

Project Title: Microbial and non-conventional management practices for tomato fruitworm *Helicoverpa armigera* Hübner (Lepidoptera: Noctuidae) in Punjab

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This is the first study on the distribution, losses, microbial and non conventional integrated management of *Helicoverpa armigera* (Hübner) on tomato (*Lycopersicon esculentum* Miller) in Punjab, Pakistan. The results of the survey of tomato growing fields revealed that maximum larval population of *H. armigera* was found in district Bahawalpur with highest fruit infestation while the minimum was at Rawalpindi. It was also noted that both larval population and fruit infestation was positively correlated with temperature and negative with the relative humidity in all the locations. The larvae were reared on the novel artificial diet developed in the project and was compared with the existing diets. The blending of chickpea (*Cicer arietinum* L.) and red kidney beans (*Phaseolus vulgaris* L.) flour mixed with tomato paste proved highly favorable for the adult reproduction and did not decline the vitality of the tomato fruitworm. In different assays, the combination of *Beauveria bassiana* and *Bacillus thuringiensis* toxin proved effective in combination rather than alone treatments. The lower dose of *B. bassiana* with both concentrations of *B. thuringiensis* showed additive effect on mortality of *H. armigera* while higher dose of *B. bassiana* synergistically enhanced the mortality. Similarly, the applications of *Nuclear Polyhedrosis Virus* (NPV) with *B. thuringiensis* proved effective against tomato fruitworm prolonging the larval and pupal growth and decreasing the adult duration when neonates were fed on NPV and *B. thuringiensis* mixed diet. Similarly, the combinations of NPV with *Azadirachta indica* and chlorantraniliprole gave higher mortality, reduced pupation and produced additive effect compared to their alone applications for all test populations of *H. armigera*. These tactics were validated in tomato fields, the chlorantraniliprole was found the most effective with minimum larval population and fruit infestation which lead to the highest yield and cost-benefit ratio (CBR), on the other hand, the maximum number of natural allies viz *Chrysoperla carnea*, spiders, Tetranychus species, lady bird beetle and predatory bugs were recorded in plants sprayed with BION. In another field trial, the Nuclear polyhedrosis virus (HaNPV), *B. thuringiensis*, *B. bassiana*, Jasmonic acid (JA) alone and in combination was evaluated for the sustainable management of this notorious insect pest. All the treatments significantly reduced the larval population of *H. armigera* when compared to untreated control. The combined application of HaNPV + chlorantraniliprole was found to be superior among all other treatments in reducing larval population, fruit losses and increasing yield. The trials conducted during this project present the baseline data on the management of tomato fruitworm suggesting the potential use of microbial control agents as the integral part of successful and sustainable control of fruitworm in tomato production systems.