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INDUCTION OF ISR (INDUCED SYSTEMIC RESISTANCE) IN PEA AGAINST RUST OF PEA THROUGH BIOAGENTS

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ABSTRACT

Pea is third most important pulse crop of the world, which is being cultivated all over the globe over the land area of two million hectares. Despite of its being grown in large area, this crop is infected by numerous pathogens including rust disease. Rust disease of pea is caused by *Uromyces viciaefabae* affect the pea crop all over the mid-hill conditions of Himachal Pradesh. The data revealed that all the bioagents decreases the % disease severity over control. The minimum PDI was recorded in T_6- Soil application of *Trichoderma viride* @ 20g/ m^2 (38.27%) followed by T_5-Soil application of *Trichoderma harzianum* @ 20g/m^2 (40.74%) and T_3- Seed treatment with *Pseudomonas fluorescens* @10g/ kg of seed (43.20%). Whereas, maximum PDI T_1- Seed treatment with *Trichoderma harzianum* @ 10g/kg of seed (53.08%) followed by T_4- Seed treatment with *Bacillus sp* @ 10g/kg of seed (50.61%) and T_2- Seed treatment with *Tricoderma viride* @ 10g/kg of seed (48.14%), respectively. In case of control 71.60% PDI was recorded. The maximum PDC was recorded in T_6- Soil application of *Trichoderma viride* @ 20g/m^2 (46.55%) and minimum PDC was recorded under the treatment T_1- Seed treatment with *Trichoderma harzianum* @ 10g/kg of seed (25.86%).

Key words : Pea, *Uromyces viciaefabae*, *Trichoderma harzianum* and *Trichoderma viride*.

Introduction

Pea (*Pisum sativum*) a member of the *Fabaceae* family, is an annual cool-season legume characterized by its climbing or bushy growth habit. The plant typically reaches heights of 2 to 4 feet and features compound leaves with tendrils for climbing support. Pea flowers are distinct, showcasing the classic pea blossom form with a fusion of white or pink petals. Peas indeed exhibit remarkable diversity, and they are broadly categorized into field peas (*P. sativum* var. *sativum*), snow peas (*P. sativum* var. *saccharatum*), and snap peas (*P. sativum* var. *macrocarpon*). Each variety has distinct culinary attributes, with field peas known for their sweet seeds, snow peas for their tender flat pods, and snap peas offering a delightful combination of both pod and seed characteristics (Anonymous, 2024a). The third-most significant pulse crop in the world is the pea (*P. sativum* L.). It is grown on more than two million hectares of land worldwide (McKay *et al*., 2003). India has a significant role in the global production of peas. India is the world's second-largest producer of peas and ranks second in both categories (Singh *et al*., 2020). Among the principal producing states of India are Uttar Pradesh, Madhya Pradesh, Bihar, Maharashtra and Himachal Pradesh with 294.96 thousand metric tonnes produced in 2017–18, it is the fifth-largest producing state in India (FAO, 2014; Singh *et al*., 2020; Mondor, 2020; Aishwarya *et al*., 2022).

The rust pathogen attacks pea plant stems, pods, and lower surfaces of leaves. The earliest symptoms are tiny, white, slightly elevated spots that develop and tear the epidermis to form irregular, reddish-brown pustules. The yellowish-white aecial cups, which are single or in tiny clusters with a profusion of powdered urediospores, are formed on leaflets and on pods. When teliospores for

overwintering are generated, these pustules change from dark brown to black (Xue, 2003). When an infection is severe, the plant dries up and either produces little, wrinkled seeds or no seeds at all in pods. If fully infected, the plant has a dark brown to blackish look that is noticeable in afflicted areas (Beniwal *et al.*, 1993). Himachal Pradesh is a hilly state of 55,673 km^2. Over 90% of the state's population is directly employed in horticulture and agriculture. The state's diverse topography and climate led to the division of the region into a number of agro-climatic zones, each of which is better suited for the development of particular horticultural and agricultural products. Himachal Pradesh is divided into four agro climatic zones, with the mid hill zone spanning from 651 to 1800 meters above sea level. About 32% of all geographical areas and roughly 37% of all agricultural area are covered by its mild temperate climate (Gulati *et al.*, 2004 and Samant *et al.*, 2007). Himachal Pradesh, occupies 5^{th} position in pea production in India with total production of 294.96 thousand metric tons per year (Upadhyay *et al.*, 2019).

