Himachal Journal of Agricultural Research 48(2): 300-306 (2022)

Short Communication

Repellent and deterrent effects of natural products against diamondback moth, *Plutella xylostella* (Linnaeus)

Kavita*, Sanjay Kumar Sharma[1] and A.K. Sood
Department of Entomology, College of Agriculture
CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062, India.
[1] Krishi Vigyan Kendra, Una- 174303, HP

*Corresponding author: ghotrakavita1797@gmail.com
Mansucript Received: 27.01.2022; Accepted:11.07.2022

Abstract

Four farm made natural products viz. *Agniastra, Brahmastra, Darekastra, Dashparni* each applied @ 10 per cent concentration and one commercial product Neem Baan containing azadirachtin @ 0.0005 per cent were evaluated for repellence and oviposition deterrence against *Plutella xylostella* using 'Leaf dip' method of bioassay under laboratory conditions. In 'No choice' test, repellence of natural products to adults of *P. xylostella* varied from 20.8 – 82.3 per cent up to 4h after adult release. However, in 'Choice' test, it varied from 10.4 – 70.4 per cent. Similarly, deterrence to oviposition by females of *P. xylostella* varied from 15.9 – 63.9 and 21.7 – 56.3 per cent up to 4h after adult release in 'No choice' and 'Choice' tests, respectively.

Key words: Azadirachtin, *Agniastra, Brahmastra, Darekastra, Dashparni*, DBM

Diamondback moth (DBM), *Plutella xylostella* (L), is the one of the most destructive oligophagous pest of crucifers throughout the world including India (Bhandari et al. 2009, Rao and Lal 2005, Sharma 2014, Sharma *et al.* 2020). Its bionomics, natural enemies and weather factors favouring survival and development have been studied under Palampur conditions (Sharma *et al*., 1999, 2002). Synthetic as well as bio-pesticides have been extensively employed for its effective management (Tolessa *et al.* 2021, Sood *et al.* 2001). Consequently, this pest has developed resistance to many groups of insecticides (Agboyi *et al.* 2016). Frequent sprays of pesticides cause decimation of natural enemies and lead to resistance development (Uthamasamy *et al.* 2011). Therefore, it is quite pertinent to curtail the use of synthetic pesticides and promote safer and environment friendly bio-pesticides. Nowadays, many vegetable growers practicing natural farming use farm made natural products for managing pests. These natural products purportedly possess lethal as well repellent properties against many pests (Thakur and Sood, 2019, 2022). However, these avowed properties have not been scientifically proven against many pests including *P. xylostella*. Therefore, the present laboratory studies were undertaken to assess the repellence and oviposition deterrence of some farm made products and safer bio-pesticides against this pest.

These studies were carried out in the Department of Entomology, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur during 2021. *Plutella xylostella* was mass reared at room temperature from field collected larvae, pupae and adults on potted mustard seedlings kept in rearing cages ($45\times45\times55cm^3$). The seedlings were grown in soilless medium (Sood *et al.* 1996). Cotton swabs soaked in sugar solution (10%) served as food for adults. The natural farm made products viz. *Agniastra*, *Brahmastra, Darekastra, Dashparni* and commercial product Neem Baan containing azadirachtin as active ingredient were evaluated.

Adult repellence and oviposition deterrence was assessed through 'No choice' and 'Choice' tests. In 'No choice' test, medium size (~5cm long) cauliflower leaves with intact petioles were plucked from plants and dipped for 30s in solutions having

desired concentrations of natural products and azadirachtin. The dipped leaves were shade dried and then placed in plastic vials (31x75mm^2) containing water in such a way that half of petioles got immersed and leaves turgidity was maintained. Thereafter, these vials were placed singly in oviposition cages (45×45×55cm^3). Similarly, vials with leaves dipped in water were also kept as untreated check. Twenty pairs of adult *P. xylostella* were released into each cage half an hour after placement of vials in oviposition cages. In 'Choice' test, all these vials containing dipped leaves were placed in the same cage (45×45×55cm^3). These vials were so placed that leaves of adjacent vials never touched each other. Both these experiments were conducted in completely randomized design (CRD) and replicated thrice. Fifty pairs of *P. xylostella* adults were released in the center of the cage floor. The observations were recorded on the number of adults settling on to the treated leaves after ½, 1, 2 and 4h of release for working out repellence. Whereas, eggs oviposited on leaves were counted after 24 and 48h of adult release by using magnifying lens (10X) to determine oviposition deterrence.

