



Plant Archives

Journal homepage: <http://www.plantarchives.org>

DOI Url : <https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.412>

EFFECT OF SEED TREATMENT WITH DIFFERENT COMBINATIONS OF *PSEUDOMONAS FLUORESCENS* AND ORGANIC AMENDMENTS FOR THE MANAGEMENT OF POWDERY MILDEW (*ERISIPHAE PISI*) AND RUST (*UROMYCES FABAE*) IN PEA (*PISUM SATIVUM* L.)

Aishwarya¹, Ajay Kumar Gautam¹, Anupam Kumar^{1*} Ritika Singh², Ravinder³, Shivani Kundal⁴, Manjula¹ and Pooja Thakur¹

¹Department of Plant Pathology, School of Agriculture, Abhilashi University Mandi, 175028, H.P., India

²Department of Genetics and Plant Breeding, School of Agriculture, Abhilashi University Mandi, 175028, H.P., India

³Department of Soil Science, School of Agriculture, Abhilashi University Mandi 175028, H.P., India

⁴Department of Microbiology and Crop Physiology, School of Agriculture, Abhilashi University Mandi, H.P., India

*Corresponding author E-mail: anupamkumar9616@gmail.com

(Date of Receiving : 26-04-2025; Date of Acceptance : 02-07-2025)

ABSTRACT

Pea (*Pisum sativum* L.) is a crucial leguminous crop widely cultivated in the mid hill regions of Himachal Pradesh due to its adaptability to the region's temperate climate and its role in enhancing soil fertility through nitrogen fixation. In recent years, pea production in Himachal Pradesh has faced several challenges, threatening the viability and sustainability of this important crop. One of the primary challenges is the increasing diseases incidence and disease severity, which has led to significant crop losses in some areas. In response to these challenges, there has been a growing interest in the use of bio-control agents. *Pseudomonas fluorescens* is a naturally occurring soil bacterium that has been widely studied for its ability to suppress plant pathogens. There are many fungal and bacterial diseases which are affecting the yield of pea but due to temperate and climatic conditions the most provident diseases were Powdery mildew and Rust in mid hill conditions of Himachal Pradesh. Field trials evaluating different seed treatments showed that all formulations of *P. fluorescens* combined with organic amendments significantly reduced both disease incidence and severity compared to the untreated control (T7). T4 (*P. fluorescens* + Mustard cake) was the most effective treatment in managing powdery mildew, reducing PDI 10.70% (2022–23) and 9.37% (2023–24), and PDS 23.04% and 23.64%, respectively T3 (*P. fluorescens* + Neem cake) was most effective against rust reducing PDI 10.68% (2022–23) and 10.02% (2023–24), and PDS to 27.04% and 23.73%.

Keywords : Pea, *Pseudomonas fluorescens*, Mustard cake, Neem cake and Diseases incidence.

Introduction

Pea (*Pisum sativum* L.) is a common leguminous crop that belongs to the family “Fabaceae”. “Faba” comes from a Latin word meaning “beans”. It is a crucial leguminous crop widely cultivated in the mid-hill regions of Himachal Pradesh due to its adaptability to the region's temperate climate and its role in enhancing soil fertility through nitrogen fixation (Dueholm *et al.*, 2024). It is a self-pollinated crop with chromosome number of $2n=14$ (Das and Kalloo, 1970). Pea cultivation not only supports the livelihood of

farmers but also contributes significantly to the agricultural economy of the state (Sharma *et al.* 2018). In recent years, however, pea production has faced challenges due to various diseases, necessitating the exploration of alternative sustainable agricultural practices (Verma & Thakur, 2020).

Himachal Pradesh, covering an area of 55,673 km², is a mountainous state where over 90% of the population is directly involved in agriculture and horticulture Aishwarya *et al.*, 2022. Due to its varied landscape and climatic conditions, the state is divided

into several agro-climatic zones, each favoring the cultivation of specific crops. One of these is the mid-hill zone, located between 651 and 1800 meters above sea level. This zone accounts for around 32% of the total geographical area and nearly 37% of the cultivable land, characterized by a mild temperate climate. Himachal Pradesh ranks fifth in pea production in India, with an annual output of 294.96 thousand metric tons (Upadhyay *et al.*, 2019).

