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Revisiting Trap Crops: A Look Back at Their Concept and Evolution Over the Past Decade

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Trap cropping is an integral part of integrated pest management, manipulating habitats to control pests without heavy pesticide use. It involves planting attractive crops to divert pests from the main crop. Various modalities exist, including conventional trap cropping, dead-end trap cropping, and genetically engineered trap cropping. Other approaches include perimeter, sequential, multiple, and push-pull trap cropping. Success depends on factors like crop characteristics, pest behavior, and environmental conditions. While trap cropping can reduce pesticide use and cultivation costs, its success is variable and requires careful planning and monitoring. Despite challenges, trap cropping remains a valuable tool for sustainable pest management, with ongoing research exploring new opportunities, especially with advancements in biotechnology.

Introduction

Various methods alter the habitat as a part of an integrated pest management (IPM) strategy, and such manipulation can occur either within a crop, a farm, or at a landscape level (Landis *et al*.,2000). The concept of trap cropping fits into the ecological framework of habitat manipulation of an agro-ecosystem for the purpose of pest management. Prior to the introduction of modern synthetic insecticides, trap cropping was a common method of pest control for several cropping systems. Then resurgence of interest in trap cropping is due to concerns about negative effects of pesticides on human health and the environment.

Trap crops have been defined as "plant stands grown to attract insects or other organisms like nematodes to protect target crops from pest attack, preventing the pests from reaching the crop or concentrating them in a certain part of the field where they can be economically destroyed" (Hokkanen,1989).

Modalities of Trap Cropping

A. Modalities Based on the Trap Crop Plant Characteristics

1. Conventional Trap Cropping: A trap crop planted next to a higher value crop is naturally more attractive to a pest as either a food source or oviposition site than the main crop.
Manjunath *et al*. (1970) reported that African yellow flowers-marigold attracted *Helicoverpa armigera* for deposition of eggs when intercropped with tomato. Shivayogeshwara *et al*. (2001) reported marigold as trap crop for management of *H. armigera* in tobacco showing lowest foliage loss. They also found that single-whorled orange flower trapped higher number of eggs of *H. armigera* than multi-whorled flowers. Godfrey and Leigh (1994) reported use of alfalfa as a trap crop for lygus bugs in cotton. Growing squash as a trap crop surrounding tomato could be useful for cultural manipulation in managing the silver leaf whitefly, *Bemisia tabaci* and tomato yellow leaf curl virus (Schuster, 2004). Tillman and Mullin (2004) concluded that grain sorghum could serve as an effective trap crop for *H. zea*

in cotton. Sureja (1978) reported castor as a suitable trap crop for ovipositing females of *Spodoptera litura* in different types of tobacco. Chari *et al*. (1985) found that growing castor around tobacco nursery proved an ovipositional trap crop for *S. litura*.

2. Dead-End Trap Cropping: Plants that are highly attractive to insects but on which they or their offspring cannot survive. Such crops serve as a sink for pests, preventing their movement from the trap crop to the main crop. Lu *et al.* (2004) found that the potential of the wild crucifer, *Barbarea vulgaris* serve as a dead-end trap crop for the diamondback moth, *Plutella xylostella*.

3. Genetically Engineered Trap Cropping: Genetically modified plants with improved quality were used to serve as trap crop. Mitchell *et al*. (2000) reported that planting genetically modified collards along field peripheries as a trap crop may be a promising tactic to manage the diamondback moth in commercial cabbage.

B. Modalities Based on the Deployment of the Trap Crop

1. Perimeter Trap Cropping: The use of a trap crop planted around the border of the main crop. Rao *et al*. (1994) reported that raising two rows of *Nicotiana rustica* around flue-cured tobacco was effective against *H. armigera*. Kumari and Pasalu (2003) showed effect of trap crop on the main crop in terms of ovipositional preference, dead hearts (%), white ears (%) and yield in rice.

2. Sequential Trap Cropping: Trap crops that are planted earlier and / or later than the main crop to attract the targeted insect pest. Hoy *et al*. (2000) reported use of an early-season trap crop of potatoes to manage Colorado potato beetles.

