PEST MANAGEMENT NOTES *No. 9*

Growing coffee with IPM

A briefing for the *IPM in Developing Countries Project* funded by the European Commission *Environment in Developing Countries* budget (DGVIII)

This overview of Integrated Pest Management (IPM) of pests and diseases of coffee aims to introduce Commission officers, delegations and policy advisers to important considerations which can help to reduce pesticide use in this major crop.

Integrated Pest Management

IPM is an approach to pest management which aims to develop the right mix of control measures which are cost effective and safe for the farmer and consumer, but at the same time are ecologically sustainable. While IPM may include chemical control, it usually seeks to minimise or eliminate the use of pesticides because of their cost and the dangers they pose to the environment and human health.

Preparing a coffee agro-ecosystem analysis poster. Photo: Stephanie Williamson

Problems with chemical pesticides in coffee

Insect resistance

In some cases the application of broad spectrum insecticides can actually lead to an increase in pest levels, by killing off the beneficial insects (natural enemies) which normally keep pests in check. For example, a study in Brazil showed that applications of a relatively high dose of the organophosphate dicrotophos led to outbreaks of the coffee leaf miner caterpillar two months after spraying, due to drastic reduction in the activity of predatory wasps which feed on the pest.

Environmental hazards

Endosulfan is an organochlorine pesticide widely used against many insects. In coffee endosulfan is used for the control of the coffee berry borer (CBB), a serious beetle pest worldwide which reduces coffee parchment quality by boring into coffee berries and feeding on the developing bean. However the breakdown products of this chemical are very persistent and in some systems may remain in the environment for several months after its application. Endosulfan is also relatively poisonous to mammals, including humans, and very toxic to fish. On top of these problems, CBB has become resistant to endosulfan in New Caledonia (Pacific Ocean) where resistance levels of 500-100 fold have been detected.

The natural alternatives

IPM relies chiefly on natural control processes and other ecological methods such as cultural controls which conserve and complement the action of natural enemies. Natural enemies of coffee pests can effectively reduce pest populations, and biological control is the manipulation of natural enemy populations to do just that. There are three approaches to biological control which are covered in this briefing.

> *'Participatory farmer training in the choice and adaptation of biopesticides, cultural controls and selective insecticide application methods according to farm scale is an essential part of implementation"*

Biological control strategies

Classical biological control

Classical biological control is used against exotic pests that have been introduced to a new region leaving their natural enemies behind and as a result their numbers increase rapidly. The coffee mealy bug, *Planococcus kenyae,* was introduced to Kenya from Uganda in the early 1920's, and outbreaks of this pest occurred shortly afterwards. After several failed attempts at biological control using a predatory ladybird beetle from South Africa and a predatory bug from Italy, a parasitic wasp, *Anagyrus kivensis,* from Uganda was released in 1939. This parasitoid achieved good control of the mealybug by 1949.

There are other successes like this, but as the example also illustrates, history records its share of failures. A classical biological control programme requires that the climatic conditions and ecology of the agro-ecosystem are suitable for establishment of the imported species, and that any chemical control used is compatible with the introductions. Current coffee berry borer (CBB) IPM funded by the International Coffee Organization in Latin America, India and the Caribbean aims to combine the introduction of parasitic wasps from CBB's native range in East Africa with the use of biopesticides, effective cultural controls and selective insectide application, where necessary. Participatory farmer training in the choice and adaptation of these methods according to farm scale is an essential part of this implementation programme.

Conservation

The second strategy is the conservation of the natural enemies already present in the environment. In many systems the elimination of natural enemies results from using broad spectrum insecticides. Pesticides should be used only as a last resort when other controls have failed to achieve sufficient control: minimal, efficient and carefully targeted application is the main strategy for conserving natural enemies. Some insecticides are intrinsically less harmful to natural enemies than others; biopesticides such as *Bacillus thuringiensis,* a bacteria that produces a powerful but selective insect toxin, are often safer to natural enemies than many synthetic chemicals. The effects of pesticides on natural enemies can sometimes be much more subtle than direct mortality. For example, the application of fungicides for coffee leaf rust control may increase the population of scale insects, probably as a result of the destruction of the group of fungi that cause insect diseases, which, to some extent, keep the populations of this pest in check.

