Entomology, Ornithology & Herpetology: Current Research

Tremateterra, Entomol Ornithol Herpetol 2016, 5:2
DOI: 10.4172/2161-0983.1000e117

Editorial Open Access

# Remarks on Integrated Pest Management in Food Chain

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A team of authors has published a review paper on the European Union's eight principles of Integrated Pest Management (IPM) [1]. The paper provides researchers, advisers and farmers with an approach for applying these legal requirements intelligently to promote local innovation while reducing reliance on pesticides and associated risks. The process envisioned therefore requires learning, adaptation, and tweaking of a number of farm management practices. It also requires attention to non-technical aspects such as the social environment in which farmers operate collective learning and farmer's inclination for step-wise rather than drastic changes.

Also the food industry has been moving away from structural fumigations and calendar-based chemical pesticide applications towards IPM. This shift has been driven by the loss of pesticides such as methyl bromide, consumer demand for reduced pesticide usage, and development of 'precision-application' technologies and pest guidelines. These somewhat antagonistic trends (less reliance on and use of pesticides, and the demand for perfect food products) highlight one of the main challenges faced by the food industry.

Food facilities typically are large, complex structures with many locations vulnerable to insect infestation. They differ from each other in function, commodity, product generated, structure type, equipment, geographic location and surrounding landscape, as well as other factors. This makes generalizations about pest management difficult.

The pest situation must be characterised for a given place, and an IPM programme should be both tailored to a specific location and flexible enough to deal with changing conditions. Although pest management is part of a food facility's prerequisite programme, in many cases it can be implemented more effectively. An important component of pest management is insect monitoring. Using insect monitoring and decision-making tools such as economic thresholds, predictive models and expert systems to determine the best time to suppress pest populations, economic losses due to insects and unnecessary pest management expenses can be avoided.

Early detection of pest infestation is an essential component of successful pest management programmes. In general, effective monitoring requires a combination of trap strategies, but because individual traps are only point sources of information there is great interest in methods that can predict the extent of infestation throughout a storage facility. Computer simulation models can be used to compare the effectiveness of different pest management methods, alone or in combination, for stored-product insects. According to Campbell [2] and Trematerra [3] these models can also be used to evaluate the effectiveness of different implementation options, and to optimise the timing of pest management programmes.

Full implementation of the IPM approach requires more effort than other types of control programmes, but once in place, it can be used to make more reliable pest management decisions. Unfortunately, many of the trials recorded have been under laboratory conditions, so there is limited information on their integration under field practical situations.

A successful pest manager understands: - food facility structure and operations; - the taxonomy, behaviour, ecology, and biology of pest species; - the effective use of monitoring and management tools. The ecology of stored-product insects, and thus, the insect pest management programme required are likely unique for each chain, for each location in the marketing system, and for each time those insect pests are managed. Area-wide pest management can be important in reducing the overall numbers of insect pests in the marketing system and eventually lowering the cost of these programmes. Implementation of a pest management programme requires good cooperation between people who work for the food processing company and those who work for the pest control operators.

Many of the components of an IPM programme are known and are available for use, but our understanding of how to optimally integrate and target these tactics as part of an IPM is limited. Adoption has also been obstruct by a poor understanding of pest populations in the spatially-and temporally-complex environments where food is processed and stored, the difficulty of evaluating pest populations, and finally by the limited information on field efficacy and how to optimally select and combine management tools.

Treatment thresholds and economic injury levels have not been established for practical situations, and standards and rejection criteria are difficult to apply. In current practice, many locations still rely on calendar-based pesticide applications and have little understanding of the basis of IPM. This attitude is changing, but for reasons already discussed pest management of stored-product insects in facilities storing and processing food has some unique challenges compared to pre-harvest IPM. The combination of frequent and unpredictable pest population fluctuations (due to rapid turn-over of food products or the ephemeral nature of food storage systems) and the inconsistent relationship between trap data and pest population densities are the main reasons why IPM approaches are rarely implemented in food chain systems. There are also serious research gaps impeding the acceptance and implementation of IPM programmes in food facilities. These involve the development of improved sampling programmes and more sophisticated action thresholds. Finally, there is a great need for conversion of IPM research into user-friendly decision support tools that have been developed and validated in practical situations [4].

On the part of the food industry to move away from calendar-based pesticide treatments to a more integrated approach often there is reluctance or lack of interest. This is due, in large part, to a justifiable concern about making mistakes with pest control in an industry with an extremely low pest threshold.

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**Received** March 22, 2016; **Accepted** March 28, 2016; **Published** March 31, 2016

**Citation:** Trematerra P (2016) Remarks on Integrated Pest Management in Food Chain. Entomol Ornithol Herpetol 5: e117. doi:10.4172/2161-0983.1000e117

The artificial nature of food chain environments and low tolerance in many situations for the presence of insects, means IPM relies less on promoting population regulation using natural enemies and puts greater focus on modifying the environment to make it less favourable for pest establishment and persistence [5,6].

Integrating and combining different management tools and careful selection and timing of different approaches, together with an understanding of pest behaviour and ecology can result in greater effectiveness. For example, heat combined with diatomaceous earth effectively reduced the temperatures necessary to kill stored-product insects [7]. In another test, high temperatures typically attained during a heat treatment had no negative effects on contact insecticides such as hydro prene and cyfluthrin WP, and may have even enhanced toxicity of the former [8]. Autoinoculation releases using food and pheromone baits to attract insects that pick up the pathogen and then disseminate it through the environment have been explored [9]. To control stored-product beetles synergistic interactions have been achieved by combining *Beauveria bassiana* and *Metarhizium anisopliae* with desiccant dusts [10-12]. The efficacy of diatomaceous earth and spinosad in wheat was reported by Kavallieratos et al. [11]. Sex pheromones for *Ephestia cautella*, *E. kuehniella*, *Plodia interpunctella*, *Lasioderma serricorne*, *Trogoderma granarium* and *T. variabile*, and aggregation pheromones for *Tribolium castaneum* and *T. confusum* are incorporated into natural food attractant oils [13]. Using single multiple pheromone trap will reduce the material land labour costs of maintaining a pest surveillance programme. Research should optimise and develop other attractants and repellents (semiochemicals) to aid in the monitoring and control of some stored-product insects and to provide new tools. In this regard, future stored-product protection combinations of repellents and attractants may also be used in push-pull tactics [6]. Recently, combined action of mating disruption and parasitoid activity *Habrobracon hebetor* against *P. interpunctella* in a chocolate factory was reported by Trematerra et al. [14].

## Discussion

DIRECTIVE 2009/128/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 October 2009 establishing a framework for Community action to achieve the sustainable use of pesticides.

In Article 1 this Directive establishes a framework to achieve a sustainable use of pesticides by reducing the risks and impacts of pesticide use on human health and the environment and promoting the use of integrated pest management and of alternative approaches or techniques such as non-chemical alternatives to pesticides.

In Article 14 report that Member States shall take all necessary measures to promote low pesticide-input pest management, giving wherever possible priority to non-chemical methods, so that professional users of pesticides switch to practices and products with the lowest risk to human health and the environment among those available for the same pest problem. Low pesticide-input pest management includes integrated pest management as well as organic farming according to Council Regulation (EC) No 834/2007 of 28 June 2007 on organic production and labelling of organic products.

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