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Critical Review of Onion Pathologies and Modern Countermeasures in Agroecological Systems

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Abstract: Onion cultivation is significantly affected by a range of diseases caused by fungi, bacteria, and viruses, which lead to substantial yield and quality losses. This article provides a comprehensive overview of the most common onion plant diseases, including powdery mildew (*Peronospora destructor*), throat rot (*Botrytis allii*), stem and white rot (*Fusarium* and *Sclerotium* spp.), rust (*Puccinia* and *Melampsora* spp.), bacteriosis (*Erwinia* spp.), mosaic virus, and onion rust (*Urocystis cepulae*). For each disease, typical symptoms, sources of infection, environmental conditions favoring development, and transmission methods are outlined. Special attention is given to preventive agronomic practices such as crop rotation, soil treatment, seed disinfection, and timely harvesting. Additionally, specific chemical and biological control measures are discussed to support disease management strategies. This study aims to inform farmers, agronomists, and agricultural researchers of effective approaches for protecting onion crops and ensuring sustainable vegetable production.

Keywords: *onion diseases, powdery mildew, throat rot, white rot, onion rust, bacteriosis, mosaic virus, disease control, crop protection*

1. INTRODUCTION

The value and irreplaceability of vegetable plants lie in their being the primary source of carbohydrates, vitamins, essential oils, mineral salts, phytoncides, and dietary fibers, all of which are vital for the functioning and health of living organisms. Vegetables are also considered dietary products because they enhance the taste, digestibility, and nutritional assimilation of consumed food. In addition to their dietary benefits, many vegetable plants possess therapeutic and prophylactic properties. For developing children in particular, vegetables significantly boost the immune system and increase resistance to infectious diseases and harmful environmental factors. Therefore, the regular consumption of vegetable products is crucial for maintaining health and resilience in the human body.

In order to ensure a stable supply of vegetables to the population, it is essential to increase the cultivation of diverse vegetable crops. However, agricultural productivity is often threatened by natural phenomena and both biotic and abiotic stress factors, most notably the negative impacts of plant

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diseases, pests, and weeds. These adversities can cause significant yield losses if not managed effectively. As such, developing and implementing disease and pest management strategies tailored to vegetable crops—and particularly to onions—is a critical step in safeguarding agricultural output. Timely and informed responses to diseases and pests are key to securing both the quantity and quality of onion harvests.

2. OVERVIEW OF COMMON ONION DISEASES

Onion plants are susceptible to a variety of diseases caused by fungi, bacteria, and viruses. These pathogens lead to significant reductions in yield, quality, and storage capacity. Timely identification and management of these diseases are essential to prevent widespread damage and to ensure sustainable onion production. The table below summarizes the most commonly encountered onion diseases along with their causal agents and biological classifications.

№	*Disease Name*	*Causal Agent(s)*	*Pathogen Type*
1	Powdery Mildew (Downy Mildew)	*Peronospora destructor* (Berk.) Casp. et Berkley	Fungus
2	Throat Rot	*Botrytis allii* Munn	Fungus
3	Stem Rot	*Fusarium* spp.	Fungus
4	Onion Rust	*Urocystis cepulae* Frost	Fungus
5	Leaf Rust	*Puccinia porri* Wint., *P. allii* Rud., *Melampsora allii-poplina* Kleb.	Fungus
6	Bacterial Soft Rot	*Erwinia carotovora* (Jones) Holland; *Erwinia aroideae* (Towns) Holland	Bacteria
7	Mosaic (Decorative Symptoms)	BML Onion Mosaic Virus	Virus

3. DISEASE DESCRIPTIONS AND CONTROL METHODS

3.1. Powdery Mildew (*Peronospora destructor*)

Symptoms

Infected onion leaves and stems develop oval or cylindrical lesions that appear whitish-green, yellow, or brown. Under moist and mild conditions, a gray-purple spore mass forms on the affected areas. As the disease progresses, leaves curl, wither, and become necrotic, leading to the collapse of plant tissue.

Figure 1. Powdery mildew on onion leaves
Whitish spots and spore masses forming on infected foliage.

Conditions for Development

The disease is most active under specific environmental conditions: nighttime temperatures between +5°C and +10°C and daytime temperatures from +15°C to +18°C. Moisture on the leaf surface for 1.5 to 7 hours facilitates fungal germination. If wetness persists beyond 11 hours, the infection can become critical, causing plant damage within 72 hours.

Preventive Measures

Avoid planting onions in acidic soils (pH < 6), as such conditions favor fungal development.

