Indian J. Applied & Pure Bio. Vol. 40(2), 1135-1139 (2025). **ISSN: 0970-2091**
A Web of Science Journal

Impact and Transmission Dynamics of *Pseudomonas syringae* pv. *syringae* isolated from Onion Crop grown in Alwar district of Rajasthan

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Abstract

Alwar district in Rajasthan is a significant contributor to the Rajasthan state's onion production. This study investigated the phytopathological effects and disease transmission of bacterial pathogen *Pseudomonas syringae* pv. *syringae* in onion seeds and seedlings using field and pot experiments. Two onion seed samples, Psos-2102 (healthy) and Psos-2116 (symptomatic) were evaluated. In field trials, Psos-2102 showed 100% germination, whereas Psos-2116 exhibited a reduced germination rate of 92%, with a total pre- and post-emergence loss of 16%. Pot experiments revealed similar trends, with Psos-2102 achieving 100% germination and Psos-2116 showing a slightly lower germination rate of 96%. Symptomatic seedlings displayed irregular lesions with pale yellow to brown discoloration, leading to a 4% pre- and post-emergence loss. Despite initial losses, the harvested bulbs were free of bacterial symptoms, emphasizing the critical need for managing bacterial pathogens to safeguard onion crop productivity.

Key words : Bacterial pathogen, Crop loss, Disease transmission, Onion, Seed germination.

Onion (*Allium cepa*) is a globally cultivated crop essential for its culinary and medicinal properties. However, onion production faces numerous challenges, including bacterial diseases caused by *Pseudomonas syringae* pv. *syringae*. This pathogen is responsible for leaf blight, bulb rot, and reduced yield, leading to significant economic repercussions[5]. The pathogen is prevalent in temperate and subtropical regions, thriving in cool, wet conditions. Optimal temperatures for infection range between 12°C and 25°C [12]. The bacterium survives epiphytically on leaf surfaces, in plant debris, and in association with non-host plants[8], serving as reservoirs for future infections. Environmental factors such as high humidity, frost, and mechanical injuries caused by hail or heavy rainfall enhance susceptibility to infection. It can overwinter in plant tissues and soil, ensuring its persistence

across seasons[9,10].

In this study, the effects and transmission of isolated *Pseudomonas syringae* pv. *Syringae* bacterial pathogen from onion crop grown in Alwar district of Rajasthan were studied. Onion seed samples naturally infected with *P. syringae* pv. *Syringae* acc. no. Psos-2102 (Healthy) and Psos-2116 (Symptomatic) were selected to study the phytopathological effects and disease transmission using field experiments and pot experiments.

During the field visits and experiments, the onion crop was studied to observe various symptoms and development of disease. The symptomatic and healthy seedling, plant and bulbs were collected, assayed for presence of bacterial pathogens and characterized using standard methods.

Two onion seed naturally infected with *Pseudomonas syringae* pv. *syringae* (acc. no. PSOS-2102 and PSOS-2116) were selected for the phytopathological and transmission experiments. The experiments were carried out using pot experiment and field experiment. Twenty five seeds symptomatic and healthy seeds per sample (5 seed per pot) were sown in earthen pots. After sowing, the seeds were covered with fine powdered farmyard manure followed by light watering. All the pots were watered every week for 5-7 irrigations.

In the field experiments, experimental plots of onion crop of 30x30m size were used. The onion seeds were sown to raise nursery. Each experimental plot consists of 60 rows. The spacing was about 15 cm between rows and about 10 cm between plants. Seedlings raised from nursery were transplanted to experimental plots and watered regularly until 12-15 days before maturity of crop.

The percentage of seed germination, ungerminated seeds, symptomatic seedlings, pre and post emergence losses, disease symptoms and mortality of plants were recorded up to bulb maturation at weekly intervals.

Symptomatic plants/plant parts/bulbs were harvested and assayed for the presence of bacterial pathogen by plating on nutrient agar medium and characterized using standard methods.

Onion seed samples acc. no. Psos-2102 (Healthy) and acc. no. Psos-2116 (Symptomatic) were used to study the phytopathological effects and disease transmission of the bacterial pathogen (Fig. 1).

(i) *Field experiment :*

The nursery of onion seedlings was raised in a separate plot by sowing 25 seeds per sample. The seed germination was 100% for Psos-2102 and 92% for sample Psos-2116 (Fig. 1C). The ungerminated seeds were 8% for Psos-2116. Raised seedlings were transplanted into experimental plots and 2 seedlings died after 8-12 days of transplantation. Mortality was observed due to presence of yellow to light brown spots on seedlings. Later the leaves of seedlings wither and died. The pre and post emergence total loss was recorded 16%. The harvested bulbs were found healthy and without any bacterial symptoms.

