Roving Survey of Collar Rot Disease of Chickpea Caused By *Sclerotium rolfsii* Sacc. in Rajasthan, India

ABSTRACT

Chickpea is one of the most cultivated legume crops and a rich source of protein in many countries. Among Pulses Chickpea is an important pulse crop of the semi-arid tropics and the warm temperate zones, ranking first in India. The survey conducted in the major chickpea-growing regions of Rajasthan during the *Rabi* season of 2021-22 highlighted collar rot as a significant issue caused by *Sclerotium rolfsii*. The study covered areas in Jaipur, Tonk, Kota, Bundi, Swaimadhopur and Alwar regions. To assess disease incidence, researchers randomly selected 25 square meter areas at four spots in each field, totaling 100 square meters per field. In each village, fields were chosen, and plants displaying typical collar rot symptoms were collected for further analysis. Upon examination, an average disease incidence of 23.69 per cent was recorded across the surveyed districts. The higher disease frequency of (33.08%) was assessed in Kota while least in Alwar location (15.04%).. To further understand the pathogen responsible for collar rot, samples were collected and brought to the laboratory for isolation. This comprehensive survey provides valuable insights into the prevalence of collar rot in chickpea crops across different regions of Rajasthan, aiding in the development of effective management strategies.

Keywords: *Sclerotium rolfsii; survey; chickpea; collar rot; disease; incidence.*

1. INTRODUCTION

Chickpea is one of the most cultivated legume crop and world's largest pulse crop, chickpea, which is cultivated extensively in India, accounts for about 75 per cent of all pulse production [1]. It is cultivated during the *Rabi* season and plays a significant role in the arid and semi-arid farming system. It is grown under irrigation and rainfed circumstances. Chickpea is an important grain legume providing an enormous source of minerals, fibers, and protein for humans as well as animals [2]. Chickpea is a highly nutritious pulse crop with low digestible carbohydrates (40-60%), protein (15-22%), essential fats (4-8%), and a range of minerals and vitamins. High levels of phosphorus (340 mg/100 g), calcium (190 mg/100 g), magnesium (140 mg/100 g), iron (7 mg/100 g), and zinc (3 mg/100 g) have been found in chickpea seeds. The fatty acid composition of the seed adds value because fat govern the texture, shelf-life, flavor, aroma, and nutritional composition of chickpea-based food products [3].

Formatted: Numbering: Continuous

Comment [MC1]: In the abstract, chickpea is important pulse crop this statement is repeated rwice

Comment [MC2]: Line No: 9 – Does the survey conducted for other diseases also ? if yes mention them

Formatted: Highlight

Formatted: Highlight

Comment [MC3]: In terms of what?

Comment [MC4]: Numbers speak much better try including production and productivity data

Comment [MC5]: Remove this statement. It is irrelevant

Chickpea has been and continues to be consumed by humans since ancient times owing to its good nutritional properties [4]. It is used as food in different styles in different countries [5], such as chickpea flour for making snacks in India [6], and chickpea is used in mush and soups/salads in Asia and Africa [7]. The diverse cooking styles make chickpea demand to consumers worldwide [4]. Biological nitrogen fixation (BNF) sustains sustainable agriculture by supplementing chemical fertilizers, provide optimal crop yields. Under best circumstances, this symbiotic N_2 fixation can meet up to 85 per cent of the nitrogen demands in legumes [8].

India ranks first in conditions of chickpea production and utilization in the world. About 65 per cent of the global area with 68 per cent of the global productivity is contributed by India. In India, it is grown over 10.6 million hectare with an annual production of 10.90 million tonne [9]. Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, Uttar Pradesh and Andhra Pradesh are major chickpea growing states of India, covering 98.86 lakh/ha area, 107.37 lakh tonne/ha production and 1086 kg/ha of the productivity of the country. Despite the high total production and more nutritive value, productivity of chickpea was low due to many biotic and abiotic constraints. Heavy infestation of biotic stresses *i.e.* wilt (*Fusarium oxysporum* f. sp. *ciceri*), dry root rot (*Rhizoctonia* sp.) and collar rot (*Sclerotium rolfsii* Sacc.) at different crop growth stages. The dominated soil borne diseases *i.e.* wilt, and collar rot causes highest seedling mortality in chickpea reported by [10].