The low yield of peas in our country can be attributed to various abiotic and biotic factors. Abiotic factors encompass fluctuations in temperature, humidity, and rainfall, which significantly impact pea production. On the other hand, biotic factors involve the attack of pests and pathogens, leading to crop damage, reduced yield, and compromised crop quality. The diseases affect the crop both quantitatively (yield) as well as qualitatively (seed quality) by several fungal (powdery mildew, rust, downy mildew, root rot, Alternaria blight, Aschochyta blight, wilt, anthracnose, damping off, seedling rot), Bacterial (bacterial blight and brown spot), nematode (cyst nematode, lesion nematode and root-knot nematode) and viral diseases (cucumber mosaic virus, pea early browning virus, pea mosaic and pea stunt). Powdery mildew (*Erysiphe pisi*) and rust (*Uromyces fabae*) poses continuous and substantial risk to pea-growing areas in mid-hill regions of Himachal Pradesh (Anonymous, 2022).

The pathogens of pea powdery mildew are a obligate biotrophic fungal pathogen which is distributed globally as an airborne disease. It is particularly prevalent in climates characterized by warm, dry days and cool nights (Smith *et al.*, 1996). Rust is a macrocyclic fungus first reported by Persoon in 1801. Later the genus was renamed *Uromyces viciae-fabae* (Pers.) de-Bary. The pathogen *U. viciae-fabae* is described as autoecious rust with aeciospores, urediospores, and teliospores found on the same host plant. The aeciospores-like urediospores are dikaryotic that migrate to the germ tube upon germination. The use of bio-control agents may be a different approach to induce resistance in peas. *Pseudomonas fluorescens* has gained attention for its potential to control plant pathogens and enhance crop productivity in an eco-friendly manner. This bacterium has been extensively studied and is recognized for its diverse mechanisms of action. One of the key mechanisms by which *P. fluorescens* controls plant pathogens is through the production of antibiotics. Another important mechanism by which *P. fluorescens* promotes plant health is through the induction of systemic resistance in plants. This process, known as induced systemic resistance (ISR), involves the activation of the plant's

defense mechanisms in response to the presence of the bacterium.

Materials and Methods

The materials used and technique adopted in accomplishing the objectives of the present investigation were carried out on “Bio-control potential of *Pseudomonas fluorescens* on pea (*Pisum sativum* L.) in mid hill conditions of Himachal Pradesh”. A field trial was conducted at the research farm of School of Agriculture, Abhilashi University, Mandi (H.P.) to assess the effects of bio-control potential of *Pseudomonas fluorescens* on Pea (*Pisum sativum* L.) in mid hill conditions of Himachal Pradesh. The detail of the treatments will be utilized during present study is as under:

Experiment Details:	
Design	Randomized block design
Variety	Golde
Treatments	07
Replications	03
Experiment year	2022-2023 and 2023-2024
Time of sowing	August
Seed rate	60 - 80 kg / ha
Spacing	30X10 cm
Total plot	21
Net Plot size	2m×2m=4 m ²
Total area	128 m ²

Treatment details	
T1	Seed Treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g + FYM @ 2-5 kg
T2	Seed Treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g + Vermicompost @ 2-5 kg
T3	Seed Treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g + Neem cake @ 1-2 kg
T4	Seed Treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g + Mustard cake @ 1-2 kg
T5	Seed Treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g + <i>Trichoderma viride</i> @ 5-10 g
T6	Seed Treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g
T7	Control (no manure or no fertilizer)

Assessment of disease incidence (PDI) and disease severity (PDS)

The leaves were observed for the powdery patches. It was calculated according to the Smriti Dhruw and Sandhya Sahu (2023) formula:

$$\text{Percent disease incidence (PDI)} = \frac{\text{Total number of infected plants}}{\text{Total number of plants assessed}} \times 100$$

$$\text{Percent disease severity (PDS)} = \frac{\text{Sum of all diseased ratings}}{\text{Total number of ratings} \times \text{Maximum disease grade}} \times 100$$

