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Original Article

Downy Mildew of Onion (*Allium cepa*): An Overview of the Pathogen, Disease Cycle, and Management

Priyanka Patil[1], Vasantrao Pawar[2], SatishPatil[3]
[1,2]Department of Botany, Arts and Science College, Bhalod, Maharashtra, India
[3]Department of Botany, Arts and Science College, Ainpur, Maharashtra, India

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Abstract

Onion downy mildew (ODM) is one of the serious threats to onion cultivation worldwide, caused by an oomycetes Peronospora destructor (Berk.) Casp. ex Berk. It is particularly troublesome in subtropical and dry temperate regions, where environmental conditions favor its rapid development. Cool, humid weather promotes its development, leading to significant yield losses and deterioration of bulb quality. This paper summarizes the pathogen's biology, life cycle, and epidemiology. It also describes the disease symptoms and outlines integrated management strategies. Particular attention is given to sustainable approaches to minimize economic losses and safeguard onion production.The disease spreads rapidly, especially in cool, humid climates, making it a persistent challenge for growers. Downy mildew affects all known onion varieties and can cause yield losses of up to 75%. Severe infections lead to early leaf loss, smaller bulbs, and reduced quality. The pathogen, which has been reported in over 70 countries, primarily infects leaves, which decreases the plant's photosynthetic activity. Under favorable conditions, the pathogen can defoliate entire fields in a single week.P. destructor survives as oospores in plant debris and soil, or as mycelium within onion bulbs. The oospores are the primary source of infection. When cool temperatures (10–20 °C) and high humidity (>90% RH) are present, oospores germinate and produce sporangia, which are then carried by the wind to infect new plants. Effective management requires an integrated approach that includes using disease-free bulbs, practicing crop rotation, ensuring proper plant spacing, and applying fungicides preventively during favorable weather conditions. These strategies are essential for minimizing disease incidence and ensuring sustainable onion production.

Keywords: *Downy mildew, Onion, Peronospora destructor, Climate change, Classification, Allium cepa, Life cycle, Epidemiology*

Introduction

Onion (*Allium cepa* L.) is among the most valuable vegetable crops. It is a widely cultivated across subtropical, dry temperate, temperate, and tropical regions (Ross, 2001). India ranks among the top producers with Maharashtra, Karnataka, and Madhya Pradesh leading cultivation. Downy mildew is one of the crop's most damaging diseases, capable of wiping out large portions of the harvest if unchecked. The disease spreads rapidly in cool, humid conditions, making it a recurring challenge for growers in such climates.

Downy mildew affects all known onion varieties (Gianessi & Reigner, 2005) and can cause yield losses of up to 75% (Jayakumar et al., 2008). Severe infections lead to early leaf loss, smaller bulbs, and poor quality (Surviliene et al., 2008). Since onions are a staple crop in India, this study investigates the factors affecting the infection and development of the disease under both laboratory and field conditions. The latest forecasts regarding global warming suggest a global temperature increase between 1.5° C and 2° C over the next 50 years, especially in the northern and southern regions (Hoegh-Guldberg, O.D. et al., 2018). However, the impact of climate change may vary with the geographic location of the production areas. The pathogen has a wide geographical distribution and has been reported in over 70 countries. (Lebeda and Urban, 2007).

Address for correspondence:
Priyanka Patil, Department of Botany, Arts and Science College, Bhalod, Maharashtra, India
Email: vppbotany@gmail.com

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This pathogen primarily infects the leaves, resulting in decreased photosynthesis activity. During favourable environmental conditions, the pathogen can defoliate plants and destroy entire fields within a week. Bulbs of infected plants are usually undersized.

Taxonomy And Morphology

According to the recent taxonomic studies (Thines et al., 2022), *Peronospora destructor* belongs to

Kingdom	Stramenopila (Chromista)
Division	Oomycota
Subdivision	Peronosporomycotina
Class	Oomycetes (Peronosporomycetes)
Order	Peronosporales
Family	Peronosporaceae
Genus	*Peronospora*
Species	*P. destructor*

Downy mildew usually starts as light yellow spots on the upper parts of onion leaves, which later develop a fuzzy growth. It often appears in small patches in the field at first as in Figure 1. If the weather is favorable, the disease can get worse quickly and spread across the whole field.

