{c}	0.00 (0.00)^{e}	0.00 (0.00)	0.00 (0.00)^{c}
F-test	**	**	NS	**
SEM ±	(2.04)	(2.15)	(1.73)	(2.43)
CD at P = 0.05	(8.10)	(4.79)	-	(6.66)

DAT: Days After Treatment; Figures in parentheses are angular transformed values;
**:Indicate significance of value at P= 0.01; NS: Not significant;
Means followed by same alphabetical superscript are statistically on par.

Effect of datura extracts on fourth instar larvae :

Repellency :

Six hours after treatment, the repellency of mustard leaves treated with methanol extract to fourth instar diamond back moth larvae was to the extent of 62.4 to 73.1 per cent compared to 43.6 to 49 per cent repellency observed with aqueous extract treated leaves. All the concentrations of methanol extract were statistically at par with each other in repelling the larvae (Table 3 and Fig. 4). With the passage of time (after 12 to 18 hours), the repellent effect of the extracts to the larvae declined. The percentage of larvae repelled at 12 hours on methanol extract treated leaves ranged from 60.7 to 71.1 against 33 to 44.2 per cent with water extract treated leaves. The corresponding repellency observed at 18 hours was 46.3 to 58.9 and 23.6 to 31 per cent. Compared to aqueous extract methanol extract offered good repellency to treated leaves up to 18 hours. Repellence of fourth instar larvae on methanol extract treated leaf discs was still more evident up to 18 hours (46 to 59%), while the repellent effect (33 to 44.2%) was sustained up to 12 hours with aqueous extract. Likewise with datura extracts in the present study, the repellent activity of *Annona squamosa* and *A. reticulata* against *P. xylostella* larvae is known since 1947 (Harper, 1947). Also Isman and Leatemia (2004) observed feeding deterrence of *A. squamosa* crude aqueous seed extract against the fourth instar DBM larvae.

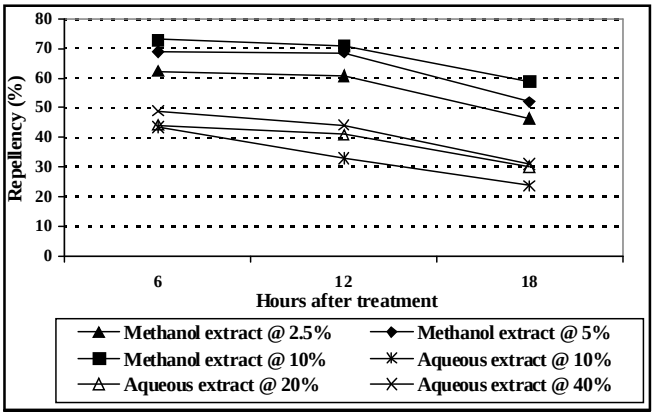

Fig. 4 : Repellency of *Datura metel* seed extracts to fourth instar DBM larvae

Table 3 : Repellency of *Datura* seed extracts to fourth instar larvae of diamond back moth

Treatment	6 hours after treatment		12 hours after treatment		18 hours after treatment	
	Repellency (%)	Repellency class	Repellency (%)	Repellency class	Repellency (%)	Repellency class
Methanol extract @2.5%	62.39 (52.51)	IV	60.74 (51.38)^{ab}	IV	46.31 (42.85)^{ab}	III
Methanol extract @5%	69.03 (56.38)	IV	68.64 (56.98)^{a}	IV	51.89 (46.11)^{a}	III
Methanol extract @10%	73.06 (58.83)	IV	71.05 (57.61)^{a}	IV	58.94 (50.23)^{a}	III
Aqueous extract @10%	43.61 (41.08)	III	32.99 (34.92)^{c}	II	23.63 (29.09)^{c}	II
Aqueous extract @20%	44.16 (41.59)	III	40.93 (39.53)^{bc}	III	30.10 (33.20)^{bc}	II
Aqueous extract @40%	48.99 (44.39)	III	44.16 (41.59)^{abc}	III	31.00 (33.50)^{bc}	II
F-test	NS	-	*	-	**	-
SEM ±	(2.34)	-	(2.80)	-	(2.23)	-
C.D. at (P=0.05)	-	-	(16.30)	-	(11.05)	-

Figures in parentheses are angular transformed values; NS: Not significant; *: Significant at P=0.05; **: Significant at P=0.01;
Means followed by same alphabetical superscript are statistically on par.