Results and Discussion

A field experiment was conducted to evaluate the effect of seed treatment with different combinations, viz. T1- *Pseudomonas fluorescens* @ 5-10 g + FYM @ 2-5 kg, T2- *Pseudomonas fluorescens* @ 5-10 g + Vermicompost @ 2-5 kg, T3- *Pseudomonas fluorescens* @ 5-10 g +Neem cake @ 1-2 kg, T4- *Pseudomonas fluorescens*@ 5-10 g + Mustard cake @ 1-2 kg, T5- *Pseudomonas fluorescens* @ 5-10 g + *Trichoderma viride* @ 5-10 g, T6- *Pseudomonas fluorescens* @ 5-10 g (15.99%) and T7 Control (no manure or no fertilizer) on disease incidence and disease severity of pea plants for powdery mildew and Rust diseases of Pea plants. The results on disease incidence are as follows:

Disease incidence (%) of powdery mildew and Rust diseases on Pea (*Pisum sativum* L.)

All the tested combinations significantly reduced the disease incidence as compared to the control. The results presented in Table 1, Figure 1 revealed that in year 2022-23, minimum (10.7%) PDI was recorded in T4 *Pseudomonas fluorescens*@ 5-10 g + Mustard cake @ 1-2 kg. Whereas, maximum (19.30%) PDI was recorded in T2 *Pseudomonas fluorescens* @ 5-10 g + Vermicompost @ 2-5 kg, followed by T1 *Pseudomonas fluorescens* @ 5-10 g + FYM @ 2-5 kg (16.30%),T6 *Pseudomonas fluorescens* @ 5-10 g (15.99%),T5 *Pseudomonas fluorescens* @ 5-10 g + *Trichoderma viride* @ 5-10 g (14.36%) and T3 *Pseudomonas fluorescens* @ 5-10 g +Neem cake @ 1-2 kg (14.02%), respectively. Whereas, (25.76%) PDI was recorded in the case of control.

In the year 2023-24, the results presented in Table 1, Figure 1 revealed that, minimum (9.37%) PDI was recorded in T4 *Pseudomonas fluorescens*@ 5-10 g + Mustard cake @ 1-2 kg. Whereas, maximum (18.62%) PDI was recorded in T2 *Pseudomonas fluorescens* @ 5-10 g + Vermicompost @ 2-5 kg followed by T1 *Pseudomonas fluorescens* @ 5-10 g + FYM @ 2-5 kg (17.29%),T6 *Pseudomonas fluorescens* @ 5-10 g (16.32%), T5 *Pseudomonas fluorescens* @ 5-10 g + *Trichoderma viride* @ 5-10 g (15.32%) and T3 *Pseudomonas fluorescens* @ 5-10 g +Neem cake @ 1-2 kg (12.88%), respectively. Whereas, (27.09%) PDI was recorded in the case of control.

The results presented in Table 1, Figure 2 revealed that in year 2022-23, minimum (10.68%) PDI was recorded in T3 *Pseudomonas fluorescens* @ 5-10

g +Neem cake @ 1-2 kg. Whereas, maximum PDI were recorded in T1 *Pseudomonas fluorescens* @ 5-10 g + FYM @ 2-5 kg (21.30%), followed by T2 *Pseudomonas fluorescens* @ 5-10 g + Vermicompost @ 2-5 kg (19.21%), followed by T6 *Pseudomonas fluorescens* @ 5-10 g (17.99%), followed by T5 *Pseudomonas fluorescens* @ 5-10 g + *Trichoderma viride* @ 5-10 g (15.74%) and *Pseudomonas fluorescens*@ 5-10 g + Mustard cake @ 1-2 kg (12.70%), respectively. Whereas, (26.42%) PDI was recorded in T7 in case of control.