Figure 1. Symptom progression of onion downy mildew (*Peronospora destructor)* in the field. (*Photos Courtesy of Farmer's IPM Guide- Guide series, March 2021*)

The disease is caused by *Peronospora destructor*, an obligate biotroph from the Peronosporaceae family. It produces characteristic branched (antler-like) sporangiophores as in Figure 2, which emerge through the stomata on infected leaves. These sporangiophores bear lemon-shaped, hyaline sporangia at their tips. Sporangia are typically single-celled, thin-walled, and measure approximately 20–30 μm × 15–20 μm. Under favorable cool and humid conditions, sporulation is abundant on the abaxial leaf surface, giving a greyish-purple appearance. The sporangia travel by wind and infect plants when environmental conditions are favorable. The pathogen can persist between seasons in infected bulbs, plant debris, or on volunteer onion plants.

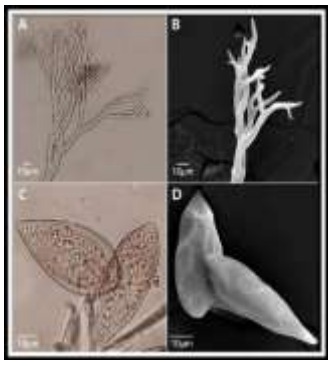

Figure 2. Morphological features of *Peronospora destructor* sporulating on onion leaves, displaying both light microscopy (left) and scanning electron microscopy (right) views of its diagnostic sporangiophores and sporangia.

A) Light microscopy showing a branched sporangiophore (dichotomous branching). B) Scanning Electron Microscopy (SEM) image of the sporangiophore structure. C) Light micrograph of ovoid, thin-walled sporangia. D) SEM view of sporangia with a smooth surface texture. Image source: Silva et al., 2025 (Creative Commons Attribution-NonCommercial 4.0 International)

Signs And Symptoms

Downy mildew can appear at any stage of onion growth. It begins as white, slightly sunken circular or elliptical spots, usually on one side of the stalk and often on older leaves. Over time, these spots develop a grey downy layer, turning purplish after heavy rain. Infected leaves change from light green to yellow and then develop necrotic patches. This pathogen typically spreads from the southern regions to northern regions in the form of airborne spore-like structures knows as sporangia.

The downy growth consists of sporangia and branched sporangiophores. Early infection can cause stunting, defoliation, tissue death, and curling of leaf tips. Yellowing in the field often spreads in the direction of the wind, leading to reduced photosynthesis and smaller bulb size. In severe cases, lesions girdle the leaves, causing collapse and hanging of the leaf stalk. Severe infection of aerial parts may also produce bottleneck-shaped bulbs. Once established in a region, the disease can spread rapidly, causing significant loss, effective management requires early detection and a coordinated control strategy.

Life Cycle And Epidemiology

Peronospora destructor, the causal agent of onion downy mildew, survives mainly as oospores in plant debris and soil, or as mycelium in onion bulbs. These oospores act as the primary source of infection. Under favorable conditions of cool temperatures (10–20 °C) and high humidity (>90% RH), the oospores germinate and produce sporangia, which are easily carried by wind and serve as the main means of secondary spread in the field.

When sporangia land on susceptible onion leaves, they release zoospores or germinate directly to penetrate through stomata. The pathogen grows between cells and develops haustoria to absorb nutrients. Soon, new sporangiophores emerge from the stomata, bearing fresh sporangia, which continue the infection cycle.

The disease is favored by moist weather, dew, and overcrowded crops that keep leaves wet for long periods. It often starts in patches and spreads quickly with wind currents. Infected plants show yellowing, leaf collapse, and reduced bulb size. Once established, repeated cycles of sporulation and dispersal can lead to epidemics, especially in cool, humid regions.

