Managing for higher yields

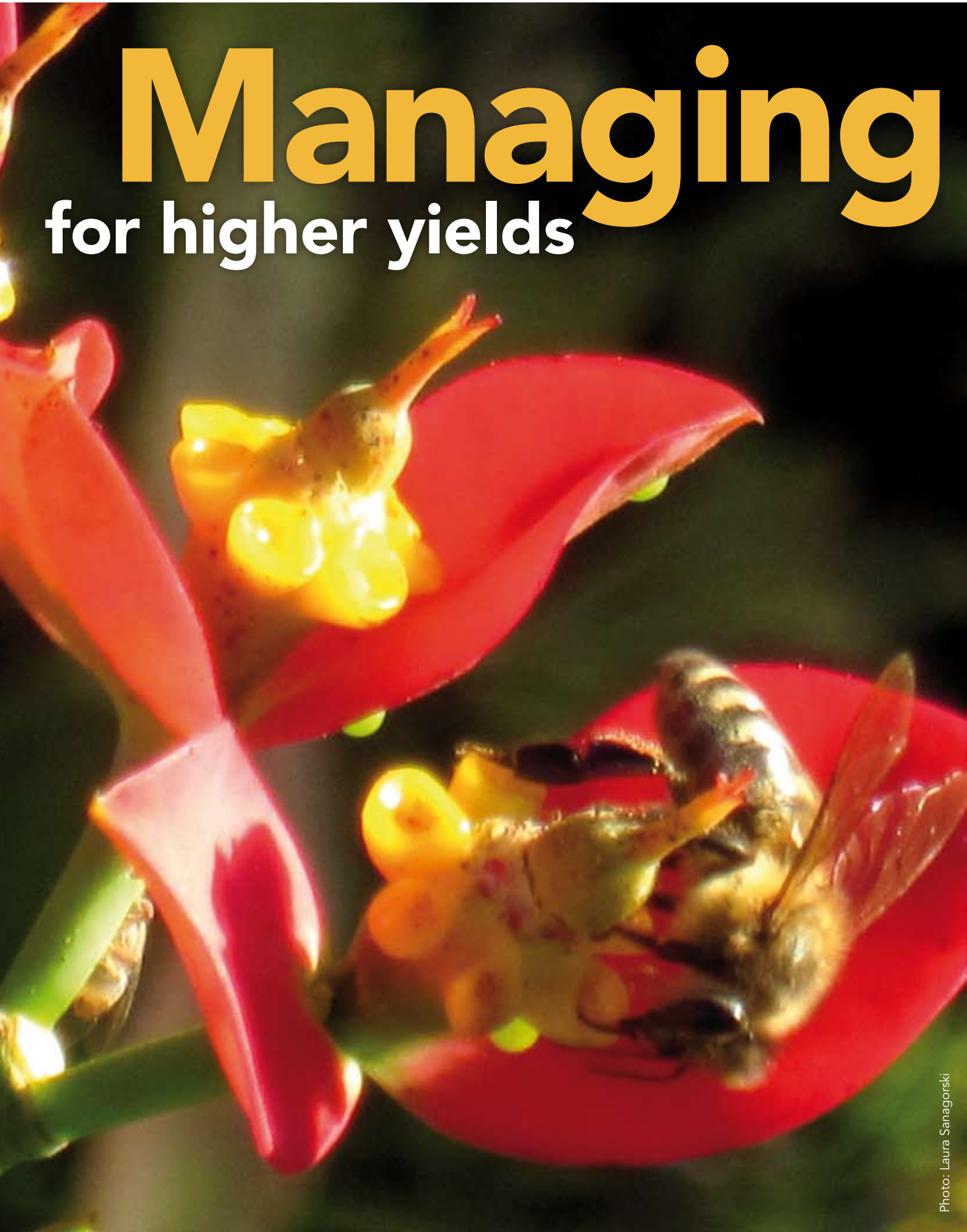

Photo: Laura Sanagorski

We tend to think of "insects" and "bugs" synonymously with words like "harmful" and "pests". However, only a very small fraction of the world's insect population cause damage to crops or harm humans. There are far more insects that can help in some way. Farmers can use techniques to attract beneficial insects to assist with pest management and pollination – and benefit enormously.

