SUMMARY AND CONCLUSION

Soybean is one of the most important oilseed cash crop of India. The luxuriant crop growth, soft and succulent foliage attracts many insects so it is attacked by several insect pests from germination to maturity causing considerable damage to the crop. Therefore, efforts were made to study the seasonal incidence and bio-efficacy of insecticides against defoliators under field and laboratory condition. The results obtained from these studies were discussed in the preceding chapter and are summarized here under.

5.1 Seasonal incidence of soybean defoliators and its relation with weather parameters

5.1.1 Tobacco leaf eating caterpillar, *S. litura* (Fabricius)

The infestation of *S. litura* was initiated from 1st WAG i.e. 3rd week of July (0.81 larvae/plant) and reached at peak level (5 larvae/plant) at 9th WAG coinciding with 2nd week of September. Thereafter, it gradually declined and reached to zero level at the time of harvest.

The correlation study indicated that population of *S. litura* and maximum temperature, morning relative humidity and evening relative humidity were positively non-significant, while minimum temperature, bright sunshine hours, rainfall and rainy days were negatively non-significant during kharif season of 2017.

5.1.2 Gram pod borer, *H. armigera* (Hubner):

The population of *H. armigera* was started from 3rd WAG i.e. 3rd week of July (0.36 larvae/plant) and reached at peak level 2.4 larvae/plant at 7th WAG coinciding with 1st week of September. Thereafter, it gradually declined and reached to zero level at the time of harvest.

The correlation study indicated that the association between the pest population and rainfall and rainy days were positively non-significant during kharif season of 2017 while morning relative humidity and evening relative humidity was
positively significant. Whereas maximum temperature, minimum temperature and bright sunshine hours were negatively non-significant.

5.2 Bio-efficacy of insecticides against soybean defoliators under laboratory condition

5.2.1 Tobacco leaf eating caterpillar, *S. litura*

The result revealed that the treatment with chlorantraniliprole 0.006 per cent found most effective and recorded highest mortality (67.79 to 89.26 per cent) followed by indoxacarb 0.008 per cent which registered 57.04 to 78.53 per cent mortality. The treatments of quinalphos 0.05 per cent, *B. bassiana* 0.0035 per cent + chlorantraniliprole 0.003 per cent, *B. bassiana* 0.0035 per cent + indoxacarb 0.004 per cent, *M. anisopliae* 0.0035 per cent + chlorantraniliprole 0.003 per cent and *M. anisopliae* 0.0035 per cent + indoxacarb 0.004 per cent were found next effective treatments with 53.71 to 75.27, 46.29 to 67.79, 42.96 to 64.47, 39.21 to 60.79 and 32.21 to 51.86 per cent mortality, respectively. The treatment with *M. anisopliae* 0.007 per cent and *B. bassiana* 0.007 per cent were found comparatively less effective against the pest as they recorded 10.36 to 28.40 and 21.47 to 42.96 per cent mortality, respectively.

5.2.2 Gram pod borer, *H. armigera*

The results revealed that the treatment with chlorantraniliprole 0.006 per cent found most effective and recorded highest mortality 57.04 to 78.53 per cent mortality. However it was at par with the indoxacarb 0.008 per cent which registered 53.71 to 75.27 per cent mortality. The treatments of quinalphos 0.05 per cent, *B. bassiana* 0.0035 per cent + chlorantraniliprole 0.003 per cent, *B. bassiana* 0.0035 per cent + indoxacarb 0.004 per cent, *M. anisopliae* 0.0035 per cent + chlorantraniliprole 0.003 per cent and *M. anisopliae* 0.0035 per cent + indoxacarb 0.004 per cent were found next effective treatments with 46.29 to 67.79, 42.96 to 64.47, 35.53 to 57.04, 32.21 to 53.71 and 21.47 to 41.47 per cent mortality, respectively. The treatment with *M. anisopliae* 0.007 per cent and *B. bassiana* 0.007 per cent were found comparatively less effective against the pest as they recorded 10.36 to 28.40 and 21.47 to 42.96 per cent mortality, respectively.
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5.3 Bio-efficacy of insecticides against soybean defoliators under field condition

5.3.1 Tobacco leaf eating caterpillar, *S. litura*

5.3.1.1 First spray

The results revealed that chlorantraniliprole 0.006 per cent found to be the most effective and recorded highest mortality 80.65 to 90.65 per cent mortality. However it was at par with indoxacarb 0.008 per cent and quinalphos 0.05 per cent which registered 76.17 to 85.41 and 73.30 to 82.50 per cent mortality, respectively. They were followed by *B. bassiana* 0.0035 per cent + chlorantraniliprole 0.003 per cent, *B. bassiana* 0.0035 per cent + indoxacarb 0.004 per cent, *M. anisopliae* 0.0035 per cent + chlorantraniliprole 0.003 per cent and *M. anisopliae* 0.0035 per cent + indoxacarb 0.004 percent which recorded 68.41 to 80.64, 65.02 to 76.93, 64.02 to 72.74 and 62.36 to 70.80 per cent mortality, respectively. The treatment with *B. bassiana* 0.007 per cent and *M. anisopliae* 0.007 per cent were found comparatively less effective against the pest as they recorded 61.59 to 67.26 and 58.47 to 62.90 per cent mortality, respectively.