In year 2023-24, the results presented in Table 1, Figure 2 revealed that minimum (10.02%) PDI was recorded in T3 *Pseudomonas fluorescens* @ 5-10 g +Neem cake @ 1-2 kg. Whereas, maximum PDI were recorded in T2 *Pseudomonas fluorescens* @ 5-10 g + Vermicompost @ 2-5 kg (19.54%), followed by T1 *Pseudomonas fluorescens* @ 5-10 g + FYM @ 2-5 kg (18.96%), followed by T6 *Pseudomonas fluorescens* @ 5-10 g (14.66%), followed by T5 *Pseudomonas fluorescens* @ 5-10 g + *Trichoderma viride* @ 5-10 g (14.41%) and T4 *Pseudomonas fluorescens*@ 5-10 g + Mustard cake @ 1-2 kg (11.70%) respectively. Whereas, (23.75%) PDI was recorded in T7 in case of control. Mishra *et al.* (2017) also reported similar results while investigating the impact of environmental factors on the development of powdery mildew (*Erysiphe pisi*) in peas under field conditions. Their epidemiological analysis indicated that the disease progressed most rapidly between the 50% flowering and pod initiation stages. A significant positive correlation was observed between powdery mildew severity and both maximum temperature and sunshine duration. In contrast, minimum temperature and relative humidity showed no significant correlation with disease severity. Deeshmukh *et al.* (2018) has also undertaken an investigation to study the management of powdery mildew of pea with botanicals. Six botanicals viz., garlic (*Allium sativum* L.), tulsi (*Ocimum sanctum* L.), neem (*Azadirachta indica* A. Juss.), Cashewnut (*Anacardium occidentale*), Ghaneri (*Lantana camera*), ginger (*Zingiber officinale* Rosc.) and were evaluated in vivo at different concentrations for their effectiveness against *Erysiphe pisi*, the causal agent of pea powdery mildew. Three sprays of NSKE and Ginger was found more effective in reducing disease severity and yield which was at par with each other.

Table 1: Disease incidence (%) of Powdery mildew and Rust diseases on Pea (*Pisum sativum* L.)

Treatment	Treatment details	PDI (%)		PDI (%)	
		Powdery mildew		Rust	
		2022-2023	2023-2024	2022-2023	2023-2024
T1	Seed treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g + FYM @ 2-5 kg	16.3	17.29	21.3	18.96
T2	Seed treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g + Vermicompost @ 2-5 kg	19.3	18.62	19.21	19.54
T3	Seed treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g +Neem cake @ 1-2 kg	14.02	12.88	10.68	10.02
T4	Seed treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g + Mustard cake @ 1-2 kg	10.7	9.37	12.7	11.7
T5	Seed treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g + <i>Trichoderma viride</i> @ 5-10 g	14.36	15.32	15.74	14.41
T6	Seed treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g	15.99	16.32	17.99	14.66
T7	Control (no manure or no fertilizer)	25.76	27.09	26.42	23.75
	C.D.at 5%	4.377	4.908	4.977	4.571
	SE(m)±	1.405	1.575	1.597	1.467

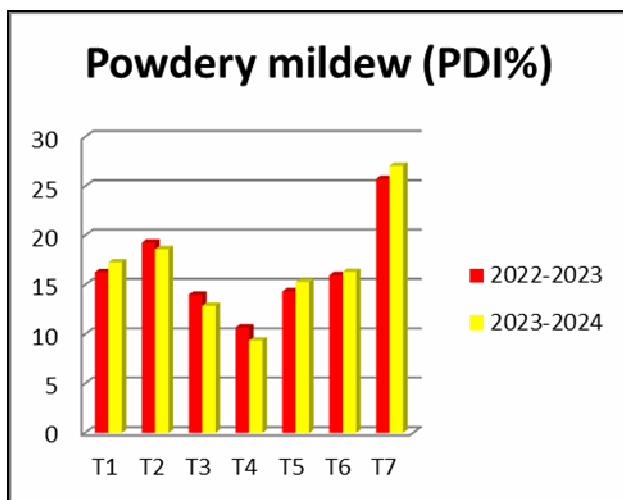


Fig. 1: Disease incidence (%) of Powdery mildew in Pea (*Pisum sativum* L.)

