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Impact of Soil Types and Sowing Times on Collar Rot of Chickpea Caused by *Sclerotium rolfsii* in Bundelkhand Region of U.P.

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ABSTRACT

Background: The devastating soil-borne chickpea disease known as collar rot, which is caused by *Sclerotium rolfsii,* results in significant yield losses globally, especially in Uttar Pradesh, India, where seedling mortality can range from 55% to 95%. Numerous environmental conditions, like as soil type, pH and sowing time, affect the frequency and severity of collar rot. Developing successful management strategies requires an understanding of the connection between these factors and the onset of disease.

Methods: The study was carried out under controlled net-house circumstances throughout the 2022 rabi season (October-March). Four soil types typical of the Bundelkhand region (red, black, light brown and yellow) were tested. Chickpea plants were cultivated in these soils with variable pH values and two sowing dates (15-Nov and 15-Dec). Collar rot disease incidence and plant growth indicators such as shoot and root length were monitored throughout the growing season. Several chickpea cultivars, including L550, were assessed for sensitivity to collar rot.

Result: The findings revealed that yellow soil had the lowest collar rot incidence (36.66%) and greatly increased plant growth, with an average shoot length of 38.24 cm and root length of 24.22 cm. In contrast, dark soil had the highest disease incidence (66.02%) and the lowest plant growth. Sowing timing had a significant impact on disease occurrence, with early sowing (15-Nov) having a greater incidence (21.37%) than late sowing (15-Dec) (11.19%). L550 was determined to be the most vulnerable to collar rot of all the cultivars studied. These findings emphasize the need of using optimal soil types and sowing timings to effectively minimize collar rot.

Key words: Chickpea, Collar rot, Disease incidence, Soil types.

INTRODUCTION

The chickpea, scientifically known as *Cicer arietinum* L., is the third most significant pulse crop globally, following beans and peas and it is the important grain legumes and cultivated mainly in the Indian subcontinent, Mediterranean region the West Asia, North Africa and Eastern Africa (Yadav *et al*., 2022). India is responsible for nearly 75% of the world's chickpea production (Kumar *et al*., 2025). It is one of the most important pulse crops in the world with high protein content of about 25.3-28.9% in its nutritive seeds (Mafakheri *et al*., 2011; Kumar *et al*., 2021). In central India, the Bundelkhand region of Uttar Pradesh state is a historically significant area for chickpea cultivation (416,007 hectares) and the annually yield around 148408 ton. In all of the major cropping sequences in this area, chickpeas are a key crop that is mostly cultivated as a rainfed monoculture (Upadhyay and Prasad, 2023). Collar rot, caused by the fungus *Sclerotium rolfsii*, is particularly destructive in certain soil and climatic conditions. The disease is favoured by good soil moisture, high soil temperature (25-30°C) and low organic matter in the soil (Mathur and Sinha, 1968). Sclerotia disseminate by cultural practices with infected soil and contaminated tools, infested transplanting seedlings, with water, wind and possibly seeds (Mahen *et al*., 1995). Understanding the influence of environmental factors, especially soil type, on the incidence and severity of diseases like collar rot is essential for the development of effective management strategies and for ensuring stable chickpea production. The chickpea cultivation is highly influenced by various types of soil borne diseases including collar rot *(Sclerotium rolfsii*), wilt (*Fusarium oxysporum* f.sp. *ciceris)* stem rot (*Sclerotinia sclerotiorum*) and dry root rot (*Rhizoctonia bataticola*) are the major limiting factor in chickpea production. They are not only reduce yield but also greatly impair the quality and stability of production year after year, undermining efforts to promote sustainable agriculture. Among them the necrotrophic soil borne pathogen collar rot caused by *Sclerotium rolfsii* is a major threat for chickpea production worldwide. Collar rot control is difficult due to