Table 4 : Antifeedant activity of *Datura* seed extracts to fourth instar DBM larvae

Treatments	Extent of feeding (%)	Antifeedant activity	
		Feeding deterrence (%)	Scale
Methanol extract @ 2.5%	85.98 (68.12)^{c}	14.02	+
Methanol extract @ 5%	79.26 (62.98)^{d}	20.74	++
Methanol extract @ 10%	79.22 (62.99)^{d}	20.78	++
Aqueous extract @ 10%	91.31 (73.01)^{b}	8.69	+
Aqueous extract @ 20%	85.64 (67.80)^{c}	14.36	+
Aqueous extract @ 40%	85.58 (67.78)^{cd}	14.42	+
Control (water/methanol)	100.00 (90.00)^{a}	0	+
F-test	**	-	-
SEM ±	(1.99)	-	-
C.D. at (P = 0.05)	(4.801)	-	-

Figures in parentheses are angular transformed values; **: Significant at P=0.01;
Means followed by same alphabetical superscript are statistically on par

Anti-feedant activity :

Feeding inhibition or anti-feedant activity observed with different concentrations of *D. metel* seed extracts against fourth instar larvae is shown in Table 4 and Fig. 5.

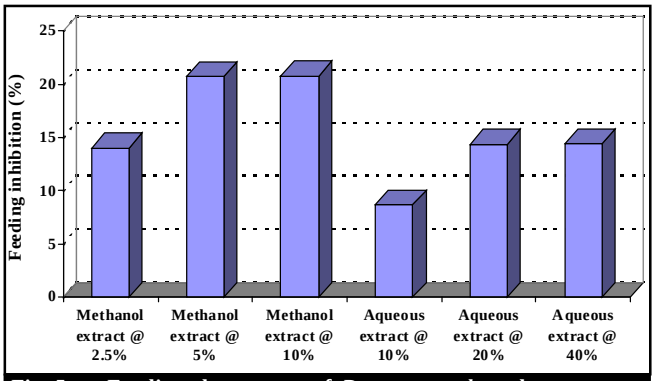

Fig. 5 : Feeding deterrence of *Datura metel* seed extracts to fourth instar DBM larvae

Feeding inhibition by methanol extract @ 5 to 10 per cent concentrations was 21 per cent compared to 14 per cent inhibition observed at its lower concentration of 2.5 per cent. Similar inhibitory trend was noticed with aqueous extracts (Table 4), with 10 per cent aqueous extract antifeedant activity was low (8.7%) and at 20 to 40 per cent concentrations, feeding inhibition was around 14.4 per cent (Fig. 5). Though antifeedant activity of datura seed extracts observed in the present study was either weak or insignificant against fourth instar larvae, the cumulative mortality which included larval mortality as well as the pupal mortality ranged from 20 to 28.9 per cent with methanol extract compared to 13.3 to 28.9 per cent observed with water extract. No literature is available on the activity of *D. metel* seed preparations on DBM larvae. But, Meshram (1995) observed antifeedant activity of *Datura* leaf extract @5 per cent to the extent of 97.2 per cent on a lepidopteran, *Eutecona machaeralis* and the leaf extract also caused mortality of treated larvae up to 50 per cent.

Mortality :

The extent of killing effect of *Datura* seed extracts on fourth instar DBM larvae are given in Table 5 and depicted in Fig. 6, 7 and 8. As noticed with second instar larvae, the effect of *Datura* extracts was evident on IV instar larvae from third day onwards and this effect continued up to pupation with both aqueous and methanol extracts. The mean larval mortality on the third day was 8.9, 11.1 and 15.6 per cent at different concentrations of methanol extract, respectively. The mortalities recorded with different concentrations of aqueous extract after 3 days were fairly low, *i.e.* 2.2, 4.5 and 11.1 per cent (Table 5).

The mortality due to water extract recorded in the entire larval period *i.e.* up to pupation, ranged from 4.5 to 17.8 per cent, which was fairly lower than that of 11.1 to 20 per cent observed with methanol extract. Mortality observed at the pupal stage due to the consumption (ingestion) of *Datura* extract treated leaves in the fourth instar larval stage ranged from 9.4 to 13.7 per cent for aqueous extracts and from 10.1 to 11.1 per cent for methanol extract and effect of these extracts was statistically at par. Total (cumulative) mortality observed due to the consumption of treated leaves by fourth instar larvae was 13.3, 20 and 28.9 per cent with aqueous extract @ 10, 20 and 40 per cent concentrations, respectively. The corresponding mortalities due to methanol extract @ 2.5, 5 and 10 were 20, 24.5 and 28.9 per cent. However, except aqueous extract @ 10 per cent all other treatments were statistically at par, particularly with regard to the extent of total mortality observed (Table 5).

