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Occurrence and distribution of collar rot of chickpea in Bundelkhand region of Uttar Pradesh

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Abstract
Chickpea (*Cicer arietinum* L.) is one of the third most important legumes crops after dry beans and peas grown across the world. Collar rot caused by *Sclerotium rolfsii* is a major disease of chickpea in Central India that may cause 55 to 95% seedling mortality. An intensive roving survey was conducted in 2021-22 and 2022-23 during rabi cropping season to determine the prevalence and incidence of the Collar rot of Chickpea caused by *Sclerotium rolfsii* in the Bundelkhand region of Uttar Pradesh. Incidence of Collar rot disease was detected in early stages of crop (4-5 week after sowing) development with geotagging of the field. Collar rot is commonly seen in the high moist condition. The location of the field was taken through GPS camera, and each field three spots were randomly selected using quadrate (1 m^2). Collar rot disease was found in all of the surveyed blocks. Highest mean disease incidence of 14.5% was recorded in Lodhipur village of Muskara block followed by 14.5% in Kakrau village of Kurara block. Lowest mean incidence 4.5% was recorded in Chakrauli village of Karwi block. The overall mean disease incidence highest in Hamirpur district 10.06% followed by Mahoba district 10.02%. Thus, the incidence of collar rot in chickpea ranged from 4.5 to 14.5%, which was quite high to causing seedling mortality and significant crop losses.
This data might provide a solid background for effective knowledge for further researchers.

Keywords: Survey, chickpea, collar rot

Introduction
Pulses are essential leguminous crops grows in subtropical and temperate regions. They are high in protein and are high in nutrients. Pulses are low in fat and high in soluble fibre, which can decrease cholesterol and aid with blood sugar management. Pulses are an essential crop for farmers since they may be sold as well as consumed by farmers and their families. Pulses also help to maintain soil health by fixing atmospheric nitrogen. Furthermore, the nitrogen-fixing characteristics of pulses promote soil fertility, increasing and extending farmland production. Bundelkhand region is known as pulse bowl of the state. In the pulses crops, chickpea, lentil, pigeon pea, urd bean, mung bean and pea are the main crops of this region. Total production of pulse in India 23.15 million Tonnes in which Rajasthan produce highest pulse production (4.49 million Tonnes) followed by Maharashtra (4.03 million Tonnes) and Madhya Pradesh (3.80 million Tonnes) in 2019-20. Total Area of Chickpea in Rabi season 9.28 Million Hectares, Production 9.02 Million Tonnes and yield 972 kg/ha in India (Average estimation 2014-15 to 2018-19) (Source- Directorate of Economic and Statistics, DAC&FW). The most important states growing chickpea are Madhya Pradesh (32.97%), Maharashtra (18.36%), Rajasthan (16.70%), Andhra Pradesh (8.55%), Karnataka (8.21%), Uttar Pradesh (6.85%) and Gujarat (2.92%) which together accounts for about 95% of total production. Chickpea (*Cicer arietinum* L.) is an important rabi season pulse crop belong to family fabaceae and sub family papilionaceae. It is naturally diploid, having the chromosome number 2n=16. Chickpea is a legume that thrives in both subtropical and temperate climates. During the rabi season, it is generally grown under rainfed conditions. (Shiyani *et al.*, 2001) [16]. Chickpeas are a highly nutritious pulse. It provides 25% protein and 60% carbohydrate, which is the maximum provided by any pulse and ranking third on the list of the most important food legumes. after bean (*Phaseolus vulgaris* L.) and pea (*Pisum sativum* L). It is grown in over 45 countries in all continents of the world. The chickpea cultivation is highly influenced by various type insects and diseases. Among the diseases soil borne diseases such as collor rot (*Sclerotium rolfsii*), wilt (*Fusarium oxysporum* f.sp. *lentis)* stem rot (*Sclerotinia sclerotiorum*) and dry root rot (*Rhizoctonia bataticola*) are the primary constraint on chickpea production.