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the pathogen's extensive host range, which includes at least 500 species belonging to 100 groups that are typically found in legumes, crucifers and cucurbits (Aycock, 1966). The disease causes about 20% yield loss in tropical areas and causes 55- 95% seedling mortality (Gurha and Dubey, 1982). *Sclerotium rolfsii* is a well known polyphagous pathogen. The fungus being a well known type member of the genus Sclerotium it forms differentiated sclerotia, usually causes collar rot diseases. Sclerotia are considered to be extremely hardy and relatively (Rasu *et al*., 2013). *S. rolfsii* can over winter as mycelium in infected tissues or plant debris. Sclerotia serve as the principal over wintering structure and primary inoculum for disease persisting near the soil surface, Sclerotia may exist free in soil or in association with plant debris. Those buried deep in soil may survive for a year or less, whereas those at surface remain viable and may germinate in response to alcohol and other volatile compound released from decomposing plant material. Management of *Sclerotium rolfsii* causing collar rot of chickpea is difficult to achieve chemically and excessive use of agrochemicals in conventional crop management has caused serious environmental and health problems including loss of biodiversity and human disorders. As root disease severity is strongly influenced by soil type, soil pH, soil temperature, moisture and the biological activity of suppressive microorganism. Organic matter is known to affect soil structure, aeration, drainage, moisture holding capacity, nutrient availability and microbial ecology (Davey, 1996). Considering the threat of collar rot disease of chickpea in near future the present study was conducted to the effect of different soil types on collar rot incidence in chickpea.

MATERIALS AND METHODS

The experiment was carried out during the rabi season of 2022 in net house conditions at Banda University of Agriculture and Technology in Banda, Uttar Pradesh. The study focusses on soil samples gathered from various regions of Bundelkhnad, Uttar Pradesh, including Rocker, Mar, Kabar and Padua, which represent red, black, light brown and yellow soil types, respectively. This region has semi-arid agro-climatic conditions and is characterised by diverse soil textures and low to medium fertility, making it an ideal location for studying soil-borne diseases like collar rot in chickpeas.

Infected plants which show typical collar rot symptoms were collected from chickpea fields. Samples were brought to the Plant Pathology laboratory for isolation and further studies. The fungus was isolated under aseptic conditions in laminar air flow. The infected tissues were cut into small pieces of 1-2 mm size and surface sterilized with one per cent sodium hypochlorite solution for one minute and washed three time in sterile distilled water. These pieces were transferred to sterile blotting paper to remove excess moisture adhered to sample and placed in Petri plates containing sterilized PDA and incubated at 27±1°C in BOD incubator. After 3-4 days mycelial growth was observed. Fungal cultures are purified by a single hyphal tip from the culture of pathogen and transferred on PDA slants or PDA plates. The plates were incubated at 27±1°C three days for growth of test fungus.

Sorghum grains were soaked in water for overnight. Thereafter drained of excess water and air dried. One hundred gram this sorghum grains were filled in 250 ml conical flasks and sterilized in autoclave with 15 psi at 120.6°C for 15 minutes. Sterilized sorghum grains in flask were inoculated with 4-5 mycelial discs taken from the periphery of the 4 days old culture of *S. rolfsii* grown on PDA. The inoculated flasks incubated in BOD incubator at 25±1°C for 20 days. Multiplied culture of *Sclerotium rolfsii* utilized for mix of inoculum in pot containing different types of soil. Inoculum of chickpea collar rot were mix @ 6 g/kg soil in each soil type Rocker, Mar, Kabar, Padua. The soil pH was measured through potentiometric method (Jackson, 1967). Two pots were kept for each treatment and one pot without inoculum serves as control. The pots were irrigated and covered with polythene sheet for the inoculum to establish. Six surface sterilized seeds of chickpea were sown in each pot and data on seedling mortality were recorded two weeks after sowing. For estimation shoot and root length of plant, three plants per pot in each replication were selected randomly among total geminated plants (06 seed sown each pot) and uprooted from each pot as per treatment at the interval of 30 and 60 DAS. These uprooted plants were used for recording shoot and root length. The shoot length was measured from collar region up to apical shoot and root length was measured from collar region up to central root.

