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Air Pollution and Its Impact on Horticultural Crops: A Silent Threat to Our Food and Livelihood

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Air pollution has emerged as a significant and often overlooked threat to horticultural crops, affecting not only their productivity and quality but also the livelihood of millions of farmers. Pollutants such as ozone, sulfur dioxide, nitrogen oxides, particulate matter, ammonia, and carbon monoxide—originating from both urban and rural sources—negatively impact the physiological and biochemical functions of fruits, vegetables, flowers, spices, and plantation crops. Symptoms range from chlorosis, necrosis, and flower drop to reduced fruit set, smaller yields, and compromised nutritional value. Polluted environments also endanger pollinators and beneficial insects, further compounding the challenge. Urban and peri-urban agriculture is especially vulnerable, requiring targeted interventions. The article highlights adaptive strategies for farmers, including buffer planting, protective cultivation, and sustainable practices, and calls for research, policy support, and community awareness to mitigate the long-term effects of air pollution on horticultural systems.

Keywords: Air pollution, Ozone injury, Sulfur dioxide, Urban agriculture, Climate resilience.

Introduction

Air pollution is no longer just a concern for urban environments—it has become a pressing issue for rural and agricultural regions, especially those cultivating horticultural crops. These crops—including fruits, vegetables, flowers, spices, and plantation crops—are vital not only for nutritional security but also for the livelihood of millions of farmers globally. However, rising levels of air pollutants are increasingly threatening the productivity, quality, and marketability of these crops.

Sources of Air Pollution in Agriculture

While industrial emissions and vehicular traffic are widely known contributors to air pollution, agricultural areas face additional localized sources. These include the burning of crop residues, smoke from traditional biomass cooking, diesel-powered irrigation pumps, and emissions from excessive use of fertilizers (especially ammonia). Construction activities, unpaved roads, and nearby industrial zones further degrade air quality in peri-urban farming areas. Common pollutants—such as ozone (O_3), sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon monoxide (CO), ammonia (NH_3), and particulate matter (PM2.5 and PM10)—are often invisible but can cause long-lasting harm to crop health.

Common Air Pollutants and Their Effects on Plants

Pollutant	Source	Effect on Plants
Ozone (O_3)	Vehicle exhaust + sunlight	Leaf injury, reduced photosynthesis
Sulfur dioxide (SO_2)	Coal combustion, smelters	Leaf necrosis, poor root development

Nitrogen oxides (NO_x)	Diesel engines, fertilizer use	Chlorosis, flower drop
Particulate Matter (PM2.5/PM10)	Dust, burning, industry	Blocks stomata, reduces leaf activity
Carbon monoxide (CO)	Fuel combustion	Disrupts respiration in plant cells
Ammonia (NH_3)	Livestock waste, fertilizers	Alters leaf chemistry, promotes disease

Impacts on Horticultural Crops

Air pollution harms horticultural crops both visibly and physiologically. One of the earliest signs is leaf damage, yellowing, browning, and premature leaf fall. Crops like mango, apple, and citrus are particularly vulnerable to ozone and sulfur dioxide. Dust and particulate matter settle on leaf surfaces, reducing light absorption and photosynthetic activity, leading to stunted growth and poor yield. Fruits like apple and citrus show reduced fruit set, deformities, and disorders like black tip in mango near brick kilns. Vegetables such as spinach, cabbage, and tomato may become smaller, misshapen, and nutrient-deficient due to pollutant exposure. Leafy greens often lose vitamin C and beta-carotene content. Flowers experience reduced bloom size, discoloration, and shorter vase life, directly affecting their market value. For example, roses grown near highways fade quickly due to ozone and dust exposure. Spices such as coriander and chilli may show reduced essential oil content and increased susceptibility to pests and diseases. Plantation crops like tea and coffee are not immune either; sulfur dioxide causes necrotic spotting in tea leaves, impacting both yield and flavor.

