OPEN ACCESS

Saudi Journal of Pathology and Microbiology

Abbreviated Key Title: Saudi J Pathol Microbiol
ISSN 2518-3362 (Print) |ISSN 2518-3370 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Occurrence of Self-fertile *Phytophthora infestans* Isolates and Oospore Formation on Tomato in Arunachal Pradesh, India

Dr. Raghuveer Singh[1*]

[1]Indian Council of Agricultural Research (ICAR) Research Complex for North-East Hills (NEH) Region, Arunachal Pradesh Centre, Basar-791101, India

DOI: https://doi.org/10.36348/sjpm.2025.v10i05.002 | **Received:** 23.06.2025 | **Accepted:** 25.08.2025 | **Published:** 28.08.2025

***Corresponding author:** Dr. Raghuveer Singh
Indian Council of Agricultural Research (ICAR) Research Complex for North-East Hills (NEH) Region, Arunachal Pradesh Centre, Basar-791101, India

Abstract

Late blight, caused by *Phytophthora infestans*, is a devastating disease of tomato, primarily driven by asexual reproduction through sporangia and zoospores. This study presents the first confirmed report of self-fertile *P. infestans* isolates in Northeast India, capable of producing sexual oospores, signifying a major shift in the pathogen's survival strategy. Infected tomato plants collected between November and December were cultured on rye agar at 18 ± 1°C. Oospore initiation occurred after 28 days, with mature oospores averaging 35 µm in diameter. These self-fertile isolates formed oospores independently and exhibited pathogenicity as confirmed by Koch's postulates. Field observations over five years in semi-temperate conditions (10–17°C, high humidity) confirmed oospore formation in senescing tissues. This discovery suggests that *P. infestans* may now overwinter in soil via oospores, increasing its persistence and genetic diversity, and possibly resulting in earlier and more severe outbreaks. These findings highlight the urgent need for integrated management strategies targeting both asexual and sexual propagules.

Keywords *Phytophthora infestans*, oospore, self-fertile isolates, Northeast India.

Late blight of tomato (*Solanum lycopersicum* L.), caused by *Phytophthora infestans* (Mont.) de Bary, is one of the most destructive diseases affecting tomato cultivation worldwide (Singh *et al.,* 2022). It is responsible for an estimated annual yield loss of approximately USD 170 billion globally (Wu *et al.,* 2012). In India, yield losses due to late blight have been reported to reach as high as 79% under favorable conditions (Chowdappa *et al.,* 2015). The pathogen predominantly propagates through asexual means via sporangia and zoospores, but sexual reproduction through oospore formation significantly contributes to its long-term survival, particularly in temperate and semi-temperate regions (Romero and Irwin 1969; Flier *et al.,* 2002).

Historically, sexual reproduction of *P. infestans* was thought to occur only in its center of origin, Mexico, where A1 and A2 mating types coexist. However, the detection of A2 mating type in Europe (1984) and later in India (1990) indicated the potential for sexual reproduction outside Mexico (Sharma and Singh 2013). This study reports the occurrence of self-fertile *P. infestans* isolates in Northeast India that can produce oospores without the need for a mating partner, raising concerns about the pathogen's evolutionary potential and long-term persistence.

Long-term observations in semi-temperate fields of ICAR Research Farm, Gori, Arunachal Pradesh (27.59350 N, 94.42170 E; 705 MSL), India, have consistently shown late blight epidemics occurring at the end of December, coinciding with the senescence of tomato plants (Singh *et al.,* 2022). In December 2024, tomato plants exhibiting late blight symptoms were observed in research plots at the ICAR Research Farm, Gori. Symptoms included irregular, water-soaked lesions with characteristic whitish sporulation under high humidity. Infected leaf, stem and fruit were collected (Fig. 1) and incubated in a moist chamber for 48 hrs. The causal agent was isolated using the standard tissue isolation method on rye-A agar medium (Hollomon 1965). The purified isolate was subjected to a pathogenicity test by inoculating *P. infestans* onto four-week-old susceptible tomato cv. Pusa Ruby (Loliam *et al.,* 2012).

Fig. 1: Typical initial symptoms appeared as small, irregular and water-soaked spots on leaf and petioles and dark olivaceous and greasy spots on fruits

Morphological identification followed the criteria of Waterhouse (1963). The isolate exhibited fluffy, cottony mycelium with a slow growth rate on rye B agar medium (Fig. 2). Microscopic examination revealed hyaline, moderately thick, coenocytic, and profusely branched hyphae. Sporangiophores were sympodial, with small swellings at the base of each branch (Fig. 3). Sporangia were terminal or lateral, ellipsoid, limoniform, semi-papillate, deciduous, and pedicellate, with greater abundance on infected tomato plants than in pure culture.