In order to determine how different planting dates affected the occurrence of *S. rolfsii* caused chickpea collar rot, a pot experiment was carried out in a net house with the following specifics. Three sowing dates were chosen in total: the first two weeks of November (15.11.2020), the second two weeks of November (25.11.2020) and the first two weeks of December (15.12.2020). The observations were recorded for incidence of collar rot at seedling stage of crop (two to three weeks) and percent disease incidence was calculated according to following formula:

$$\text{PDI} = \frac{\text{Number of disease plants}}{\text{Total number of plants}} \times 100$$

RESULTS AND DISCUSSION

Soil types

For the purpose of studying the incidence of collar rot in chickpeas under pot condition, four different types of soil Colected from the Bundelkhand region of Uttar Pradesh (Plate 1). Data presented in Table 1 showed that the Black soil was found to be the most conducive to high incidence; recording the greatest incidence (66.02%), followed by light brown (61.13%) and red soil (48.16%). Yellow soil had the lowest occurrence (36.66%), which was much lower than that of black and red brown soil (Fig 1). Similar findings

were found by Wokocha (1987) while examining the impact of soil type on *Sclerotium rolfsii* induced tomato seedling damping. He reported that soil low in percentage clay content were more conducive to the disease than those with high clay content. Hussain *et al*. (2006) reported that seedling mortality was 94% in clayey soil and 82, 78 and 60% in clay loam, sandy loamy and sandy soils, respectively. Seedling mortality in sandy soil was significantly less than that noted in all other types of soil. Mishra and Shukla (1986) reported similar results while working with different textures of soil in chickpea.

Soil pH

The study assessed the prevalence of illness in four different soil types *viz*, yellow, light brown, black and red each of which had its own local name and pH range. The incidence of disease differed significantly depending on the kind of soil. In addition to having a pH of 6.8, red soil had a 76.0% disease incidence. At 79.0%, the highest illness incidence was found in black soil with a pH of 7.1, which is slightly alkaline. The pH of the light brown soil was 7.7 and the illness incidence was 78.3%. Yellow soil, on the other hand, had the lowest disease incidence at 50.0% and the highest pH at 7.8. (Table 2). Kulkarni (2007) also obtained highest per cent of saprophytic activity at pH level of 6.00. Soil pH 5.00 showed least mortality (61.29 %). Mortality at pH 5 (61.29), pH 7 (68.69) and pH 8.00 were significantly less from that of pH 6.00. Harlapur (1988) also reported similar result that pH 6.00 was more favorable for survival of *Sclerotium rolfsii* during study on foot rot of wheat.

Shoot and root length of chickpea

Effect of different types of soil on plant growth promotion was evaluated in pot culture experiment under net-house conditions. The results revealed that yellow color soil significantly increased the root and shoot length 38.24 cm and 24.22 cm respectively followed by red color soil 34.00 cm shoot length and 22.03 cm root length. The least shoot and root length were observed black colure soil 18.00 cm shoot length and 30.25 cm (Table 3). Effect of different types of soil on root and shoot length was also realized as soil types are affect their growth of roots and shoots with leaves was observed in almost all the treatments.

Plate 1: Effect of soil type on collar rot incidence.

Table 1: Effect of different types of soil and their pH on collar rot incidence.

Soil type	Local name	Disease incidence (%)
Red soil	Rocker	48.16 (44.18)
Black soil	Mar	66.02 (54.40)
Light brown	Kabar	61.13 (51.46)
Yellow soil	Padua	36.66 (37.23)
C.D.		5.22
C.V.		7.16

Table 2: Effect of soil pH on collar rot incidence.

Soil type	Local name	Soil pH	Disease incidence (%)
Red soil	Rocker	6.8	76.0
Black soil	Mar	7.1	79.0
Light brown	Kabar	7.7	78.3
Yellow soil	Padua	7.8	50.0

Values given in arcsin $\sqrt{}$ transformaion.

Table 3: Effects of different types of soil on shoot and root length of chickpea.

Soil type	Shoot length (cm)	Root length (cm)
Red soil	34.00	22.03
Black soil	30.25	18.00
Light brown	35.00	19.00
Yellow soil	38.24	24.22

Average of three replication.

Table 4: Effect of sowing time on incidence of collar rot of chickpea.

Variety	Per cent collar rot incidence
15-Nov-22	
L550	24.5
JG16	20.13
JG12	19.5
Mean	21.37
25-Nov-22	
L550	16.5
JG16	15
JG12	13.5
Mean	15.00
15-Dec-22	
L550	13.15
JG16	11.21
JG12	9.22
Mean	11.19

