

CHAPTER VI

SUMMARY

The salient findings of investigations done while evaluating “Push- Pull strategies for the management of diamondback moth, *Plutella xylostella* (L.) in cruciferous vegetables” are presented here.

- ❖ Among the crude extracts, hexane exhibited the highest (ovicidal activity) egg mortality (52.66-95.83%) after 72 h of treatment followed by petroleum ether, acetone, and ethyl acetate extract (21.43-90.83%), ethanol (61.21-92.12%) methanol (6.66-57.22%) and aqueous extracts (12.50-54.60%). Neem oil used as a standard check recorded 20.00-91.11 per cent egg mortalities.
- ❖ The results of experiments at 10 per cent aqueousextract revealed that after, the highest larval mortality of 73.33 and 60.00 per cent was recorded at 72 h and 48h in second instar larvae. The same concentration after 72h, recorded 73.33 and 43.33 per cent mortality against third and fourth instar larvae respectively. Concentrations of 1, 2, and 4 per cent showed little larvicidal activity (10-36.67%) even after 72 h of treatment that was however significantly superior to control.
- ❖ The results of experiments at 10 per cent hexane extract revealed that after 72 and 48h, the highest larval mortality of 99.88 and 90.00 per cent was recorded in second instar larvae. The same concentrations after 24, 48 and 72h, recorded 70.67, 86.67 and 99.88 in third instar larvae and 40.00, 60.00 and 63.33 per cent mortality against fourth instar larvae respectively.
- ❖ The results of the experiments with 10 per cent extract revealed that after 72 and 48 h, the highest larval mortality of 93.33 and 86.67 per cent recorded in second instar larvae. The same concentrations after 24, 48 and 72 h, recorded 86.67, 93.33 and 99.88 in third instar larvae and 80.00, 96.67 and 99.88 per cent mortality against fourth instar larvae respectively.
- ❖ Different kinds of phytochemicals present in crude extracts influenced larval mortality (LC₅₀) viz., acetone (16.93, 23.43, 32.70%); benzene (23.67, 40.07, 50.47%); chloroform (3.66, 11.90, 21.76%); ethanol (9.95, 28.29, 32.13%); ethylacetate (8.86,

26.60, 40.37%); petroleum ether (6.52, 13.12, 31.44%) and methanol (25.67, 37.67, 52.73%) of second, third and fourth instar respectively. Neem oil used as positive control, produced 50% mortality at 1.90, 2.28 and 3.54% concentrations on second, third and fourth instar respectively within 24 h.

- ❖ Maximum mortalities at 8 and 10 per cent of *Lantana* leaves of all solvent crude extracts were *viz.*, acetone (20.00; 26.33 %), benzene (37.33; 41.33 %), chloroform (16.67; 26.66 %), ethanol (13.30; 16.70 %), ethyl acetate (13.33; 26.67 %), petroleum ether (30.00; 40.00 %) and methanol (16.60; 20.00 %) respectively.
- ❖ Maximum protection at 10 per cent of *Lantana* leaves of all solvent crude extracts are as follows, acetone (41.49±3.10; 35.37±6.11; 23.17±3.67 sq.cm), benzene (44.71±2.52; 40.51±7.37; 53.67±2.42 sq.cm), chloroform (38.78±4.00; 34.44±3.50; 51.40±1.56 sq.cm), ethanol (48.29±2.65; 44.12±3.30; 52.70±5.46 sq.cm), ethyl acetate (40.53±5.90; 35.06±6.59; 37.80±7.43 sq.cm), petroleum ether (54.81±3.68; 56.71±5.18; 50.90±5.27 sq.cm) and methanol (51.32±4.85; 38.66±15.06; 48.93±2.31 sq.cm) of second, third and fourth instar larvae respectively. Irrespective of plant extracts high concentration resulted in maximum mean protection to foliage (60.64±1.11sq.cm). In general, antifeedancy was found to increase in a dose dependent manner.
- ❖ Repellency among third and fourth instar larvae at 8 and 10 per cent of aqueous concentration was recorded 60.00, 63.33; 56.67, 73.33 and 73.33, 73.33 per cent and 40.00, 43.33; 43.10, 63.33 and 63.33, 63.10 per cent larvae repelled after exposure of 1, 3 and 5h respectively.
- ❖ The repellency registered more at higher concentrations of hexane (8 and 10%) were 52.22, 83.33; 70.00, 86.67 and 73.33, 90.00 per cent against second instar larvae after treatment during 1, 3 and 5h respectively, than observed in control (0.00-3.33%). While third and fourth instar recorded 80.00, 83.33; 73.33, 90.00; 56.67, 93.00 per cent and 80.0, 86.67; 86.67, 93.33; 90.0, 96.67 per cent repellency at 8 and 10 per cent concentration after exposure of 1, 3 and 5 h, respectively.

