Chapter VI

SUMMARY

The current investigation entitled, “Integrated Pest Management in Okra, *Abelmoschus esculentus* (L.) Moench” was undertaken during 2005 and 2006 crop seasons at the experimental farm of the Department of Entomology, CSK HPKV, Palampur and farmer’s fields in village Kachhiari (Kangra). The findings of the investigation are summarized as under:

The surveillance studies revealed that 18 different pest species were associated with okra, *A. esculentus* at Palampur while 19 different pest species were associated with okra at Kachhiari. Out of these pests, 4 were identified as the major pests of okra crop at Palampur. These included cotton jassid, *A. biguttula biguttula*, cotton aphid, *A. gossypii*, blister beetle, *M. pustulata* and cotton leafroller, *S. derogata*. At Kachhiari, in addition to these 4 pests, shoot and fruit borer, *E. vittella* was also observed to cause major damage to the crop.

The activity of *A. biguttula biguttula* started in 1st week of July at Palampur during 2005 and 2006 whereas, at Kachhiari, it initiated much earlier in the month of May (3rd to 4th week) during both the seasons. The jassid population ranged from 0.60 to 51.02 per 3 leaves at both the locations with peak population (39.21 to 51.02/3 leaves) appearing in 3rd to 4th week of August at Palampur and 4th week of July to 1st week of August at Kachhiari. The infestation index varied from 25.88 to 39.29 during the peak activity of the pest.
The appearance of *A. gossypii* was first noticed during 1st week of July at Palampur and 4th week of June at Kachhiari during both the seasons. The aphid population varied between 2.15 and 94.65 per 3 leaves at the two locations with peak population (54.75 to 94.65/3 leaves) observed in 2nd to 3rd week of August at Palampur and 2nd to 4th week of July at Kachhiari. The infestation index varied from 32.85 to 68.15 during the peak period of pest activity.

The incidence of *E. vittella* commenced during 3rd to 4th week of May at Kachhiari with low damage on shoots varying between 0.82 to 2.24 per cent during the 2 seasons. After initial infestation on shoots for just 2 weeks, the pest shifted its activity completely on fruits immediately after fruit set and remained active till 3rd week of July to 2nd week of August after which the activity ceased altogether. The fruit infestation varied from 1.23 to 35.85 per cent and the larval population varied from 0.37 to 2.35 per fruit during the 2 seasons with the maximum fruit infestation (29.64 to 35.85%) and larval population (2.33 to 2.35/fruit) recorded in 3rd to 4th week of June.

*Mylabris* spp. showed its appearance in okra fields at Palampur in the last week of July to 1st week of August, while at Kachhiari, the beetle activity initiated in 1st to 3rd week of July. The beetle population varied from 1 to 35.6 per 10 plants and the flower damage varied from 1.18 to 38.52 per cent at the two locations during the 2 seasons. The maximum beetle population (24.5 to 35.6/10 plants) as well as flower damage by the pest (26.90 to 38.52 %) were observed.
in 3rd week of August to 1st week of September at Palampur and 2nd to 3rd week of August at Kachhiari. During the peak pest activity, the infestation index ranged between 1.03 and 2.46.

The activity of S. derogata initiated in 2nd to 4th week of July at Palampur and last week of June to 1st week of July at Kachhiari. The rolled leaf infestation varied from 0.86 to 29.21 per cent and larval population varied between 1.4 and 38.1 per 10 plants at the 2 locations during the 2 seasons. The peak rolled leaf infestation (25.70 to 29.21 %) as well as larval population (33.8 to 38.1/10 plants) were recorded during 1st to 3rd week of August at Palampur and in the last week of July at Kachhiari. The infestation index varied from 2.10 to 2.67 at the time when peak activity of the pest was detected.

The simple correlation coefficients obtained between population/infestation of the major pests and various abiotic factors revealed a significant negative relationship of A. biguttula biguttula population with rainfall (-0.6187) and a significant positive correlation with hours of bright sunshine (0.5551) at Palampur during 2005. At Kachhiari, relative humidity had a significant positive correlation with pest population (0.6805, 0.7483) during 2005 and 2006, respectively, and minimum temperature too influenced the population significantly and positively at Kachhiari (0.7148) during 2006.

The correlation analysis between A. gossypii population and maximum temperature revealed a significant negative correlation at Palampur during 2006 (-0.6047) and at Kachhiari during 2005 (-0.6910) as well as 2006
Further, relative humidity positively and significantly influenced population count both at Palampur (0.5536, 0.6898) and Kachhiari (0.7005, 0.7556) during 2005 and 2006, respectively. Minimum temperature too registered a significant positive association with aphid population at Kachhiari (0.6604) during 2006.

At Kachhiari, the per cent fruit infestation (0.7793, 0.6918) and larval population of *E. vittella* (0.6726, 0.7687) exhibited significant positive correlation with maximum temperature during 2005 and 2006, correspondingly while a significant negative association of fruit infestation with relative humidity (-0.6066) and larval population with rainfall (-0.6235) were recorded during 2005.

The data on per cent flower damage and beetle population of *Mylabris* spp. at Palampur displayed a significant positive relationship with maximum temperature during 2005 (0.8927) and 2006 (0.8609), whereas, a significant negative correlation of flower damage with relative humidity (-0.7069) and a significant positive correlation with bright sunshine hours (0.7048) was noticed during 2006. At Kachhiari, during 2006, minimum temperature was the only significant factor to affect the flower damage by the pest negatively (-0.7157).

