Impact of sowing dates and row spacing on the root rot incidence and seed yield of pea crop under field conditions

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ABSTRACT

Pea (*Pisum sativum* L) is an important cool-season legume cultivated widely for its fresh pods, seeds and foliage, yet its productivity is severely constrained by the root rot complex caused predominantly by the soil-borne pathogen *Fusarium solani* f sp *pisi*. During the rabi season of 2023, a field experiment was conducted at the Department of Plant Pathology, CCS Haryana Agricultural University, Hisar, Haryana to assess the influence of sowing dates and row-to-row spacings on disease incidence and seed yield in the pea cultivar HFP-529. The pathogen was isolated from symptomatic roots, purified and its pathogenicity validated using Koch's postulates. Early symptoms included reddish-brown lesions on roots, progressing to dark, coalescing necrosis and complete root disintegration. Sowing date significantly affected disease development: the earliest sowing (10 October) resulted in the highest incidence (33.61%) and lowest yield (18.78 q/ha), whereas, sowing on 10 November produced the maximum seed yield (22.25 q/ha). The lowest disease incidence (24.51%) was observed in the 25 November sowing. Row spacing also played a crucial role. A 20 cm spacing favoured the highest disease incidence (39.52%), while 50 cm spacing minimized disease (16.72%) but drastically reduced yield (14.30 q/ha). An intermediate spacing of 30 cm proved most effective, registering the highest yield (22.30 q/ha). The study demonstrates that optimizing cultural practices, particularly sowing window and plant spacing, offers an eco-friendly and practical strategy for reducing pea root rot and improving crop productivity.

Keywords: Pea root rot complex; *Fusarium solani* f sp *pisi*; HFP-529; sowing dates; row spacing

INTRODUTION

Pea (*Pisum sativum* L), belonging to the family Fabaceae (sub-family Papilionaceae) is an annual self-pollinated crop with fragile stems (Duke and Kakefuda 1981). It is globally grown for its tender fresh green seeds, dried seeds, green pods and foliage and is considered as the second most important legume crop worldwide after beans (Taran et al 2005). China, the largest producer of peas, produces about 11.82 million tonnes of peas each year, according to 2023 data. The country is followed by India, which grows around 6.59 million tonnes. Together, these two countries make up over 80 per cent of the world's total pea production (Kaur 2025). In India, pea is cultivated on a large scale especially in Haryana, Punjab, Uttar Pradesh and parts of Himachal Pradesh. Yield and quality of pea is adversely affected by a wide range of diseases such as root rot complex, seedling blight (*Pythium* spp), ascochyta blight (*Ascochyta pisi*), powdery mildew (*Erysiphe pisi*), downy mildew (*Peronospora pisi*), leaf spot (*Cladosporium pisicola*), grey mold (*Botrytis cinerea*), bacterial blight (*Pseudomonas syringae*), bacterial soft rot (*Erwinia carotovora*) etc. Out of these diseases, root rot complex disease is considered the most devastating as it affects the initial plant stand. It has been reported that more than 20 different pathogens viz *Fusarium solani* f sp *pisi*, *Aphanomyces euteiches*, *F oxysporum* f sp *pisi*, *Phoma medicaginis* var *pinodella*, *Rhizoctonia solani* and *Pythium* spp viz *Pythium vexans*, *P debaryanum*, *P aphanidermatum* etc are related with pea root rot disease from different regions of the world (Grünwald et al 2004). Among these, *F solani* f sp *pisi*, *A euteiches*, *R solani*, *Pythium* spp and

F oxysporum f sp *pisi* considerably damage the crop and reduce crop yield and quality.

The disease initially results in the inhibition of growth and development of the underground root system, which affects nutrient and water uptake, leading to stunted growth and the eventual drying of the plant (Oyarzun et al 1993). Recurrent cultivation of pea in the same fields brings about the build-up of inoculum causing considerable yield losses in the subsequent crops. The disease adversely affects the plant stand causing considerable yield losses and under favourable environmental circumstances, sometimes cause complete crop failure (Tu 1987). Reddish brown streaking of the roots near the cotyledon attachment point is one of the first symptoms of pea root rot. As the streaks combine, they form a black lesion that encircles the roots and epicotyl. The roots of infected plants grow dark and weak as the root rot progresses and they commonly disintegrate when they are removed from the soil.

