SUMMARY

Diamondback moth, *Plutella xylostella* (Lepidoptera: Plutellidae) is a serious pest of cruciferious vegetables and cosmopolitan in distribution. It was first recorded in Pakistan in 1914. Insecticides are mainly used for its control. Wide spread use of synthetic insecticides on high value crops has resulted in develpment of resistance in the pest. The present studies were carried out to evaluate the level of resistance in DBM in this country. In spatial variation trial, insecticides namely cypermethrin, deltamethrin, bifenthrin, lambdacyhalothrin, chlorpyrifos, triazophos, profenofos, endosulfan, spinosad, indoxacarb, emamectin benzoate, abamectin, lufenuron from different groups were used against 2nd instar larvae to determine the resistance factors (RFs) of eighteen populations from different ecological zones of Punjab province. Cypermethrin gave highest 67.1 and 59.2 RFs against Rawalpindi 2 and 3 whereas lowest value of 7.0 was determined for Rawalpindi 1. Deltamethrin gave highest 37.3 for Multan 7 and lowest 4.4 from Rawalpindi 1. Lambdacyhalothrin gave highest RF 34.5 for Multan 2 and lowest 2.5 for Rawalpindi 1. Bifenthrin gave highest RF 28.8 from Multan 5 and 2.4 RF from Rawalpindi 1. Triazophos gave highest 78.1 from Multan 7 and lowest RF 7 from Rawalpindi 1. Chlorpyrifos gave highest values 127.1 from Rawalpindi 2, 98.0 from Multan 7 and 96.4 from Multan 2 and lowest RF was 11.6 from Rawalpindi 1. Profenofos gave highest value of RF 114.4 and 136.1 from Multan 4 and Lahore 4 and lowest RF 1.4 was observed from Rawalpindi 1. In new chemistries spinosad showed maximum value 12.3 for Rawalpindi 3 and minimum was 1.1 from Multan 6 that was equal to standard susceptible strain (locally developed). Indoxacarb gave highest 38.3 RF from Lahore 2 and lowest 1 from Lahore 3 that was also equal to susceptible strain. Emamectin benzoate gave highest value of 6.3 from Lahore 5 and lowest value of 0.33 from Multan 6 which is lower than the standard value 1.0. Abamectin gave highest 20.3 RF from Rawalpindi 2 and lowest 2.0 from Rawalpindi 4. Lufenuron, a growth regulator, showed maximum 30.0 RF from Multan 8 and lowest 1.4 RF from Lahore 3.

In seasonal variation trial (August collected population), cypermethrin gave 143.2 chlorpyrifos 5248.6 and endosulfan 473.5 LC_{50} values respectively. From new chemistry

compounds, lufenuron gave highest LC_{50} (604.6) and emamectin benzoate gave lowest value (0.07). In November collected population, deltamethrin, chlorpyrifos, endosulfan, emamectin benzoate and lufenuron gave LC_{50} values of 1243.2, 2383.60, 487.6, 0.08 and 306.2 respectively. February colleted population gave 697.9, 1795.1, 429.5, 0.05 and 192.9 LC_{50s} for deltamethrin, chlorpyrifos, endosulfan, emamectin benzoate and lufenuron respectively.

In comparative knock down trial, three new chemistry chemicals namely spinosad, abamectin and emamectin benzoate gave more than 80 % mortality against all the instars of DBM. However, lufenuron and indoxacarb were less effective than spinosad, abamectin and emamectin benzoate.

Five insecticides (chlorpyrifos, bifenthrin, emamectin benzoate, spinosad and indoxacarb) were assessed separately on a susceptible strain (Lab-UK) of *P. xylostella* and a field population collected from Multan. The field population showed significant resistance to chlorpyrifos (331,100 fold), bifenthrin (45,200 fold), emamectin (1800 fold), spinosad (11 fold) and indoxacarb (5600 fold) when compared with the Lab-UK population. When insecticides were mixed based on LC_{50} and tested at serial concentrations against Lab-UK, significant synergy (synergistic factor > 1) occurred between bifenthrin, spinosad and emamectin. In contrast, the interaction between bifenthrin and indoxacarb population was additive (synergistic factor < 1). The toxicity of bifenthrin against the field population increased significantly ($P < 0.0001$) when combined with spinosad, emamectin and indoxacarb. Synergistic effects could be attributed to the complementary modes of action by these insecticide classes acting on different components of nerve impulse transmission. However, chlorpyrifos /bifenthrin mixture was not significantly different either from bifenthrin or chlorpyrifos alone, indicating an additive affect. In combinations with spinosad and emamectin, toxicity of chlorpyrifos increased significantly against the resistant field population and was even more than with indoxacarb.

Most effective chemical, spinosad was used in field conditions for its efficacy against this pest which gave almost 80 % mortality after 48 hours on three doses 60 ml/acre, 40 ml/acre and 20 ml/acre against field population that were similar to laboratory results after 48 hours. In two spray machine trial, Knap sack sprayer and power mist sprayer gave almost 80 % mortality after 48 hours at two spray volumes of 40 liters/acre and 80 liters/acre.

Present results indicated that resistance to deltamethrin is autosomal, incompletely dominant and dose dependent. Many of the novel chemicals (spinosad, indoxacarb and fipronil) are being used to control *P.xylostella* in Pakistan and are considered less harmful to natural enemies than pyrethroids. Further use of such novel products should therefore help to conserve parasitoids such as *Cotesia plutellae*. Equally important to management of resistance is avoiding over-reliance on any given insecticide group. Similarly adding other mortality agents, like crop rotation, biological control and sex pheomones to an IPM program could decrease the frequency of resistance to deltamethrin in *P. xylostella.*

Ten populations of *P.xylostella* collected from different geographical areas were studied on PAGE. Total proteins extracted from these populations were separated in three bands a, b and c on the polyacrylamide gel. These populations have variations in intensity of separated bands as well as their polymorphisms among them. The differences are suspected due to different spray schedules in specific areas and these variations can be helpful for the management of resistance developed against insecticide in DBM.