Replication wise relative proportion of adults settled on treated and untreated leaves was worked out to assess adult repellence as under:

$$\text{Proportion of adults settled on specific treated or untreated leaf (\%)} = \frac{\text{No. of adults settled on specific treated or untreated leaf}}{\text{No. of adults settled on all leaves}} \times 100$$

Subsequently, per cent adult repellence was calculated as:

$$\text{Adult repellence (\%)} = \frac{PAS_u - PAS_t}{PAS_u} \times 100$$

PAS_u - Proportion of adult settlement on untreated leaves (%), PAS_t - Proportion of adult settlement on treated leaves (%)

The data on per cent repellence were subjected to statistical analysis after arc sine transformation using OP Stat and WASP softwares. Further, repellence indices (RI) were calculated to know the overall repellence of various test products (Baldin *et al*. 2013):

$$RI = \frac{2T}{T + C}$$

Where, *T*: No. of *P. xylostella* adults settled on treated leaves; *C* : No. of *P. xylostella* adults settled on untreated (check) leaves. RI<1 indicated repellence and RI>1 indicated attractiveness

Replication wise relative proportion of eggs oviposited on treated and untreated leaves was worked out to assess adult repellence as under:

$$\text{Proportion of eggs oviposited on specific treated or untreated leaf (\%)} = \frac{\text{No. of eggs oviposited on specific treated or untreated leaf}}{\text{No. of eggs oviposited on all leaves}} \times 100$$

Subsequently, per cent oviposition deterrence was calculated as:

$$\text{Oviposition deterrence (\%)} = \frac{PEO_u - PEO_t}{PEO_u} \times 100$$

Where PEO_u - Proportion of eggs oviposited on untreated leaves (%), PEO_t - Proportion of eggs oviposited on treated leaves (%)

The data on per cent oviposition deterrence were also statistically analyzed after arc sine transformation by using OP Stat and WASP softwares. Further, the oviposition deterrence indices (ODI) were worked out to know the extent of attractiveness and repellence elicited by different test products (Hang *et al*. 1982):

$$ODI = \frac{T - C}{T + C} \times 100$$

Where, *T*: No. of eggs oviposited on treated leaves; *C*: No. of eggs oviposited on untreated (check) leaves. Positive (+) and negative (–) values of ODI pointed to attraction and repulsion, respectively.

Repellence of natural products to adults of *P. xylostella*

Adult settlement on treated leaves

In 'Choice' test, lowest adult settlement was recorded on leaves treated with azadirachtin (11.1%) followed by *Agniastra* (14.7%), *Darekastra* (14.8%), *Brahmastra* (16.4%) and *Dashparni* (18.4%) as against 24.6 per cent on untreated leaves. Whereas, in 'No choice' test, respective test products recorded 9.6, 14.8, 12.4, 15.7, 18.0 and 29.5 per cent adult settlement (Fig. 1). In 'Choice' test, *Darekastra* caused maximum repellence of (38.4%) amongst natural products. However, it was statistically at par with *Agniastra* (38.2%) and *Brahmastra* (32.3%). On the other hand, *Dashparni* extract recorded the least repellent activity (23.3%). Azadirachtin treated leaves repelled 53.7 per cent adults of *P. xylostella*. Also, the highest repellent activity was noticed at ½h after adult release (52.3%) and it was significantly higher than