They not only reduce yields but also have a detrimental influence on output quality and consistency year after year, undermining sustainable agricultural initiatives. Among them collar rot caused by *Sclerotium rolfsii* is emerging as major disease of chickpea It is common in regions were high soil moisture and warm temperatures. A destructive and rapidly spreading chickpea disease of collar rot wherever the crop is cultivated in environmental circumstances suitable for its development, it results in severe output losses. *Sclerotium rolfsii*, a pathogen, is present in tropical and subtropical areas of the world where high temperatures are common. The disease is distinguished by the presence of white cottony mycelium growth on the collar region of the chickpea plant, right above the soil line. When soil moisture is high and temperature is warm (30 °C), the pathogen can cause significant plant stand loss, favouring sclerotial germination and disease development. (Aycock, 1996) [5]. *S. rolfsii* has a wide host range, prolific growth, and the potential to develop chronic sclerotia that can cause significant economic losses. (Ramesh *et al.* 2014) [13]. The occurrence of collar rot reduces with crop age. In tropical locations, the disease causes roughly 20% yield loss and 55-95% seedling death. (Gurha and Dubey, 1982) [7]. A comprehensive survey of chickpea diseases of collar rot to find out the occurrence and distribution of chickpea disease. The severity of root disease is highly determined by soil type, pH, temperature, moisture, and the biological activity of suppressive microorganisms. (*Sahu et al.*, 2015) [14]. A roving survey was conducted under the climate change scenario to investigate the incidence of chickpea diseases in relation to Bundelkhand region of Uttar Pradesh.

Materials and Methods

Survey to assess disease incidence of collar rot of chickpea in Bundelkhand region of Uttar Pradesh.

The rapid roving survey of chickpea fields of Banda, Hamirpur, Mahoba, Jhansi, Chitrakoot, Jalaun, Lalitpur district comes under Bundelkhand region of Uttar Pradesh.

Thus, total three block were selected in each district and in each block three village are selected to determine the disease incidence, an area of 1 m x 1m was marked diagonally across each field at five points, and the percent disease incidence (PDI) was determined with the help of following formula: -

$$\text{Collar rot incidence}(\%) = \frac{\text{Infected Plants}}{\text{Total Plant}} \text{x}100$$

The mean of three farmer fields from each village was used to calculate the block-wise incidence of collar rot. When the disease first shows, the plant's growth is initially slowed, the leaves of infected chickpea plants change colour to a light pale colour, the plant starts to dry out, and eventually dies; seedlings are easily removed. The seedling collapsed and displayed decay on the collar area. White mycelial growth that is attached to the collar and is connected to sclerotia that resemble mustard. In-person discussions about the prevalence and severity of the disease, as well as agronomic methods and field history, were also conducted with cultivators during the survey.

Collection of diseased samples

During the months of November to January 2021–2022, infected plants exhibiting typical collar rot signs were taken from the chickpea fields in the Bundelkhand region of Uttar Pradesh. The samples were brought in to Department of Plant Pathology laboratory at the College of Agriculture in Banda, (U.P.), for isolation and additional research.

Isolation of fungus

The collar area displaying typical illness signs was sliced into tiny pieces. The parts were then surface sterilized for one minute in a 1% sodium hypo chloride solution. These pieces were properly rinsed three times in sterile distilled water to eliminate any remnants of sodium hypo chloride solution before aseptically transferred to sterilize potato dextrose agar (PDA) plates. They were incubated at 25±1 °C for three days to allow the fungus growth. The fungal growth was thereafter transferred to PDA slants. The pure culture of fungus was obtained by further growing culture and following hyphal tip culture under aseptic conditions. For later studies, the pure cultures were maintained on PDA slants at 4±1 °C.

Identification of fungus

The pathogen *S. rolfsii* produces cottony white colonies on PDA media. After 8–9 days of incubation, the colonies showed mycelial development that are from slightly white to completely white, as well as the initiation of sclerotia production. Sclerotia are dark in color and shaped like mustard seeds. The pathogen is identified as *Sclerotium rolfsii* based on typical cultural characteristics and sclerotial development patterns. (Barnett and Hunter 1972) [6] Several researchers have documented such kind of standard characteristic of *Sclerotium rolfsii* (Palaiah and Adiver 2006; Okereke and Wokocha, 2007; Rakholiya and Jadeja 2011; Sharma *et al*., 2013) [10, 9, 12, 15].

Maintenance of pure cultures

The fungus was sub-cultured on PDA slants and allowed to develop at a temperature of 27±1 °C. The cultures were kept in the refrigerator at 5 °C for future investigations and sub-cultured once a month.

Mass multiplication of *S. rolfsii* on sorghum seeds

The *Sclerotium rolfsii* pathogen was mass multiplied on sorghum seeds. Sorghum grain weighing 50 gm was placed in a 250 ml conical flask, soaked overnight, and then repeatedly sterilised for two days at 15 psi for 15 min. at 121.6 °C. These autoclaved sorghum grain flasks permitted cooling and were inoculated with the test fungus using three to four 5 mm-diameter mycelium discs from a pathogen culture that had previously been cultured on PDA. 10 days were spent incubating at 27 ±1 °C in an aseptic environment. The flasks were shaken on alternate days for uniform colonization on sorghum grains by incubated fungus. The sorghum grains fully covered with fungal growth were used as inoculums.