Fig. 2: Single lesion tissues inoculated on rye-A agar medium and fluffy cottony mycelium in Petri plate

Microscopic analysis confirmed the presence of spherical, thick-walled, double-layered oospores (35 µm in diameter, with a 5 µm wall thickness) in diseased and senescing tomato tissues. To verify oospore formation, *P. infestans* isolates from the same research plots were inoculated on rye B agar medium in Petri plates. After 28 days of incubation at 18°C, microscopic examination of slide preparations from the hyphal region of the culture revealed thick-walled, globose oospores, morphologically identical to those observed in infected plant tissues. Micrograph exhibited oospores encapsulated within an oogonium, as well as detached oospores associated with hyphal structures (Fig. 4). The presence of adjacent antheridial and oogonial structures

further supports sexual reproduction. The transparent outer layer enclosing the oospore within the oogonium confirms its sexual origin, indicating the self-fertile mating types in the region.

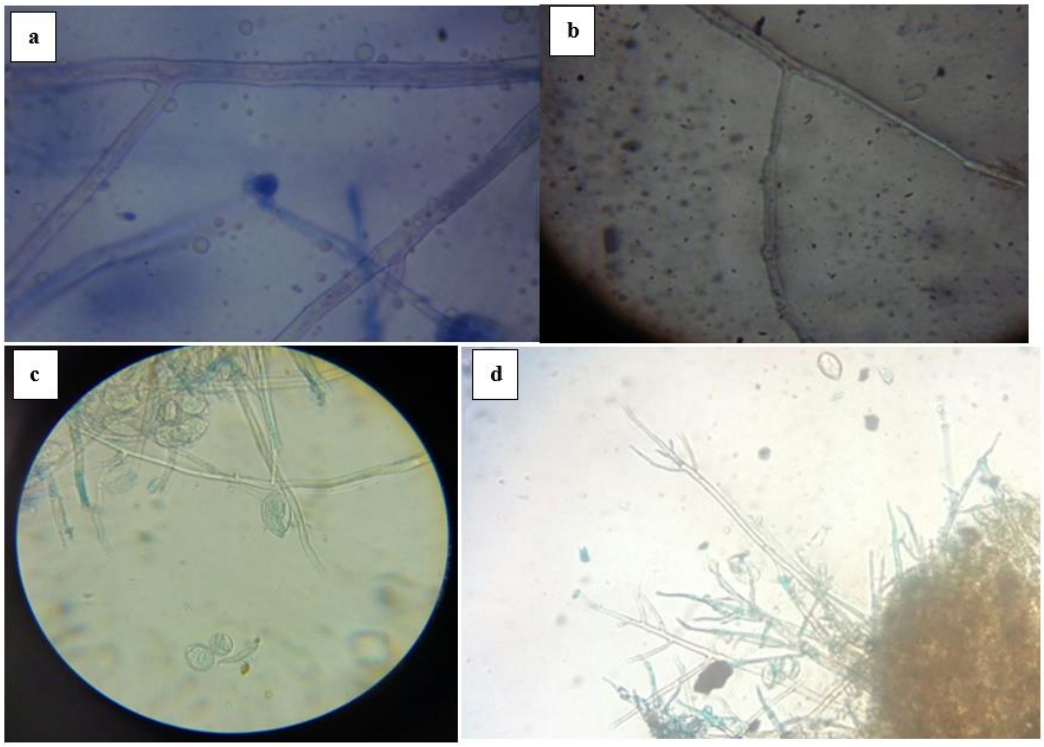

Fig. 3: Microscopic view: (a) Hyaline, profusely branched, coenocytic, moderately thick hyphae at 45 x, (b) Sympodial with nodal swellings of sporangiophore at 45 x; (c) Sporangiophore with sporangium at 45 x; (d) Branching pattern of sporangiophore at 45 x