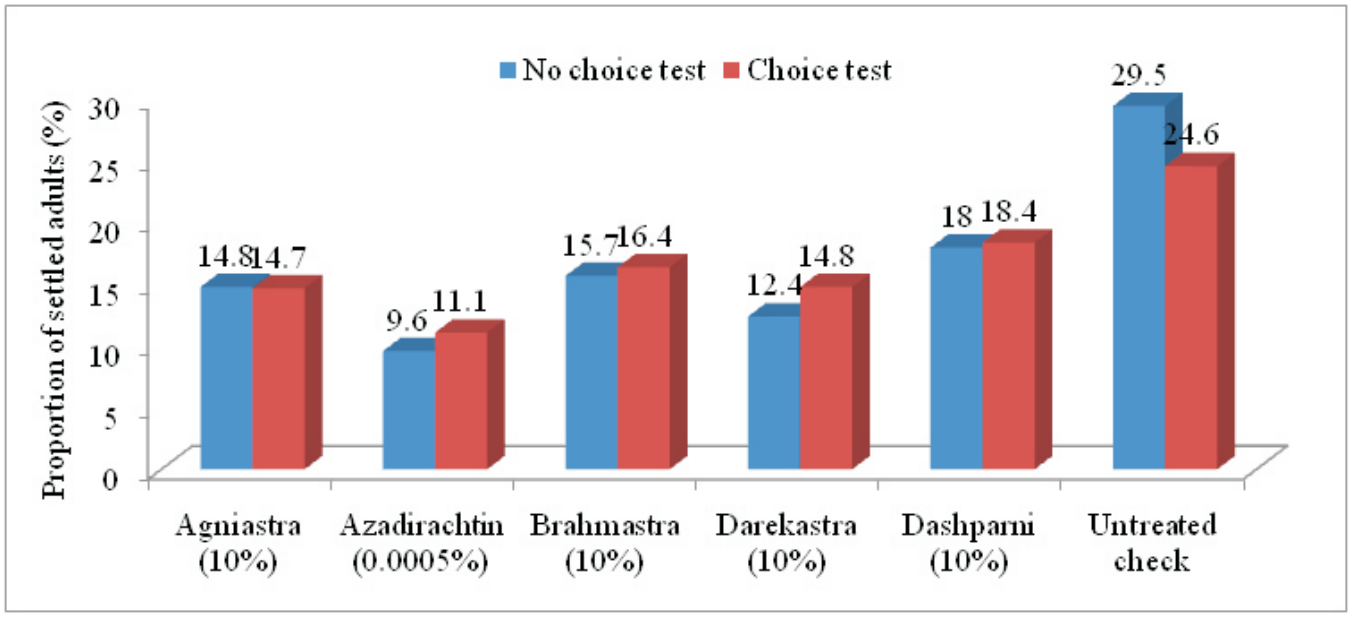

Fig. 1. Proportion of *P. xylostella* adults settled on leaves treated with different products

recorded at 1, 2, 4h after adult release which corresponded to 37.6, 27.4 and 31.5 per cent, respectively (Table 1).

Repellent indices in respect of azadirachtin, *Agniastra, Brahmastra, Dashparni* and *Darekastra* were 0.65, 0.77, 0.81, 0.88 and 0.77, respectively

Table 1. Repellence of natural products and azadirachtin to adults of *P. xylostella*

Treatment	Adult repellence (%)*#									
	Choice test					No choice test				
	½ h	1h	2h	4h	Mean	½ h	1h	2h	4h	Mean
T_1	59.2	35.4	23.4	34.8	38.2	65.3	47.3	31.9	41.7	46.6
	(50.4)	(36.4)	(28.2)	(36.1)	(37.8)^{b}	(54.0)	(43.4)	(33.0)	(40.0)	(42.6)^{bc}
T_2	70.4	53.7	47.2	43.4	53.7	82.3	60.7	61.8	55.0	65.0
	(57.0)	(47.1)	(43.4)	(41.2)	(47.2)^{a}	(65.3)	(51.2)	(52.0)	(48.1)	(54.1)^{a}
T_3	35.4	43.0	21.3	29.8	32.3	61.0	42.9	26.1	41.1	42.8
	(36.3)	(40.9	(26.5)	(33.0)	(34.2)^{b}	(51.6)	(40.8)	(30.5)	(39.6)	(40.6)^{c}
T_4	54.7	31.7	34.6	32.6	38.4	71.3	59.2	52.4	38.9	55.4
	(47.7)	(34.2)	(35.9)	(34.8)	(38.1)^{b}	(57.7)	(50.4)	(46.4)	(38.4)	(48.2)^{ab}
T_5	41.6	24.3	10.4	16.9	23.3	55.1	34.5	20.8	28.9	34.8
	(40.1)	(29.5)	(15.3)	(24.1)	(27.2)^{c}	(48.0)	(35.9)	(26.5)	(31.9)	(35.6)^{c}
Mean	52.3	37.6	27.4	31.5	—	67.0	48.9	38.6	41.1	—
	(46.3)^{a}	(37.6)^{b}	(29.9)^{c}	(33.8)^{bc}		(55.3)^{a}	(44.3)^{b}	(37.7)^{b}	(39.6)^{b}	
CD (P=0.05)	Products = (5.1); Time = (4.6); Product x Time = (NS)					Products = (7.4); Time = (6.6); Product x Time = (NS)				