Proving the pathogenicity by artificially Soil inoculation

S. rolfsii was tested for pathogenicity in plastic pots. Plastic pots of 2 kg capacity were filled with two times sterilized soil. The inoculum of *S. rolfsii* was multiplied on two times sterilized sorghum seeds and added to each pot. The top 15 cm of soil was thoroughly mixed with the inoculum. Similarly 3 pots with sterilized soil without inoculums were used as control. The pots were incubated for 4-5 days with light watering. Collar rot susceptible chickpea variety L-550 was sown in each pot (6 seeds/pot). Observations on germination,

pre and post emergence mortality were recorded.

Results and Discussion

The results obtained from the present investigation are summarized below:

A total of twenty nine isolates of *S. rolfsii* were obtained from Bundelkhand region of U.P. which was designated as SRC 1 (*Sclerotium rolfsii* Chickpea) to SRC 29. Using similar method of isolation of mycelium from collar area using tissue segment method was also reported by Narasimha *et al*. (2004) [8] and Arunsri *et al*. (2011) [3].

Pathogenicity test

The pathogenicity of the 29 distinct isolates was examined using the susceptible cultivar L550, which exhibited symptoms two weeks after seeding. Plants that had been inoculated displayed the earliest signs, such as clear rotting and the development of white mycelial fungus. Through their pathogenicity, it was found that all twenty-nine isolates were pathogenic. Similar pathogenicity of chickpea collar rot were reported by earlier researchers Ansari and Agnihotri *et al.* (2000) [2]; Abida *et al.* (2008) [1], Prasad *et al.* (2010) [11]], Awasthi *et al.* (2010) [4].

Survey for disease incidence

During rabi season in 2021-22 and 2022-23, conduct a survey and found that the mean incidence ranged from 4.5 to 14.5%. (Table1). Plants were examined for disease based on visible symptoms on the plant and white mycelial development at the collar region (Plate 1) along with mustard like sclerotia were also observed. Highest mean disease incidence of 14.5% was recorded in Lodhipur village of Muskara block (Table 1) followed by 14.0% in Kakrau village of Kurara block. Lowest incidence 4.5% was recorded in Chakrauli village of Karwi block. The overall mean disease incidence highest in Hamirpur district 10.06% followed by Mahoba district 10.02%.

Table 1: Survey on occurrence and distribution of collar rot Bundelkhand region of Uttar Pradesh

S.No.	District	Block	Village	PDI (%) 2021-22	PDI(%) 2022-23	PDI (Mean)
1	Banda	Badokhar Khurdh	Pachanehi	13	9	11
2			Mahokhar	7	5	6
3			Mawai bujurg	7	4	5.5
		Mean				7.5
4		Tindwari	Kurseza	9	6	7.5
5			Mungus	11	8	9.5
6			Paprenda	5	7	6
		Mean				7.6
7		Naraini	Basrahi	16	14	15
8			Sahapur	13	9	11
9			Sahabajpur	6	7	6.5
		Mean				10.83
		Over all Mean				8.64
10	Hamirpur	Muskara	Lodhipur	17	12	14.5
11			Damupurwa	10.5	8	9.25
12			Khadehi	12	11	11.5
		Mean				11.75
13		Kurara	Kakrau	14	14	14
14			Badanpur	12	13	12.5
15			Beri	11.5	7	9.25
		Mean				11.91
16		Maudaha	Sayar	10.5	8	9.25
17			Biwar	8.5	7	7.75
18			Gosiyari	15.5	12	13.75
		Mean				10.25
		Over all Mean				10.06
19	Mahoba	Kabrai	Raiwaar	9	10	9.5
20			Rawai sunecha	11	11	11
21			Bilkhi	13	7	10
		Mean				10.16
22		Charkhari	Balyaan	8.5	5	6.75
23			Chandauli	10	9	9.5
24			Atrauli	11	11	11
		Mean				9.08
25		Jaitpur	Badkhera	14	12	13
26			Bacheura	9	10	9.5
27			Akunaa	10	10	10
		Mean				10.83
		Over all Mean				10.02
28	Chitrakoot	Karwi	Bhratpur	5	8	6.5
29			Chakrauli	4	5	4.5
30			Barampur	7	6	6.5
		Mean				5.83