- ❖ Repellency registered more at higher concentrations of neem oil (8 and 10%) were 70.00, 80.00; 76.67, 86.67 and 100 per cent against second instar larvae after treatment during 1, 3 and 5h respectively, than observed in control (0.00-3.33%). While third and fourth instar recorded 40.00, 43.33; 73.33, 80.00; 76.67, 86.67 per cent and 56.67, 73.33; 70.00, 83.33; 83.33, 90.00 per cent repellence at 8 and 10 per cent concentration after exposure of 1, 3 and 5 h, respectively.
- ❖ Maximum reduction of oviposition on leaves treated with *Lantana* extract of all solvent crud concentrations at 8 and 10 per cent was viz., aqueous (19.67, 21.33; 15.33, 20.33nos.), methanol (9.00, 7.00; 6.67, 7.67 nos.), ethanol (19.00, 17.00; 11.67, 12.33 nos.), ethyl acetate (1.33, 0.50; 0.50, 0.50 nos.), acetone (1.33, 5.67; 1.33, 6.33 nos.), chloroform (3.00, 4.00; 0.67,0.50 nos.), benzene (9.67,13.33; 9.33,14.67 nos.), petroleum ether (1.00, 5.67; 0.50, 6.33 nos.) and hexane (4.67, 8.33; 2.33,7.00 nos.) respectively in 24 and 72 h after spray.
- ❖ Persistent toxicity observed in 4th instar at seven days after application was high as PTI recorded in treatment at 10 per cent concentration was 710.24 with a mortality of 50.73 per cent. However it was on par at 8 and 6 per cent (47.81; 39.40% of mortality) with PTI of 669.34; 551.64 respectively. The effective persistence period was up to 10 days as recorded in third instars with PTI of 559.90, 701.44 and 846.00 at 6, 8 and 10 per cent concentrations and mortalities of 39.99, 50.10 and 60.43 per cent, respectively. The same concentrations gave highest mortality in second instar at 3 days after spraying (82.14; 83.00 and 96.43%), whereas, the effect of one and two per cent never attained even 50 per cent mortality.
- ❖ Phytotoxicity symptoms of leaf tip injury was observed in hexane crude extracts at 8 and 10 per cent concentrations in potted plants of both cauliflower (33.00 and 49.50%) and cabbage (2.0 and 9.0), respectively. Crude extracts up to six per cent concentration recorded no leaf tip injury after treatments imposed.
- ❖ Eight and ten per cent crude extracts produced creamy layer of 0.10, 0.20ml in bottom with phytotoxicity of 2.00, 9.30 and 33.00 and 49.50 per cent of cabbage and cauliflower respectively. Combinations of neem oil 3% and NSKE 5% + crude

extracts 6% produced creamy layer up to 0.20, 0.10 ml at top of the 100 ml measuring cylinder in neem oil and NSKE, respectively.

- ❖ Concentrations of 8 and 10 per cent killed within 24h, but showed less toxicity at 1, 2, 4 and 6 per cent concentrations recording mortalities of 3.33, 3.33; 3.33, 6.67; 6.67, 10.00 per cent and 40.00, 36.67 per cent, respectively of parasitoid pupae and adults.
- ❖ The lesser egg mortalities of 10.00, 17.50, 2.67 and 30.83 per cent were observed in the concentration of hexane crude extracts tested i.e., 1, 2, 4, and 6 per cent respectively. At the same concentration grub mortalities recorded were 6.67, 10.00, 23.33, 31.67, and 41.67 per cent at 48 h after treatment, respectively of *C. zastrowi sillemi*.
- ❖ *Lantana* crude extracts in hexane 8 and 10% caused 63.33, 73.33 per cent in Indian bees and 43.33, 50.00 per cent mortalities in stingless bee respectively 48h after treatment, while 4% concentration registered 43.33 and 36.67 per cent mortalities of Indian bee and stingless bee, respectively.
- ❖ The diamondback moth made negative movements towards the odours of marigold, garlic, tomato, coriander and onion comparing the preference of the DBM towards the treatment and control. Cauliflower recorded more number of diamondback moth (80.00% to treatment arm) than control (20.00%).
- ❖ Regarding EAG responses in diamondback moth, *P. xylostella* male antenna response was more pronounced than that of females. The response of one day old male insects were very high to AITC 0.5, 0.75 and 1.00 μ l lure⁻¹ and the mean values being -7.66, -7.26, and -6.54 mV, respectively. Female response was lower than male insects.
- ❖ In GC-MS study all crude extracts of *Lantana* leaves recorded six to nineteen important components viz., caryophyllene, caryophyllene oxide, selina-6-en-4-ol, 2-hexadecen-1-ol, hexatriacontane, tetrapentacontane, 1,3-cyclohexadiene-1-carboxaldehyde, 6-S-2,3,8,8-tetramethyltricyclo [5.2.2.0(1,6)]undec-2-ene, benzene, 1,2-Benzenedicarboxylic acid, mono(2-ethylhexyl) ester, 2,6,10-Trimethyl, 14-ethylene-14-pentadecne, 3-nonanone, phytol and squalene were identified in various crude extracts.