The larval population of *S. derogata* showed a significant positive relationship with relative humidity at Palampur during 2006 (0.6390) and at Kachhiari during 2005 (0.6919) as well as 2006 (0.7089). Further, bright
sunshine hours illustrated a significant negative impact on rolled leaf infestation (-0.6638) as well as larval population (-0.6748) at Palampur during 2006. Besides, a significant negative correlation was obtained between maximum temperature and larval population (-0.6402) at Kachhiari during 2006.

The studies on the relative susceptibility of okra varieties to the major pests revealed variety Tulsi to be the least susceptible to *A. biguttula biguttula*, *A. gossypii* and *E. vittella* and variety Varsha Uphar to be the least susceptible to *Mylabris* spp. and *S. derogata* at both the locations during both the seasons. In addition, other varieties *viz.* Arka Anamika, Parbhani Kranti and Panchaali also revealed lower levels of infestation by all the major pests. Further, highest marketable yield of okra fruits was registered by variety Tulsi followed by Varsha Uphar at both the locations during both the seasons.

The sucking pests *viz.* *A. biguttula biguttula* and *A. gossypii* were effectively managed by foliar sprays of cypermethrin (0.01%) and endosulfan (0.07%). The performance of malathion, azadirachtin, *T. chilonis* + endosulfan, *B. thuringiensis* + endosulfan and seed treatment with imidacloprid was rated as moderate, the latter found effective only at Palampur. The egg parasitoid, *T. chilonis*, *T. chilonis* + imidacloprid, *B. thuringiensis* and *T. chilonis* + *B. thuringiensis* resulted in lower reduction in population of sucking pests and thus were not effective.

In case of lepidopterous pests *viz.* *E. vittella* and *S. derogata*, the highest reduction was brought about by application of cypermethrin followed by
endosulfan. In addition, *B. thuringiensis* + endosulfan also proved quite effective and their efficacy enhanced substantially by 15th day of spray thus checking population of these pests for longer duration. Other treatments which decreased the population of shoot and fruit borer and leafroller conspicuously were *B. thuringiensis* and *T. chilonis* + *B. thuringiensis*. Malathion and azadirachtin were effective only upto a week. The treatments comprising *T. chilonis*, *T. chilonis* + endosulfan, imidacloprid and *T. chilonis* + imidacloprid were not found much promising against these pests.

The coleopteran pest, *Mylabris* spp. was best suppressed by application of cypermethrin, followed by endosulfan. Also, *B. thuringiensis* + endosulfan proved quite effective in suppressing this pest even after 15 days of spray. Malathion and azadirachtin, though initially effective lost their efficacy after a week. Other treatments *viz.* *T. chilonis*, *B. thuringiensis*, imidacloprid, *T. chilonis* + *B. thuringiensis*, *T. chilonis* + imidacloprid and *T. chilonis* + endosulfan demonstrated poor performance against this pest.

On the basis of these findings, following conclusions can be drawn:

1. Four species of insects *viz.* cotton jassid, *A. biguttula biguttula*, cotton aphid, *A. gossypii*, blister beetle, *M. pustulata* and cotton leafroller, *S. derogata* were identified as major pests of okra crop at Palampur. At Kachhiari, one more species, shoot and fruit borer, *E. vittella* was also recorded as the major pest of okra besides these 4 pests.
2. The appearance as well as the peak activity periods of these 5 pests varied through seasons and locations. Therefore, the initiation of management measures should be decided based on the actual incidence of the pest(s) and not on the basis of pre determined periods of their occurrence.

3. The population/infestation of major pests revealed significant correlation with one or the other abiotic factors emphasizing that the combined effect of weather parameters played an important role in influencing the pest incidence at both the locations during the two seasons.

4. Varieties Tulsi and Varsha Uphar were least susceptible to all the major pests and also registered higher marketable yield.

5. Sucking pests viz. *A. biguttula biguttula* and *A. gossypii* were successfully managed by foliar application of cypermethrin (0.01%), endosulfan (0.07%) and *B. thuringiensis* (1.98 x 10^7 IU ha\(^{-1}\)) + endosulfan (0.035%). Seed treatment with imidacloprid (5g kg\(^{-1}\) seed) provided moderate level of protection only when the sucking pests appeared earlier in the season. Therefore, it should be used in integration with foliar sprays for better results.

6. Lepidopterous pests viz. *E. vittella* and *S. derogata* were effectively suppressed by the application of cypermethrin (0.01%), endosulfan (0.07%), *B. thuringiensis* (1.98 x 10^7 IU ha\(^{-1}\)) + endosulfan (0.035%),
*B. thuringiensis* (3.96 x 10^7 IU ha^{-1}) and *T. chilonis* (25000 parasitized host eggs ha^{-1}) + *B. thuringiensis* (1.98 x 10^7 IU ha^{-1}).

7. The population of *Mylabris* beetles was successfully managed by application of cypermethrin (0.01%), endosulfan (0.07%) or *B. thuringiensis* (1.98 x 10^7 IU ha^{-1}) + endosulfan (0.035%).

8. Six releases of *T. chilonis* (50000 PE ha^{-1}) at Kachhiari and four releases at Palampur could not yield desirable results, however, when the parasitoid (25000 PE ha^{-1}) was used in combination with *B. thuringiensis* (1.98 x 10^7 IU ha^{-1}) proved a success in the management of lepidopterous pests on okra.

9. It is suggested that seed treatment with imidacloprid (5g kg^{-1}) followed by foliar sprays (frequency depending on the pests’ prevalence) with cypermethrin (0.01%), endosulfan (0.07%) or integrated treatment of *B. thuringiensis* (1.98 x 10^7 IU ha^{-1}) + endosulfan (0.035%) can be applied for the effective management of insect-pest complex of okra.