TACTICS

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INTRODUCTION

Pest management tactics are the methods used to reduce economic loss caused by pest activities. The methods vary widely and depend on the product to be protected, its value, and the specific pest and natural enemy complex. The different types of tactics can be broken down into three major groups (1), but any given tactic may fall into several groups. The groups are:

1. Those that change the favorability or carrying capacity of the environment (=ecological management);
2. Those that decrease the reproductive capacity of the pest;
3. Those that decrease the survival of the pest within the environment.

Tactics from these groups are integrated as necessary to reduce damage to an acceptable level while providing the maximum benefits in terms of cost and ecosystem stability.

ECOLOGICAL MANAGEMENT

The focus in ecological management is to reduce pest problems by modifying the environment at critical points in the pest’s life cycle (1). For these techniques to be successful, a thorough understanding of the relationship between the pest and all potential hosts must be known. Example tactics include elimination of alternate hosts, removal or destruction of crop residues that are breeding or overwintering sites, tilling the soil to expose or bury a vulnerable stage of the pest, or use of trap crops to divert the pest away from the main commodity. In post-harvest situations and some urban situations, temperature extremes alone or in combination with high carbon dioxide or nitrogen, or low oxygen atmospheres are used to eliminate pests.

Ecological management also seeks to break up the spatial and chronological synchrony of the pest with its host (1). Reducing spatial continuity can be applied at both the single field level, where plant spacing or plant diversity is modified, or at the area-wide level, where the mosaic of crops planted within a large area is designed to prevent movement of pests from one favorable crop to another.

MANAGEMENT BY ALTERING REPRODUCTION

Chronological synchrony of the pest and its host can be broken up through the practices of crop rotation, crop fallowing, early harvest, or early or late planting (1). Crop rotation is most efficient when the pest reproduces before the crop is planted, if the pest has a narrow host range, and if the damaging stage is relatively immobile. When these conditions are met, rotation of the host crop with a non-host crop (or over a period of several years, several non-host crops) can effectively minimize pest damage. These techniques can also be used for veterinary pests by rotation of pastures or rotation of the type of animal kept in a particular pasture. For crop fallowing to be a good management practice, the fields need to be kept free of crop residue and weeds that might support the pest population. Fallowing may also require several years to reduce pest population levels, which limits its usefulness in many systems. Early harvest and early or late planting disrupt the synchrony of the pest with the susceptible stages of the host and can drastically reduce damage.

Methods to reduce the reproductive rate of the pest are becoming more common as our knowledge of pest biology and behavior increases. Examples include the sterile male technique, sex pheromone-based mating disruption to reduce or delay mating (2), attraction of one sex to a lure combined with pesticide (=male annihilation, attracticide), or the use of sub-lethal pathogens that reduce pest reproductive capacity (such as *Nosema locustae* for locust control). While each of these tactics has been used successfully in different systems, their applicability is generally restricted to a few systems. This is partly a result of...
their specificity, but also because these tactics are generally more effective on a large scale where the dispersal of pests from outside the treated area is minimized.

**MANAGEMENT BY ALTERING SURVIVAL**

Methods of reducing survivorship are probably the best-known ways to reduce pest populations. These include pesticides, use of natural enemies (= biological control), resistant cultivars (including transgenic insecticidal cultivars) (3), and irradiation for post-harvest situations. From a management perspective, pesticide use requires knowledge of the effect on both the pests and their natural enemies. Without this information, pesticides may cause instability in the production system by eliminating natural enemies, and in some cases, direct reproductive stimulation of the pest species (hormolygosis). Resistant cultivars may simply tolerate damage well enough that the general equilibrium position of the pest is below the economic threshold or they may reduce pest survivorship or reproduction (particularly when using transgenic insecticidal cultivars).

The conservation and augmentation of natural enemies is the core of many management strategies. In pesticide-dominated systems, natural enemies can be conserved by using selective pesticides, or by changing their dose, formulation, application time, or location of application. Conservation can also be achieved by cultivating plants near the fields to provide nectar or alternate hosts during times when the main pest is at low numbers or not present (4). Augmentation is when natural enemy populations are increased by releasing laboratory-reared individuals. In many cases, the augmentation tactic uses the natural enemies as a “biotic pesticide” where direct mortality is expected within a short period, but the natural enemy is not expected to persist in the environment. Examples of this include the use of *Bacillus thuringensis* and other non-persistent disease organisms (such as nematodes, viruses, or fungi), or mass release of *Trichogramma* egg parasitoids for caterpillar control.

The final area of natural enemy use is classical biological control. This is generally used when an exotic pest is introduced into an area without natural enemies (5). Natural enemies are imported into the new system to permanently establish the natural enemy and reduce the pest population level to sub-economic status. However, the degree of control can be variable depending on a broad range of factors including the geographic distribution of the pest, the searching ability of the natural enemy, different host plants, and the effect of other natural enemies already present in the system.

The diversity of pests and the systems they occur in have spawned a large number of potential tactics. For these tactics to reduce pest damage to sub-economic levels, in most systems they must be carefully integrated with a thorough understanding of the relationship between the pest and the crop (or animal) system to be protected. Ideally, proper integration results in a sustainable system that is economically viable and that requires few alterations unless new pests are accidentally introduced into the production system.

**REFERENCES**