Crop-Specific Effects

- **Fruits:**
- ✓ *Apple:* Ozone reduces size; causes russeting.
- ✓ *Banana:* Dust impairs bunch development.
- ✓ *Citrus:* SO_2 causes chlorosis; affects juice quality.
- ✓ *Mango:* Black tip disorder due to acidic gases.
- **Vegetables:**
- ✓ *Tomato:* Ozone stress reduces fruit set.
- ✓ *Cabbage:* Dust hampers head formation.
- ✓ *Onion/Garlic:* SO_2 affects bulb development.
- ✓ *Spinach:* Heavy metals reduce nutrient value.
- **Flowers:**
- ✓ *Marigold, Chrysanthemum:* Reduced bloom near roads.
- ✓ *Roses:* Petal fading and short shelf life.
- ✓ *Jasmine, Tuberose:* Discoloration; drop in fragrance.
- **Spices:**
- ✓ *Coriander:* Sulfur exposure reduces oil content.
- ✓ *Chilli:* Pollutants increase fruit rot.
- **Plantation Crops:**
- ✓ *Tea:* Necrosis from SO_2; loss of aroma.
- ✓ *Coffee:* Dust affects flowering and quality.
- ✓ *Coconut, Arecanut:* Reduced nut size; flower drop.

Nutritional and Economic losses

Air pollution not only affects yield but also compromises the nutritional quality of produce. Research shows a decline in vitamins and antioxidants in vegetables exposed to pollutants. The accumulation of heavy metals on edible parts can make them unsafe for consumption. Reduced productivity and quality ultimately impact farmers' income, consumer health, and food security.

What can farmers do?

Though total elimination of pollution is impossible, farmers can adopt several mitigation strategies:

- Buffer planting: Use pollution-filtering trees like neem or bamboo along field borders.
- Protective structures: Use shade nets or polyhouses for sensitive crops.
- Foliage cleaning: Periodic washing of leaves in floriculture and leafy vegetable crops.
- Sustainable practices: Adopt drip irrigation, mulching, and biofertilizers to reduce pollution load.
- Air quality monitoring: Use mobile apps to track AQI and avoid farm operations on high-pollution days.
- Avoid crop residue burning: Compost residues instead to maintain soil health and reduce emissions.

Policy and Research Support

There is an urgent need for research into pollution-tolerant crop varieties and clean farming techniques. Government policies must support emission controls near agricultural zones, promote clean energy in rural areas, and incentivize residue management alternatives. Extension agencies and Krishi Vigyan Kendras (KVKs) should actively disseminate knowledge and conduct training programs.

Invisible Risk to Pollinators

Pollution also affects the broader ecosystem. Pollinators like bees and butterflies are sensitive to pollutants, particularly ozone and PM. This reduces pollination efficiency, directly affecting fruit and seed set. Insects that prey on pests may also decline, leading to more pest problems and increased pesticide use.

Urban and Peri-Urban Horticulture: Added Challenges

Urban farming areas, often located near highways and industrial zones, face some of the worst air quality conditions. Leafy vegetables grown in these areas may accumulate heavy metals if not washed thoroughly, posing health risks to urban consumers.

Air Pollution and Climate Change: A Double Threat

Climate change and air pollution are closely linked. Higher temperatures intensify ozone levels, aggravating stress on plants. Many sources of greenhouse gases also emit air pollutants. Thus, climate-smart agriculture must include pollution control as a central strategy.

Community Awareness and Action

Empowering farmers through participatory air-quality monitoring, community-led pollution mapping, and eco-education can bring positive change. School initiatives, NGOs, and farmer cooperatives can work together to raise awareness and encourage eco-friendly practices.

Conclusion

Air pollution is an unseen but growing menace in the world of horticulture. It not only threatens plant health and yield but also undermines food safety and farmer income. Combating this challenge requires coordinated action—from informed farmers and proactive researchers to supportive policies and conscious consumers. Clean air is not just a human health necessity—it's a lifeline for sustainable horticulture and food security.