Consumption of *Datura* seed extract treated leaves by DBM larvae (II or IV instar) showed no apparent morphogenic effects in any of its further developmental stages.

Londerhausen *et al.* (1991) observed more than 90 per

Table 5 : Effect of *Datura* seed extracts on fourth instar DBM larvae

Treatments	Mortality (%)		Mortality of pupae (%)	Cumulative mortality (%)
	3 DAT	Upto pupation		
Methanol extract @ 2.5%	8.89 (17.12)^{ab}	11.11 (19.26)^{bc}	10.07 (18.23)^{a}	20.00 (26.36)^{ab}
Methanol extract @ 5 %	11.11 (19.26)^{ab}	15.55 (23.13)^{abc}	10.47 (18.66)^{a}	24.45 (29.58)^{a}
Methanol extract @ 10%	15.55 (23.13)^{a}	20.00 (26.57)^{a}	11.11 (19.22)^{a}	28.89 (32.48)^{a}
Aqueous extract @ 10%	2.22 (4.99)^{cd}	4.45 (9.98)^{d}	9.37 (17.26)^{a}	13.33 (20.98)^{b}
Aqueous extract @ 20%	4.45 (9.98)^{bc}	8.89 (17.12)^{cd}	12.27 (20.27)^{a}	20.00 (26.36)^{ab}
Aqueous extract @ 40%	11.11 (19.26)^{ab}	17.78 (24.85)^{ab}	13.68 (21.43)^{a}	28.89 (32.36)^{a}
Control (water/methanol)	0.00 (0.00)^{d}	0.00 (0.00)^{e}	0.00 (0.00)^{b}	0.00 (0.00)^{c}
F-test	**	**	**	**
SEM ±	(2.02)	(2.09)	(1.68)	(2.46)
C.D. (P=0.05)	(9.36)	(7.25)	(6.80)	(7.20)

DAT: Days After Treatment; Figures in parentheses are angular transformed values;
**: Significant at P=0.01; Means followed by same alphabetical superscript are statistically at par

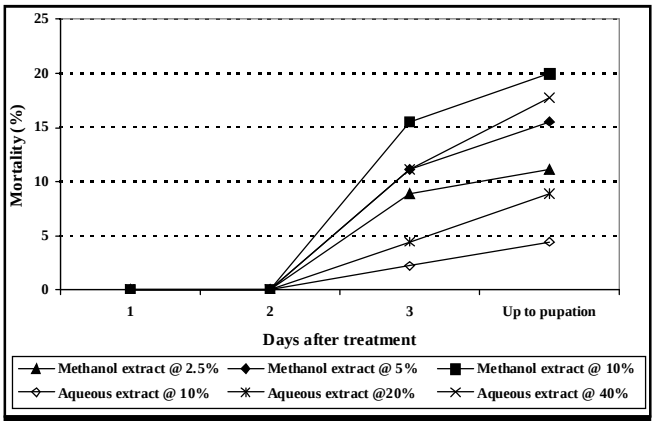

Fig. 6 : Killing effect of *Datura* seed extracts on fourth instar DBM larvae

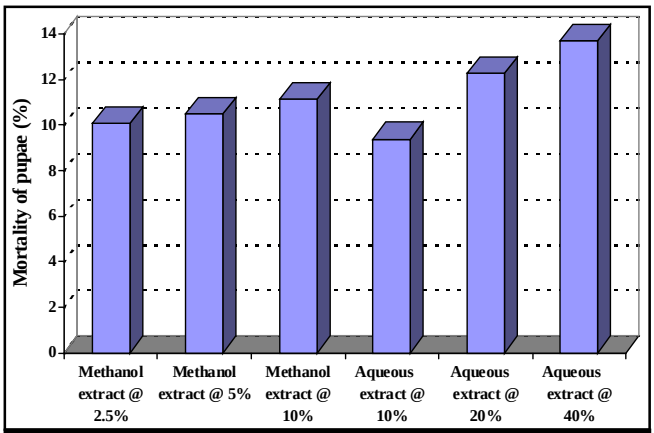

Fig. 7 : Mortality of pupae due to exposure of IV instar DBM larvae to *Datura* seed extracts

