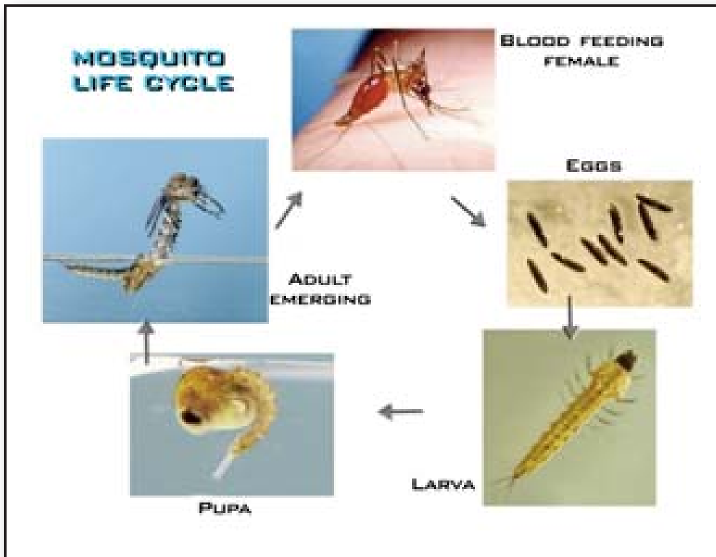
The IR-4 Project
Pest Management Solutions for Specialty Crops and Minor Uses

Newsletter

Vol. 41 No. 3 Summer 2010

Controlling Adult Mosquitoes with Pesticides (Part I)

— by Karl Malamud-Roam, IR-4 Public Health Pesticide Man-



Mosquitoes are universally recognized as a substantial threat to human health, each year killing almost a million people and sickening hundreds of millions more. However, the best response to these noxious pests is controversial. No "silver bullet" has ever been found that solely counters mosquitoes, and every intervention that has been developed – from drainage to pesticides to bednets – has faced questions about cost, effectiveness, and side effects. In particular, the use of pesticides to combat adult mosquitoes has prompted vigorous debate. This article is the first of a series that describe mosquito adulticides and the methods used to assess their benefits, costs, and risks; specifically, Part I is focused on how and why pesticides are used against adult mosquitoes.

Of thousands of species of mosquitoes in the world, hundreds bite humans in virtually all inhabited parts of the globe. For all species, the mosquito life cycle includes four distinct stages (egg, larva, pupa, adult), with the juvenile, larval, and pupal stages occuring in water. Adult mosquitoes disperse and are generally distributed more widely in an area than juveniles. Only adult females bite people or animals, searching for blood to nourish their eggs. This means that only adult female mosquitoes can transmit pathogens or cause nuisance. Therefore, the basic goal of mosquito control programs is to minimize contact between people and adult female mosquitoes, and thus o minimize the frequency of mosquito bites and their associated hazards.

Digging a drainage ditch to reduce mosquitoes

All mosquito bites carry some risk of disease or discomfort, but the risk varies significantly, and this is important in deciding how to respond. The primary risk is the mosquito's potential for serving as a vector of pathogenic (disease-causing) organisms from one infected host to another. This requires that an adult mosquito lives long enough to bite an infected animal, digest the blood meal, lay eggs, and bite again – the second or later bites being the dangerous ones in terms of disease transmission. Thus, the vector risk of individual adult mosquitoes depends on their age as well as their sex. The risk also depends on the species, as some bite more often per full blood meal, target humans preferentially, and/or are more compatible with specific pathogens (which must enter the mosquito's gut, develop, migrate to a salivary gland, and exit through a bite). Other disease risks associated with mosquito bites – allergic reactions to proteins injected during bites, for example, or secondary infections following scratching of bites – can be serious and only require adult mosquitoes to live long enough to bite once. Mosquitoes can cause significant nuisance even without clinical disease; the degree of nuisance depends on their abundance, aggressiveness, period of activity, and other factors which depend on the species but not on the mosquito's age.

There are many ways to reduce mosquito bites. They can basically be divided into those actions which directly or indirectly reduce the abundance of adult mosquitoes, and those which prevent contact between adult mosquitoes and people.

Drainage of wet areas and other habitat manipulations typically reduce juvenile mosquito populations, and thus indirectly prevent or minimize production of adults.

Biological control of immature mosquitoes is often effective in limiting adult mosquito production from permanent water bodies, but predators and parasites are rarely successful tools for controlling mosquitoes from temporary habitats. Bats and birds eat some adult mosquitoes, but biological control of adults has not been an effective control intervention. Baited traps can be used effectively to reduce adult populations in some circumstances.