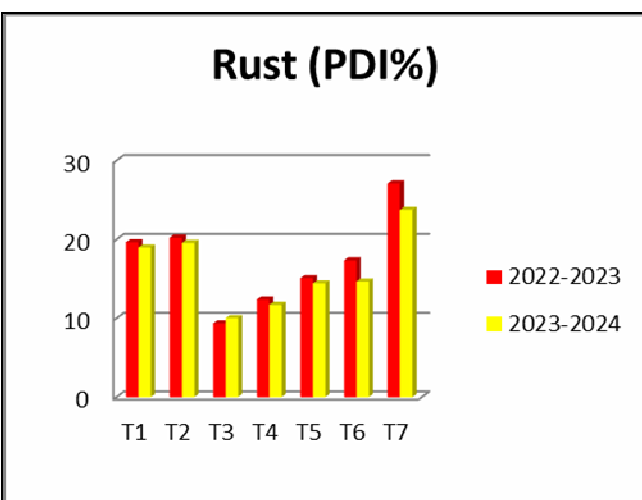


Fig. 2: Disease incidence (%) of Rust in Pea (*Pisum sativum* L.)

Percent Disease Severity (PDS %) of field pea against Powdery mildew and Rust disease of pea (*Pisum sativum* L.)

All the tested combinations significantly reduced the disease severity as compared to the control. The results presented in Table 2, Figure 3 revealed that in year 2022-23, minimum (23.04%) PDS was recorded in T4 *Pseudomonas fluorescens*@ 5-10 g + Mustard cake @ 1-2 kg. Whereas, maximum was recorded in T2 *Pseudomonas fluorescens* @ 5-10 g + Vermicompost @ 2-5 kg (38.15%), followed by T6 *Pseudomonas fluorescens* @ 5-10 g (38.27%), followed by T1 *Pseudomonas fluorescens* @ 5-10 g + FYM @ 2-5 kg (37.97%), followed by T5 *Pseudomonas fluorescens* @ 5-10 g + *Trichoderma viride* @ 5-10 g (32.98%) and T3 *Pseudomonas fluorescens* @ 5-10 g +Neem cake @ 1-2 kg (27.13%) respectively. Whereas, (46.04%) PDI was recorded in T7 in case of control.

In year 2023-24, the results presented in Table 2 and Figure 3 revealed that minimum (23.64%) PDS was recorded in T4 *Pseudomonas fluorescens*@ 5-10 g + Mustard cake @ 1-2 kg. Whereas, maximum PDI was recorded in T1 *Pseudomonas fluorescens* @ 5-10 g + FYM @ 2-5 kg (35.31%), followed by T2 (*Pseudomonas fluorescens* @ 5-10 g + Vermicompost @ 2-5 kg (33.82%), followed by T5 *Pseudomonas fluorescens* @ 5-10 g + *Trichoderma viride* @ 5-10 g (30.65%), followed by T6 *Pseudomonas fluorescens* @ 5-10 g (30.27%) and T3 *Pseudomonas fluorescens* @ 5-10 g +Neem cake @ 1-2 kg (25.20%) respectively. Whereas, (38.37%) PDI was recorded in T7 in case of control.

The results presented in Table 2, Figure 4 revealed that in year 2022-23, minimum (27.04%) PDS % was recorded in T3 *Pseudomonas fluorescens* @ 5-10 g +Neem cake @ 1-2 kg. Whereas, maximum was

recorded in T1 *Pseudomonas fluorescens* @ 5-10 g + FYM @ 2-5 kg (35.3%), followed by T2 *Pseudomonas fluorescens* @ 5-10 g + Vermicompost @ 2-5 kg (37.03%), followed by T5 *Pseudomonas fluorescens* @ 5-10 g + *Trichoderma viride* @ 5-10 g (33.28%), followed by T4 *Pseudomonas fluorescens* @ 5-10 g + Mustard cake @ 1-2 kg (30.38%) and T6 *Pseudomonas fluorescens* @ 5-10 g (39.32%) respectively. Whereas, (45.02%) PDS% was recorded in T7 in case of Control.