*Figures in parentheses are arc sine transformed means; #Figures in row and column followed by the same alphabet are statistically at par with each other; T_1: *Agniastra* (10%), T_2: Azadirachtin (0.0005%), T_3: *Brahmastra* (10%), T_4: *Darekastra* (10%), T_5: *Dashparni* (10%).

(Fig. 2). In 'No-choice' test, the highest repellence was recorded in azadirachtin (65%) and it was statistically at par with *Darekastra* (55.4%). *Agniastra*, *Brahmastra*, *Dashparni* recorded 46.6, 42.8, 34.8 per cent repellence, respectively and were statistically at par with each other.

Also, repellence was highest at ½h after adult release (67%) and it was significantly higher than observed at 1, 2, 4h after adult release i.e. 48.9, 38.6, 41.1 per cent, respectively which were statistically at par with each other (Table 1). Better repellence of azadirachtin was also indicated by low value of repellent index (0.20) in 'No choice' test as against 0.68, 0.71, 0.78, 0.61 in case of *Agniatra, Brahmastra, Dashparni* and *Darekastra*, respectively (Fig. 2).

Oviposition deterrence of natural products to females of *P. xylostella*

In 'Choice' test, proportion of eggs oviposited by *P. xylostella* was lowest (10.6%) on azadirachtin treated cauliflower leaves which corresponded to 56.3 per cent oviposition deterrence. Amongst natural products, *Darekastra* recorded the lowest proportion of eggs laid (12.8%) followed by *Agniastra* (15.6%), *Brahmastra* (15.8%) and *Dashparni* (19.8%). These corresponded to 47.8, 37.6, 36.6 and 21.7 per cent oviposition deterrence over untreated leaves, respectively. The eggs laid on *Darekastra* treated leaves were significantly lower than the other natural products.

In 'No choice' test, the oviposition deterrence of azadirachtin, *Agniastra, Brahmastra*, *Darekastra* and *Dashparni* over untreated check was 63.9, 33.0, 34.6, 33.2 and 15.9 per cent, respectively (Table 2). Effectiveness of azadirachtin as oviposition deterrent to females of *P. xylostella* was also substantiated by oviposition deterrence indices of -57.6, -25.6 in