It has been reported that collar rot disease is more severe and most frequently at high moistures and high temperatures conditions [11]. Collar rot mostly appears in the early growth stage of the crop particularly before pod formation. Affected younger seedlings turn yellow and may collapse, but older seedlings may dry without collapsing. If affected seedlings are uprooted from moist soil in the earlier stages of infection, rapeseed like sclerotia can be seen. The yellowing of leaves and constriction at the collar region with white mycelial strands of *S. rolfsii*, attached around the collar region are major characteristic symptoms of disease [12]. In advanced stage of infection, all the leaves shed, turn brown dry and often adhere to dead stem. The mycelium of pathogen grows over the diseased tissue and nearby the soil forming a white mat of mycelial thread with the typical brown to chocolate brown mustard seed sized sclerotia [13]. Collar rot is an emerging soil-borne disease of chickpea that may stimulate 55-95 per cent mortality of chickpea seedlings under favorable environmental conditions like high soil temperature (25-30°C) and heavy rainfall [14]. Warm and humid condition with a temperature ranging between 25–30°C is optimum for its growth and sclerotial germination [15-17]. Looking to this disease, the survey was made to know the distribution and occurrence of this important problem in chickpea in different region of Rajasthan.

2. MATERIAL AND METHODS

Survey in major chickpea growing districts of Rajasthan *viz.,* Jaipur, Kota, Bundi, Sawaimadhopur, Tonk and Alwar was undertaken to know the incidence of collar rot disease. Survey was conducted during the *Rabi* season of 2021 in fourty four fields of twenty two villages of eleven tehsil of six districts. In each tehsil, two villages was selected, and under each village, two farmer's fields was assessed, and incidence was recorded. In each field, five spots of one square meter area were marked diagonally at randomly to

Comment [MC6]: This statement is not necessary here

Comment [MC7]: Loses caused due to collar rot disease in chickpea (both production and economic loses)

Comment [MC8]: Please define the objectives clearly

Comment [MC9]: Combine these two sentences and write the names of districts in brackets

Comment [MC10]: Were they selected randomly ?

cover entire field. The collar rot infected samples of chickpea was also collected from the above-surveyed areas. Diseased and healthy plants were counted in each spot and the per cent disease incidence. Based on observation, the disease incidence was calculated by following formula (Horsfall and Cowling, [18].

$$\text{Per cent disease incidence} = \frac{\text{Number of diseased plants}}{\text{Total number of plants observed}} \times 100$$

3. RESULTS AND DISCUSSION

A survey was conducted in major chickpea growing region of Rajasthan during *Rabi* season of 2021-22. Collar rot caused by *Sclerotium rolfsii* was major issue for the major part of Jaipur, Tonk, Kota, Bundi, Swaimadhopur and Alwar regions. An average disease incidence of 23.69 per cent was recorded in these surveyed districts. The higher disease frequency of (33.08%) was assessed in Kota while least in Alwar location (15.04%). The survey was conducted during crop stage was between 20 to 60 days. The most extreme disease frequency was seen in plants at seedling to podding stage. The severity of the disease was highest in Kota region which ranged from 34.36 to 31.80 per cent with an average of 33.08 per cent followed by Swaimadhopur, Jaipur, Tonk, Bundi and Alwar district. Information on the predominance of collar rot of chickpea summed up (Plate -1).

3.1. Jaipur: Sanganer and Phagi tehsils in the Jaipur district were selected for the survey. Two fields were chosen at random in each community for a roving survey. The average disease incidence in Jaipur district was 24.34 per cent with the highest average disease incidence in Phagi tehsil (26.17%) followed by Sanganer tehsil (22.52%).

3.2. Tonk: Malpura tehsil in the Tonk district was selected for the survey. Two fields were chosen at random in each community for a roving survey. The average disease incidence in Tonk district was 22.93 per cent with the highest average disease incidence in Malpura tehsil (22.93%).

3.3. Alwar: Rajgarh and Alwar tehsils in the Alwar district were selected for the survey. Two fields were chosen at random in each community for a roving survey. The average disease incidence in Alwar district was 15.04 per cent with the highest average disease incidence in Alwar tehsil (16.10%) followed by Rajgarh tehsil (13.97%).

3.4. Kota: Digod tehsil in the Kota district was selected for the survey. Two fields were chosen at random in each community for a roving survey. The average disease incidence in Kota district was 33.08 per cent with the highest average disease incidence in Ladpura tehsil (34.36%) followed by Digod tehsil (31.80%).

3.5. Swaimadhopur: Chauth Ka Barwara and Swaimadhopur tehsils in the Swaimadhopur district were selected for the survey. Two fields were chosen at random in each community for a roving survey. The

Comment [MC11]: If available also include data for disease severity

Comment [MC12]: Is it early crop stage ?

average disease incidence in Swaimadhopur district was 28.58 per cent with the highest average disease incidence in Swaimadhopur tehsil (29.55%) followed by Chauth Ka Barwara tehsil (27.60%).