Text: Laura Anne Sanagorski

IPM, or Integrated Pest Management, is widely presented as an environmentally friendly and sustainable method. It relies on scouting activities and the setting of action thresholds, which together with regular monitoring, are used to prevent pest and disease outbreaks. Farmers and agriculturalists can use these techniques to identify the risk of pest and disease outbreaks at an early stage, which allows for the use of less toxic and less severe management options. IPM rejects the idea that the mere presence of any insects warrants control measures. IPM incorporates the principle of "managing" the presence of insects, in contrast to completely eradicating them, so that populations remain below a particular threshold level.

As in many other parts of the world, farmers in the United States are harvesting the benefits of this approach. Farmers in the southern state of Florida produce approximately 40% of the tomatoes consumed in the whole country. This high value crop is threatened by very many pests and diseases and has historically been protected by high doses of chemical products. IPM techniques are proving to be a very useful alternative to this. Statistics show that the adoption of IPM in tomato production has led to an 82% reduction in pesticide usage. More surprising, however, is that the farmers have seen their yields increase from an average of 29,000 to 36,700 pounds per acre in just 8 years. This increase is directly related to this more sustainable approach and to the resulting biological diversity.

Planting diversity

Diversity refers to the variety of plant species, types, and ages within an (agro)-ecosystem. Plant diversity adds stability to an agro-ecosystem. The more diverse an agricultural system is, the more resistant it is likely to be to the damage caused by pests, diseases, or severe weather. We know that monocrops are risky in many ways: some of the most severe disasters in agricultural history have been the result of plant monocultures. Consider the Irish Potato Famine of the 1840s. The particular variety of potato that was so widely planted and so heavily depended upon as a food source was a vegetatively-propagated clone. Each potato plant was genetically identical, and the lack of genetic diversity meant that there was no resistance when potato blight began to infect crops throughout the country.

Planting one single crop may seem, at first sight, to be the most productive and profitable option. But most pests prefer a single specific plant host, so diversity can reduce the amount of damage that they can do. Equally important, plant diversity has the added advantage of attracting beneficial insects. Diversity in crops provides more plant types with more blooms at different times of the year, something that attracts a more diverse population of insects.

More bees, more yields

Less than 5 percent of the world's insects are harmful to humans or crops. This means that more than 95% of the

Hand pollination is hard work, expensive, and not really necessary. Photo: Laura Sanagorski

Small but powerful: Braconid wasps on a tomato hornworm. Photo: Laura Sanagorski.

insects killed by indiscriminate management techniques, such as blanket applications of pesticides, are not pests and may even be beneficial. The loss of beneficial insects through such activities is detrimental in different ways. This is particularly evident in the decline of bee populations around the world, a phenomenon known as Colony Collapse Disorder. Researchers believe that this phenomenon is related to some combination of environmental disruption, diseases and excessive pesticide use.

As many other insects, bees are critical to Florida's agriculture. Approximately one-third of all of Florida's vegetable and fruit growers hire pollinator services for crops such as citrus, avocados, watermelons, cantaloupes and squash. This is because honey bees have been shown to increase crop yields by anywhere between 20 and more than 60 percent. Florida's citrus industry benefits greatly from pollinators. Bees ensure adequate fruit size and set, and the citrus blossoms provide nectar that makes for a very high quality honey. This creates a valuable relationship between beekeepers and citrus growers: beekeepers want to raise their bees near citrus groves and citrus growers benefit from the pollination. (Florida has such mild winters that some beekeepers from colder parts of the country overwinter their bees in parts of the state.) Some of

Parasitoids, predators and pollinators

The actual percentage of insects that are considered to be pests is very low: the majority of insects are actually helping farmers, in different ways:

Predatory, or insectivorous insects, eat other insects: pests that would otherwise feed on important crops and plants. Lacewings feed on the eggs and juvenile stages of a number of agricultural pests, such as some types of thrips, mites, whiteflies, mealybugs and the caterpillars and eggs of numerous pest moths. Ladybirds feed on aphids, mealybugs, spider mites and the eggs of some beetle and borer agricultural pests.