Chemicals can also be made to act more selectively by the way in which they are applied. A good example of this is stem treatment of coffee bushes against ants. Most ants are not a problem, in fact some are extremely important predators, but certain species, such as *Pheidole punctulata*, feed on the sugary waste that mealybugs excrete and so protect them from many of their natural enemies. Thus, ant control is an integral part of mealybug management. Ants can be effectively controlled by painting a band of insecticide (or a non-toxic insect glue), about 10cm wide around the lower part of the coffee stem. Ants foraging from the ground fail to cross this barrier as they pick up a lethal dose but predators that live in the leaf canopy and flying insects such as parasitic wasps are left almost completely unharmed.

Augmentation

The final biological control strategy is augmentation. This involves actively boosting the populations of native natural enemies that are already in the ecosystem, but are unable, for one reason or another, to prevent the pests from reaching levels that cause economic damage. In Colombia, for example, some coffee growers spray *Beauveria bassiana*, a fungus that infects and kills CBB as it bores into berries, onto their coffee trees to increase natural levels of this fungus in the environment.

Cultural control

There are several cultural control methods developed for specific pests. Much of the recent research on these techniques has been in relation to the key pest, coffee berry borer. Since CBB survival from one season to the next is in berries that have either dropped to the ground or been left on trees after harvest, one of the most effective ways to control this pest is to pick up and destroy any ripe, over-ripe or dry berries either on the ground or on the trees at the end of the season. Picking berries off the ground is very labour intensive, and therefore to keep berry drop to a minimum, mature berries should be harvested promptly, and care taken to avoid dropping the berries. If practical, the trees should be stripped completely bare of berries as soon as possible after harvest. Coffee growers must also be convinced of the economic benefit of investing in

Developing IPM Systems

An IPM programme can never be a prescriptive, 'off the shelf' package. A grower must look at all the options available to him or her and make an informed decision as to which measures to take. Because each farmer's situation is different, so the types of IPM measures they implement may vary between regions and often from farm to farm. Many factors influence the choices farmers make, for instance, the time and labour they are willing to expend, how much money they have available for pest management, or other priorities, such as the production of food crops to feed their families. A successful coffee IPM programme depends on:

1 farmers' sound knowledge of the agro-ecosystem and how this relates to pests, weeds and diseases

2 a practical approach to manipulating the cropping system to manage pests on a cost-effective and sustainable basis

3 willingness on the part of both farmers and researchers to experiment, modify and innovate

4 participatory training approaches in coffee extension services

5 promotion of non-chemical methods in coffee management

Discussing pest control methods at a coffee and vegetable Farmer Field School in Kenya.

the extra labour required in order to reduce CBB damage in the next season.

The use of clean (pest and disease free) seed at planting is an important strategy for controlling seedborne diseases, such as coffee wilt disease. Seed from disease free sources should always be used. Pruning of coffee trees increases the vigour of the plant by cutting away unproductive vegetation and opening up the leaf canopy. This allows more light to penetrate and air to circulate, thus reducing the humidity and temperature. These conditions are less favourable to many pests and diseases, for example, coffee berry disease and *Antestia* berry-sucking bugs. Kenyan farmers in a pilot coffee IPM training project observed higher parasitism rates of *Antestia* bugs in pruned, compared with unpruned, trees.

By growing a healthier, more robust coffee bush, farmers can increase the plant's ability to resist pest or disease attack, or help the plants to compensate for damage. Mulching with a suitable material, such as banana leaves or cut dried grass, may help to improve soil conditions by increasing soil fertility, conserving soil moisture, protecting the soil from compaction, and reducing soil acidity. A mulch may help to conserve the soil by reducing loss to surface run off water. Mulching can also have a direct effect on pest populations; it appears that populations of coffee thrips which thrive under hot, dry conditions are reduced in the cooler, humid conditions of a mulched soil. However, mulching may increase attack by leafminer pests, possibly because it provides a more favourable environment for the pest when it drops to the ground to build its pupal cocoon.

> *"In many systems the elimination of natural enemies results from using broad spectrum insecticides"*

Pest and disease resistant coffee varieties

The use of resistant varieties is a valuable IPM strategy, and cultivars resistant to various pests and diseases are now available: for example resistance to coffee berry disease was bred into 'Ruiru 11' variety, developed in Kenya. Most varieties resistant to coffee leaf rust disease are only resistant to one, or a few strains of the fungus, but a natural hybrid from Timor is resistant to all major strains of coffee leaf rust. This hybrid has been used in breeding programmes with 'Caturra' varieties in Brazil and Colombia to develop 'Catimor' varieties resistant to all major strains. These are now used in many countries to produce locally-adapted rust resistant cultivars.

