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Floral Attractants Based Pest Management Strategy

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SUMMARY

The evolution of plants and insects is evidenced by the close connection between their floral volatile organic compounds and the ability of insects to detect and respond to the chemicals produced by plants. Flower constancy and insect associative learning increase the chance that an insect will carry the plant's genetic material to a conspecific (Schoonhoven et al., 2005). Herbivorous insects recognize a suitable host for feasting and oviposition through chemical cues. Furthermore, the specific combination and ratios of compounds in the volatile blend play an important role in herbivorous insects locating the host even when the host is among other plants. Identification of behaviourally active volatile molecules from the insect's host that cause attraction could aid in behavioral research in the lab and the field, allowing for a better understanding of plant-insect interactions and the development of effective monitoring and control measures.

INTRODUCTION

The link between insect associative learning and flower constancy is also evidenced by the large crossover in volatile production by insects. In 2010, Schiesti showed that out of the 71 commonly used floral volatiles, 83% were produced by insects and used in their insect-insect communication. This suggests that plants are using these volatile compounds to recruit insects and develop new communication methods. The concept of keeping an insect away from an area where it's not wanted or encouraged to enter is a compelling one. This allows us to use non-toxic chemicals to attract and keep beneficial insects away from crops. Sex pheromones are among the many types of semiochemicals that are being studied for their use as crop protection tools. Although sex pheromones can be used to protect crops from pests and diseases, they tend to attract only male insects. It's an issue since it is the larval stage that causes damage, and a larva's location is decided by the female parent. Floral volatile organic compounds serve as an attractant for pollinators as well as phytophagous insect pests. Specific attractants from flowers are identified and used to attract and trap both sexes of insect pests, thus reducing the population leading to yield enhancement of crops.

Floral volatiles

The flowering parts of a plant emit a wide array of volatiles that make up the floral odour of that plant. Currently, over 1700 compounds have been identified with the most common occurring in more than 50% of families examined so far. These common compounds are a selection of monoterpenes (limonene, (E)-beta-ocimene, myrcene, linalool, pinene) and benzenoids (benzaldehyde, Methyl salicylate, benzyl alcohol, and 2-phenyl ethanol) (Knudsen *et al*., 2006). Insects are sensitive to even minor components and may use these as well as major components to identify resources.

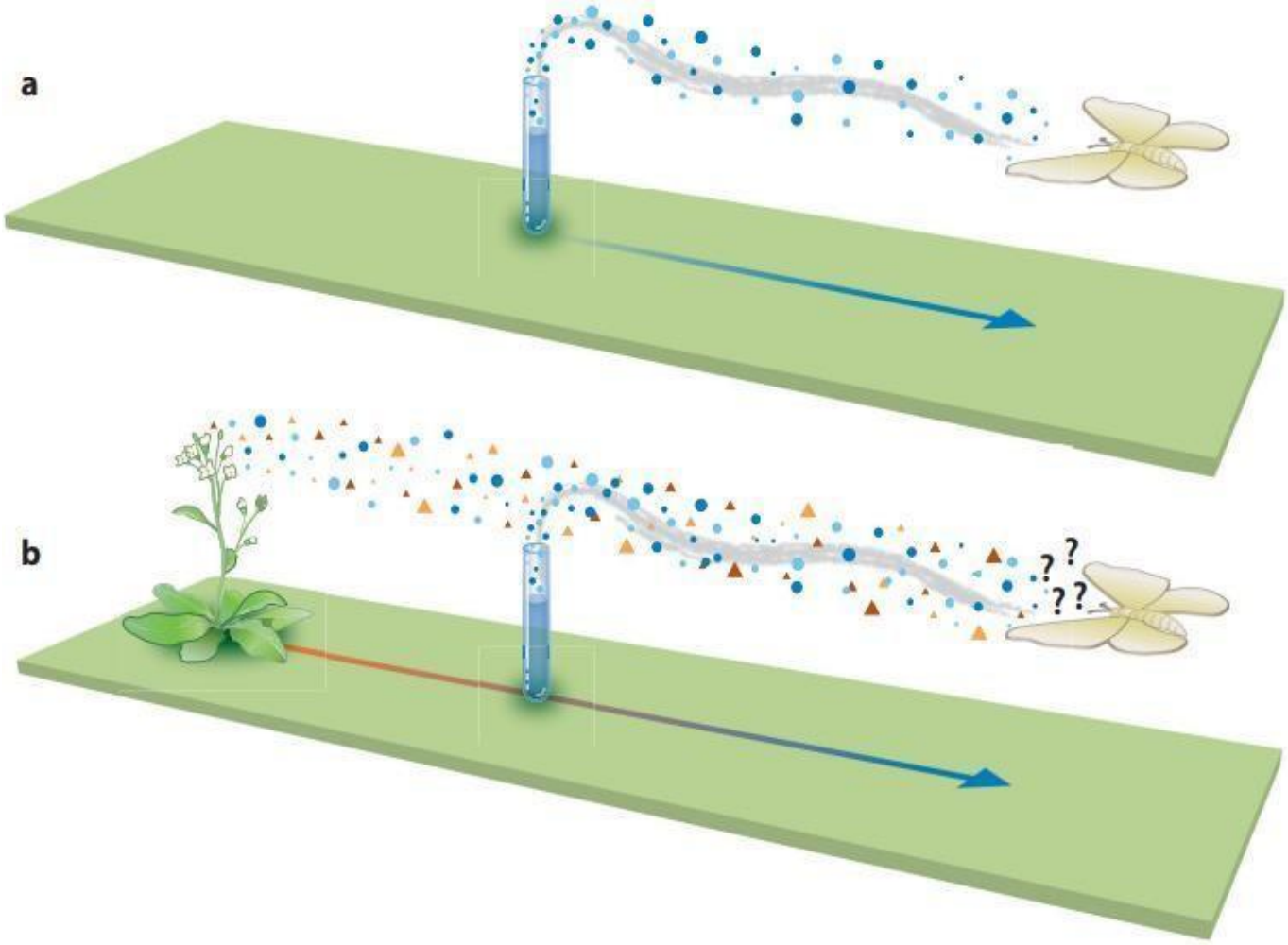
Origin of floral volatiles and floral attractants