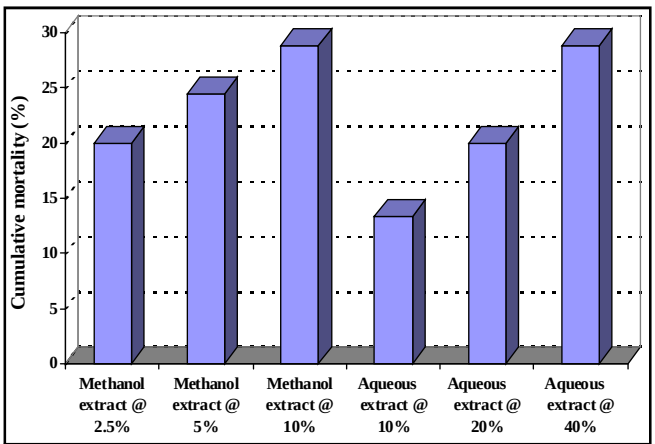

Fig. 8 : Cumulative mortality due to the exposure of fourth instar DBM larvae to *Datura* seed extracts

cent mortality of DBM larvae due to crude aqueous seed extracts of *A. squamosa* @ 7.5 and 15 per cent. Methanolic yeheb (*Cordeauxia edulis*) seed extract @ 0.5 per cent and crude aqueous extract @ 5 per cent killed more than 80 per cent of treated DBM larvae and feeding by the larvae was strongly inhibited by methanol leaf extract (Egigu *et al.*, 2010). Of five different extracts from five different Chinese medicinal plants screened by Vanichpakorn *et al.* (2010), ethyl acetate extract from the roots and rhizome of *Veratrum nigrum* showed strong activity against second and third instar larvae of *P. xylostella*, with the corresponding LC_{50} values of 225 and 335pm. *Trichilia connaroides* benzene, acetone and methanol extracts were more effective against four instar larvae, recording mean larval mortalities of 69, 53 and 60 per cent, respectively.

Effect of datura extracts on oviposition by female moths :

Oviposition of *P. xylostella* moths observed on *Datura* seed extract treated leaves is shown in Table 6 and Fig. 9. Maximum oviposition deterrence observed was 54.5 per cent with water extract @ 40 per cent followed by other two lower concentrations with the corresponding deterrence records of 44.5 and 33.6 per cent. Methanol extract @ 2.5 and 5 per cent, affected egg laying by 19.8 and 17.8 per cent, respectively. Interestingly, both methanol and aqueous extracts @10 per

Table 6 : Effect of *Datura* seed extracts on oviposition of *Plutella xylostella* moths

Treatments	Oviposition deterrence (%)
Methanol extract @ 2.5%	19.82 (25.56)^{cd}
Methanol extract @ 5%	17.76 (23.25)^{d}
Methanol extract @ 10%	34.90 (35.85)^{b}
Aqueous extract @ 10%	33.56 (35.34)^{bc}
Aqueous extract @ 20%	44.54 (41.84)^{ab}
Aqueous extract @ 40%	54.45 (47.58)^{a}
Control (water/methanol)	0.00 (0.00)^{e}
F-test	**
SEM ±	(3.02)
C.D. at (P=0.05)	(10.17)

Figures in parentheses are angular transformed values;
**: Significant at P=0.01;
Means followed by same alphabetical superscript are statistically on par

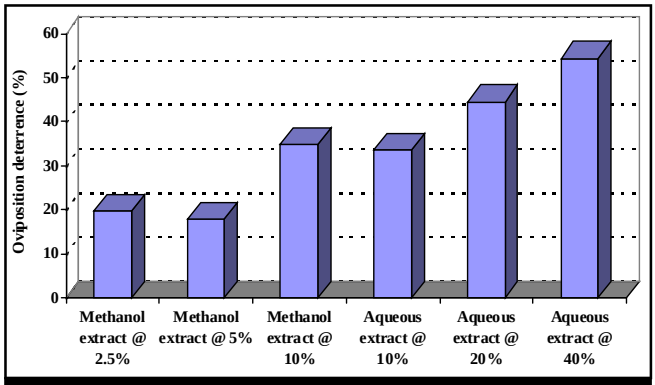

Fig. 9 : Effect of *Datura* seed extracts on oviposition of *Plutella xylostella* moths

cent concentration resulted in similar level of ovipositional deterrence (Table 6 and Fig. 9). Though both aqueous and methanol extracts adversely affected oviposition of *P. xylostella* moth on treated mustard seedlings, methanol extract (at lower concentrations of 2.5 and 5%) deterred female moths from laying eggs more significantly. *Egigu et al.* (2010) also reported strong inhibition of *P. xylostella* moths oviposition with yeheb (*Cordeauxia edulis*) leaf methanol extract.

Conclusion :

Identification of active principle(s) present in *Datura metel* seeds, which can be extracted using water or organic solvent like methanol, may be further used for the development of newer molecules and/ synthesis of analogues, in view of diverse activities like repellence, feeding and oviposition deterrence, killing effects etc., observed on economically important pest like diamond back moth, *Plutella xylostella*.

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