Plant health is enhanced by the beneficial bacteria found in the microbiome of plant roots. Selective plant growth-promoting bacteria and fungi in the rhizosphere have been shown to induce induced systemic resistance (ISR), which primes the entire plant body for improved defense against a variety of diseases and insect herbivores. Numerous root-associated mutualists, such as *Bacillus*, *Pseudomonas*, *Trichoderma* and *mycorrhiza* species, increase the sensitivity of the plant immune system to improve defense without requiring the activation of expensive defense mechanisms. This study focuses on the advancements in our knowledge of ISR signaling and systemic defense priming, as well as the molecular mechanisms at the interface between plant roots and ISR-eliciting mutualists (Corne and Devid, 2014).

The growth and health of the related plants are enhanced by the beneficial microorganisms that induce systemic resistance in plants, hence enhancing plant immunity. When helpful bacteria are applied, the host develops improved resistance, commonly known as induced systemic resistance, or ISR, against a variety of infections. Plants use long-distance systemic signaling to protect distal tissue and trigger powerful immune responses against pathogen invasions when their ISR is activated (Jiyang *et al.*, 2022).

Materials and Methods

The material used and technique adopted in accomplishing the objective of present investigation was carried out entitled "Induction of ISR (induced systemic resistance) in pea against rust of pea through bio agent" during 2023-2024. Experiment was conducted at research farm, School of Agriculture, Abhilashi University, Mandi - 175 028, which is located in the chail-chowk , Himachal Pradesh, India. Biocontrol agents *viz*; *Tricoderma harzianum*, *Tricoderma viridi*, *Pseudomonas flourescens* and *Bacillu*s are collected from market. These bioagent were used for the management study conducted in field condition.

Application of bioagents

A field experiment was conducted to study the effect of bio-agents *viz*; *T. harzianum* @ 10g/kg, *T.viridi* @ 10g/kg, *P. flourescens* @ 10g/kg and *Bacillu*s sp.@10g/ kg were used as seed treatment while *T. harzianum* @ 10g/kg and *T. viridi* @ 10g/k applied as soil application. Three replications were maintained for each treatment. Randomized block design (RBD) was used in the field experiment. One untreated control was maintained for comparison. The details of experiment are given below:

Treatments - 7
Crop - Pea
Replications - 3
Design - Randomized block design (RBD)
Spacing - 30cm × 15cm
Variety - Goldy

Treatments details

T_1- Seed treatment with *Trichoderma harzianum* @ 10g/kg of seed.

T_2- Seed treatment with *Trichoderma viride* @ 10g/kg of seed.

T_3- Seed treatment with *Pseudomonas fluorescens* @ 10g/kg of seed.

T_4- Seed treatment with *Bacillus sp* @ 10g/ kg of seed.

T_5- Soil application of *Trichoderma harzianum* @ 20g/ m^2

T_6- Soil application of *Trichoderma viride* @ 20g/ m^2

T_7- Control

Observations: Percent disease severity/ Index and percent disease control

Percent disease index (Mahrotra and Aggarwal, 2003)

$$PDI = \frac{\text{Sum of all the disease rating}}{\text{Number of plant observed} \times \text{Maximum disease grading}} \times 100$$

Percent disease control

$$PDC = \frac{\text{PDI in control plot} - \text{PDI in treated plot}}{\text{PSI in control plot}} \times 100$$

Whereas, PDI = Percent disease index.