Floral emissions primarily emanate from the petals (Raguso and Pichersky,1995; Rohrbeck *et al*., 2006), secondarily from other floral organs like pistils and sepals (Mactavish and Menary, 1997). Chemicals that cause insects to make oriented movements towards the floral source are floral attractants. Floral attractants are effective, less specific attractants that would be an important adjunct to an integrated control program (Donaldson *et al.*,1990). Moths oviposit on a particular plant but select a broad range of flowering plants for feeding (Meagher and Landolt, 2008). Both male and female adult moths feed on nectar sources and so floral baits advantageously attract both sexes.

Need for Floral attractants in insect pest management

The idea of using floral volatiles to control insect pest behavior and protect crops has been around since the 1960s when developments in technology allowed scientists to record the sensitivity of insect antennae to specific plant volatiles (Schneider, 1957; Moorhouse *et al*., 1969). However, since then the number of products

based on floral volatile remains small. As more and more pesticides are withdrawn from the market due to concerns over ecological damage, novel methods of protecting the crops are required. Utilizing the innate behaviors of insects towards compounds found naturally in the environment has inherent benefits in terms of environmental safety and reduced chances of development of resistance. However, other hurdles must be overcome. The first and most obvious hurdle is identifying the correct chemical(s) to stimulate the desired behavior in the target insect. If more than one compound is present in the odor , it must be optimized to ensure that the chemicals are in the most effective ratio.



Advantages of floral attractants

Detection of floral attractant components from the host plants which attract the insects aid to explore behavioral studies both in the laboratory as well as in the field for a better understanding of plant-insect interaction and to develop efficient monitoring and control strategies. This technique aids in the reduction of foliar-applied insecticides for larval control. Floral attractants can be used in mass trapping as well as in long-term pest management. It can be used to manage endophytic insect pests like *Tuta absoluta*. Targeting females, as well as males, offers the potential for direct impacts on the numbers in the next generation, since every time a female is removed from the population, her potential fecundity is lost as well. The capture of female moths in great numbers could lead to a faster reduction in the number of larvae. An advantage of attract-and-kill is the restriction or elimination of contact between a toxicant and the crop, beneficial organisms, or the environment (Del Socorro *et al.*, 2018). Female insects can be removed before mating or oviposition and also floral attractants Provide information on the abundance of females.

Disadvantages of floral attractants

Since floral volatiles attract both pollinators as well as insect pests, pollinators shall be diverted from getting trapped. Captures of non-target Hymenoptera can be reduced by trap type and colour (Meagher & Mitchell, 1999; Clare *et al*., 2000). Semiochemicals that repel bees, such as methyl salicylate (applied to apple blossoms; Mayer, 1997), mixtures of methyl salicylate and benzyl alcohol, or of dibutyl amine and benzyl benzoate (Henning *et al*., 1992; Sahebzadeh *et al*., 2009) could be added to phenylacetaldehyde baits to discourage foraging bees from entering traps.

Hurdles behind developing floral attractants

Costs and delays associated with registration can be a significant impediment to the development of sprayable attract-and-kill products. When it comes to specific insect species and crop host ranges, as well as competing technologies like traditional pesticides and transgenic crops, markets for attract-and-kill solutions may be too limited. For these reasons, we only know of two sprayable formulations that have been registered: Magnet in Australia for *Helicoverpa* spp., and Bio-Attract Heli in South Africa, which is based on formulations developed by US Department of Agriculture researchers. Following its exemption from tolerance requirements, the pear ester ethyl- (E, Z)-2,4-decadienoate has been registered for the codling moth in the United States. Though it is appealing to adult insects, registration is intended to be used as a larvicide adjuvant rather than an attract-and-kill kairomone. Successes in identifying and developing strong bisexual kairomonal attractants for key crop pests like the codling moth, Mediterranean fruit fly, and dried fruit beetle, among others, are paving the way for the development of attract-and-kill products that target the removal of females of pest species. Harmonization of regulatory standards across nations, as well as modifications to registration procedures, might help in reducing the hurdles in developing floral attractant-based commercial products. Early interaction with business partners and regulators, as well as a willingness to challenge mainstream thinking, are critical for researchers. The attributes that will be necessary for technology developers include forethought, patience, smart marketing, and knowledge about the requirements of farmers.

CONCLUSION

Attract-and-kill has considerable potential as a tactic in integrated pest management. Volatile compounds from flowers are found promising in attracting females and have been used in traps for pest monitoring and control. Unlike sex pheromones, floral attractants can be used to trap both sexes of insects. The active compound identified by floral volatile analysis can be used as a pest monitoring and management tool compatible with the IPM program. Floral attractants are found effective in many insect species in the order Lepidoptera, Coleoptera, Thysanoptera, Diptera, and Hemiptera. The requirement for a novel method for crop protection is increasing since numbers of pesticides have been withdrawn from the market due to concerns over ecological safety. Floral attractants may have direct impacts on pest populations since it particularly targets female insects. Floral attractants that attract both sexes can be suitable alternatives to hazardous pesticides.

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