In year 2023-24, the results presented in Table no. 2, Fig. no. 4 revealed that minimum (23.73%) PDS% was recorded in T3 *Pseudomonas fluorescens* @ 5-10 g + Neem cake @ 1-2 kg. Whereas, maximum was recorded in T6 *Pseudomonas fluorescens* @ 5-10 g (42.46%), followed by T2 *Pseudomonas fluorescens* @ 5-10 g + Vermicompost @ 2-5 kg (35.91%), followed by T1 *Pseudomonas fluorescens* @ 5-10 g + FYM @

2-5 kg (33.61%), followed by T5 *Pseudomonas fluorescens* @ 5-10 g + *Trichoderma viride* @ 5-10 g (32.58%) and T4 *Pseudomonas fluorescens* @ 5-10 g + Mustard cake @ 1-2 kg (26.43%) respectively. Whereas, (44.07%) PDS% was recorded in T7 in case of Control. Mishra *et al.* (2017) also reported similar results while investigating the impact of environmental factors on the development of powdery mildew (*Erysiphe pisi*) in peas under field conditions. Their epidemiological analysis indicated that the disease progressed most rapidly between the 50% flowering and pod initiation stages. A significant positive correlation was observed between powdery mildew severity and both maximum temperature and sunshine duration. In contrast, minimum temperature and relative humidity showed no significant correlation with disease severity.

Table 2 : Percent Disease Severity (PDS %) of field pea against powdery mildew and rust of pea (*Pisum sativum* L.)

Treatment	Treatment details	PDS (%)		PDS (%)	
		Powdery mildew		Rust	
		2022-2023	2023-2024	2022-2023	2023-2024
T1	Seed treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g + FYM @ 2-5 kg	37.97	35.31	35.3	33.61
T2	Seed treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g + Vermicompost @ 2-5 kg	38.15	33.82	37.03	35.91
T3	Seed treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g + Neem cake @ 1-2 kg	27.13	25.2	27.04	23.73
T4	Seed treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g + Mustard cake @ 1-2 kg	23.04	23.64	30.38	26.43
T5	Seed treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g + <i>Trichoderma viride</i> @ 5-10 g	32.98	30.65	33.28	32.58
T6	Seed treatment with <i>Pseudomonas fluorescens</i> @ 5-10 g	38.27	30.27	39.32	42.46
T7	Control (no manure or no fertilizer)	46.04	38.37	45.02	44.07
	C.D.at 5%	4.945	4.667	4.254	4.506
	SE(m)±	1.587	1.498	1.365	1.446

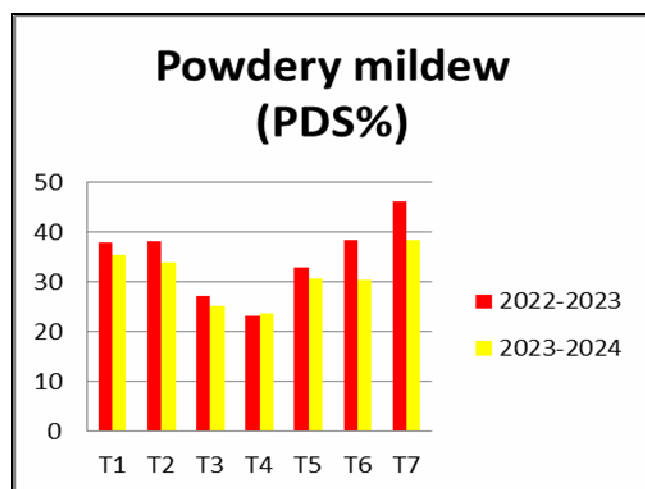


Fig. 3: Disease severity (%) of Powdery mildew of Pea (*Pisum sativum* L.)