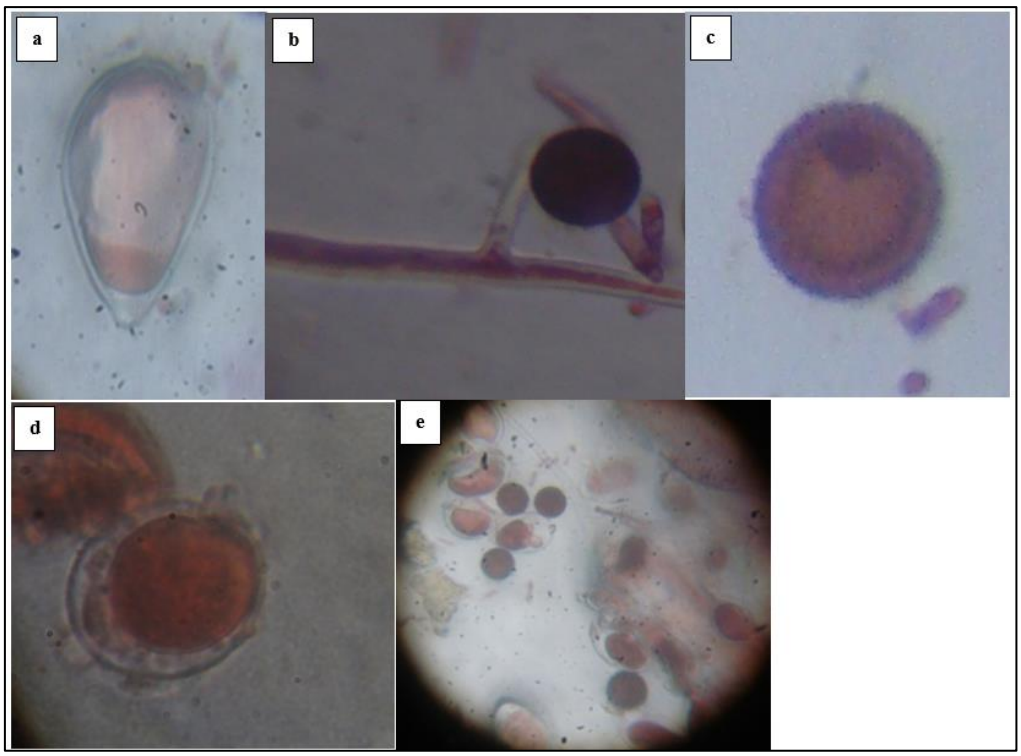

Fig. 4: Microscopic view: (a) A hyaline, limoniform, an apical papilla on sporangium at 100 x; (b) Presence of adjacent antheridial and oogonial structures with oospores at 45 x; (c) Thick-double walled oospores from pure culture at 45 x; (d) Displayed oospores encapsulated within an oogonium; (e) Oospores from plant tissues samples at 10 x

This study provides the first confirmed evidence of *P. infestans* oospore formation in Northeast India, both in infected tissues and under in vitro conditions. The detection of oospores marks a significant shift in the epidemiology of late blight, as these structures can persist in soil for extended periods, potentially leading to early-season outbreaks and complicating disease management strategies (Cohen and Rubin 2000). Sexual recombination may also contribute to the emergence of new, more virulent strains, increasing the challenge of disease control (Romero and Irwin 1969).

Further research is necessary to evaluate the viability, infectivity, and geographical distribution of oospores across different agro-climatic regions in India (Sharma and Singh 2013). Understanding their role in the disease cycle is crucial for developing long-term management strategies, including resistant cultivar deployment, improved forecasting models, and sustainable disease control measures.

Ethical Approval: Not required.

Competing Interests: There is no conflict of interest.

Funding: This is Institute approved project (IXX17154) works, so there is no external funding agencies involved.

Data Availability: Available on request from the author.

Acknowledgment: I extend my gratitude to the Director, ICAR Research Complex for NEH Region, Umiam for providing research facilities.

REFERENCES

- Chowdappa P, Kumar NBJ, Madhura S, Myers KL, Fry WE, Cooke DL (2015) Severe outbreak of late blight on potato and tomato in south India caused by recent changes in the *Phytophthora infestans* population. Plant Pathol 64: 191-199
- Cohen Y, Rubin AE (2000) Oospore production of *Phytophthora infestans* in potato and tomato leaves. Phytopathology 90(10): 1121-1126
- Flier WG, Kessel GJT, Van den Bosch GBM, Turkensteen LJ (2002) Assessing the threat of oospore inoculum in potato late blight. Eur J Plant Pathol 108(6): 495-502
- Hollomon DW (1965) Isolation of *Phytophthora infestans* from blighted leaves. Plant Pathol 14:34–35
- Loliam B, Morinaga T, Chaiyanan S (2012) Biocontrol of *Phytophthora infestans*, fungal pathogen of seedling damping-off disease of economic plant nursery. J Entomol http://dx.doi.org/10.1155/2019/324317
- Romero S, Irwin JAG (1969) Germination of oospores of *Phytophthora infestans*. Trans Br Mycol Soc 52(2): 237-245
- Sharma KK, Singh BP (2013) Detection of self-fertile isolates of *Phytophthora infestans* in India. Potato J 32 (3-4). https://epubs.icar.org.in/index.php/PotatoJ/article/view/33539
- Singh R, Ao NT, Kangjam V, Rajesha G, Banik S (2022) Plant growth promoting microbial consortia against late blight disease of tomato under natural epiphytotic condition. Indian Phytopathol 75 (2): 527-539
- Waterhouse GM (1963) Key to the species of *Phytophthora* de Bary. Mycol Pap 92:22
- Wu Y, Jiang J, Gui C (2012) Low genetic diversity of *Phytophthora infestans* population in potato in north China. Afr J Biotechnol 11 (90): 15636-15642