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Short Communication

Influence of different sowing dates on stem rot disease in pea and its management

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ABSTRACT

Stem rot caused by *Sclerotinia sclerotiorum* (Lib.) de Bary is a major soil-borne disease that attacks a large number of crops, including peas. Incidence of this disease was studied over two consecutive years (2023-24 and 2024-25). Results revealed that the lowest percentage disease index (PDI) and disease incidence were observed in the November 16th sowing (late sowing), specifically, at 90 days after sowing (DAS), the PDI was 20.66% and the disease incidence was 23.66%. Conversely, the highest PDI (44.00%) and disease incidence (47.33%) were recorded at 90 DAS for the October 16th sowing (control). This shows that late sowing significantly reduces stem rot impact and potential crop losses, possibly by allowing the crop to avoid peak disease exposure. Also, during these two years, three sprays at 60, 75 and 90 DAS were given, and they significantly controlled the stem rot disease of pea. Metiram 55% + Pyraclostrobin 5% WG consistently showed the lowest (PDI) and highest disease control at each spray. Salicylic acid and *Trichoderma harzianum* also exhibited good control. Thus, these can be recommended for use against the disease.

***Key words*:** Disease control, Metiram and Pyraclostrobin, Per cent disease index, Salicylic acid, Stem rot and *Trichoderma harzianum*.

Peas (*Pisum sativum*) are one of the oldest cultivated leguminous crops, with evidence of their domestication dating back to around 7,000 BCE in the Near East (Smýkal *et al*. 2012). Belonging to the legume family, peas are a rich source of protein, fibre and essential vitamins, making them a valuable component of diets around the world. In addition to their nutritional value, peas contribute to sustainable agriculture through nitrogen fixation, improving soil fertility and reducing the need for synthetic fertilizers (Mandal *et al*. 2005). India ranks 4th in area as well as in production under pea cultivation after Russia, Canada and China, respectively. The total area under pea cultivation is 7.62 lakh ha with a production of 10.04 lakh tons. India's productivity is 1318 kg/ha (Anonymous 2022).

Pea cultivation in this region is affected by multiple biotic and abiotic constraints. Major fungal diseases like stem rot (*Sclerotinia sclerotiorum*), powdery mildew (*Erysiphe Polygoni*) and Fusarium wilt (*Fusarium oxysporum* f. sp. *pisi*) significantly reduce yields, along with insect pests such as pod borers (*Helicoverpa armigera*) and aphids (*Aphis craccivora*). Environmental challenges, including erratic rainfall, frost and soil nutrient depletion, further hinder production. Among these, stem rot caused by *Sclerotinia sclerotiorum* is particularly devastating, which has the potential to cause significant crop loss, with recorded disease occurrences ranging from 60% to 80% and yield reductions varying from negligible to complete loss across numerous economically vital crops globally (Shukla 2005) while in pea this disease alone can cause upto 5 to 40 % yield loss (Singh 2022). *Sclerotinia sclerotiorum* (Lib.) de Bary is a widespread fungus that induces stem rot disease across a diverse range of crops. This soil-dwelling, necrotrophic pathogen is notably destructive and lacks host specificity, displaying a near-global distribution and affecting numerous plant species (Mehta 2009). The pathogen produces sclerotia, which are dormant structures capable of persisting for long periods in the soil. Stem rot is considered as a major soil-borne disease.

Contributing factors to disease outbreaks include the use of infected seeds, repeated cultivation of the same crop (monoculture), successive planting of susceptible crop varieties, cool night temperatures (below 18 ºC), extended periods of rainfall during crop growth, excessive nitrogen application, and improper irrigation practices (Leite 2005, Juliatti FC 2010).

The enormous production of sclerotia enables the fungus to remain viable in soil for over a decade and thus renders white mould a challenging disease to manage (Reis and Tomazini 2005). Stem rot can be managed through an integrated approach combining cultural, biological and chemical controls. Cultural practices include using sclerotia-free seeds, crop rotation with non-host plants for 3–5 years, open canopy cultivation, tillage, weed management and late sowing, which helps peas avoid infection. Biological control involves use of bio-agents like *Trichoderma* spp. *Pseudomonas* spp., *Bacillus* spp., etc. as seed treatments and soil drenches. For chemical control, fungicides should be applied at early disease symptoms or during flowering. Combining these strategies ensures effective disease suppression.

