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Horticultural Mineral Oils: A Smart & Sustainable Choice for Pest Management

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Horticultural mineral oils (HMOs) are highly refined petroleum-derived products widely used in agriculture for managing a range of insect pests and mites. Their unique physical mode of action, low mammalian toxicity, and compatibility with biological control agents make them an important component of sustainable pest management systems. This review summarizes their properties, mode of action, target pests, advantages, limitations, and role in Integrated Pest Management (IPM), with emphasis on horticultural crops.

Introduction

In recent years, farmers are facing serious challenges due to increasing pest attacks, pesticide resistance, and strict limits on chemical residues in fruits and vegetables and environmental safety have driven the search for alternative pest management strategies. To overcome these problems, horticultural mineral oils (HMOs) also known as white oils or superior oils have emerged as a simple, effective, and eco-friendly solution for pest control. Historically used as dormant sprays, modern formulations are refined to minimize phytotoxicity and maximize efficacy, allowing their use even during active crop growth stages.. These oils are gaining popularity among farmers practicing sustainable and residue-free farming.

Properties and Classification

Horticultural oils are characterized by:

- High degree of refinement
- Narrow distillation range
- High unsulfonated residue (UR > 92%)
- Appropriate viscosity

Classification:

- **Dormant oils** – applied during plant dormancy
- **Summer oils (superior oils)** – applied during active growth
- **Narrow-range oils** – modern, highly refined oils with low phytotoxicity

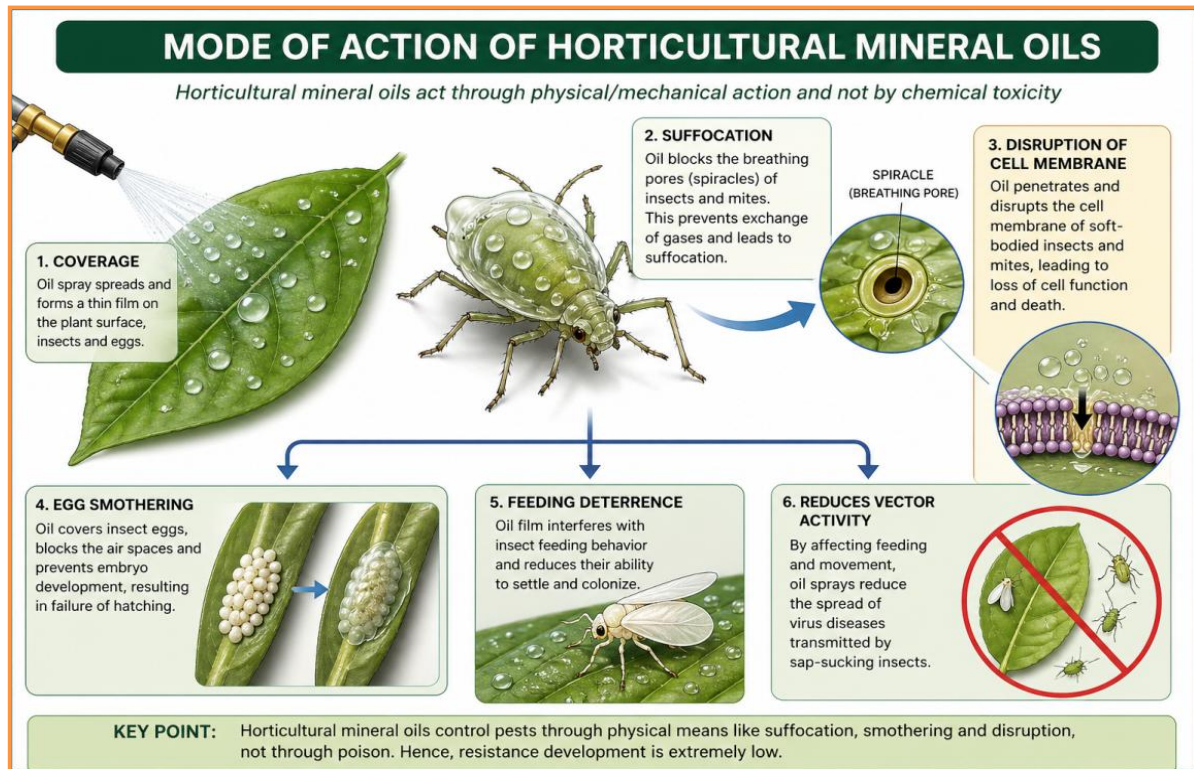
Mode of Action

Horticultural oils act primarily through physical mechanisms:

Key Actions:

- **Suffocation:** Blocks insect spiracles → disrupts respiration
- **Cell membrane disruption:** Affects soft-bodied insects
- **Egg mortality:** Prevents oxygen exchange in eggs
- **Feeding deterrence:** Reduces pest colonization
- **Virus transmission reduction:** Interferes with vector feeding

Since the mode of action is physical rather than biochemical, resistance development is unlikely, making HMOs valuable in resistance management program



Horticultural oils are highly effective against **soft-bodied pests**:

- Aphids
- Whiteflies
- Mealybugs
- Scale insects
- Thrips (partial control)
- Mites (especially spider mites)
- Psylla

Applications in Horticultural Crops

Crop	Target Pests	Concentration (%)	Dose (ml/L water)	Spray Interval	Remarks
Citrus (Acid lime, Orange)	Psylla, scale insects, mites, whiteflies	1–1.5%	10–15 ml	10–15 days	Ensure thorough coverage of undersides of leaves
Mango	Hoppers, mealybugs, scale insects	1–1.5%	10–15 ml	10–15 days	Avoid spraying during flowering
Grapes	Mealybugs, thrips, mites	1–1.5%	10–15 ml	10–12 days	Spray at early infestation stage
Apple/Pear	Scale insects, aphids (dormant stage)	2–3% (dormant)	20–30 ml	Once in dormancy	Apply before bud break
Vegetables (Brinjal, Tomato, Chilli)	Aphids, whiteflies, mites	0.5–1%	5–10 ml	7–10 days	Use lower concentration to avoid phytotoxicity
Cotton	Whiteflies, aphids, jassids	1%	10 ml	10–12 days	Useful in resistance management
Ornamentals	Aphids, mites, scales	0.5–1%	5–10 ml	7–10 days	Test on small area before full spray
Guava	Mealybugs, scale insects	1–1.5%	10–15 ml	10–15 days	Ensure complete plant coverage

Important Spray Guidelines

- Spray only during cool hours (morning/evening)

- Avoid spraying above 30–32°C
- Do not spray on water-stressed plants
- Avoid mixing with sulfur or copper fungicides
- Ensure uniform coverage for best results

Why They Are Sustainable

Eco-Friendly Features:

- Low toxicity to humans and animals
- Minimal environmental persistence
- Compatible with **biological control agents**
- No residue problems (safe for export crops)
- Approved in many **organic farming systems**

Advantages vs Limitations

Advantages

- No resistance development
- Broad-spectrum control
- Safe to beneficial insects (if used correctly)
- No pesticide residue problem (good for export crops)
- Cost-effective
- Improves spray coverage (acts as spreader)

Limitations

- Can cause **phytotoxicity** under high temperature (>32°C)
- Requires **direct contact** with pests
- Frequent applications may be needed
- Not effective against hard-bodied insects
- Do not spray on water-stressed plants
- Ensure complete coverage of leaves and pests
- Do not mix with sulfur or certain chemicals

Application Guidelines

- Use **1–2% concentration** (10–20 ml per liter of water)
- Spray during **cool hours** (morning/evening)
- Spray interval: **10–15 days**, depending on pest severity
- Ensure **uniform coverage**
- Avoid spraying during:
 - ✓ High temperatures
 - ✓ Water stress conditions
 - ✓ Flowering stage (in some crops)

Compatibility:

- Avoid mixing with sulfur or certain pesticides
- Maintain a gap of **2–3 weeks** between sulfur sprays

Role in Modern IPM Programs

Horticultural mineral oils are a **cornerstone in IPM**, especially in:

- Resistance management strategies
- Organic and residue-free farming
- Export-oriented horticulture

They are often combined with:

- Biological agents (e.g., predators, parasitoids)
- Botanical pesticides (like neem oil)
- Cultural practices

Scientific Basis & Standardization

Key parameters influencing efficacy:

- **Unulfonated residue (UR%)** → higher = safer

- **Viscosity** → affects spreading and persistence
- **Distillation range** → determines volatility

Conclusion

Horticultural mineral oils represent a scientifically proven, environmentally safe, and economically viable pest management tool. Their unique physical mode of action, compatibility with IPM, and low ecological footprint make them a key component in sustainable horticulture—especially in regions aiming for residue-free and export-quality produce.

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