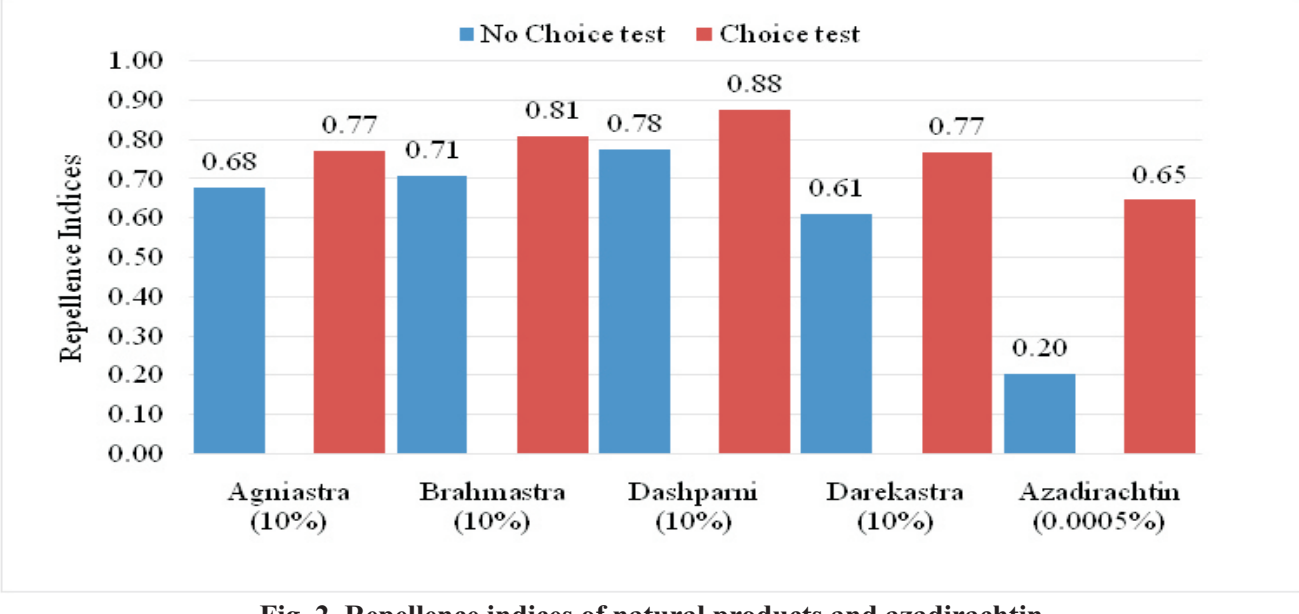

Fig. 2. Repellence indices of natural products and azadirachtin

Table 2. Oviposition deterrence of natural products and azadirachtin to female *P. xylostella*

Product (Conc.)	Choice test			No choice test	
	No. of eggs laid	Proportion of eggs laid (%)*#	Oviposition deterrence (%)*#	No. of eggs laid	Oviposition deterrence (%)*#
Agniastra (10%)	125	15.6 (23.3)^{c}	37.6 (37.7)^{c}	122	33.0 (35.0)^{b}
Azadirachtin (0.0005%)	52	10.6 (18.8)^{e}	56.3 (48.8)^{a}	106	63.9 (53.2)^{a}
Brahmastra (10%)	129	15.8 (23.4)^{c}	36.6 (37.1)^{c}	126	34.6 (36.0)^{b}
Darekastra (10%)	130	12.8 (20.9)^{d}	47.8 (43.7)^{b}	120	33.2 (35.1)^{b}
Dashparni (10%)	161	19.8 (26.4)^{b}	21.7 (27.7)^{d}	139	15.9 (23.2)^{c}
Untreated check	193	25.3 (30.2)^{a}	—	179	—
CD (P=0.05)		(1.3)	(4.7)		(5.7)

*Figures in parentheses are the arc sine transformed means; #Figures in column followed by the same alphabet are statistically at par with each other

'Choice' and 'No Choice' tests, respectively. Amongst natural products, *Agniastra* recorded maximum deterrence in 'No choice' test (ODI= -21.4) and *Darekastra* in 'Choice' test (ODI= -19.7) (Fig. 3).

Though repellence of local herbs like *Azadirachta indica*, *Melia azedarach*, *Carica papaya*, *Lantana camara* etc. to feeding by *P. xylostella* have been reported earlier (Chandrashekharaiah *et al,* 2015; Charleston *et al.,* 2005; Dwivedi and Mathur, 1999; Leatemia and Isman, 2004; Ogbonna *et al.,* 2021; Sharma *et al*., 2006), studies on repellence to adults of *P. xylostella* are lacking. Charleston *et al.* (2005) observed that fewer eggs were oviposited by females of *P. xylostella* on *M. azedarach* treated plants as compared to those treated with *A. indica*.