Use certified disease-free planting material.

Ensure good soil aeration and ventilation between plants.

Monitor leaf tips biweekly for early symptoms.

Avoid irrigation during rainy periods; if necessary, water in the morning to allow drying before nightfall.

Before planting, treat onion heads thermally: dry at 40°C for 8 hours or immerse in 42–50°C water for 15–30 minutes, then dry thoroughly.

Control Measures

Apply the following fungicides as needed during the growing season:

Mancozeb (640 g/kg) + Metalaxyl (80 g/kg): 2.5 kg/ha, 2–3 applications.

Azoxystrobin (250 g/L): 0.6–1.0 L/ha, 2–3 applications.

Mancozeb (600 g/kg) + Dimethomorph (90 g/kg): 2 kg/ha, 2 applications

3.2. Throat Rot (*Botrytis allii*)

Description & Symptoms

Throat rot is primarily caused by *Botrytis allii*, with related species such as *B. aclada* and *B. porri* also capable of causing infection. The disease typically affects onion bulbs during late field maturity and storage. Initial symptoms include a faint gray mold on the bulb surface, followed by the development of a black sclerotial mass. The fungus enters the bulb through the neck or throat area during leaf senescence. Although symptoms are often not visible during harvest, infected bulbs later become soft, discolored, and are easily crushed. Gray, hairy mycelium and flat, black sclerotia form between the bulb scales. The disease progresses more rapidly in immature onions.

Figure 2. Throat rot disease in onion
Gray mycelial growth and sclerotia formation between onion layers.

Spread and Development

The infection originates from infected planting material and overwintering fungal mycelia in the soil. The disease is spread primarily via fungal conidia. Risk factors include:

Late harvesting, especially in wet weather

Planting in heavy or poorly drained soils

Coinfection with powdery mildew

Use of high doses of nitrogen fertilizer late in the season

Countermeasures

Agrotechnical Measures:

1. Harvest onions only when fully ripe.

2. Dry harvested onions for 8–10 days at 30–35°C in the open or under ventilated shelter.
3. Implement strict crop rotation.
4. Apply sufficient phosphorus fertilizers.
5. Grade and sort bulbs post-harvest, removing any damaged or unhealthy material.
6. Apply nitrogen fertilizers early in the growing period; switch to phosphorus and potassium later.
7. Avoid proximity to garlic fields to prevent windborne spread.
8. Remove and destroy all infected plant residues and rotten bulbs.

Chemical Measures:

Treat seeds with:

25 g/L fludioxonil (2 L/t)

80% thiram (3 kg/t)

Spray crops with:

375 g/L syprodinil + 250 g/L fludioxonil (1 L/ha)

640 g/kg mancozeb + 80 g/kg metalaxyl or mefonaxam (2.5 kg/ha), 2–3 times

600 g/kg mancozeb + 90 g/kg dimethomorph (2 kg/ha)

3.3. Fusarium Stem Rot (*Fusarium oxysporium*)

Description

Fusarium stem rot, caused by *Fusarium oxysporium*, affects onion and garlic crops both in the field and during storage. Early symptoms include yellowing of the leaves, beginning at the tips and gradually extending downward. As the infection progresses, the leaves collapse and die. At the base of infected plants, particularly on the roots and the neck of the bulb, white cotton-like mycelia and watery rot are visible. Poppy seed-sized black sclerotia form on the decayed tissues. If infection occurs late in the growing season, symptoms are usually more evident during harvesting, with visible fungal structures at the base of the bulb.

Figure 3. *Fusarium rot symptoms – white mold and black sclerotia on bulb base.*

Environmental Factors

The disease thrives in environments with high temperature and humidity. The fungus is able to survive in the soil for extended periods through its resistant sclerotia, making it a persistent challenge in affected fields.

Countermeasures

Agrotechnical and Chemical Measures:

1. Implement a strict crop rotation system, avoiding continuous onion planting.
2. Select and plant only healthy, disease-free bulbs.
3. Disinfect planting bulbs with:
    - 80% thiram (3–4 kg/t)
    - 140 g/L imidacloprid + 150 g/L pencycuron (2–3 L/t)
4. To prevent vector transmission by insects (especially flies), apply:
    - 40% dimethoate (2 L/ha)
    - 65% malathion (1.5 L/ha)

3.4. White Rot (*Sclerotium cepivorum*)

Infection Process

White rot is a destructive fungal disease caused by *Sclerotium cepivorum*, affecting both onion and garlic crops. The fungus targets plants in the field and continues its activity during storage. Infected young plants show leaf yellowing beginning at the neck, followed by tissue collapse and death. On the roots and lower stem, soft white mycelia appear, along with the formation of minute, black, spherical sclerotia embedded in decaying tissue.