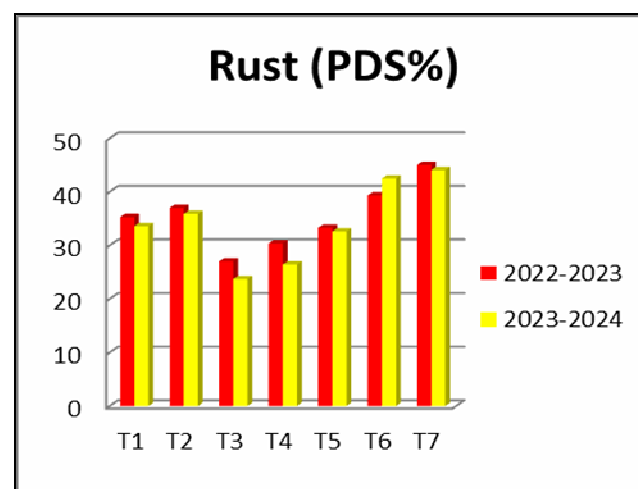


Fig. 4: Disease severity (%) of Rust of Pea (*Pisum sativum* L.)

Conclusion

On the basis of field trials, concluded that seed treatments with *P. fluorescens* combined with organic amendments significantly reduced both disease incidence and severity compared to the untreated control (T7). This suggests that the combination of *P. fluorescens* with organic amendments provides strong biological control against fungal pathogens are helpful in the management of Powdery mildew of Pea and Rust disease of Pea.

Acknowledgment

The authors are grateful to Department of Plant Pathology and Dean, School of Agriculture, Abhilashi University, Mandi – 175028, H.P., India for necessary laboratory facilities and encouragement to carry out the present investigation successfully. Respective organizations of each author are also gratefully acknowledged for their support towards this research directly and indirectly.

References

- Aishwarya, M.P., Shivani, K., Ravinder, K., Ritika, S. and Gautam, A.K. (2022). Arbuscular mycorrhizal fungal diversity and root colonization in *Pisum sativum*. *Biolog. Forum-AnInt. Journal* **14**, 1626-1632.
- Anonymous (2022). Agricultural Statistics at a Glance 2021-22, Department of Agriculture, Corporation and Farmers Welfare, Ministry of Agriculture and Farmer's Welfare, Government of India, Krishi Bhawan, New Delhi.
- Das, K. and Kallo, G. (1970). A technique of squashing stipule tips on pea. *Current Indian Science*, **39**, 494–495.
- Deeshmukh, N.J., Deokar, C.D. and Ilhe, B.L. (2018). Management of powdery mildew of pea with botanicals. *Indian Journals*, **7**(34), 1-6.
- Dueholm, B., Fonskov, J., Grimberg, Å., Carlsson, S., Hefni, M., Henriksson, T. *et al.* (2024). Cookability of 24 pea accessions determining factors and potential predictors of cooking quality. *Journal of the Science of Food and Agriculture*, **104**, 3685–3696. doi,10.1002/jsfa.13253.
- Mishra, V. and Siman, S. (2017). Efficacy of bioagent against rust disease of garden pea (*Pisum sativum*). *Journal of Pharmacognosy and Phytochemistry*, **6**(5), 652–653.
- Smriti, D. and Sandhya, S. (2023). Assessment of brown spot disease incidence and severity in rice cultivation across different region of Chhattisgarh. *The Pharma Innovation Journal*, **12**(11), 1663-1667.
- Upadhyay, V., Kushwaha, K.P.S. and Pandey, P. (2015). Inspection of different localities in Uttarakhand and Uttar Pradesh for the prevalence of rust disease of pea (*Pisum sativum*). *Trends in Biosciences*, **8**(16), 436–440.
- Verma, M. and Thakur, R. (2018). Rhizosphere microbiome, A key player in sustainable agriculture. *Microbiological Research*, **240**, 126531.
- Vikrant, K.A., Alam, M.S., Ravinder, K.B. and Thakur, P. (2024). Induction of ISR (Induced Systemic Resistance) in pea against rust of pea through bioagents. *Plant Archives*, **24**(2), 1583–1586.