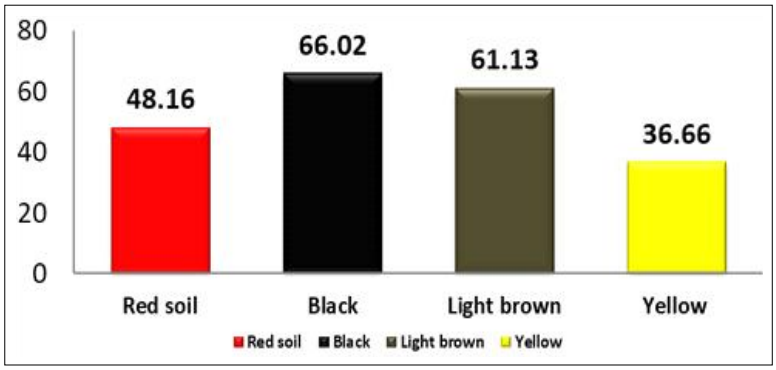

Fig 1: Effect of different types of soil on collar rot incidence.

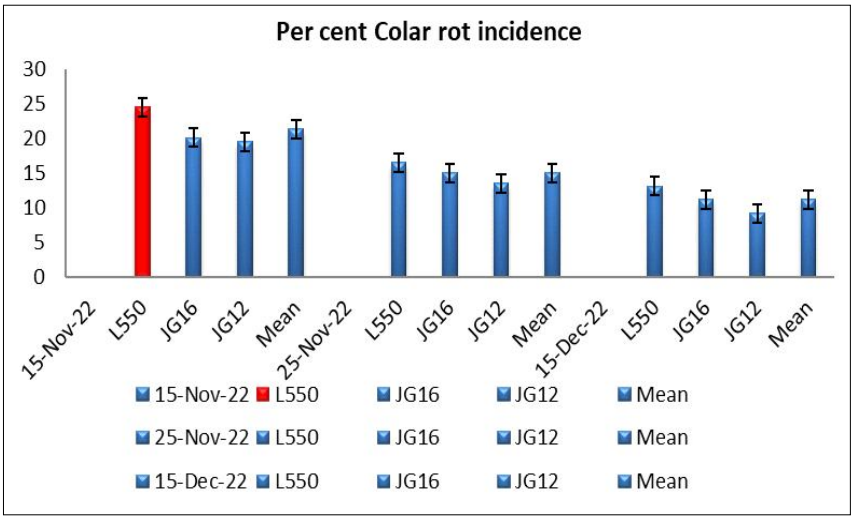

Fig 2: Effect of sowing time on incidence of collar rot.

The similar work were recorded Brown *et al.,* (1989) on shoot and root growth of chickpea.

Effect of sowing time on incidence of collar rot of chickpea

In early sowing the incidence of chickpea collar rot was highest and as sowing was delayed, it continued to decline. The first two weeks of November found that the highest mean incidence of collar rot (21.37%), which was followed by the second two weeks of November (15.00%). The first two weeks of December was the sowing date for the lowest mean collar rot incidence, which was 11.19%. Regarding the date of sowing, a comparable pattern of collar rot occurrence was noted for each variety. Nonetheless, the highest collar rot incidence of 24.50% was noted in L550 among various cultivars and planting dates, followed by JG 16 (20.13%) and JG 12 (19.50%) (Table 4). Finally the result was found or indicated that the development of collar rot in chickpeas is not conducive to late sowing conditions (Fig 2). Pal *et al.* (2018) recorded maximum disease Incidence of *S. rolfsii* in variety JG-62 (46.66%) and minimum in variety JG-130 (31.92%). With respect to date of sowing, maximum diseases incidence was recorded in 15th October sowing (46.71%) and reduced thereafter. Interaction of varieties and dates of sowing revealed that JG-62 exhibited maximum disease Incidence of 51.42% in 15th October sowing and minimum in JG- 130 (23.73%) under 1st November sown crop. Tiwari *et al*. (2023) also reported where maximum Incidence of *S. rolfsii* was recorded highest during early sowing and it kept on decreasing by delaying the sowing.

CONCLUSION

The study comes to the conclusion that the type of soil has a substantial impact on the prevalence of *Sclerotium rolfsii* caused collar rot in chickpeas. Indicating the impact of soil characteristics on disease development, black soil had the highest disease incidence and yellow soil the lowest. Effective management can lessen the burden of disease by choosing less favourable soils, improving drainage and enriching organic matter. Chickpea farming should prioritise integrated soil management techniques to reduce losses and improve crop output and health.

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Conflict of interest

All authors declare that they have no conflict of interest.

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