Figure 4. White rot disease in onion
White cotton-like fungal growth and black sclerotia on basal tissues.

Storage Issues

If infected bulbs are harvested without thorough drying, white rot can proliferate rapidly during storage. In such cases, the bulbs exhibit advanced fungal growth, extensive rot, and surface sclerotia that compromise bulb integrity and marketability.

Countermeasures

Preventive and Control Measures:

1. Follow a proper crop rotation schedule to avoid planting onions in contaminated soil.
2. Harvest onions only after they have fully matured.
3. Ensure thorough drying of bulbs before storage to suppress post-harvest fungal growth.
4. Before planting, treat bulbs with:
    - **Fungicides**: Cortiram Forte, Yungo Forte at 3–4 kg/t
    - **Insecticide**: 140 g/L imidacloprid + 150 g/L pencycuron at 2–3 L/t

5. Formalin disinfection: immerse bulbs in a 40% formalin solution (40 mL/120 L water) for 10–15 minutes, then air-dry and keep bulbs covered between tarpaulins for 1.5–2 hours before planting.

3.5. Rust Diseases (*Puccinia* spp., *Melampsora* spp.)

Visual Symptoms

Rust diseases in onions and garlic are mainly caused by fungi such as *Puccinia porri*, *Puccinia allii*, and *Melampsora allii-poplina*. These pathogens primarily attack the leaves, where small, yellowish pustules or pads appear in scattered spots. As the disease progresses, these pads turn dark and develop into teliospores—dense black clusters formed late in the fungal lifecycle. Infected leaves yellow prematurely, dry out, and the plants experience reduced growth and bulb formation.

Figure 5. Rust disease on onion leaves
Yellow spore pads and dark teliospore spots on infected leaf surfaces.

Seasonal Development

The fungi overwinter in the form of teliospores on plant debris left in the field. In spring or early summer, under favorable conditions—mild temperatures and moist leaf surfaces—spores germinate and spread through wind or rain splash. Infected plants often grow poorly and yield substandard bulbs, significantly reducing the economic value of the crop.

Countermeasures

Preventive and Control Measures:

1. **Crop Rotation**: Avoid planting bulbous crops on previously infected land for 5–6 years.
2. **Field Sanitation**: Remove and destroy post-harvest plant residues; conduct deep plowing to bury remaining spores.
3. **Soil Disinfection**: Apply sulfur-lime mixture (56 kg sulfur + 1.2 kg lime per hectare) before planting.

4. **Seed Treatment**: Disinfect seed material with:

   40% formalin (40 mL/120 L water) for 2 hours (keep under tarpaulin), or

   25 g/L fludioxonil (2 L/t), 80% thiram (3–4 kg/t)

5. **Biological Sprays**: Use Fitosporin M (15 mL per 10 L water) between rows.

6. **Chemical Control (upon symptoms)**:

   Copper oxychloride + mancozeb + metalaxyl (2 L/ha)

   640 g/kg mancozeb + 80 g/kg mefonaxam (2.5 kg/ha)

   350 g/kg copper hydroxide (2 kg/ha)

3.6. Bacterial Soft Rot (*Erwinia* spp.)

Identification

Bacterial soft rot in onions is primarily caused by *Erwinia carotovora* (also known as *Pectobacterium carotovorum*) and *Erwinia aroideae*. This disease typically becomes apparent at the end of the growing season and during storage. In the field, infected bulbs are difficult to distinguish from healthy ones. Upon cutting, however, dull, water-soaked areas with yellow-brown streaks appear between healthy tissues. As the disease progresses—usually 2–3 months post-harvest—the throat area softens, emits a foul odor, and undergoes extensive rot.

Figure 6. Bacteriosis disease in onion
Softened, discolored bulb tissue and foul-smelling decay.

Sprouting from infected bulbs results in weak, yellowing leaves that often collapse and dry. The infection may also appear on the outer layers of the bulb as undefined, round or oval necrotic spots. The disease spreads more aggressively during storage and is often facilitated by insect vectors.

Carriers and Storage Problems

Transmission is primarily through pests such as the onion fly, thrips, onion mite, and viziza (onion leaf miner). These vectors damage plant tissue, providing entry points for bacteria. Improper post-harvest handling, such as inadequate drying or physical damage to bulbs, further enhances the disease's spread during storage. High humidity and temperatures above 5°C favor bacterial multiplication.