Since root rot of pea is a serious threat to profitable cultivation of pea, efforts have been made to manage the disease through chemicals (Singh et al 2014), bio-agents (Hamid et al 2012) and cultural interventions (Tu 1987). There is virtually little information regarding the pathogen(s) associated with disease complex, their synergistic/antagonistic effects on its development and role of cultural practices for minimizing the incidence of this disease.

However, development of fungicide-resistant phytopathogenic strains and adverse effect of pesticides on soil, plant health and crop products have compelled plant pathologists to look for ecofriendly strategies for plant disease management. Further, the soil borne nature of the disease has rendered disease management through fungicides a difficult task. Therefore, thrust is laid on developing ecofriendly approach with respect to cultural operations for minimizing root rot disease of pea crop. Thus present study was undertaken to generate ecofriendly approach for the management of the disease.

MATERIAL and METHODS

Present investigations on the effect of date of sowing and row spacing distance on root rot disease of pea and on seed yield under field conditions were conducted at research farm, Department of Plant Pathology, Chaudhary Charan Singh Haryana Agricultural University, during rabi 2023. The laboratory experiments for pathogenicity test were carried out at the Department of Plant Pathology, College of Agriculture, CCS Haryana Agricultural University, Hisar, Haryana.

Isolation, purification of *Fusarium solani* f sp *pisi* and its pathogenicity test

Symptomatology

Belowground and aboveground symptoms of pea root rot were recorded.

Belowground symptoms on roots: Root portions that were affected with root rot disease showed reddish to brown lesions as preliminary symptoms near the soil line and below it. As the disease progressed, these lesions became dark brown to black and the lesions later coalesced and spread throughout the roots. Lateral roots were observed rotted and reduced with distorted root hairs. Diseased roots were completely sloughed and macerated. No vascular discoloration was observed when diseased roots showed initial symptoms of rotting which were cut longitudinally. However, in later stages of disease development, there was an extensive tissue disintegration and discoloration and progressed to the interior to the roots.

Aboveground symptoms: Root rot affected plants showed typical yellowing of the lower leaves which later on progressed towards the top of the affected plant. As the disease progressed, the lower leaves seemed wilted.

Isolation of the pathogen

Pea plants showing typical root rot symptoms were collected from the pea fields and subjected to isolation of pathogens in the laboratory. Isolation of the pathogens was carried out from the root portions showing the root rot symptoms. The fungus was isolated on potato dextrose agar from black to brown necrotic spots of infected roots of pea under aseptic conditions by using the tissue bit isolation technique. The fungal mycelial growths emanating from these inoculated tissues bits were pertaining to *F solani* f sp *pisi.*

Purification and maintenance of the pathogen

The pure culture of suspected colonies was obtained by hyphal tip technique. *F solani* f sp *pisi* produced profusely branched, septate dense mycelium which was initially white in colour and later turned to creamy white on PDA (Plate 1). The isolated fungus produced two types of spores viz macroconidia and

(A) (B)

Plate 1. Pure cultures of root rot pathogen, *Fusarium solani* f sp *pisi* (A) On PDA, (B) On slants

microconidia. Macroconidia were fusiform, cylindrical and moderately curved with a short blunt apical point, with three to five septa. The microconidia were cylindrical to ovoid with one to two septa.

The pure culture of the pathogen was maintained separately on PDA medium. Further sub-culturing was done at 30 days intervals and the culture was stored in refrigerator at 4°C for further studies (Plate 1).

Pathogenicity test

In order to prove the Koch's postulates, pathogenicity of the isolated pathogen ie *F solani* f sp *pisi* was established using sick soil plot method under open field condition (Plate 2). In *F solani* f sp *pisi* inoculated plants, typical symptoms of the disease appeared after twenty days of inoculation. The leaves first started dropping and yellowing followed by the death of the whole plant. The roots were rotten when examined after the plants were excavated from the pots. The infected seedlings displayed reddish brown to dark brown necrotic streaks on collar region of the stem. On examination of roots, they were observed to be of reduced size and showed the rotting symptoms. The infected plants could easily be pulled out from the soil and there was collapse of whole root system. The infected root portion was collected and pathogen was re-isolated on PDA medium and its cultural characteristics were identical with original culture and, hence proved Koch's postulates.