5.3.1.2 Second spray

The nine insecticides were evaluated against pest revealed that the of chlorantraniliprole 0.006 per cent per cent proved to be the most effective against the pest as it recorded the highest mortality among all tested insecticides 78.70 to 87.65 per cent. This treatment was followed by indoxacarb 0.008 per cent, quinalphos 0.05 per cent, *B. bassiana* 0.0035 per cent + chlorantraniliprole 0.003 per cent and *B. bassiana* 0.0035 per cent + indoxacarb 0.004 per cent which showed 75.40 to 83.81, 72.93 to 82.80, 71.85 to 78.51 and 68.90 to 72.40 per cent mortality, respectively. The treatments of *M. anisopliae* 0.0035 per cent + chlorantraniliprole 0.003 per cent, *M. anisopliae* 0.0035 per cent + indoxacarb 0.004 per cent were found next in order with 66.53 to 71.97 and 64.06 to 68.02 per cent mortality, respectively. However *M. anisopliae* 0.007 per cent and *B. bassiana* 0.007 per cent were less effective in controlling the pest and registered lowest mortality 50.93 to 62.16 and 62.79 to 66.18 per cent, respectively, among all evaluated insecticides.

5.3.2 Gram pod borer, *H. armigera*

5.3.2.1 First spray
Among the nine treatments tested for the control of gram pod borer, the treatment chlorantraniliprole 0.006 per cent found to be the most effective as it recorded highest mortality 85.07 to 90.54 per cent. It found at par with indoxacarb 0.008 per cent, quinalphos 0.05 per cent and B. bassiana 0.0035 per cent + chlorantraniliprole 0.003 per cent which registered 79.62 to 86.43, 76.04 to 82.03 and 74.37 to 80.64 per cent mortality, respectively. Next effective treatment were found as B. bassiana 0.0035 per cent + indoxacarb 0.004 per cent, M. anisopliae 0.0035 per cent + chlorantraniliprole 0.003 per cent and M. anisopliae 0.0035 per cent + indoxacarb 0.004 per cent which recorded 72.36 to 77.54, 69.12 to 74.76 and 67.46 to 73.56 per cent mortality, respectively. The treatment with B. bassiana 0.007 per cent and M. anisopliae 0.007 per cent were found comparatively less effective against the pest as they recorded 63.91 to 71.51 and 60.61 to 68.48 per cent mortality, respectively.

5.3.2.2 Second spray

The results on relative bio efficacy of insecticides against gram pod borer showed that the treatment of chlorantraniliprole 0.006 per cent proved to be the most effective against the pest as it recorded the highest mortality among all tested insecticides 80.64 to 87.73 per cent. This treatment was statistically at par with indoxacarb 0.008 per cent, quinalphos 0.05 per cent, B. bassiana 0.0035 per cent + chlorantraniliprole 0.003 per cent and B. bassiana 0.0035 per cent + indoxacarb 0.004 per cent which showed 78.44 to 84.12, 76.71 to 83.21, 75.32 to 81.38, and 73.58 to 77.07 per cent mortality, respectively. The treatments of M. anisopliae 0.0035 per cent + chlorantraniliprole 0.003 per cent and M. anisopliae 0.0035 per cent + indoxacarb 0.004 per cent were found next in order with 69.88 to 75.22 and 67.43 to 73.00 per cent mortality, respectively. However M. anisopliae 0.007 per cent and B. bassiana 0.007 per cent were less effective in controlling the pest and registered lowest mortality 54.15 to 60.05 and 61.73 to 68.18 per cent, respectively among all evaluated insecticides.

5.4 Yield and economics

The results on grain yield of soybean obtained from various insecticidal treatments revealed that chlorantraniliprole 0.006 per cent gave the highest grain yield (2296.67 kg/ha) and it was at par with indoxacarb 0.008 per cent which recorded
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the yield 2113.33 kg/ha. The minimum grain yield of 1250.00 kg/ha was recorded from control plots. Among the biopesticides, *B. bassiana* 0.007 per cent gave higher yield 1550.00 kg/ha as compared to *M. anisopliae* 0.007 per cent which gave 1496.67 kg/ha.

Indoxacarb 0.008 per cent gave the highest cost benefit ratio of 1:13.47 followed by quinalphos 0.05 per cent (1:13.01) and *B. bassiana* 0.0035 per cent + indoxacarb 0.004 per cent (1:8.52). Among the biopesticides *B. bassiana* 0.007 per cent gave the highest cost benefit ratio as 1:5.39 as compared to *M. anisopliae* 0.007 per cent (1:4.44).

Considering the effectiveness, yield and economics of insecticides indoxacarb 0.008 per cent and quinalphos 0.05 per cent were found most effective and economical treatments for the control of soybean defoliators. Treatment of chlorantraniliprole 0.006 per cent and *B. bassiana* 0.0035 per cent + chlorantraniliprole 0.003 per cent was found as effective as the recommended chemical insecticides against defoliators in soybean ecosystem.