- ❖ Marigold as intercrop was superior in reduction of diamondback moth (3.19; 3.64) population incidence followed by coriander (3.21; 1.85), tomato (4.50; 1.94), onion (4.42; 1.98), and radish (5.00). Onion, neem oil (4.96; 1.71) and tomato + cauliflower were on par statistically in both cauliflower and cabbage intercropping system. However, all the intercropped systems harboured more diamondback moth than plots maintained as per farmer practices (1.31; 1.06). The natural enemies populations were more in intercropped plots than farmer practices in both vadavalli and pooluvapatti field trials.
- ❖ The mean number of parasitoid pupae and coccinellid beetle were found in plots intercropped with mustard was 2.81; 8.66 per five plants followed by coriander (2.66; 3.42 nos.) and french beans (2.56; 14.09 nos.) per five plants which was significantly higher than farmer practices (0.61; 2.92 per five plants) and sole crop cabbage alone (1.32; 7.17 per five plants) during 2015-16 in Annanagar, Ooty. Economic feasibility of different intercropping systems in terms of additional income over cabbage sole crop, mustard recorded highest additional income per hectare (Rs. 252813) followed by coriander (Rs. 154555), french bean (Rs. 129161), farmer practices (Rs. 243685).
- ❖ Repellent components namely 1-(2-trimethylsiloxy-1,1-dideuteriovinyl)-4-trimethylsiloxy-benzene (27.52%), 3-(Maleimido-2-yl)-1-methyl-2-(1-methylindol-2-yl) indole (11.10); 3,7,11,15-Tetramethyl-2-hexadecen-1-ol (2.89) and () Caryophyllene oxide (1.58%), 13-Docosenamide, (Z) - (22.77), Nonahexacontanoic acid (CAS) (17.56%), 2-Bromotetradecanoic acid (5.99%) and Dimethyl 2-Methoxymethyl benzene-1, 3-dicarboxylate (0.62%) present in onion plant sample.
- ❖ Phytochemicals identified in the hexane leaf extracts of marigold identified were 9-Octadecenamide, (Z)- (CAS) and deoxyspergualin (23.02%), 2-Nonadecanone and Oxirane, [(hexadecyloxy)methyl] (17.33%), Neophytadiene (5.21%), 1-hydroxy-2-phenyl-3-ethoxyyl-6-azaindole (4.11%) and least area per cent recorded trans-Caryophyllene (1.24%), (-)-Caryophyllene oxide 93.37%.
- ❖ Attraction components from coriander leaf (hybrid) extracts were identified to be 9-Octadecenamide (30.81%), 2,2-Dichloro-N-(2-phenylmethoxyimino ethyl)

-N-(2-propenyl) acetamide (8.99%), (E)-Ethyl 2-benzyl-3-(4'-phenylphenyl)but-2-enoate (2.55%), (S)-(1-Methylbutyl) (E)-2,4-dimethyl-2-pentenoate (2.50%) and least quantum recorded in hexadecane, 2,6,11,15-tetra methyl- (CAS) (0.69%) N-(2-Methyl-2H-tetrazol-5-yl)-acetamide (0.77%).

- ❖ The descending order of mean moth capture recorded at different doses of AITC is as follows: Ph + AITC @ 50µl (70.04), Ph + AITC @ 75µl (90.40), Ph + AITC @ 100µl (89.69) synthetic lure alone (29.26), water pan trap-lure on top lid (7.20) and poor attraction observed in sleeve trap (2.08) and AITC alone (2.98) respectively on cabbage at Coimbatore during 2014-2015.
- ❖ Traps baited with a single plant volatile compound (AITC) have significant mean moth attraction, which were Ph + AITC @ 50 µl (63.59), Ph + AITC @ 75 µl (73.62), Ph + AITC @ 100 µl (106.48) and followed by synthetic lure alone (22.09), water pan trap-lure on top lid (9.18) and poor attraction observed in sleeve trap (2.44) and AITC alone (5.39) respectively on cauliflower at Coimbatore during 2014-15.
- ❖ Traps baited with pheromone (Ph) compounds of (Z)-3-hexenyl acetate and Ph (Z)-3-hexenyl acetate (Z)-3-hexen-1-ol + allyl-isothiocyanate at 50µl per septa had enhanced male catches viz., (19.50, 25.50, 23.50 and 41.17 respectively); 75µl (119.33, 100.33, 154.33 and 100.50 respectively) and 100µl (116.00, 139.50, 111.00 and 185.83) respectively on cabbage at Ooty during 2015-16.
- ❖ Pooled mean data on the attraction efficiency revealed that Ph+ AITC @ 50µl, per septa recorded 70.04, 6.80; 63.59, 8.40 and 23.19, 7.80 male and female moths in cabbage (CBE), cauliflower (CBE) and cabbage (Ooty) respectively. The same increased pattern was observed in 75, 100µl per septa of irrespective of the locations.
- ❖ The per cent reduction of *P. xylostella* population over control was maximum in plots with Push-Pull strategies (77.74, 68.92 and 54.88%) than the farmer's practice (76.87, 65.30 and 34.22%). Maximum yield was recorded from plots with push-pull strategies (34.72, 29.96 and 39.74 t/ha) when compared to untreated check (24.56, 17.97 and 23.79 t/ha) of cabbage (CBE), cauliflower (CBE) and cabbage in Kothagiri, Ooty respectively.