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Cotton Exchange Building, 2nd Floor, Cotton Green, Mumbai - 400 033
Phone: 30063400 Fax: 2370 0337 Email: cai@caionline.in
www.caionline.in

Insect War in Cotton Battle Fields

(Dr. K.R. Kranthi, Director of Central Institute for Cotton Research (CICR), Nagpur has completed his Ph.D in Entomology from IARI, New Delhi. He has more than 20 years of experience in the field of cotton research.

The views expressed in this column are his own and not that of Cotton Association of India)

I remember, twenty years ago, a cotton farmer said 'it is a war between man and insects'. I was on a field visit to Guntur district of Andhra Pradesh to collect bollworms for insecticide resistance monitoring. Farmers were angry, frustrated and crest fallen. One farmer had a bunch of receipts. Unbelievable but true, there were about forty bills for insecticides in the bunch. He had purchased insecticides, mixed them as cocktails and sprayed through the season at weekly intervals. And the cause for frustration was that the American cotton bollworm refused to die. Within ten years from 1980 to 1990, the bollworms emerged as major pests of cotton and by 1990 had become resistant to all the recommended insecticides sprayed with an intention to kill them. They were resistant to an extent that even when the bollworm caterpillars were dipped directly into the insecticide formulation, which would otherwise be diluted in 1000 liters of water before spraying, the insects still wouldn't die. This was a pathetic story that had several facets to it. The farmer was actually responsible for the bollworm becoming almost invincible to insecticides by spraying insecticide cocktails desperately and repeatedly. But, it was also scientists and pesticide companies who were the unwitting cause of the tragic story. Their recommendation was -spray insecticides for higher yields. Initially, farmers got good yields because the target pests died and so did the beneficial insects that used to kill the target insect pests. After a few seasons, when the insect pests developed resistance to insecticides, they survived but the beneficial insects were still being killed by the pesticides. The war was based on poor science and therefore helped the target pests win the war eventually.

EXPERT's Column

Dr K.R. Kranthi

I need to explain this. It is important to know that insecticides kill all kinds of insects, but are more toxic to some species. There are insects that eat plants and cause economic damage. These are called 'pests'. There are other insects in the same fields that eat pests. These are catagorised as 'beneficial insects'. To complicate matters further, there are also insects that eat beneficial insects and are 'undesirable insects'. And, there is a constant ongoing war between insects in cotton fields all through the season. When a farmer sprays an insecticide, he is actually interfering and disrupting the war only to tilt the balance in favor of some types of insects. Newly introduced chemicals, when used initially, generally kill more than 90% of all types of insects and thus make farmers happy. After a few seasons, some insect types get used to the insecticide rapidly whereas others are slow. When the pests develop resistance rapidly, they get an edge over the beneficial insects and use the advantage to win the war, especially when the insecticide is used regularly. Farmers also help pests by cultivating insect-susceptible varieties, which give the pests good food so that they can keep fit. Many chemicals used as insecticides also affect plant physiology that sometimes makes plants 'green-phase' or take them to senescence. This also tilts the balance in favour of pests.

It is important to know that the American bollworm, Helicoverpa armigera was not a major pest of cotton in India before 1980. It was induced by a group of insecticides called 'pyrethroids' which were introduced into India in 1980. A combination of factors such as 'wide-spread cultivation of American cotton hybrids' coupled with 'extensive use of synthetic pyrethroids' and 'high toxicity of pyrethroids beneficial to insects' eventually helped American bollworms attain the status of 'incorrigible-invincible-intractable-insect pest'. There are other stories related to mealy bugs which are small insects with a wax coating on their body. Insecticides do not affect them as much as they kill beneficial insects. Thus mealy bugs survive and spread more when insecticides are used to control them.

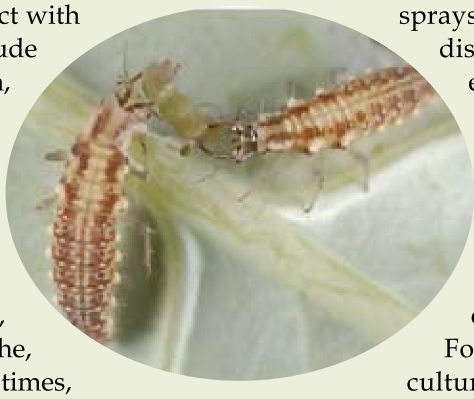
What makes insects invincible? Why is it that insect have the capacity to develop resistance to any kind of chemical that scientists invent? Several biotypes of mosquitoes and houseflies are now known to survive the deadly DDT and BHC, which were thought to decimate them, when used first. It is often said that a nuclear war can decimate all living beings, but cockroaches could survive. That brings home the point that the war will be won by insects because of their evolutionary strength. Scientists often remind us that it is a fallacy to think that insects can be wiped out. It is important to remember that the earth belongs to insects. The planet earth has been inhabited by insects for more than 330 million years. Human beings evolved only 1.5 millon years ago. Insects survived everything that decimated the dinosaurs and many other species on earth. Insects are probably destined to win the war, but human intelligence should find ways to live with them without getting affected.