Parasitoids live out most of their lifespan "attached" in some way to another insect or being, and ultimately kill their host. The *Braconidae* family, made up of over 1000 species of tiny wasps, represents only one of the many examples: these wasps feed on, reproduce in, and eventually kill some very harmful caterpillar pests that damage agricultural crops, such as hornworms. The female braconid wasp lays her eggs just under a hornworm's skin, rendering it unable to continue feeding and damaging crops. After the wasp eggs hatch, the juveniles feed on the living hornworm. When the juveniles are ready to become adults, they will chew their way out of the hornworm and spin cocoons that protrude from its body. Once the adult wasps emerge from their cocoons, the hornworm perishes.

A number of insects, including different types of bees, butterflies, wasps, and some ants, are responsible for pollinating plants around the world. They transport pollen from the male stamen of a flower to the female pistil of another flower on the same plant or another within the same species, allowing for the combination of genes, fertilisation, and sexual reproduction. Some plants, including at least one-third of the world's agricultural crops, and an estimated 90% of all flowering species, are reliant on pollinators. It is a mutually beneficial relationship that ensures the survival of both plants and insects. Plants rely on pollinators to ensure reproduction, fruit set, and seed dispersal. Pollinator insects rely on plants for food and habitat.

"Managing" the presence of insects should not be limited to those species we recognise as pests.
Photos: Don Rice / Laura Sanagorski.

Florida's citrus varieties, such as Mandarin and Pummelo Orange, are self-incompatible, meaning that they require cross-pollination. Bees are the most reliable, economical, and efficient method of pollination for these varieties.

A blanket application of a pesticide can actually make a pest infestation worse if it also kills the pest's natural enemies alongside the pest, as the absence of predators gives the pest an opportunity to re-infest a crop. But there are even greater risks, as farmers in the Chinese province of Sichuan have found out. The use of pesticides has led to a drastic reduction of naturally occurring insect pollinators, something that in turn has created the need for them to hand-pollinate their crops in order to achieve a satisfactory yield. It can cost a farmer eight times more to produce hand-pollinated fruit than insect-pollinated fruit. And it is difficult for farmers in this area to rent bee colonies for pollination as beekeepers are wary of relocating their bees due to the high use of pesticides in the vicinity.

The same fear is sometimes felt by producers and consumers in Florida, where bee populations are also threatened by the overuse and misuse of pesticides. Millions of bees died rapidly and mysteriously in September 2011. The cause was later found to be the misapplication of a pesticide commonly used around homes. Everyone is affected by the loss of pollinators; yet this is avoidable.

Managing habitats

While IPM practices can bring many benefits, "managing" the presence of insects should not be limited to those species we recognise as pests, nor to the (reduced) use of pesticides. Different species of flowering plants can be established among or close to crops to attract beneficial insects. The provision of plentiful nectar will attract beneficial insects and increase their lifespan and the number of offspring they produce. This means more pollinators, higher crop yields and more predator and parasitoid insects that help reduce the presence of pests. Even a simple patch of undisturbed land, allowed to remain in its natural state next to a cultivated field, can attract and nurture populations of beneficial insects of all types. There are many opportunities to protect and attract beneficial insects in agricultural operations, regardless of a farmer's location. It is our responsibility, as stewards of our planet, to participate in the sustainable management of pests and beneficial insects. In return for our stewardship, we can enjoy the assistance that beneficial insects afford our agricultural operations.

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More information

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