The present research was carried out at Acharya Narendra Deva University of Agriculture & Technology's Student Instructional Farm, situated 46 km from Ayodhya in the Indo-Gangetic plains (26.47 °N, 82.12 °E) at an elevation of 113 meters above mean sea level. The farm lies along the Ayodhya-Raebareli highway, providing an ideal agro-climatic setting for the study. The experiment investigated the influence of four distinct sowing dates on stem rot disease development and Percent Disease Index (PDI) in the pea variety NDVP 5 over two consecutive Rabi seasons (2023–24 and 2024–25). A randomized block design (RBD) with three replications was adopted, resulting in 12 experimental plots, each measuring 3 m × 3 m, with a planting spacing of 30 × 10 cm. The sowing treatments included four dates viz., 16th October (control), 26th October, 6th November and 16th November-maintained consistently across both years. Disease progression was monitored at 60, 75 and 90 days after sowing (DAS) to assess temporal variations in infection severity.

To evaluate management strategies against stem rot in pea, the study was conducted at Acharya Narendra Deva University of Agriculture & Technology's Student Instructional Farm, Ayodhya, during the 2023-24 and 2024-25 *Rabi* seasons. Efficacy of 10 treatments viz., T_1- seed treatment @ 2ml/kg + foliar spray + soil drenching with *Bacillussubtilis* @ 4kg in 100 kg FYM, T_2- seed treatment @ 10 g/kg + foliar spray @ 20 g/L + soil drenching with *Pseudomonas fluorescens* @ 20 g/L, T_3 - intercropping with fenugreek in the ratio of 1:1, T_4- seed treatment @ 5 g/kg + foliar spray + soil drenching with *Trichoderma harzianum* @ 5 kg/ha (the bio-agents were obtained from the Department of Plant Pathology, College of Agriculture, A.N.D.U.A.&T., Kumarganj, Ayodhya, U.P.), T_5-soil drenching with humic acid @ 0.1%, T_6- foliar spray 0.5g/L + soil drenching with salicylic acid, T_7- seed treatment with bijamrit @ 5 ml/kg + foliar spray with jeevamrit @ 200 L/acre + soil drenching with ghanamrit @ 100 kg/acre, T_8- foliar spray @ 2% + soil drenching with chitosan, T_9-foliar spray + soil drenching with Metiram 55% + Pyraclostrobin 5% WG (Promos) @ 500 ppm and T_{10}- control with two sprays of water was compared to treated plants against stem rot of pea. The data of the experiments conducted in the fields were subjected to statistical analysis using OPSTAT software. The critical differences were worked out at 5% probability level to find the difference between the treatments.

The data presented in Table 1 indicates that per cent disease index and disease incidence significantly increased with the advancement of crop growth stages and early sowing dates favoured disease development. The pooled data of two consecutive years, 2023-24 and 2024-25,

Table 1. Effects of different dates of sowing on the disease incidence and percent disease index of stem rot of pea (pooled mean of two years 2023-25)

Date of sowing	Disease incidence (%)			PDI (Percent disease index)			PDC (Percent disease control)		
	Pooled mean of two years (2023-24 and 2024-25)			Pooled mean of two years (2023-24 and 2024-25)			Pooled mean of two years (2023-24 and 2024-25)		
	60 DAS	75 DAS	90 DAS	60 DAS	75 DAS	90 DAS	60 DAS	75 DAS	90 DAS
16th October (Control)	37.33^{a}±1.33	41.99^{a}±0.66	47.33^{a}±2.67	33.99^{a}±1.33	38.66^{a}±1.33	44.00^{a}±2.00	0^{c}±0.00	0^{c}±0.00	0^{c}±0.00
26th October	33.99^{a}±1.33	37.00^{ab}±1.00	42.33^{a}±3.00	30.99^{ab}±1.66	34.33^{ab}±1.67	38.33^{ab}±2.33	10.81^{bc} ±3.30	11.20^{bc}±1.27	12.73^{bc}±1.34
6th November	28.66^{a}±2.00	31.66^{ab}±2.33	34.33^{ab}±1.00	24.66^{ab}±1.33	27.99^{ab}±1.33	30.99^{ab}±0.33	27.99^{b} ±1.63	27.53^{b}±0.92	29.45^{b}±2.42
16th November	20.33^{a}±1.67	22.66^{b}±0.66	23.66^{b}±1.33	15.00^{b}±1.00	18.33^{b}±1.00	20.66^{b}±1.33	53.50^{a}±4.59	52.50^{a}±1.00	52.93^{a}±1.11
CD (p=0.05)	1.49	3.70	6.00	1.26	1.27	4.10	9.3	2.57	8.04
CV (%)	1.50	3.37	4.93	1.46	1.29	3.71	12.25	3.42	10.26