(ii) *Pot experiment :*

The seeds sown into pots showed

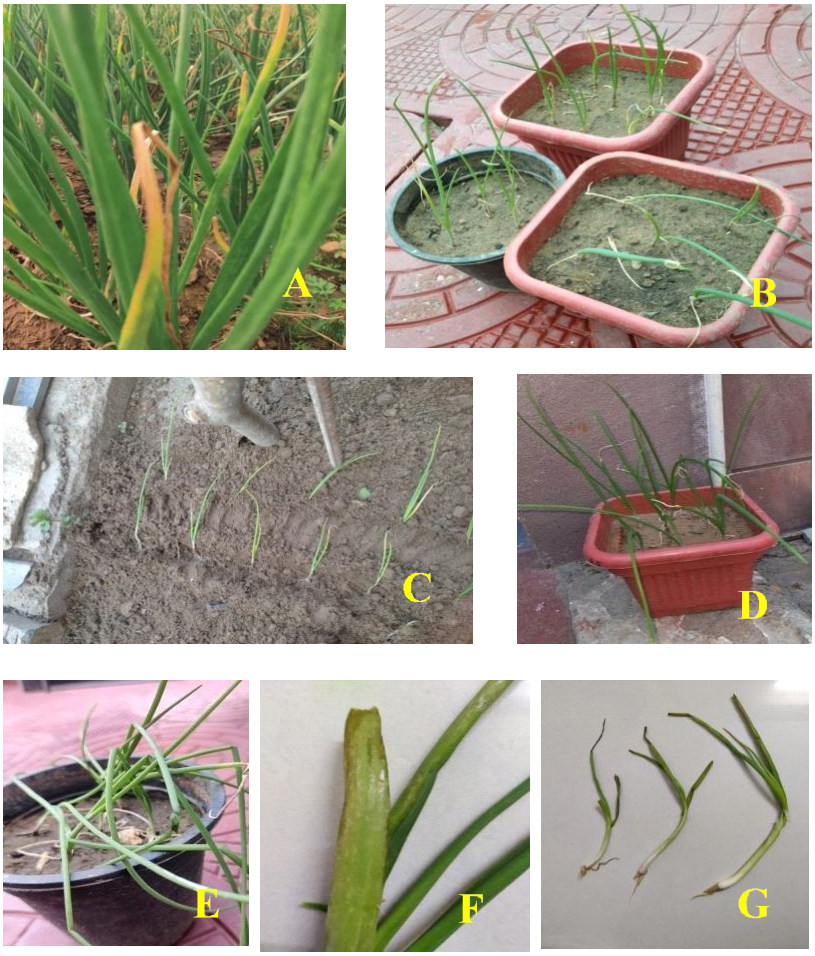

Fig. 1. Phytopathological effects and disease transmission studies on *Pseudomonas syringae* pv. *syringae.* (Pot experiments and studies) **A.**Appearance of typical leaf necrosis disease symptom caused by *P. syringae* pv. *Syringae.* **B.** Experimental pots showing germination and health variation of onion seedlings. **C.** Transplantation of seedlings on experimental plot. **D&E.** Healthy raised plants on pots. **F.** Harvested symptomatic plant with yellow to light brown irregular spots**. G.** Categorization of healthy and symptomatic plants for transmission studies.

100% germination for Psos-2102 and 96% for Psos-2116 and 4% ungerminated seeds were recorded. The maximum 24% symptomatic seedlings were observed (Fig.). Seedlings showed irregular lesions with white margins of leaves (Fig. 17 B,D & E). The lesions were pale yellow to brown in color. Two to four weeks old 3 plants died before maturity. The pre and post emergence loss was recorded 4% due to bacterial pathogen.

The study aimed to investigate the phytopathological effects and disease transmission of a bacterial pathogen in onion seeds under different experimental conditions, specifically comparing a healthy seed sample (Psos-2102) with a symptomatic one (Psos-2116). In both field and pot experiments, the germination rate of the symptomatic seed sample (Psos-2116) was lower than that of the healthy sample (Psos-2102). This suggests that the presence of the bacterial pathogen might impair seed vigor or the germination process itself, similar to findings where seed-borne bacteria reduce germination rates in other crops[6].

In the field experiment, initial symptoms observed were yellow to light brown spots on seedlings, leading to leaf withering and eventual death of seedlings. This progression from spotting to total plant death indicates a severe pathogenic impact, possibly due to bacterial infection directly affecting plant tissue health or indirectly through compromising plant defences[4,7]. The pot experiment further corroborated these findings with visible symptoms of irregular lesions with white margins on the leaves, varying from pale yellow to brown. These symptoms are typical of bacterial infections, where the pathogen might produce toxins or disrupt the plant's water and nutrient transport, leading to necrosis, as seen in studies involving *Xanthomonas axonopodis* pv. *allii* [2,11].

The mortality rate was higher in the field experiment (16% total loss) compared to the pot experiment (4% loss), which might be due to environmental factors such as soil conditions, humidity, or microclimate variations that favour disease spread. The field setting likely provides more opportunities for pathogen dispersal through soil, water, or vectors like insects, similar to the epidemiology of bacterial diseases in seeds as described by Darasse *et al.*,[3]. In both settings, the symptomatic seedlings were significantly higher in number for Psos-2116, confirming that this seed lot harbors a more substantial bacterial load or a more virulent strain, leading to higher disease incidence, echoing the seed infestation studies by Schaad & Sowell[14].

Despite the observed symptoms and seedling mortality in the field, the harvested bulbs did not show bacterial symptoms. This could indicate that the bacterial infection might be primarily foliar, not significantly affecting the bulb directly, or there could be some form of recovery or resistance at later growth stages, reducing the impact on the bulb. This phenomenon aligns with observations where pathogens might not affect all parts of the plant uniformly[13,15].

The results underscore the importance of seed health in onion cultivation, similar to conclusions drawn by research involving seed-borne pathogens[1]. The symptomatic seeds (Psos-2116) not only had lower germination rates but also led to higher disease incidence, affecting crop health and potentially yield. This highlights the necessity of rigorous seed testing and treatment before sowing to control bacterial diseases. Further research could focus on identifying the pathogen at the molecular level, understanding its lifecycle, and developing strategies for effective seed treatment and disease management in onion crops, as suggested by various studies on seed pathology and bacterial diseases in onions[2,6].

The authors acknowledge Principal, Raj Rishi College, Alwar for the unwavering support and providing resources and guidance in conducting this study.

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