3.6. Bundi: Bundi and Keshoraipatan tehsils in the Bundi district were selected for the survey. Two fields were chosen at random in each community for a roving survey. The average disease incidence in Bundi district was 18.20 per cent with the highest average disease incidence in Keshoraipatan tehsil (19.94%) followed by Bundi tehsil (16.47%). The results obtained are presented in the Table 1-2, Fig.1 and Fig 2.

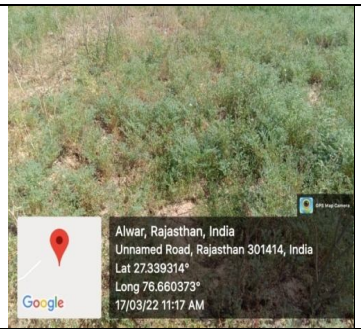
4. DISCUSSION

A total of 44 fields from six districts covering eleven tehsils with 22 villages of Rajasthan were surveyed. The survey results revealed that the collar rot caused by *Sclerotium rolfsii* is an important pathological problem, mainly in chickpea growing districts and collar rot incidence appeared in all the surveyed districts. Collar rot infected plants appeared in patches in all the affected fields. During survey it was also noticed that collar rot incidence varied from location to location. It may be due to higher moisture content and presence of un-decomposed organic matter near soil surface, which could be attributed to the higher level of disease incidence in different regions. Our results are supported by the findings of Singh *et al.* [19] who conducted roving survey of chickpea growing areas at different locations of Kota district of Rajasthan, to assess the incidence of collar rot of chickpea during *Rabi* 2018-19. The maximum incidence was recorded in the field of Agriculture Research Station, Ummedganj (19.82%), followed by Galana (14.38%) Sultanpur (12.05%), Sangod (11.20%), Itawa (10.40%), Dhakerkhedi (9.32%) and Char-chouma (6.69%) fields. Thus, the incidence of collar rot in chickpea was in the range of 6.69 - 19.82 per cent, which was quite high to cause seedling mortality and crop losses. Singh *et al.* [20] also conducted a survey in Kymore Plateau and Satpura to evaluate the collar rot incidence in chickpea and also found similar findings in Hills during 2018 and collar rot incidence was ranged from 9.30 to 14.80 per cent. Highest incidence (14.80%) was in the Rampur Naikin block of Sidhi district and the lowest incidence (9.30%) was recorded in the Kundam block of Jabalpur district. Similarly, Srividya *et al.* [21] conducted the roving survey in Kurnool and Anantapur districts of Andhra Pradesh during *Rabi* 2017 indicated that chickpea collar rot disease incidence range was 4.66 to 18.00 per cent during 10 to 20 days after sowing.

Comment [MC13]: Include citation

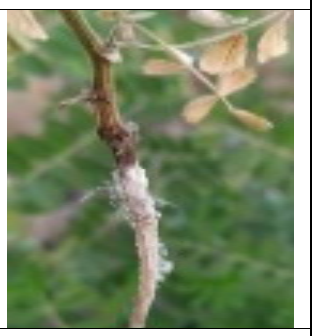
Comment [MC14]: Concise it

Comment [MC15]: Also include citation related to the reasons for varied disease incidence at different areas