reveals that the lowest percentage disease index (PDI) and disease incidence were observed in the November 16th sowing, specifically, at 90 days after sowing (DAS), the PDI was 20.66% and the disease incidence was 23.66%. This was followed by a PDI of 30.99% and a disease incidence of 34.33% at 90 DAS for the third sowing date (6th November). Conversely, the highest PDI (44.00%) and disease incidence (47.33%) were recorded at 90 DAS for the October 16th sowing (control). Similarly, maximum percent disease control (PDC) was observed in the late sown plot i.e., 16th November (52.93%) at 90 DAS, followed by the third sowing date at 6th November with PDC 29.45% while the lowest was in the second sowing date at 26th October with PDC 12.73%. Thus, this trend clearly shows that late sowing of the crop significantly reduces disease impact, thereby minimizing crop losses. In some instances, late sowing may even allow the crop to avoid disease exposure altogether, preventing damage. It shows that there is a critical role of cooler temperatures and high humidity in promoting stem rot development in the pea crop.

Studies consistently demonstrate that the timing of planting significantly impacts the severity of fungal diseases in crops, with later sowing dates generally leading to higher disease incidence. Research by Pal *et al.* (2018) on chickpea collar rot revealed that an October 15th sowing of one variety resulted in the highest disease levels, while a November 1st sowing of another variety showed the lowest. Similarly, investigations by (Arjun 2022) into *Sclerotinia* stem rot indicated that a November 21st sowing consistently led to the highest disease percentages across multiple seasons. Specifically, in one season, the November 21st sowing exhibited the highest incidence at 60 days after sowing, while an October 30th sowing showed the lowest. These findings collectively highlight the critical role that sowing date plays in influencing the susceptibility of crops to fungal pathogens.

During the first year (2023-24) and the second year (2024-25), after the first, second and third spray at 60, 75 and 90 DAS, all the treatments were found to be significantly effective against stem rot as compared with the control. The average of the two years revealed that minimum per cent disease index was recorded in the Metiram 55% + Pyraclostrobin 5% WG (23.00 %) treated plot, followed by salicylic acid (23.66 %) treated plot, *T.harzianum* (25.33 %), Humic acid (27.00 %), Chitosan (28.33 %), *Bacillus subtilis* (31.00%), Bijamrit + Jeevamrit + Ghanamrit

Table 2. Effects of the treatments on the stem rot of pea after first, second and third spray at 60, 75 and 90 DAS (pooled mean of two years 2023-25)