In vivo evaluation of efficacy of cultural management against *Fusarium solani* f sp *pisi*

The experiment was conducted in plot size of 2×2 m^2 using RBD with five replications under natural conditions. The pea variety HFP-529 was sown at four different row-to-row spacings viz 20, 30, 40 and 50 cm on four different dates viz 10 October 2023, 25 October 2023, 10 November 2023 and 25 November 2023. All the agronomical practices were done as per the package of practices for rabi crops of CCS Haryana Agricultural University, Hisar, Haryana.

RESULTS and DISCUSSION

Effect of different sowing dates on pea root rot complex and seed yield

Data on the effect of sowing dates on disease incidence and seed yield are tabulated in Table 1. The crop sown on 10 October 2023 recorded the highest (33.61%) root rot incidence at flowering stage with minimum seed yield (18.78 q/ha). However, the minimum root rot incidence of 24.51 per cent was recorded in crop sown on 25 November 2023. The maximum seed yield of 22.25 q per ha was recorded in the crop sown on 10 November 2023, followed by crop sown on 25 November 2023 and 25 October, 2023 with seed yield of 21.63 and 19.20 q per ha respectively.

Effect of row to row spacing on root rot disease of pea

Four different row to row spacings viz 20, 30, 40 and 50 cm with five replications were maintained during sowing of pea crop using same variety HFP-529. The results obtained in respect of effect of row spacing on disease incidence and seed yield are presented in Table 2. The crop with row to row spacing of 20 cm recorded the maximum disease incidence of 39.52 per cent at flowering stage, followed by spacing of 30 and 40 cm with disease incidence of 28.67 and 20.67 per cent respectively. Minimum disease incidence of 16.72 per cent was recorded in the crop with row to row spacing of 50 cm. The maximum seed yield of 22.30 q per ha was recorded in the crop with row to row spacing of 30 cm followed by 20 and 40 cm with

Table 1. Effect of sowing date on incidence of root rot and seed yield of pea under field conditions in rabi 2023

Sowing date	Root rot incidence at flowering stage (%)	Seed yield (q/ha)
10 October 2023	33.61 (35.42)	18.78
25 October 2023	32.51 (34.75)	19.20
10 November 2023	25.38 (30.24)	22.25
25 November 2023	24.51 (29.66)	21.63
$CD_{0.05}$	0.17	

Figures in parentheses are angular transformed values

Table 2. Effect of row to row spacing on incidence of root rot and seed yield of pea under field conditions in rabi 2023

Spacing (cm)	Root rot incidence at flowering stage (%)	Seed yield (q/ha)
20	39.52 (38.96)	21.00
30	28.67 (32.36)	22.30
40	20.67 (27.03)	16.40
50	16.72 (24.13)	14.30
$CD_{0.05}$	0.23	

