Hybrid parasitoids for pest management

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Biological control using natural enemies such as parasitoids, predators and pathogens, is an age-old sustainable practice of the control of crop pests. It has gained impetus in recent times, as conventional insecticides did not achieve the desired level of control of pest insects due to the evolution of resistance in them, and in addition, showed deleterious effects like environment pollution, pest resurgence, and reduction in their natural enemies in the agroecosystem. Successful examples of biological control using parasitoids and predators are the control of woolly aphids, the San Jose scale, sugarcane lepidopterous borers and sugarcane Pyrilla.

The use of parasitoids is not free from limitations, as they are often equally susceptible, like the host insects, to insecticides. Parasitoids also have limited adaptability to extreme environmental conditions of temperature and humidity in a semi-tropical country such as ours. In contrast to other animals that are economically important in agriculture, natural enemies of pest insects have not yet been subjected to any genetic improvement programme, except through selection[1], although genetic mapping studies are reported in the extensively used parasitoid, *Trichogramma* sp.[2]. Hybrid vigour is routinely exploited in the development of several crop plants for high yields and other traits. A similar attempt in developing hybrid parasitoids that are tolerant to unfavourable environmental conditions and also to insecticides is a distinct possibility and is desirable in contemporary agriculture.

The All India Coordinated Research Project on biological control of the Indian Council of Agricultural Research (ICAR) has done commendable work on identification and utilization of parasites and predators of harmful insects, especially the American bollworm, *Helicoverpa armigera*. This polyphagous pest of important crops, such as cotton, vegetables and pulses, causes an estimated damage equivalent to about Rs 5000 crores annually in India. Nearly 50% of insecticide usage in India is aimed at the control of pest insects of cotton, especially *H. armigera*. However, many of these insecticides have proved ineffective due to development of widespread resistance in larvae of *H. armigera*. Further, these insecticides have adversely affected natural enemies and changed pest status of others. Hence, in recent years, use of *Trichogramma* spp. as biological control agents against lepidopterans (including *H. armigera*) is strongly advocated and practised over a million hectares of land annually all over the globe. Adult wasps of *T. chilonis* lay their tiny eggs in the eggs of *H. armigera*. The larvae of *T. chilonis*, on hatching, feed inside host eggs and complete growth and development till adult emergence. Host eggs of *H. armigera* are thus killed, saving crops from insect damage. *T. chilonis* is used at a rate of about 150,000 parasitized eggs/ha from about 45 days of age during July–September of the cotton-growing season[3]. However, *T. chilonis* is temperature-sensitive and therefore, its efficacy to survive and parasitize eggs of *H. armigera* under the semi-tropical conditions is limited. Efforts to develop a temperature-tolerant strain of *T. chilonis* are one of the important research activities in many institutions. The Project Directorate of Biological Control (PDBC; ICAR), Bangalore has successfully developed a temperature-tolerant strain of *T. chilonis* by continually rearing and selecting these insects under increasing temperature regimes. Thus, *T. chilonis* strain tolerant to temperature of 32–36°C and equally competent to parasitize eggs has been made commercially available[4].

Endosulfan is the most common insecticide used for crop protection in India and elsewhere, and is used for control of early stages of lepidopteran larvae in cotton. Since endosulfan does not distinguish between the pest and its biocontrol agent, successful use of *T. chilonis* will need development of endosulfan-tolerant strains. PDBC has also developed a 0.07% endosulfan-tolerant strain by selecting it over 325 generations during the period of more than eight years, and transferred the rearing technology as endogramma® to Indian pesticide industry[5].

Since these two *T. chilonis* strains carry genes for temperature and endosulfan tolerance, it will be a good idea to explore and utilize F_1 hybrids that express tolerance to both high temperature and repetitive endosulfan sprays, and also possess hybrid vigour in their fecundity and parasitizing ability. However, expression of temperature and endosulfan tolerance will be governed by the nature of genes responsible for these traits. The traits could be monogenic (dominant or recessive) or polygenic. Expression of both traits in F_1 hybrids can be expected only if their respective genes are of dominant nature. Alternately, if both traits are polygenic or recessive, hybrids are unlikely to express the traits and only homozygotes (pure lines) can be used. In the case of pure lines, the heterotic advantage offered by hybrids will need to be sacrificed.

A cost-effective technology for the generation of hybrid strain will have to be additionally developed, for which male and female parental lines of both strains will have to be reared in large numbers. Since males are known to emerge earlier than females[6], sex-separation of adults could be done temporally. In recent years, species-specific primers based upon rDNA–ITS2 sequences have been developed for identification of some species of *Trichogramma*. Further, a genetic map (spanning over 1330 cM) based upon RAPD markers from the parental lines, polymorphic for longevity and fecundity, has been made. As more knowledge on the genome of *Trichogramma* becomes available, it would be possible to genetically engineer them for male and/or female sterility for developing hybrids. Presence of endosymbiote, *Wolbachia* often associated with Trichogrammatids could further complicate sex ratio of progeny[7]. Eventually, the concept of hybrid insects could be extended to beneficial insects like silkworm for higher productivity and disease resistance, or to the development of hybrid parasitoids that have extended host range, as in the case of hybrid parasitoid of the yellow-headed spruce sawfly or pine false webworm developed by cross-mating the Canadian native strain with the European strain[8].

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3. http://www.ncipm.org.in/SuccessStory.asp
4. http://dbtindia.nic.in/r&d/biopest-crop.html
5. http://icar.org.in/crsci.htm
6. http://www.rinconvitova.com/trichogr.htm
7. http://www.gcw.nl/dissertations/3389/dis3389.pdf
8. http://www.biocontrol.ca (Biocontrol Network 2003–04 Report; Univ. of Montreal).

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