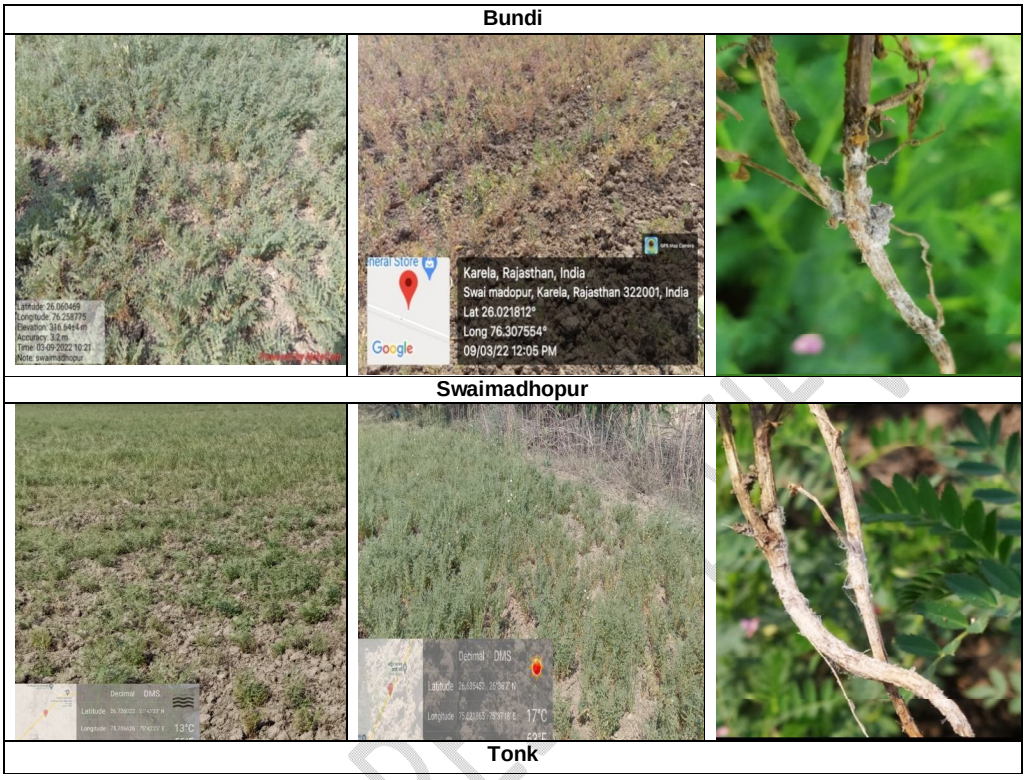


Alwar

Jaipur



Kota



126 **Fig. 1. Survey of collar rot disease of chickpea in different areas of Rajasthan**

127

128

129

Table 1: Status of collar rot incidence in chickpea growing districts of Rajasthan during the survey

Districts	Tehsils	Villages	No. of field	PDI in surveyed field		Avg. PDI (avg. of 2 fields)	Avg. PDI (Tehsil)	Mean of districts
Jaipur	Sanganer	1. Manpura Teelawala	2	21.92 (1)	24.65 (2)	23.28	22.52	24.34
		2. Mohanpura	2	23.73 (3)	19.78 (4)	21.75		
	Phagi	1. Renwal manji	2	28.13 (5)	25.56 (6)	26.84	26.17	
		2. Nimeda	2	26.57 (7)	24.43 (8)	25.50		
Tonk	Malpura	1. Malpura	2	22.07 (9)	25.33 (10)	23.70	22.93	22.93
		2. Diggi	2	20.76 (11)	23.58 (12)	22.17		
Alwar	Rajgarh	1. Shrichandpura	2	15.54 (13)	10.76 (14)	13.15	13.97	15.04
		2. Kali pahari	2	16.22 (15)	13.36 (16)	14.79		
	Alwar	1. Malakhera	2	18.68 (17)	15.74 (18)	17.21	16.10	
		2. Haldeena	2	12.45 (19)	17.56 (20)	15.00		
Kota	Digod	1. Digod	2	28.30 (21)	33.56 (22)	30.93	31.80	33.08
		2. Borkhera	2	34.53 (23)	30.83 (24)	32.68		
	Ladpura	1. Ummedganj	2	38.06 (25)	35.12 (26)	36.59	34.36	
		2. Chhatrapura	2	30.05 (27)	34.20 (28)	32.12		
Swaimadhopur	Chauth Ka Barwara	1. Kawad	2	25.56 (29)	23.34 (30)	24.45	27.60	28.58
		2. Jonla	2	29.12 (31)	32.40 (32)	30.76		
	Swaimadhopur	1. Karela	2	34.02 (33)	30.56 (34)	32.29	29.55	
		2. Itawa	2	28.21 (35)	25.43 (36)	26.82		
Bundi	Bundi	1.Baldevpura	2	17.23 (37)	14.23 (38)	15.73	16.47	18.20
		2. Rajwas	2	15.67 (39)	18.76 (40)	17.21		
	Keshoraipatan	1. Ajeta	2	19.02 (41)	16.98 (42)	18.00	19.94	
		2. Rampura	2	24.23 (43)	19.54 (44)	21.88		
Over all mean = 23.69								

Formatted: Numbering: Continuous

Table 2: Details of different isolates of *S. rolfsii* collected during survey from ten tehsils of Rajasthan