How do insects develop resistance? When an insecticide is used initially, it actually kills about 99% of the insects of the same species. The insects that survive are likely to have resistance genes in them. These insects later become the source for resistance through recurrent survival from the repeated onslaught of insecticides and thus gain advantage to finally evolve into an insecticide-resistant species. The World Health Organization (WHO) defined resistance as "the inherited ability of a strain of some organism to survive doses of a toxicant that would kill the majority of individuals in a normal population of the same species".

Thus far there are more than 12,000 documented cases of insecticide resistance in 168 countries from 596 insect species to 421 different insecticides. Cotton insect pests find their place in 10 out of the 20 most 'resistance-prone' insect species. Five cotton pests feature in the top six ranks. Interestingly, the cotton bollworm tops the list with the highest number of resistance cases. More than 63% of insecticide resistance cases are from agriculture and 28% of cases from insects of medical importance. This is because of the extensive use of insecticides in agriculture and public health. The highest number of resistance reports was from USA with 2400 cases followed by 850 from Pakistan, 700 from China, 600 from Australia and 400 from India.

Indian farmers continue to use deadly insecticides in cotton fields and on food crops. Several insecticides being used the country are considered to be extremely hazardous to the environment and which have been severely regulated by the FAO (Food and Agricultural Organization), WHO (World Health Organization) and the UNEP (United Nations Environment Programme).

Insecticides such as monocrotophos, phorate, methyl parathion, dichlorvos, carbofuran, methomyl, triazophos and metasystox and phosphamidon are highly hazardous and extremely dangerous to human beings and the environment. Unfortunately several state agricultural universities in India still recommend them for pest management in cotton and other food crops. These insecticides have been banned and phased out by several countries across the globe. The above listed insecticides pose acute hazard to developing countries where the lack of protective clothing and mechanical equipment makes farmers/farm workers vulnerable to direct contact with chemicals. Medical effects include nausea, diarrhoea, blurred vision, and, in severe cases, respiratory depression, convulsions and death. Effects reported in workers repeatedly exposed to methyl parathion include impaired memory and concentration, disorientation, severe depressions, irritability, confusion, headache, speech difficulties, delayed reaction times, nightmares, sleepwalking, drowsiness and insomnia. Some of these chemicals fulfill one or more of the following criteria: highly acutely toxic, known/probable carcinogen, known groundwater pollutant or known reproductive or developmental toxicant, unacceptably high risk to workers, to wildlife, especially avian and aquatic species, and to trade. It is a pity that these chemicals are still being used extensively for pest control in cotton.



The cotton insect pest management strategies from CICR listed below come from relatively simple thinking and can create a win-win situation for all warring groups in the cotton battle field.

1) It needs scientific selection of the most appropriate chemicals that can be as specific as possible to kill insect pests with least effects on beneficial insects. Bt cotton is an excellent example of such a pest specific management strategy.
2) It is necessary to reduce insecticide interventions so that selection pressure is reduced.
3) Farmers should not use the same chemical group for more than once in a season.
4) It is important to design a rational and sensible sequence of insecticides that are effective on the target species, and cause least disturbance to beneficial fauna and minimise selection pressure
5) It is better to depend more on pest resistant varieties, natural control, biological control with least interference of insecticides.

Strategies such as the cultivation of sucking pest tolerant varieties and chemical seed treatment, helps in delaying the first spray, thereby conserving the initial build-up of beneficial insects as natural enemies. Also avoidance of insecticide sprays initially in the season, prevents disruption of the beneficial insect ecosystems early in the season. The use of neem-based products and biological pesticides also helps to control sap-sucking insects.

Bt cotton is highly effective in controlling bollworms in an ecologically acceptable manner. For non-Bt varieties, apart from other cultural and biological control methods, the newly introduced insecticides can be effectively used to keep the bollworms under check. Spray Spinosad or Indoxacarb or Chloantraniprole or Flubendiamide for bollworm control and spray synthetic pyrethroids for pink bollworm management during late fruiting phase. Expensive insecticides such as spinosad, emamectin and indoxacarb may be used in irrigated regions with high input use, wherein bollworm infestations are more severe.

Conclusion: The insect war will continue in the cotton battlefields. We need to get rid of many poisonous insecticides from the country so that cotton farmers, food crops and our environment can breathe free of the extremely hazardous pesticides that are being used now. We must strengthen our science to develop pest varieties that can allow insects to survive without causing economic damage to the crop produce. In other words: If you can't beat them, join them. Thus the final message is Make Peace With Insects.