Management

Effective management of onion downy mildew requires an integrated approach that combines cultural practices, resistant varieties, chemical applications, and proper field hygiene.

· Use healthy, disease-free bulbs.

· Practice crop rotation (3–4 years gap).

· Avoid overcrowding, maintain good spacing for airflow.

· Irrigate in the morning to allow leaves to dry.

· Remove and destroy infected plant debris.

· Apply fungicides preventively during cool, humid weather.

· Rotate fungicides to prevent resistance.

· Use resistant/tolerant varieties where available.

· Follow integrated pest management (IPM) practices.

Result

The study highlights that *Peronospora destructor* is a major pathogen of onion, surviving as oospores in soil and bulbs, and spreading rapidly under cool, humid conditions. The disease cycle involves primary infection through oospores and mycelium, followed by repeated secondary spread via sporangia dispersed by wind. Symptoms include yellowing, leaf collapse, and reduced bulb size, which significantly impacts the yield. Epidemiological observations confirm that high humidity, prolonged leaf wetness, and dense crop stands favor epidemic development.

Conclusion

Onion downy mildew caused by *P. destructor* is a destructive disease that can lead to severe yield losses if not managed correctly. The establishment of the identity is a matter of fundamental importance. Despite this fact, concerned efforts could hardly be made to achieve objective. Understanding its life cycle and epidemiology is crucial for timely detection and control. Effective management requires an integrated approach combining clean planting material, cultural practices, crop rotation, and fungicide application under conducive weather conditions. Adoption of these strategies can minimize disease incidence, improve bulb quality, and ensure sustainable onion production.

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Conflicts of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

References

1. Ankita, Sunita Chandel, Rajender Sharma and Vijay Kamal Meena. 2020. Epidemiological Studies of Downy Mildew of Onion. Int.J.Curr.Microbiol.App.Sci. 9(05): 01-12.
2. Becker, W. F., Duarte, H. S. S., & Casa, R. T. (2019). Management of onion downy mildew by combining resistant cultivars and a disease-warning system. Tropical Plant Pathology. 44: 460-468.
3. Brewster JL. 2001. The structure of edible alliums. In: Onions and other allium (López M and Brewster JL eds). Editorial Acribia, Zaragoza. pp.230-266.
4. Brewster, J. L. (2008). Onions and Other Vegetable Alliums. CABI.
5. Buler, E.J. (1968). Fungi and Disease plants (revised). Thacker Spink and Co., Calcutta, India. Pp 98.
6. Develash RK and Sugha SK. 1997. Management of downy mildew (*Peronospora destructor*) of onion (*Allium cepa*). *Crop Protection* 16: 63–67.
7. Garrett, K.A. Big data insights into pest spread. Nat. Clim. Chang. 2013, 3, 955–957.
8. Gupta, R.P. and Srivastava, K.J. (1987). Chemical control of downy mildew (*Peronospora destructor)* of onion. Indian Phytopathology. 40(1): 111-113.
9. Hilal, A.A., El-Kot, G.A.N., and El-Mougy, N.S. (2016). Epidemiology and management of onion downy mildew (*Peronospora destructor*). International Journal of Phytopathology. 5(2): 67–76.
10. Holmes, G.J., Main, C.E., and Keever, Z.T., III. (2004). Cucurbit downy mildew: a unique pathosystem for disease forecasting. In P.T.N. Spencer-Phillips & M. Jeger (Eds.), Advances in downy mildew research, vol. 2 (pp. 69–80). Dordrecht: Kluwer Academic Publishers.
11. Holmes, G.J., Ojiambo, P.S., Hausbeck, M.K., Keinath, A.P. (2015). Resurgence of Cucurbit Downy Mildew in the United States: A Watershed Event for Research and Extension. Plant Disease. 99(4):428-441.
12. Jesperson, G.D.; Sutton, J.C. Evaluation of a forecaster for downy mildew of onion (*Allium cepa* L.). Crop Prot.1987, 6, 95–103.
13. Jhooty, J.S. and Munshi, G.D. (1975). Indian Journal of Mycology and Plant Pathology. 5: 105-106.
14. Koike, S. T., et al. (2007). Vegetable Diseases: A Color Handbook. Academic Press.
15. Langston DB, and Sumner DR. 2000. First report of downy mildew (caused by *Peronospora destructor*) of onion in Georgia. *Plant Disease* 84:489-91.
16. McDonald, M.R. and Boland, G.J. (2004). Forecasting outbreaks of downy mildew of onion caused by *Peronospora destructor*. Canadian Journal of Plant Pathology. 26(3): 281-288.
17. Palti J, Brosh S, Stettiner M, Zilkha M, 1972. The downy mildew of onion [*Peronospora destructor* (Berk.) Casp.] in Israel. Phytopathologia Mediterranea, 11(1):30-36.
18. Palti J, 1989. Epidemiology, prediction and control of onion downy mildew caused by *Peronospora destructor*. Phytoparasitica, 17(1):31-48.
19. Premila A. 2013. Fungal airspora over onion field in Manipur valley. International Journal of Current Science &Technology 2: 177 – 79.
20. Rashtra Vardhana, 2017. Plant's diseases of district Ghaziabad and adjacent areas.Plant Archives, 17(1) 727-732. http://www.plantarchives.org/PDF%2017-1/727-732%20(3511).pdf
21. Research articles from journals like Plant Disease, Journal of Plant Pathology, and Indian Phytopathology.
22. Ross IA. 2001. Medicinal Plants of the world: Chemical Constituents, Traditional and Modern Medicinal Uses. Vol 2. Humana Press, Totowa. 487p.
23. Rostovzev, S.I. (1903) Beitrage zur Kenntnis der Peronosporeen. Flora, 92, 405–430.
24. Runia, W. T., Heijne, B., de Visser, C. L. M., & van der Gaag, D. J. (2020). Forecasting downy