S. No.	Districts	Tehsils	Details of field chosen for establishing isolate		Representative isolates of tehsil and their code No.	Avg. disease incidence of tehsils (avg. 4 fields)
			Village (Field No.)	Disease incidence of field		
1	Jaipur	Sanganer	Manpura Teelawala (2)	24.65	CSR 3	22.52
2	Jaipur	Phagi	Renwal Manji (5)	28.13	CSR 7	26.17
3	Tonk	Malpura	Malpura (10)	25.33	CSR 4	22.93
4	Alwar	Alwar	Malakhera (17)	18.68	CSR 10	16.10
5	Kota	Digod	Borkhera (23)	34.53	CSR 8	31.80
6	Kota	Ladpura	Ummedganj (ARS) (25)	38.06	CSR 9	34.36
7	Swaimadhopur	Chauth Ka Barwara	Jonla (32)	32.40	CSR 1	27.60
8	Swaimadhopur	Swaimadhopur	Karela (33)	34.02	CSR 6	29.55
9	Bundi	Bundi	Rajwas (40)	18.76	CSR 2	16.47
10	Bundi	Keshoraipatan	Rampura (43)	24.23	CSR 5	19.94

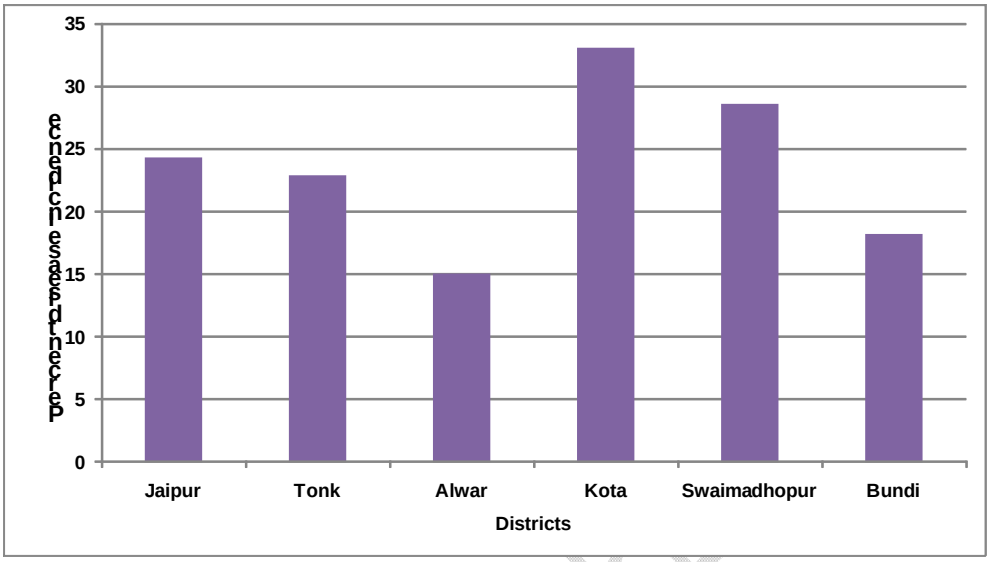


Fig.2: Status of collar rot incidence in chickpea growing districts of Rajasthan during the survey

5. CONCLUSION

Collar rot disease is a serious threat to chickpea production area. Data clearly showed that the collar rot of chickpea caused by *Sclerotium rolfsii* is an exigent pathological concern especially in Kota, Swaimadhopur, Jaipur, Tonk, Bundi and Alwar. The mean maximum collar rot incidence was recorded in Kota (33.08%) followed by Swaimadhopur (28.58%), Jaipur (24.34%), Tonk (22.93%), Bundi (18.20%) and Alwar (15.04%) districts. No area or location in the surveyed region was completely devoid of the collar rot of chickpea. Since *S. rolfsii* are soil inhabitants and survive long time in soil. The practical implications of research findings on collar rot disease in chickpea crops for agronomists and farmers are significant. Integrated disease management Implementing IPM strategies can help in controlling collar rot disease while minimizing reliance on chemicals. This may involve practices such as biological control using antagonistic micro-organisms, organic amendments, crop sanitation, and judicious use of fungicides only when needed and as part of an overall management strategy.

REFRENCES

1. Keote GA., Prakash Reddy MS., Kapgate OY, Wasnikar AR and Bhoyar SD. Effect of bio-inoculants for the management of collar rot of chickpea. *International Journal of Chemical Studies.* 2019; 7(4): 1857-1861.
2. Varol IS, Kardes YM, Irik HA, Kirnak H and Kaplan M. Supplementary irrigations at different physiological growth stages of chickpea (*Cicer arietinum* L.) change grain nutritional composition. *Food Chemistry*. 2020; 303:125402.