Results and Discussion

The results presented in Table 1 and Fig. 1 revealed tested all the bioagents decreases the percent disease severity over control. The minimum PDI was recorded in T_6 - Soil application of *Trichoderma viride* @ 20g/m^2 (38.27%) followed by T_5- Soil application of *Trichoderma harzianum* @ 20g/m^2 (40.74%) and T_3- Seed treatment with *Pseudomonas fluorescens* @ 10g/kg of seed (43.20%). Whereas, maximum PDI T_1- Seed treatment with *Trichoderma harzianum* @ 10g/kg of seed (53.08%), followed by T_4- Seed treatment with *Bacillus* sp @ 10g/kg of seed (50.61%) and T_2- Seed treatment with *Tricoderma viride* @ 10g/kg of seed (48.14%), respectively. In case of control 71.60% PDI was recorded. The maximum PDC was recorded in T_6- Soil application of *Trichoderma viride* @ 20g/m^2 (46.55%) and minimum PDC was recorded under the treatment T_1- Seed treatment with *Trichoderma harzianum* @ 10g/kg of seed (25.86%). Similarly Mishra *et al*. (2017) studied that five treatments *viz*. neem leaves extract 3%, eucalyptus leaves extract 3%, neem oil 3%, *Trichoderma harzianum* 3% and *Pseudomonas fluoroscens* 0.2% with treated control hexaconazole 0.1% and control (distilled water) were used as foliar spray on plants. Among all the treatments, neem leaf extract was found to be effective to controlling rust disease of pea. Minimum per cent disease incidence (30.80%) was recorded from this plot. Two foliar sprays of neem leaf extract at interval of 10 days may be the option for the management of rust disease in severe condition. Corne and Devid (2014) studied the beneficial microbes in the microbiome of plant roots improve plant health. Induced systemic resistance (ISR) emerged as an important mechanism by which

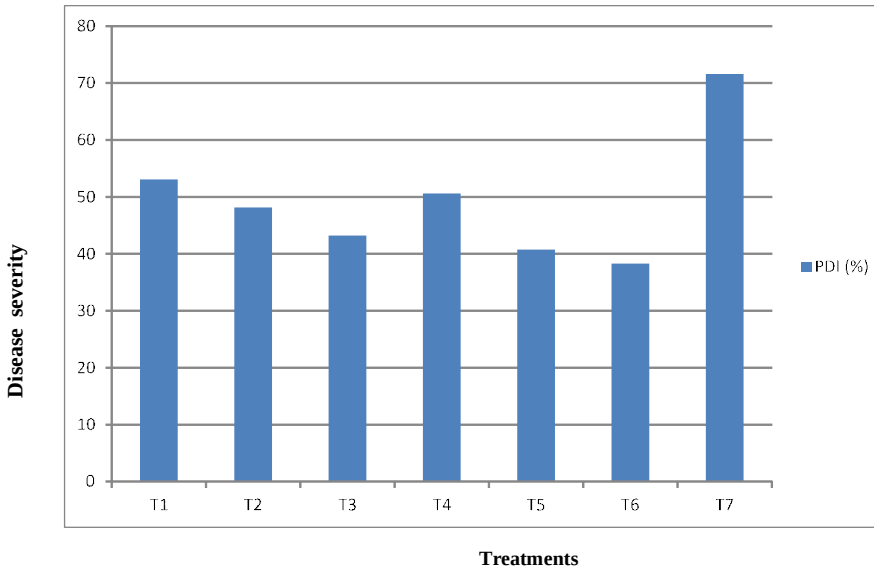

Fig. 1 : Induction of ISR (induced systemic resistance) in pea against rust of pea through bio agent.

Table 1 : Induction of ISR (induced systemic resistance) in pea against rust of pea through bioagents.

S. no.	Treatments	PDI (%)	PDC (%)
T_1	Seed treatment with *Trichoderma harzianum*@10g/kg of seed.	53.08	25.86
T_2	Seed treatment with *Trichoderma viride* @10g/kg of seed	48.14	32.76
T_3	Seed treatment with *Pseudomonas fluorescens* @10g/kg of seed	43.20	39.66
T_4	Seed treatment with *Bacillus sp* @10g/kg of seed	50.61	29.31
T_5	Soil application of *Trichoderma harzianum* @20g/m^2	40.74	43.1
T_6	Soil application of *Trichoderma viride* @ 20g/m^2	38.27	46.55
T_7	Control	71.60	
CD at 5 % level		**3.095**	
SE(m)		**0.993**	

selected plant growth-promoting bacteria and fungi in the rhizosphere prime the whole plant body for enhanced defense against a broad range of pathogens and insect herbivores. A wide variety of root-associated mutualists, including *Pseudomonas*, *Bacillus*, *Trichoderma* and mycorrhiza species sensitize the plant immune system for enhanced defense without directly activating costly defenses. This review focuses on molecular processes at the interface between plant roots and ISR-eliciting mutualists, and on the progress in our understanding of ISR signaling and systemic defense priming.

Conclusion

Based on the results of present investigation, it can be concluded that T6-Soil application of *Trichoderma viride* @ 20g/m^2 and soil application of *Trichoderma harzianum* @ 20g/ m^2 are helpful in the management of rust disease in pea crop.

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