Figures in parentheses are angular transformed values

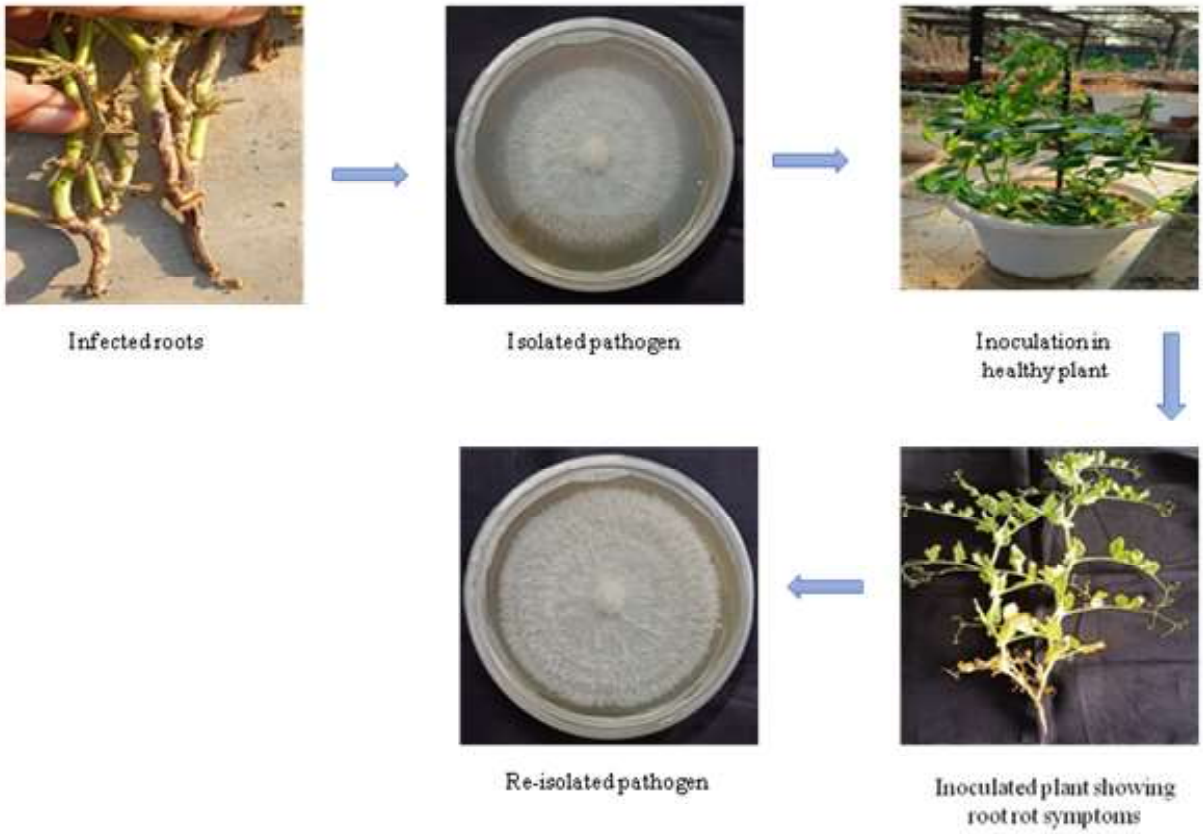

Plate 2. Pathogenicity test of *Fusarium solani* f sp *pisi*

seed yield of 21.00 and 16.40 q per ha respectively. The lowest seed yield of 14.30 q per ha was recorded in the crop with row to row spacing of 50 cm.

It was thus found that the ideal combination for maximum productivity was sowing on 10 November with a row-to-row spacing of 30 cm. In an area historically prone to severe root rot, delaying sowing to 25 November while maintaining the 30 cm spacing was advisable. The early sowing date (10 October), led to both the highest disease and lowest yield.

Merkuz and Getachew (2012) reported that disease incidence was higher in crop sown 12 September 2007 (93.40%) and 12 October 2007 (94.60%) and lower in crop sown on 27 September 2007 (90.20%). Landa et al (2004) also reported that sowing delayed from winter (January) to early spring (March) increases fusarium wilt intensity caused by *F oxysporum* f sp *ciceris.*

Prusinski and Borowska (2022) recorded no effect of row spacing on pea yield. Peksen et al (2002) obtained the highest green pod yield of Utrillo and Sprinter cultivars of pea (14.49 tonnes/ha) from 20 cm row spacing. Thakur et al (2025) observed that spacing of 45 cm × 10 cm resulted in maximum pod yield per ha of garden pea. Wide spacing of 60 cm × 10 cm accompanied with 125 per cent fertility level resulted in maximum pod yield per plant.

Sing et al (2025) reported that among different time of plantings tested, 13 December planting recorded the highest disease severity and minimum grain yield. It was also noticed that row spacing had significant influence on disease severity. The minimum disease severity was recorded in plots having wider row spacing (45 cm) followed by 37.5 and 30 cm.

CONCLUSION

The present investigations highlight the pivotal role of cultural practices in mitigating the pea root rot complex and enhancing productivity in HFP-529. The results clearly show that early sowing increases disease pressure, possibly due to favourable soil and moisture conditions for the pathogen. Conversely, sowing around mid-November offers the best balance between reduced disease incidence and optimum plant growth, resulting in the highest seed yield. Row spacing strongly influenced disease development and yield, with narrower spacing (20 cm) promoting disease due to denser canopy microclimate and restricted aeration, while excessively wide spacing (50 cm) reduced yield despite lowering disease incidence. The 30 cm spacing emerged as the most suitable, combining efficient resource use with reduced disease favourability.

Overall, the study confirms that environmentally sound practices optimal sowing time and balanced row spacing can significantly curb the impact of *Fusarium solani* f sp *pisi* and allied pathogens. These insights offer a practical, low-cost and sustainable foundation for developing integrated disease management strategies for pea cultivation in regions facing similar soil-borne disease challenges.

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