Dilawari *et al.* (1994) too reported that the females of *P. xylostella* oviposited significantly lesser number of eggs (up to 71%) on the surfaces treated with methanolic extracts of *M. azedarach* than on those treated with solvent only. Likewise, Patil and Goud (2003) reported reduction in oviposition of *P. xylostella* by 62.43 per cent on *A. indica* treated plants in free choice test. These earlier studies supported present results where reduced oviposition by females of *P. xylostella* was observed in natural products including *Agniastra* and *Darekastra*. Similarly, Hassan *et al.* (2018) tested the effect of azadirachtin (0.31, 0.5, 0.6 and 1.0%) on the oviposition, hatching and feeding by *P. xylostella*. These authors reported that oviposition was significantly reduced to 53.75 mean numbers of eggs by azadirachtin (1.0%) as against 272.5 in control. On the other hand, Liang *et al.* (2003) reported that Agroneem, Ecozin, and Neemix, all containing azadirachtin as active ingredient did not exhibit significant oviposition deterrence to females of *P. xylostella*. It could possibly be due to quantitative difference in active ingredient, azadirachtin in these products. Natural products probably contained comparatively higher quantities of active ingredients which resulted in deterrence to oviposition by females of *P. xylostella.* Also, prior exposure of female adults to Neemix had been reported to receive more eggs on treated leaves than on untreated leaves (Liu and Liu, 2006).