mildew (*Peronospora destructor)* in onion: Evaluation of three forecasting systems under Dutch conditions. Agronomy. 10(5): 738.

25. Schwartz, H. F., Mohan, S. K. (2008). Compendium of Onion and Garlic Diseases and Pests. APS Press.
26. Shabeer Ahmad, Karimullah, 1998. Relevance of management practices to downy mildew in onion. Sarhad Journal of Agriculture, 14(2):161-162; 4 ref.
27. Sharma IM, 1997. Reaction of onion lines to downy mildew caused by *Peronospora destructor*. Journal of Mycology and Plant Pathology, 27(3):324-325; 5 ref.
28. Sharma RC, Gill SS, Neelu Kohli, 2002. Pathological problems in production and storage of onion seed in Punjab and their remedial measures. Seed Research, 30(1):134-141.
29. Sharma, R.L. and Sharma, N. (2019). Incidence and yield loss relationship of onion downy mildew (*Peronospora destructor*) in Himachal Pradesh. Indian Phytopathology. 72(4): 605-611.
30. Singh BM, Dhanbir Singh, Paul YS, 1987. Outbreak of downy mildew of onion in Himachal Pradesh. Plant Disease Research, 2(2):124.
31. Sudhakara T (2014) Characterization of muskmelon local types of Karnataka for morphological traits, nutritional qualities and resistance to downy mildew disease. M. Sc. Thesis, Univ. Hortic. Sci., Bagalkot (India), pp. 1-91.
32. Thakur R.P. and Kusum Mathur. (2002). Downy Mildews of India. Crop Protection. 21: 333-345.
33. Viranyi F. 1975.Studies on the biology and ecology of onion downy mildew (*Peronospora destructor*) Berk. (Fries) in Hungary. Epidemiology of the disease. Acta Phytopathologica Academiae Scientiarum Hungaricae 10:321-28.
34. Wheeler, B.E.J. (1969). An Introduction to Plant Diseases., John Wiley and Sons Limited, London, p. 301.