Treatment details	Percent Disease Index (PDI)			Percent disease control (PDC)		
	60 DAS	75 DAS	90 DAS	60 DAS	75 DAS	90 DAS
Seed treatment @ 2 ml/kg + foliar spray + soil drenching with *Bacillus subtilis* @ 4 kg in 100 kg FYM	21.66^{ab}±0.33	26.00^{ab}±0.66	31.00^{ab}±0.33	35.73^{bcd}±3.70	32.60^{cde}±0.44	29.29^{bcde}±4.09
Seed treatment @ 10 g/kg + foliar spray @ 20 g/L + soil drenching with *Pseudomonas fluorescens* @ 20 g/L	27.33^{ab}±0.67	30.00^{ab}±0.00	34.33^{ab}±0.66	19.33^{de}±1.24	22.09^{de}±2.60	21.77^{de}±2.70
Intercropping with fenugreek in the ratio of 1:1	29.00^{ab}±1.00	32.33^{ab}±1.00	35.66^{ab}±0.33	14.46^{ef}±0.67	16.43^{ef}±0.26	18.70^{e}±3.11
Seed treatment @ 5 g/kg + Foliar spray + Soil drenching with *Trichoderma harzianum* @ 5 kg/ha	18.00^{ab}±0.00	19.66^{b}±0.33	25.33^{b}±1.33	46.61^{abc}±2.40	49.15^{abc}±2.67	42.18^{abc}±0.43
Soil drenching with humic acid @ 0.1%	18.66^{ab}±0.00	21.00^{ab}±0.33	27.00^{ab}±0.33	44.52^{abc}±2.53	45.63^{abc}±1.10	38.15^{abcd}±1.89
Foliar spray 0.5 g/L + soil drenching with salicylic acid	16.66^{ab}±0.00	18.66^{b}±0.66	23.66^{b}±1.00	50.60^{ab}±2.23	51.52^{ab}±3.48	45.91^{ab}±0.20
Seed treatment with bijamrit @ 5 ml/kg + foliar spray with jeevamrit @ 200 L/acre + soil drenching with ghanamrit @ 100 kg/acre	24.00^{ab}±1.33	28.66^{ab}±0.00	31.66^{ab}±1.66	28.81^{cde}±7.01	25.74^{de}±2.55	27.41^{cde}±7.13
Foliar spray @ 2% + soil drenching with chitosan	20.00^{ab}±0.66	23.66^{ab}±0.33	28.33^{ab}±0.33	40.58^{abc}±4.51	38.57^{bcd}±1.15	35.64^{abcde}±2.11
Foliar spray + soil drenching with Metiram 55% + Pyraclostrobin 5% WG (Promos) @ 500 ppm	15.33^{b}±0.67	16.66^{b}±0.66	23.00^{b}±0.33	54.49^{a}±0.19	56.76^{a}±0.34	48.98^{a}±0.20
Control with two sprays of water was compared to treated	34.00^{a}±1.33	38.66^{a}±1.33	44.00^{a}±2.00	0^{f}±0.00	0^{f}±0.00	0^{f}±0.00
SEm±	0.90	0.85	0.93	2.43	2.21	2.48
LSD (5%)	2.68	2.51	2.76	7.23	6.55	7.36

(31.66 %), *Pseudomonas fluorescens* (34.33 %) treated plot and maximum per cent disease intensity was recorded in the plot in which intercropping with fenugreek was done (35.66 %) as compared to untreated check (44.00 %) (Table 2).

While maximum per cent disease control was found in the Metiram 55% + Pyraclostrobin 5% WG (48.98 %) treated plot, followed by the Salicylic acid (45.91 %) treated plot, *T. harzianum* (42.18 %), Humic acid (38.15 %), Chitosan (35.64 %), *Bacillus subtilis* (29.29 %), Bijamrit + Jeevamrit + Ghanamrit (27.41 %) and *Pseudomonas fluorescens* (21.77 %) treated plot and minimum per cent disease control was recorded in the plot in which intercropping with fenugreek was done (18.70 %) (Table 2). Arif *et al.* (2023) evaluated *Trichoderma* species that were obtained from rhizospheric soil samples of different locations and tested them for their antagonistic activity against major pulse pathogens. They found three potent *Trichoderma* isolates (Pipal TH-2, ATH-Kashipur, Mz/AP-2) inhibited major pulse pathogens by 52–83% and demonstrated plant growth-promoting traits. In the same way, studies by Yadav *et al.* (2024) evaluated biocontrol agents and plant extracts against *Sclerotinia sclerotiorum* and reported that *T. harzianum* showed the highest suppression (69.29 %), followed by *T. viride* and *P. fluorescens* (61.51 %). A study by Singh *et al.* (2024) showed that vitavax seed treatment showed 100% disease control (PESR) against chickpea collar rot, while hexaconazole (seed + drenching at 7 DAG) achieved 62.5 % PESM reduction and the highest yield (45.9 g/pot). Both out performed controls, proving integrated fungicide applications are most effective. These findings highlight the potential of both biological and chemical methods, particularly integrated strategies, in managing *Sclerotinia*-related diseasesin various crops.

The two-year research (2023-25) demonstrated that late sowing (November 16th) significantly reduced stem rot impact, with the lowest disease index (PDI) and incidence (19.33 % PDI, 23.33 % incidence) compared to early sowing (October 16th), which recorded the highest PDI (42 %) and incidence (44.66 %). Among treatments, Metiram 55 % + Pyraclostrobin 5 % WG was most effective, showing the lowest PDI (23 %) and highest disease control (48.98 %), followed by salicylic acid and *Trichoderma harzianum*, while intercropping with fenugreek was least effective. Thus, combining late sowing with targeted fungicides or biocontrol agents like Metiram + Pyraclostrobin or salicylic acid can optimally reduce losses due to stem rot.

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