Chemical toxicants can be used to directly reduce mosquito populations as larvae, pupae, or adults. Generally, larvicides are more selective than adulticides and are applied over more limited areas.

Contact with adult mosquitoes can be lessened through physical barriers (bed nets, window screens, bite-resistant clothing), behaviors (staying inside during periods of mosquito activity), and/or chemical repellents.

Physical barriers, behavior changes, and chemical repellents can all be used at the individual or family level to reduce mosquito biting, but if the disease risk and/or nuisance level is high enough to justify mosquito population reduction, this usually requires community-wide programs. Organized mosquito control programs typically apply multiple techniques to reduce mosquito populations, with specific actions based on abundance surveys, disease risk, and historic observations, in a general strategy known as Integrated Vector Management (IVM) or Integrated Mosquito Management (IMM). IVM/IMM tools exist to reduce mosquito populations at all life stages, and the key operational questions to ask are what are the appropriate control targets and the best techniques to address them?

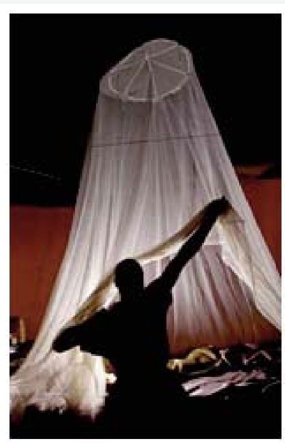
Many mosquito control programs preferentially target juvenile mosquitoes. However, this indirect control of adult mosquitos through the management of the juvenile populations is not always effective at managing the adult population. For example, some habitats are not amenable to larval control techniques because of their configuration or distribution – e.g. tire piles, artificial containers in urban areas, and tree holes. In addition, in many warm, wet areas the extent of larval habitat within mosquito flight range of inhabited areas can be simply overwhelming. Finally, direct targeting of adult mosquitoes with interventions is critical when they are present in levels which pose significant risk of disease or substantial nuisance. If mosquito adults are present in an area, and especially if a significant portion of them

The FQPA addresses: vector control and public health pesticides (PHP's) as a specific pesticide "minor use", provisions for a Public Health Coordinator within the Office of Pesticides Programs, requirements that public health consequences be considered in regulatory decisions involving PHP's, and an authorization for potential federal funding if the costs of new data requirements caused registrants to pull PHP's off the market. Since the Act's passage, however, these provisions were not directly put to the test until recently, when the registrants of resmethrin, a pyrethroid used to control adult mosquitoes, and temephos, an organophosphate larvicide, announced that they could not afford the data-call-in (DCI) expenses associated with re-registration of their materials (edocket.access.gpo.gov/2010/pdf/2010-11697.pdf; edocket.access.gpo.gov/2010/pdf/2010-1583.pdf). Vector control practitioners, represented primarily by the American Mosquito Control Association (AMCA), the Centers for Disease Control and Prevention (CDC), and the IR-4 Public Health Pesticides Program, submitted numerous comments and letters on the proposed cancellations, focusing on the small number of registered PHP's and the need to protect them generally, as well as providing information on use patterns and extraordinary attributes of these specific chemicals. However, efforts to secure an appropriation of federal funds to generate the data required by the DCI's have been unsuccessful, perhaps not surprisingly given current budget challenges. Proposals to satisfy the DCI's with existing data or to justify waivers from some data requirements have been prepared, but it is not now clear whether these proposals will be accepted, whether the materials will in fact disappear from the tool box, or whether there will be some other outcome.

Resmethrin and temephos are not the only mosquitocides that have faced regulatory scrutiny in recent decades, from state or local as well as federal authorities. Many carbamates and organophosphates have been taken off the market and mosquito larvicidal oils are increasingly scarce and scrutinized. While new control tools have also entered the market during this period, the loss or potential loss of well-known, reliable products has caused significant uncertainty in many corners about whether needed tools will be available in years to come not only for routine operations against familiar pests, but also to respond quickly and effectively to introduced mosquito species, disease outbreaks requiring high vector control efficacy, resistance to standard pesticides, budget cuts, or a number of other foreseeable challenges.

In light of these challenges and questions, IR-4 approached OPMP and AMCA early in 2011 to discuss the feasibility of developing a Mosquito Control PMSP similar to those in agriculture. Specifically, there is a need for an inventory of the chemical tools that are available or under development, a review of their limitations and the regulatory challenges facing them, and a presentation of priorities for research, regulatory assistance, funding, and training. These discussions led to a series of subsequent workshops, and has demonstrated that there is significant interest in the idea. Current plans include a final workgroup meeting in late October, and a draft PMSP for public comments for release in early 2012.

Mosquitofish and larval mosquito



Chemically treated bed net