31		Ramnagar	Badhauin	8	3	5.5
32			Barauch	6	7	6.5
33			Bhawanipur	6	8.5	7.25
		Mean				6.41
34		Mau	Ahiri	9	9	9
35			Atrosi	11	11	11
36			Bariya	13	12.5	12.75
		Mean				10.91
		Over all Mean				7.71
37	Jhansi	Balgaon	Marora	12	11	11.5
38			Hazipur	12.5	9.5	11
39			Pala	10	9	9.5
		Mean				10.66
40		Bamaur	Ajneri	9	10	9.5
41			Bamaur	6.5	5	5.75
42			Birpura	7	8	7.5
		Mean				7.58
43		Chirgaon	Aamargarh	7	9	8
44			Chirgaon	9	9	9
45			Chiruna	15	12	13.5
		Mean				10.16
		Over all Mean				9.46
46	Jaluna	Jalun	Alipura	10	10	10
47			Aurekhi	8.5	7	7.75
48			Bichuli	9.5	9	9.25
		Mean				9
49		Kadora	Ata	11	11	11
50			Akbarpur	13	12	12.5
51			Bogi	12	11.5	11.75
		Mean				11.75
52		Rampura	Alampura	11.5	8	9.75
53			Bera	11	9	10
54			Bitaura	6	6	6
		Mean				8.58
		Over all Mean				9.77
55	Lalitpur	Baar	Simriya	9	9	9
56			Badokhara	8	5	6.5
57			Banpur	7.5	7	7.25
		Mean				7.58
58		Jakhaura	Adhwa	11	11	11
59			Badora	8.5	6	7.25
60			Bharavat	8	8	8
		Mean				8.75
61		Mehruni	Bhusra	9	9	9
62			Chandra	10	5	7.5
63			Devrankhurd	7.5	5	6.25
		Mean				7.58
		Over all Mean				7.97

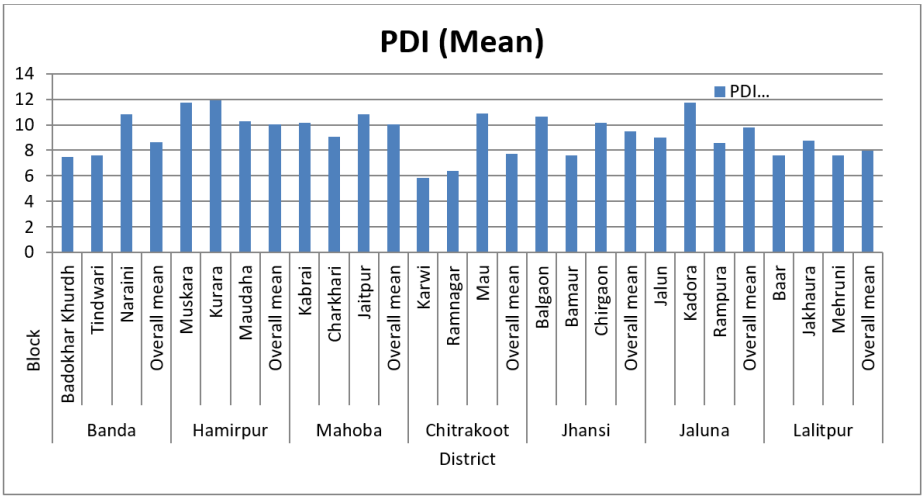

Fig 1: Percent disease incidence of chickpea collar rot in surveyed area of Bundelkhand region of U.P.

Plate 1: Symptoms showing chickpea collar rot

Plate 2: Pure culture of collar rot with forming Sclerotia

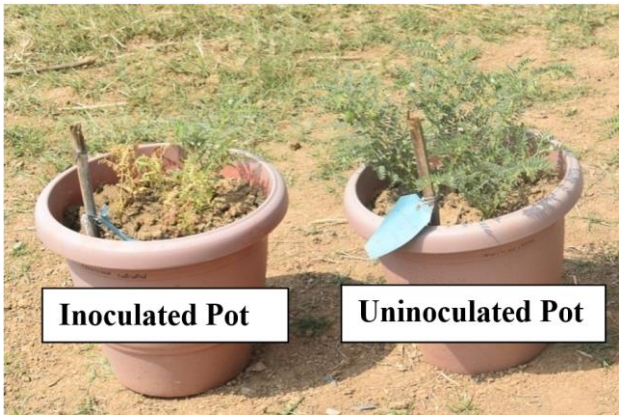

Plate 3: Pathogenicity test of *Sclerotium rolfsii*

Plate 3: Geotagged field view shows collar rot-affected chickpea fields in various places.

Conclusion

Under surveyed districts of Bundelkhand region of U.P. maximum Percent disease incidence (PDI) was observed from Muskara (14.5%) block of Hamirpur district. While minimum percent disease incidence was observed from karwi (4.5%) block of Chitrakoot district. The overall mean disease incidence highest in Hamirpur district 10.06% followed by Mahoba district 10.02%. Thus, the incidence of collar rot in chickpea ranged from 4.5 to 14.5%.

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