Resistance is also considered an important strategy for coffee wilt disease although previously resistant varieties developed during the 1950's and 1960's are succumbing in the current East and Central African coffee wilt epidemic. Grafting is another valuable technique for the production of resistant plants, on a shorter timescale than growing from seed. 'Ruiru 11' cultivars may be grafted onto growers' existing root stock to confer coffee leaf rust resistance. *Arabica* coffee stems, which produce coffee of high quality, can be grafted onto

Key points

- Combined biological and cultural controls can successfully replace use of insecticides in coffee production, reducing use and maintaining yields
- Farmer-participatory IPM in coffee can significantly reduce risks to health and environment in smallholder coffee farming systems
- Donors supporting coffee programmes can encourage IPM options and farmer participatory training and discourage requests for pesticides

root stock of *Robusta* coffee which is resistant to the white stemborer (a serious wood-boring beetle pest in Africa), to produce a bush that is both resistant to the insect pest and yields a high quality product.

Weed control

A number of weed control strategies are available to smallholders. Cultural and mechanical controls include weed slashing, using a machete, and the use of a mulch or cover crop which can be effective for many grass weeds such as couch and star grass. Hoeing may be used in some systems, but it may increase soil erosion and is not recommended where coffee is grown on slopes. Broad-spectrum herbicides and blanket application techniques may also promote soil erosion by removing ground-cover.

While weeds may cause serious yield losses in coffee, removal of all non-crop vegetation can lead to serious soil degradation through disintegration of the soil structure and compaction of the soil, which in turn leads to poorer drainage, reduces aeration, and increases soil erosion. One option is to grow a cover crop under the coffee bushes. This gives plenty of ground cover, and can be very effective in smothering out a range of weeds. In South and Central America cover crops are often legumes, which have the added bonus of being able to fix nitrogen from the air in the soil though specialised bacteria that live on their roots, thus indirectly increasing the nitrogen content of the soil to the benefit of the coffee crop. Some species of legume, such as *Cassia spp* actually produce chemicals which prevent the germination of some weed seeds.

Selective weeding practices are directed at the most problematic weed types such as vines, grasses and tall broad leaved weeds, leaving less damaging species to provide ground cover, with little effect on yields. The problem weeds may be controlled either by slashing or by spot application of a herbicide. This approach has been tested in Nicaragua where training was provided to help farmers recognise the most damaging weed species.

Resources

Publications

Wrigley G, 'Coffee', *Tropical Agriculture Series*, Longman Scientific & Technical (co-published with John Wiley & Sons), New York, 1988.

Cambrony HR, 'Coffee growing', *The tropical Agriculturalist* Macmillan, London, 1992.

Contacts

CABI Bioscience UK Centre (Ascot), Silwood Park, Buckhurst Road, Ascot, Berks SL5 7TA, UK. Contact Peter Baker, Tel. +44 1491 829169, Fax +44 1491 829123, p.baker@cabi.org

Coffee Research Network (CORNET), coordinates research in East African coffee growing countries. Contact Sarah Simons, CABI Bioscience, PO Box 633, Village Market, Nairobi, Kenya. Tel +254 2 521450, Fax +254 2 522150, Email s.simons@cabi.org

Coffee Research Foundation, Joseph Kimenia, PO Box 4, Ruiru, Kenya. Tel +254 151 54027, Fax +254 151 54133.

National Coffee Research Centre, CEN\CAFE, Publicity Department, PO Box 2427, Manizales, Chinchiná, Colombia. Tel +968 506631 Fax +968 504723.

These notes have been compiled by Tony Little, IPM Information Officer, CABI Bioscience's Technical Support Group to the Global IPM Facility, which is funded by the Swiss Agency for Development & Cooperation (SDC).

PESTICIDE ACTION NETWORK *UK*

Growing Coffee with IPM, PMN No. 9, November 1998.
This briefing is one of a series prepared by Pesticide Action Network *UK* (PAN *UK*), which is responsible for its contents, as consultants to DGVIII of the EC. PAN *UK* is an independent charity working to reduce pesticide problems in developing countries. Its quarterly journal *Pesticides News* reports on pesticides and IPM.

Contact *Mark Davis, Barbara Dinham* or *Stephanie Williamson* at **Pesticide Action Network *UK***
Eurolink Centre, 49 Effra Road, London SW2 1BZ, UK
Tel +44 20 7274 8895 *Fax* +44 20 7274 9084
Email admin@pan-uk.org, *Website* www.pan-uk.org