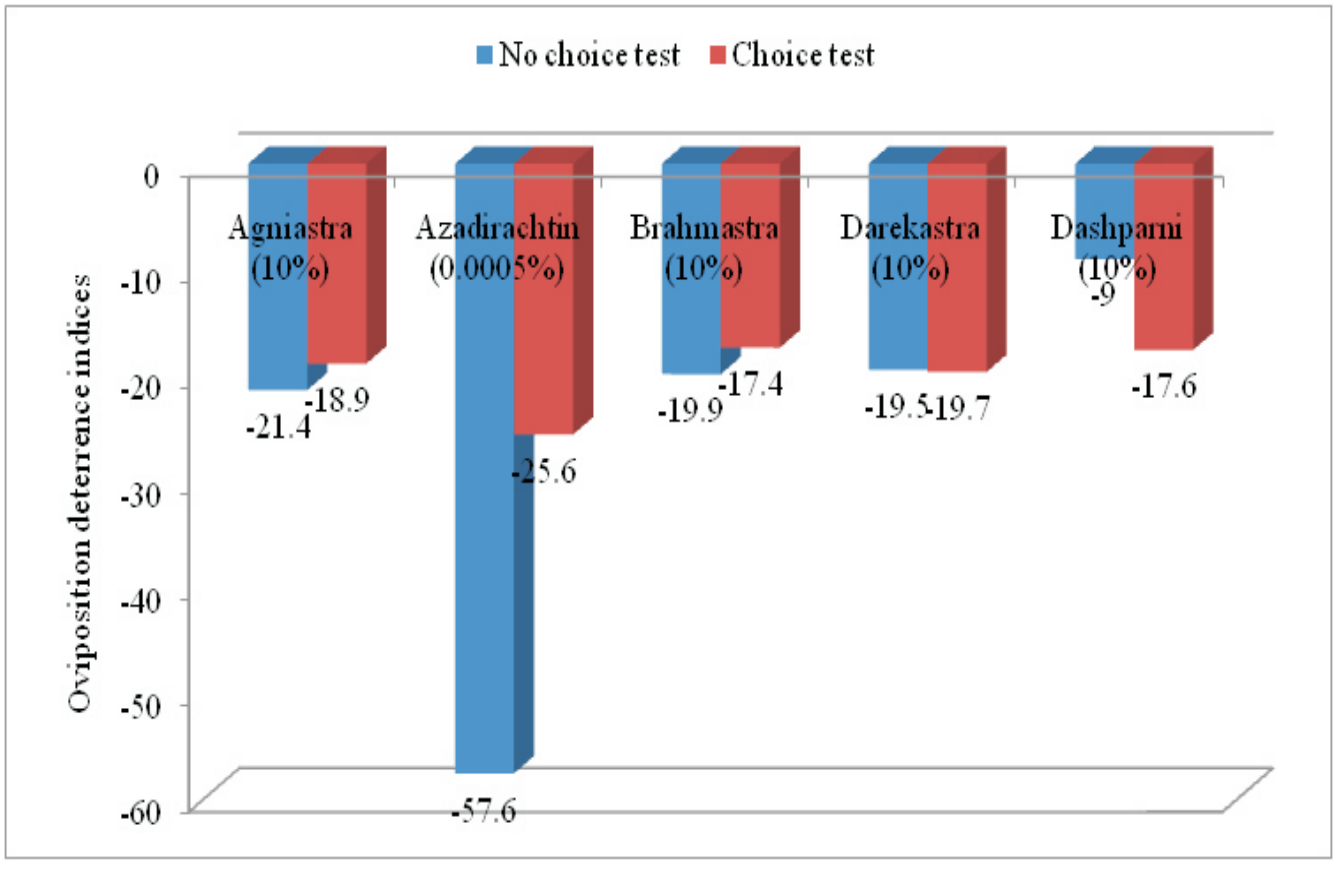

Fig. 3. Oviposition deterrence indices of natural products and azadirachtin

Conclusion

The tested products *viz*. *Agniastra,* azadirachtin, *Brahmastra, Darekastra* and *Dashparni* possessed repellent and oviposition deterrent properties against adults of *P. xylostella.* Therefore, preventive sprays of these environmentally safe products may be done to check build up of this pest on crucifer crops.

Conflict of interests

No conflict of interests exists *vis-à-vis* this manuscript.

References

Agboyi LK, Ketoh GK, Martin T, Glitho IA and Tamò M. 2016. Pesticide resistance in *Plutella xylostella* (Lepidoptera: Plutellidae) populations from Togo and Benin. International Journal of Tropical Insect Science **36** (4): 204-210.

Baldin ELL, Crotti AEM, Wakabayashi KAL, Silva JPGF, Aguiar GP, Souza ES, Veneziani RCS and Groppo M. 2013. Plant-derived essential oils affecting settlement and oviposition of *Bemisia tabaci* (Genn.) biotype B on tomato. Journal of Pesticide Science **86**: 301-308.

Bhandari K, Sood P, Mehta PK, Choudhary A and Prabhakar CS. 2009. Effect of botanical extracts on the biological activity of granulosis virus against *Pieris brassicae.* Phytoparasitica **37**: 317-322.

Chandrashekharaiah M, Satish SC, Vasudev K, Arya VV and Narasimhamurthy GM. 2015. Efficacy of plant and aboriginal preparations against diamondback moth, *Plutella xylostella* (L.) (Lepidoptera: Plutellidae). Journal of Entomology and Zoology Studies **3** 4): 18-23.

Charleston DS, Kfir R, Vet LEM and Dicke M. 2005. Behavioural responses of diamondback moth *Plutella xylostella* (Lepidoptera: Plutellidae) to extracts derived from *Melia azedarach* and *Azadirachta indica*. Bulletin of Entomological Research **95** (5): 457-465.

Dilawari VK, Singh K and Dhaliwal GS. 1994. Effects of *Melia azedarach* L. on oviposition and feeding of *Plutella xylostella* L. International Journal of Tropical Insect Science **15** (2): 203-205.

Dwivedi SC and Mathur M. 1999. Evaluation of plant extracts against IV- instar larvae of diamondback moth, *Plutella xylostella* (Lepidoptera: Plutellidae). Ectotoxicology and Environment Monitoring **9**: 164-166.

Ghongade DS and Sood AK. 2019. Population dynamics of two spotted spider mite (*Tetranychus urticae* Koch) on cucumber in relation to weather parameters under protected environment. Journal of Agrometeorology **21**: 204-210.

Hang YS, Schultz GW, Axelord H, Krame WL and Mulla MS. 1982. Ovipositional repellency of fatty acids and their derivatives against *Culex* and *Aedes* mosquitos. Environmental Entomology **11**: 223-226.

Hassan E, Zada H and Ahmad B. 2018. Effect of different neem extracts on *Plutella xylostella* (Lepidoptera; Plutellidae) under laboratory conditions. Journal of Agricultural and Crop Sciences: Open Access **1**: 1-5.

