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Push Pull Strategy of Integrated Pest Management

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Introduction

To date, many pest management approaches have been developed that rely on enhanced cultural practises, reduced fertiliser application, and chemical inputs. However, due to the low economics of subsistence farming, weather conditions are always unclear, with irregular rainfall patterns, making farmers hesitant to invest in high-cost crop production technology, which could result in crop failure without the necessary profits. As a result, modern pest management practises have shifted away from pesticides in favour of environmentally benign alternatives.

Behavioural manipulation is solely based on communication disruption techniques which interferes with the common habit of principal pests so that their ill effects on crop production can be minimised.It involves the use of natural and/or artificial signals like pheromones, kairomones and planting of trap crops etc. Push pull strategy is one such method that focuses on behavioural manipulation of pest in favour of mankind.

Pyke and colleagues in Australia coined the term push-pull as an insect pest management (IPM) method in 1987. They looked into using a combination of repellent and appealing stimuli to manipulate the distribution of Helicoverpa spp. in cotton, minimising the need for insecticides, to which the moths were becoming resistant to.

Principles of push-pull strategy

Push-pull tactics are used to manipulate the behaviour of insect pests and their natural enemies by combining cues that work to make protected resources undesirable to pests (push) while drawing them towards an appealing source (pull). As a result, the tactics include a two-pronged system of direct insect migration and influence their distribution and abundance (push-pull).

- Pests are pushed away from the main crop by stimuli that disguise host appearance or are repulsive or deterrent.

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- The pests are simultaneously attracted (pull), using highly apparent and attractive stimuli, to other areas such as traps or trap crops where they are concentrated, facilitating their elimination.

The principles of the push-pull strategy are to maximize control efficacy, efficiency, sustainability, and output, while minimizing negative environmental effects.

Components

- Push components: Push components are there to makeprotected resourcesdifficult to find, unappealing, or undesirable for the pest.
- Pull components: In pull components, attractive stimuli are used to divert pests from the protected resource to a trap or trap crop.

Stimuli

1. **Stimuli for Push Components**

The stimuli that can be employed as push components are listed and discussed in this section. The stimuli are divided into the following categories.

A. **Visual Clues:** In IPM, manipulating the colour, shape, or size of the host to prevent pests from orienting to it and accepting it.

B. **Repellent:** Chemicals like MNDA and DEET, which are intended to keep pests away, are commercially available and can be used in push-pull tactics to control cockroaches and invasive lady beetles.

C. **Non host Volatile:** Non host volatiles can be employed to obscure host odors or to elicit nonhost avoidance and repellence. Citronella and eucalyptus essential oils are commercially produced as insect repellents against hematophagous insects.

D. **Host-Derived Semio Chemicals:** The word comes from the Greek word "semeon," which meaning "sign" or "signal." Semiochemicals (chemicals present in certain ratios) are used by insects to find a mate, a host, or food.

E. **Antifeedants:** Plants create organic chemicals that protect them against insect attack, like-azadirachtin.

F. **Alarm pheromones:** When attacked by natural enemies, several insect species produce alarm pheromones, causing conspecific to avoid or disperse. (E)-β-

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farnesene (Eβf) is the alarm pheromone for numerous pest aphids. It can be used to repel aphids in the field by spraying it on the main crop.

2. **Stimuli for Pull Components**

The stimuli that can be employed as pull components are listed and discussed in this section. They're organised in the same way that the push stimuli were in the previous section.

A. **Visual stimulants:** Visual stimuli are rarely employed alone to lure pests to traps or trap crops, but they can help olfactory stimuli work better.

B. **Host Volatiles-Baits/HIPVs, Kairomones-Plant volatiles:** Plants discharge metabolites into the atmosphere. In attractancies tactics, host volatiles can be utilised to bait traps for monitoring, mass-trapping, and monitoring.

C. **Sex and aggregation pheromones:** To attract conspecifics for mating and to optimise resource usage, insects produce sex and aggregation pheromones. These pheromones are used to bait traps.

D. **Gustatory and oviposition stimulants:** Natural oviposition or gustatory stimulants in trap crops may aid to keep insect populations in the trap crop area.

Case studies

1. **Management of the stem borer pests of cereals in Africa**

One of the most rewarding push pull strategies has been developed in East Africa to protect the maize and sorghum crop from borer pests. These two principal crops are under the attack of lepidopteron pest namely Maize stalk borer *Busseolafusca*, Spotted stem borer *Chilopartellus*, African sugarcane borer *Eldana saccharina* etc. Stem borers are repelled from the crops by planting repellent nonhost intercrops like molasses grass(*Melinisminutiflora*), silverleaf desmodium(*Desmodium uncinatum*) or green leaf desmodium (*Desmodiumintortum*) which act as the “push”. They are then concentrated on trap crops like Napier grass(*Pennisetum purpureum*) or Sudan grass (*Sorghumvulgare sudanense)*-the “pull" component.

