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Prospects for biological control and habitat enhancement to minimize quarantine risks and losses from insect bunch pests in organic export banana

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Can plant diversity as habitat ensure clean bananas?

Insect pests of the banana bunch generate losses of clusters, bunches, boxes and containers rejected for export as the result of cosmetic damage or quarantine enforcement of prohibited insects. The banana sector realized in the 1960's that controlling these insects with broadcast insecticides generated increasingly severe pest outbreaks (Stephens 1984). Pesticide use is now targeted through impregnated bags and strips and injections to the standing bell. Organic banana growers use repellents and insecticides approved by regulations. Broadcast spraying with organically-approved botanical and mineral insecticides still occurs often disrupting beneficial organisms, helpful in biological control. However, both supply chain certifications and national government regulations increasingly restrict permitted products and question the use of plastic bags for bunch protection even with organized disposal or recycling.

Project objective – Desk review of the state of knowledge on beneficial organisms and their preferred habitats to determine the feasibility of pest-suppressive plant diversity to manage insect bunch pests.
Hypothesis: current scientific and practical experience available is sufficient to propose vegetation strips as habitat for natural enemies of key banana bunch pests

Ecological management of important bunch insect pests

Red rust thrips	Flower thrips	Banana aphid	Scale insects	Mealybugs	*Colaspis* beetle
					
					

Opportune bagging effective as physical barrier					
free flight (orchiidi) or restricted flight hops (signipennis), lucifugous	free flight between mats, many species, many hosts	Stationary – wind assisted winged adults, banana only host	Stationary adults, nymph crawlers walk, infest hand separators	Stationary, nymph crawlers walk/seek ant transport, infest hand separators	Free flight nocturnal; Larva feed on grass roots, pupa in soil

Summary – the different life stages of banana bunch insect pests are prey for predators, parasitoids, fungi and bacteria which reduce bunch insect pests. A literature review and unpublished results by co-authors showed 12 predators, 20 parasitoids and 6 entomopathogens of the bunch pests. Of these, 40% can be artificially reared for release (Arias et al in press) and more are waiting to be inventoried.

Habitat corridors

Selection criteria for planted/ managed vegetation every 3 to 5 banana rows:

- abundant flowering during most months of the year
- Perennial/semi-perennial shrub
- vigorous flowering in partial shade
- plants with nectaries or domatia
- relatively easy to establish and maintain at 1-2 meters in height
- no major pest problems debilitating growth
- not an ant host for ants which promote aphids, mealybugs or scale insects
- low demand for water and nutrients

Species for hábitat corridors – preliminary

Malvacea – native cotton, okra, hibiscus
Ocimum basilicum - Perennial basil
Ricinus communis – castor bean
Tithonia spp
Moringa oleifera
Lantana camara
Malphigea
Short-lived perennial shrub legumes (eg *Sesbania sesban*)
Long-lived perennial shrub legumes (*Leucaena* spp)

Indicator beneficial organism - prey and food resources

Beneficial	Description	Important habitat features
Ceraeochrysa sp	Larva predate **aphids, thrips**	Adults feed on pollen, nectar and honeydew
Blastopthestus pallescens	Stink bug predator of nymph and adult **thrips**	Not known
Amblyseius Swirskii	Predatory mite of larval stage of **thrips and white flies**	Adults feed on pollen, nectar, honeydew. Leaf hairs and domitia for refuge
Orius insidiosus	Nymphs and adults predate **thrips, aphids, spider mites**	Pollen, sap
Franklinothrips vespiformis	Nymphs/adults ant-like thrips predate **thrips, white fly larva, small arthropods**	Pollen, nectar
Castollus plagiaticollis	Predatory stink bug of **Colaspis**	No reports
Scymnus sp	Predatory ladybug larva and adults predate aphids and larva of **mealybugs**	Pollen, nectar, honeydew, extrafloral nectaries
Coccobius sp.	Parasitoid laying eggs into larva and adults of **scale insects**	Pollen, nectar
Megaphragma sp	Very small Parasitoid laying eggs into eggs of **thrips**	Pollen, nectar
Hambletonia pseudoccocina	Parasitoid laying eggs into nymphs and adults of **mealybugs**	Pollen, nectar

Repeated broadcast insecticides are toxic for parasitoids and predators – pyrethroids, neonicotinoids, organophosphates, and carbamates. Organically certified insecticides when broadcast are toxic for parasitoids. Broadcast insecticides should be eliminated.

Perspectives: vegetation strips for conservation biological control

Accompanying practices	Research gaps
- Sanitation – banana separators/protectors - Planting material banana and other species free of scale insects and mealybugs - Bagging of closed flower bud with bags treated with botanical repellents - Scouting routine of % discarded banana due to bunch insect pests and multi-year data base to define critical seasons or climatic conditions - Targeted release of beneficials based on triggering indicators	- Advanced inventory of predators, parasitoids and entomopathogens, habitat factors in their abundance and life cycle - Habitat and other conditions to favor alternate prey of beneficial insects - Evaluation of use of vegetation colonized by scale insects and mealybugs – risks and utility as prey to sustain predators and parasitoids - Practical scouting methods for beneficial insects - Field test of prototype vegetation strips – monitoring of beneficials, pest damage and availability of feed resources - Strategies for use of predator/parasitoid release – climatic factors, priority seasons, predictive indicators - Big data approaches with climate data, reject banana levels. alternate practices

Okra row in banana field

References: Stephens, C. 1984. Ecological upset and recuperation of natural control of insect pests in some Costa Rican banana plantations. *Turrialba.*, *34*(1), 101-105. https://agris.fao.org/agris-search/search.do?recordID=XL8600128
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