CHAPTER VI

SUMMARY

In order to determine the toxicity of some newer pesticides to honey bees and study the dissipation of some pesticides on *Brassica* blooms, experiments were carried out in the Toxicology laboratory and at Experimental Farm of Department of Entomology, CSK HPKV, Palampur during 2003-05. Monitoring of pesticide residues in honey samples collected from Himachal Pradesh along with their effects on physico-chemical properties was also carried out. The salient findings are reported here as under:

- The order of safety of pesticides on the basis of LD$_{50}$ (contact and stomach) against *Apis cerana cerana* foragers was benzoylphenyl urea = azadirachtin = *B. thuringiensis* subsp. *kurstaki* > spiromesifen > thiacloprid > endosulfan > spinosad > imidacloprid > cypermethrin > lambda cyhalothrin.

- The order of safety against the foragers of *A. mellifera* was; benzoylphenyl urea = azadirachtin = *B. thuringiensis* subsp. *kurstaki* > spiromesifen > thiacloprid > endosulfan > imidacloprid > spinosad > cypermethrin > lambda cyhalothrin.

- On the basis of LD$_{50}$'s; cypermethrin, imidacloprid, lambda cyhalothrin and spinosad can be classified as highly toxic (LD$_{50}$ 0.001- 1.99 µg bee$^{-1}$), endosulfan as moderately toxic (LD$_{50}$ 2.0 – 10.0 µg bee$^{-1}$) and azadirachtin, *B. thuringiensis* subsp. *kurstaki*, benzoylphenyl urea, spiromesifen and thiacloprid as relatively non toxic (LD$_{50}$ > 11.0 µg bee$^{-1}$).
- *A. c. cerana* foragers were found comparatively more susceptible than *A. mellifera* foragers to all the tested pesticides.

- On the basis of PT values it was observed that imidacloprid (seed treatment) @ 21 g a.i. ha\(^{-1}\) seed found harmless to the foragers of *A. c. cerana* and *A. mellifera*. The order of safety of spray treatments was spiromesifen (225.00 g a.i. ha\(^{-1}\)) > *B. thuringiensis* subsp. *kurstaki* (78.75 g a.i. ha\(^{-1}\)) > endosulfan (525.00 g a.i. ha\(^{-1}\)) > imidacloprid foliar application (25.00 g a.i. ha\(^{-1}\)) > cypermethrin + *B. thuringiensis* subsp. *kurstaki* (37.5 + 39.37 g a.i. ha\(^{-1}\)) > lambda cyhalothrin + azadirachtin (37.5 + 1.687 g a.i. ha\(^{-1}\)) > cypermethrin (75.00 g a.i. ha\(^{-1}\)) > lambda cyhalothrin (75.00 g a.i. ha\(^{-1}\)).

- Residues of endosulfan (525.00 g a.i. ha\(^{-1}\)), imidacloprid seed treatment (21 g a.i. kg\(^{-1}\)), lambda cyhalothrin (75.00 g a.i. ha\(^{-1}\)) and spiromesifen (225.00 g a.i. ha\(^{-1}\)) were determined through bioassay and chromatographic methods.

- Bioassay method using *D. melanogaster* was more sensitive for the estimation of imidacloprid (0.0003 ppm) followed by endosulfan (0.0012 ppm), lambda cyhalothrin (0.0078 ppm) and spiromesifen (0.0597 ppm).

- In general, chromatographic methods (GLC and HPLC) were more sensitive for the estimation of residues than bioassay method. Average recoveries in nectar samples varied between 82.85 and 88.90 per cent by bioassay and 91.20 and 93.55 per cent by chromatographic techniques. In pollen samples, recoveries varied between 81.44 and 86.44 per cent by bioassay and 88.50 and 91.30 per cent by chromatographic methods.

- Average initial deposits of 1.654, 1.793 and 1.471 ppm were recorded in respect of endosulfan, lambda cyhalothrin and spiromesifen, respectively in nectar samples.
- In pollen samples, average initial deposits of endosulfan, lambda cyhalothrin and spiromesifen were found to be 2.097, 1.592 and 1.932 ppm, respectively. Imidacloprid residues were detected neither in nectar nor in pollen samples.

- In nectar samples, the order of average half life of residues was lambda cyhalothrin (12.45 hours) < spiromesifen (19.99 hours) < endosulfan (27.49 hours). The order of average half life of residues in pollen samples was spiromesifen (9.69 hours) < lambda cyhalothrin (12.44 hours) < endosulfan (17.84 hours).

- Fifty one honey samples collected from the different localities of Himachal Pradesh were analyzed for the physico-chemical properties and pesticide residues.

- The average physico-chemical properties were as follows: optical density 0.219 at 560 nm, colour white, refractive index 1.4930 at 20⁰C, moisture 17.59 per cent, viscosity 5.772 minutes at 40⁰C, density 1.617 g cm⁻³ at 27⁰C, pollen grains 64141.17 per 10 gram of honey, total soluble solids 82.40 per cent, fructose 35.95 per cent, glucose 33.05 per cent, f/g ratio 1.095, pH 4.414, total reducing sugars 69.034 per cent, sucrose 4.883 per cent, ash 0.139 per cent and HMF 9.027 ppm.

- Pesticide residues in honey samples were estimated through multiresidue analysis on GLC. The average recoveries of organochlorine and cyclodiene pesticides varied between 83.66 and 91.33 per cent however, the range was 87.83 to 90.33 per cent for synthetic pyrethroids. The average recoveries for the seven organophosphorus pesticides varied between 76.33 and 83.66 per cent.

- Out of total 51 samples, 49.02 per cent samples were found contaminated with the residues of one or other pesticide. However, only 5.88 per cent samples have residues of only one
pesticide *viz.* malathion above MRL, proposed by the Ministry of Commerce, Government of India.

There was no effect of micro quantities of pesticides on the physico-chemical properties of the honey.

On the basis of above studies, it can be concluded that biopesticides (azadirachtin and *B. thuringiensis* subsp. *kurstaki*) and CSI (benzoylphenyl urea) were harmless to honey bee foragers. The synthetic pyrethroids (cypermethrin and lambda cyhalothrin) were highly toxic both in contact and stomach toxicity and persistent toxicity tests. Imidacloprid seed treatment, azadirachtin and *B. thuringiensis* subsp. *kurstaki* foliar applications showed practically non significant persistent toxicity against *A. c. cerana* and *A. mellifera*. At the same time, residues of imidacloprid seed treatment in nectar and pollen could not be recorded whereas, the residues of other tested pesticides *viz.* endosulfan, lambda cyhalothrin and spiromesifen dissipated to more than 95 per cent in average of five days. The studies further revealed that a large proportion of honey samples analyzed from different localities of Himachal Pradesh contained residues below MRL, which did not alter the physico-chemical properties. Thus honey produced in Himachal Pradesh is likely to pose little risk to consumer health and can be exploited for export so that farmers can fetch high economic returns.