Leatemia JA and Isman MB. 2004. Efficacy of crude seed extracts of *Annona squamosa* against diamondback moth, *Plutella xylostella* L. in the greenhouse. International Journal of Pest Management **50** (2): 129-133.

Liang GM, Chen W and Liu TX. 2003. Effects of three neem-based insecticides on diamondback moth (Lepidoptera: Plutellidae). Crop Protection **22** (2): 333-340.

Liu TX and Liu SS. 2006. Experience-altered oviposition responses to a neem-based product, Neemix by the diamondback moth, *Plutella xylostella*. Pest Management Science **62**: 38-45.

Ogbonna CU, Okonkwo NJ, Nwankwo EN, Ezemuoka LC, Anorue CO, Irikannuk C and Egbuche CM. 2021. *Carica papaya* seed oil extract in the management of insect pest of cabbage plant both in the laboratory and field. International Journal of Entomology Research **6** (2): 12-21.

Patil RS and Goud KB. 2003. Efficacy of methanolic plant extracts as ovipositional repellents against diamondback moth, *Plutella xylostella* (L.). Journal of Entomological Research **27** (1): 13-18.

Rao SRK and Lal OP. 2005. Seasonal incidence of mustard aphid, *Lipaphis erysimi* (Kalt) and diamondback moth, *Plutella xylostella* (L.) on cabbage. Journal of Insect Science **18**: 106-110.

Sharma A, Kaushal P, Sharma KC and Kumar R. 2006. Bioefficacy of some plant products against diamondback moth, *Plutella xylostella* L. (Lepidoptera: Yponomeutidae). Journal of Entomological Research **30** (3): 213-217.

Sharma S, Verma SC, Sharma PL and Chandel RS. 2020. Diversity of inset-pests and their natural enemies in cauliflower under mid hills of Himachal Pradesh. Journal of Entomology and Zoology Studies **8** (2): 1204-1209.

Sharma SK, Devi N and Raj D. 1999. Bionomics and parasitization of diamondback moth, *Plutella xylostella* (L.) (Lep.: Plutellidae). Journal of Entomological Research **23** (4): 309-314.

Sharma SK, Devi N and Raj D. 2002. Abiotic factors affecting the abundance of *Plutella xylostella* L. (Lep.: Plutellidae). Journal of Entomological Research **15** (1&2): 09-11.

Sharma SK. 2014. Pests of commercial vegetable and horticultural crops in dry temperate regions of Himachal Pradesh. Indian Journal of Plant Protection **42** (2): 186-190.

Sood AK, Chauhan U and Bhalla OP. 1996. Laboratory rearing technique of diamondback moth, *Plutella xylostella* (L.) and the effect of host plant species on its development. Pest Management and Economic Zoology **4** (1-2): 81-84.

Sood AK, Mehta PK, Kashyap NP and Lal R. 2001. Bioefficacy of *Beauveria bassiana* against diamondback moth, *Plutella xylostella* (Yponomeutidae: Lepidoptera). Journal of Entomological Research **25** (4): 267-271.

Thakur S and Sood AK. 2019. Lethal and inhibitory activities of natural products and biopesticide formulations against *Tetranychus urticae* Koch (Acarina: Tetranychidae). International Journal of Acarology **45** (6–7): 381–390.

Thakur, S and Sood AK. 2022. Foliar application of natural products reduces population of two-spotted spider mite, *Tetranychus urticae* Koch on parthenocarpic cucumber *(Cucumis sativus* L.) under protected environment. Crop Protection (DOI: 10.2139/ssrn.4012411).

Tolessa T, Lombamo T and Chiko S. 2021. Evaluation of insecticides for the management of diamondback moth, (*Plutella xylostella* (L.) (Lepidoptera: Plutellidae) on cabbage under field condition. Journal of Biology, Agriculture and Healthcare **11** (23): 22-30.

Uthamasamy S, Kannan M, Senguttuvan K and Jayaprakash SA. 2011. Status, damage potential of diamondback moth, *Plutella xylostella* (L.) in Tamil Nadu, India. pp 270-279.