Countermeasures

Preventive and Control Strategies:

1. **Crop Rotation**: Do not plant onions after other bulbous vegetables.
2. **Post-Harvest Drying**: Ensure thorough drying before storage.
3. **Storage Conditions**: Maintain storage temperatures at 0–2°C with relative humidity below 65%.
4. **Pest Control**: Regularly monitor and control pest populations in both field and storage.
5. **Avoid Overhead Irrigation**: Use irrigation systems that minimize leaf wetness.
6. **Chemical Treatments**:

   Mandipropamid (25 g/kg) + copper chloride (245 g/kg): 2–3 kg/ha

   4.2% sumoxanil + 39.8% copper chloride: 2.5 kg/ha
   (Apply 3 times during the vegetation period)

3.7. Mosaic Virus Disease (OMI – Onion Mosaic Virus)

Transmission by Mites

The mosaic virus affecting onions is primarily transmitted by the four-legged onion mite (*Aceria tulipae*) and other microscopic mites. These vectors feed on infected plants and subsequently transfer the virus to healthy plants, both during the growing season and in storage. Once infected, bulbs can serve as a persistent viral reservoir, allowing the disease to recur in subsequent plantings.

Symptoms on Leaves

Symptoms of mosaic virus typically appear shortly after planting infected bulbs. The earliest signs include weakening of the plant and yellowing of the leaves. Over time, dense, parallel yellow stripes form along the leaf blades, and the leaves may become curled or twisted, losing their characteristic

shape. Infected plants exhibit stunted growth and delayed or weakened flowering, ultimately resulting in poor bulb formation and reduced yield.

Figure 7. Spot disease on onion leaves
Curled, yellow-streaked foliage typical of mosaic virus infection.
Countermeasures

Preventive and Control Measures:

1. **Healthy Seed Selection**: Always use planting material from verified virus-free sources.
2. **Vector Control**: Regularly monitor and combat the four-legged onion mite and other potential viral carriers.
3. **Field Isolation**: Establish physical separation between fields used for seed production and those for commercial onion cultivation to reduce cross-contamination risk.
4. **Field Hygiene**: Remove and destroy visibly infected plants to reduce viral spread during the season.

3.8. Onion Rust (*Urocystis cepulae*)

Early Symptoms

Onion rust, caused by *Urocystis cepulae*, primarily affects onion seedlings sown in their first year. The disease typically emerges 3 to 16 days after sowing, before the appearance of the first true leaf. Early signs include raised, elongated black streaks on the leaves. As the infection progresses, it spreads to the emerging bulb scales. Eventually, the surface of the leaves cracks open, releasing masses of dark fungal spores.

Figure 8. Onion rust disease
Elongated black lesions and cracked leaf surfaces indicating advanced rust infection.

Long-Term Spore Survival

The fungus is soil-borne and remarkably resilient. Its spores can remain viable in the soil for up to 5–6 years, making fields susceptible to reinfection if proper rotation is not followed. This disease is most common when onions are planted repeatedly in the same plot over successive years without rest.

Countermeasures

Preventive and Control Measures:

1. **Crop Rotation**: Avoid planting onions in infected fields for at least 4–5 years.
2. **Seed Treatment**:

Treat seeds with 80% thiram (3–5 kg/ton)

Alternatively, apply 25 g/L fludioxonil at a rate of 2 mL/kg

Proper seed sanitation and long-term rotation are critical to breaking the life cycle of *Urocystis cepulae* and maintaining field health.

4. CONCLUSION

Onion cultivation plays a vital role in both food security and agricultural economics. However, its productivity is frequently compromised by a wide range of biotic threats, particularly fungal, bacterial, and viral diseases. This article has detailed eight of the most common and destructive diseases affecting onion crops—ranging from powdery mildew and throat rot to bacterial soft rot and mosaic virus—highlighting their symptoms, environmental triggers, and pathways of infection.

Effective management of these diseases requires an integrated approach combining preventive agricultural practices, biological awareness, and timely application of chemical treatments. Key strategies include crop rotation, use of healthy seed material, appropriate fertilization schedules, pest

vector control, seed disinfection, and post-harvest drying procedures. Moreover, understanding the specific environmental conditions that favor each pathogen is essential for early intervention.

By equipping farmers, agronomists, and agricultural researchers with knowledge of symptom recognition and control methods, this study aims to support sustainable onion production and minimize post-harvest losses. Continued research and field monitoring will remain critical in adapting disease control measures to changing climatic conditions and evolving pathogen resistance.

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