Additional advantages:

a. The volatiles from molasses enhanced parasitism by *Cotesiasesamiae* whereas those from desmodium suppressed the African witchweed (*Striga hermonthica*).

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b. The trap crops of Sudan grass also increased the efficiency of stem borer natural enemies,3)Gummy exudates of Napier produced upon feeding by the first and second instar larvae restricts larval development allowing only few to survive.

2. Management of *Helicoverpa*in cotton

Push pull strategy is now used to control the polyphagous lepidopteran pest *Helicoverpaarmigera* and *Helicoverpapunctigera* attacking cotton in Australia. Neem seed extracts are applied to the cotton crop (push) and alongside an attractive trap crop of either pigeon pea (*Cajanus cajan*) or maize (Zea mays) is planted (pull).Field trials have shown the efficacy of this approach which is far more than the individual component alone.

3. Management of Colorado potato beetle in potatoes

Leptinotarsa decemlineata, Colorado potato beetle is attracted to host plant volatiles and early planted potato trap crop sprayed with an attractant. In the field, rows treated with the attractant (pull) is sandwiched between rows treated with antifeedant neem (push).The strategy can be further enhanced by employing Colorado beetle aggregation pheromone (S)-3,7-dimethyl-2-oxo-6-octene-1,3-diol that has proved its efficacy in the field.

4. Pea leaf weevil management in beans

Sitonalineatus, pea leaf weevil is a pest of legumes in Europe, the Middle East and United States. Synthetic aggregation pheromone 4-methyl-3,5-heptanedione acted as pull and commercially available neem antifeedant formed the push component of the strategy. Neem reduced weevil abundance satisfactorily. Just to maintain the efficacy repeated application was needed. Speedy removal of the aggregated weevil population must be done to prevent them from redistributing in the main crop.

5. Management of the pollen beetle in oilseed rape

Springsown plots of Oilseed rape (*Brassica napus*) is attacked by the pollen beetle, *Meligethes aeneus*. Turnip rape (*Brassica rapa*) is planted along the periphery as the pull stimuli.As a push component nonhost plant volatiles of lavender (*Lavandula angustifolia*) repels *M.aeneus* from the target crop. Oilseed rape of low proportion of alkenyl glucosinolates (the main attractant of such pest) is used as the main crop so as to lure lesser amount of pest.

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6. **Onion maggot management**

Delia antiqua is an important pest of onion in Canada, Europe and the United States which is being managed using this strategy. Potted onion culls (small unmarketable bulbs) act as a trap crop to divert oviposition of these flies in the main crop. Cinnamaldehyde, a promising oviposition deterrent forms the push stimuli. Significant reduction in fly population can be noticed combining the above two components as push pull strategy.

Advantages and disadvantages of push-pull strategies

Advantages

Push-pull tactics have a number of advantages over traditional pest management methods. Those are like:

- Attract both juveniles and adult stages
- Simple, commercially available and cheap components
- Increased efficiency of individual push and pull components: population reducing
- Improved potential for use of antifeedants and oviposition deterrents
- Resistance management

Disadvantages

The use of push-pull strategies has some disadvantages over conventional pest control regimes. These disadvantages are common to mostly all alternative pest control strategies.

- Limited specificity
- Less effective to complete with abundant surrounding odor sources for attraction
- Limitation to development:
  - Understanding the behavioral and chemical ecology of the host pest
  - Insufficient knowledge, control break down
  - Development of semi-chemical component
- Limitation to adoption
  - Integrated approach to pest control, more complex
  - Requiring monitoring and decision system
  - More insecticide and less knowledge of biological control agent

Conclusion

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The push-pull strategy has the potential to improve small farmers' lives, as well as agricultural productivity and environmental sustainability. The development of a dependable, resilient, and long-term push-pull approach necessitates a thorough scientific understanding of the pest's biology as well as the behavioural/chemical ecology of its interactions with hosts, conspecifics, and natural enemies. Each technique has a different combination of components depending on the pests to be managed (specificity, sensory abilities, and movement) and the resource to be protected. The most successful example of the push-pull approach now being utilised by farmers was created in Africa for controlling stem borers on cereal crops, among several push-pull strategies in development or in application for insect pest control. This method was created utilising technologies that are acceptable for poor farmers, and it has demonstrated a high rate of adoption and spontaneous technology transfer among farmers, resulting in a major impact on food security in the region through enhanced agricultural productivity. More of these models should be produced in order to be widely adopted by farmers in various areas. We should work on developing tools for quality control of the performance of new push and pull components, improving understanding of soil nutrient dynamics in long-term push-pull fields, and studying and solving emerging problems for the long-term sustainability of the push-pull system and its placement on a strong scientific foundation. Understanding how plants interact with insects can lead to new strategies to exploit plant defences. Understanding the chemical ecology of plant-insect interactions through a combination of analytical, chemical, neurophysiological, and behavioural studies can lead to practical advances that can aid poor farmers.

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