Formatted: Numbering: Continuous

3. Madurapperumage A, Tang L, Thavarajah P, Bridges W, Shipe E and Vandemark G, *et al*., Chickpea (*Cicer arietinum* L.) as a source of essential fatty acids–a biofortification approach. *Frontiers in Plant Science*. 2021; 12: 734980.

4. Jukanti AK, Gaur PM, Gowda CL and Chibbar RN. Nutritional quality and health benefits of chickpea (*Cicer arietinum* L.): a review. *British Journal of Nutrition*. 2012; 108 (1): 11-26.

5. Ibrikci H, Knewtson SJ and Grusak MA. Chickpea leaves as a vegetable green for humans: Evaluation of mineral composition. *J. Sci. Food Agric*. 2003; 83, 945–950.

6. Chavan JK, Kadam SS and Salunkhe DK. Biochemistry and technology of chickpea (Cicer arietinum L.) seeds. *CRC Crit. Rev. Food Technol*. 1986; 25, 107–158.

7. Gecit, H. Chickpea utilization in Turkey. In Proceedings of the Consultants Meeting, Andra Pradesh, India, 27–30 March 1989; pp. 69–74.

8. Singh Z and Singh G. Role of Rhizobium in chickpea (Cicer arietinum) production—A review. *Agric. Rev*. 2018; 39, 31–39.

9. Anonymous. Project coordinators report AICRP on chickpea annual group meet. 2019.

10. Sharma OP, Bantewad SD, Pantange NR, Bhede BV, Badqjar AG, Ghante PH *et al*. Implementation of Integrated Pest Management in Pigeon pea and Chickpea pests in major pulse growing areas of Maharashtra. *Journal of Integrated Pest Management*. 2015; 15(1):12; DOI: 10. 1093/jipm/pmv011.

11. Al-Askar AA, Rashad YM and Absulkhair WM. Antagonistic activity on an endemic isolate of Streptomyces tendae RDS 16 against phytopathogenic fungi. *J Mycobiol. Resist*. 2013; 6: 509-516.

12. Nene YL, Reddy MV, Haware MP, Ghanekar AM, Amin KS, Pande S, *et al*., *Field diagnosis of chickpea diseases and their control. information bulletin no. 28 (revised)*. International Crops Research Institute for the Semi-Arid Tropics. 2012.

13. Hasna MK, Kashem MA, and Ahmed F. Use of *Trichoderma* in Biological Control of Collar Rot of Soybean and Chickpea. *International Journal of Biochemistry Research and Review. 2020;* 29(9): 25-31.

14. Sharma M and Ghosh R. Heat and soil moisture stress differentially impact chickpea plant infection with fungal pathogens. *Plant Tolerance to Individual and Concurrent Stresses*. 2017; 47-57.

15. Punja ZK. The biology, ecology and control of *Sclerotium rolfsii*. *Annual Review of Phytopathology*. 1985; 23: 97-127.

16. Zape AS, Gade RM and Singh R. Physiological studies on different media, pH and temperature on *Sclerotium rolfsii* Isolates of soybean. *Scholarly Journal of Agriculture Science*. 2013; 2(6): 238-241.

17. Paul SK, Mahmud NU, Gupta DR, Surovy MZ, Rahman M and Islam MT. Characterization of *Sclerotium rolfsii* causing root rot of sugar beet in Bangladesh. *Sugar Tech*. 2021; 23: 1199–1205.

18. Horsfall JG and EB Cowling. Pathometry: The measurement of plant disease, p. 119–136. In: J.G. Horsfall and E.B. Cowling (eds.). Plant disease, an advanced treatis, vol. II. Academic Press, New York. 1978.

19. Singh K, Meena CB, Gautam C and Jewaliya B. Symptomatology, isolation and pathogenicity test of the collar rot of Chickpea (*Cicer arietinum* L.) Incitant by *Sclerotium rolfsii* (Sacc.). *The Pharma Innovation Journal*. 2022; 11(3): 23-29.

20. Singh G, Khare UK., Babar A, Wasnikar AR, Kumar A. and Amrate PK. Present status of collar rot in major chickpea growing state of India. *Biological Forum-An International Journal. 2022;* 14(2): 1095-1101.

21. Srividya PV, Ahamed LM, Ramana JV and Ahammed SK. Studies on diversity of *Sclerotium rolfsii* causing collar rot in chickpea using morphological and molecular markers. *Legume Research-An International Journal*; 2022; 45(1): 82-89.