3. Multiple Trap Cropping: It involves planting several plant species simultaneously as trap crops with the purpose of either managing several insect pests at the same time or enhancing the control of one insect pest by combining plants whose growth stages enhance attractiveness to the pest at different times. Muthiah (2003) reported the use of a mixture of castor, millet, and soyabean to control groundnut leafminer, *Aproarema medicella*.

4. Push-Pull Trap Cropping: The push-pull or stimulo-deterrent diversion strategy is based on a combination of pull and push components. The trap crop (Pull component) attracts the insect pest and combined with the repellant intercrop (Push component), diverts the insect pest away from the main crop. A push pull strategy based on using either Napier or Sudan grass as a trap crop planted around the main crop, and either desmodium or molasses grass planted within the field as a repellent intercrop, has greatly increased the effectiveness of trap cropping for stem borers in maize (Khan *et al*., 2001).

C. Additional Trap Cropping Modalites

1. Biological Control-Assisted Trap Cropping: A part from diverting the insect pests away from the main crop, trap crops can also reduce insect pest populations by enhancing populations of natural enemies. Khan *et al*. (1997) also reported higher parasitism of stem borers by *Cotesia seasamea* in maize when intercropped with molasses grass. Similar results were obtained by Virk *et al*. (2004) when sorghum was used as trap crop in cotton. Patel (2005) revealed that African marigold grown on either sides of five rows of tomato attracted *H. armigera* moths for oviposition and also egg parasitoid *T. chilonis* and *T. achaeae*.

2. Semiochemically Assisted Trap Cropping: They are either trap crops whose attractiveness is enhanced by the application of semiochemicals or regular crops that can act as trap crops after the application of semiochemicals. Nesnerova et *al*. (2004) demonstrated that semi synthetic pheromone formulation attracted males of *M. brassicae* even at low population densities.

Applications of Trap Cropping In Pest Management

Success of trap crop concept in preliminary laboratory, greenhouses, screen houses, or field studies may not necessarily result in a successful use at the commercial level, where additional variables and different environmental conditions may affect insect behavior. Adoption of trap cropping was also dependant on the potential economic return to the grower in a particular situation which is the same in 2024 as well (Shelton and Badenes-Perez, 2006).

Increasing The Effectiveness Of Trap Crops

1) By combining with biological and / or insecticidal control, and / or cultural method.
2) By exploiting specific characteristics of the plants which are used as a trap crop, and host preference of the target insect can be changed with reference to time (seasons) and space (cropping pattern).
3) Plant breeding can be used to develop trap crop cultivars with enhanced attractiveness to the insect pest.

These strategies made a decade ago are the pavements for today's innovative research on trap crop for pest management.

Factors determining the success of Trap Cropping Systems

1) Interaction of the characteristics of the trap crop and its deployment with the ecology and behaviour of the targeted insect pest.
2) Combination of insect and trap crop characteristics and practical considerations.
3) Management of the insect stage targeted, ability of insect to direct its movement as well as its migratory and host finding behaviour.
4) Low proportions of trap crop in a field may not be sufficient to reduce pest populations significantly, even if the trap crop is highly attractive and results in insect arrestment.

Pros:

1) Reduces the use of pesticide.
2) Lower cultivation cost.
3) Preservations of indigenous natural enemies.
4) Improvement of the crop's quality and quantity.
5) Conservation of soil and environment.

Cons:

1) In many cases, crops are attacked by a complex of insect pests and because trap crops tend to be relatively species specific, they are less frequently used compared with other alternative IPM strategies.
2) Agronomic and logistical considerations are associated with implementing trap crops.
3) The success of trap cropping is variable and may increase the risk of economic loss of the grower.
4) Trap cropping is knowledge-intensive and demands information on the temporal and spatial attractiveness of potential trap crops to maximize their effectiveness.

Conclusion

Successful implementation of trap cropping had provided and is still providing sustainable and long-term management solutions to control difficult pests. With the advent of biotechnology, new opportunities for trap cropping have arisen. Traditional trap cropping methods, such as the use of mustard to control DBM in cabbage and the use of marigold to control *H. armigera* in tomato are likely to be implemented at commercial level. To develop trap cropping to its full potential, however, requires a multifaceted approach involving research and extension. Nevertheless, trap cropping will be greatly enhanced if farmer, scientists and extension educators expand their concepts of trap cropping to include the diverse modalities.

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