

Original Research Article

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Study of Soil Factors Affecting Development of Collar Rot Disease in Chickpea

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ABSTRACT

Keywords

Vertisol, Chickpea, collar rot, *Sclerotium rolfsii*, Soybean, Drybean, Turn yellow

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The present study elucidated the role of different soil parameters viz., soil type, texture and pH on population dynamics of *S. rolfsii* in the development of collar rot of chickpea. In case of soil types [alfisol (dorsa), inceptisol (matasi), vertisol (kanhar) and entisol (bhata)] least mortality per cent (15.27 %) was observed in inceptisol (matasi) soil whereas highest mortality was observed in vertisol (kanhar) (56.02 %). The infected soil of different textures (sandy, sandy loam, loam, clay, clay loam, silt clay and silt loam), showed least mortality per cent (20.74 %) in sandy loam texture followed by sandy texture (26.67 %). However, highest mortality was observed in clay texture soil (63.22 %), followed by clay loam (45.83 %). In case of different soil pH (5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0 and 8.5) significantly least mortality per cent (19.90%) was observed at pH 8.5 followed by pH 8 (24.07 %) and pH 7.5 (38.42 %) However, highest mortality was observed at pH 6.0 it was 80.75 %.

Introduction

Chickpea (*Cicer arietinum* L.) is the world's third most important food legume after drybean and pea. India is the largest producer of chickpea, contributing more than 70 per cent of the total world production. Among the soil borne diseases of chickpea, collar rot is important disease causing seed rot and seeding mortality in the initial stage of crop growth up to 45 days. The mortality ranges from 54.7-

95% in India (Kotasthane *et al.*, 1976) causing significant reduction in plant population. Collar rot caused by *Sclerotium rolfsii* Sacc., is one of the several fungal diseases affecting this crop and is reported almost all over the world where ever chickpea is grown (Nene *et al.*, 1984). Collar rot is a fast spreading and destructive disease of chickpea. It has wide host range (Aycock, 1966 and Punja, 1988) and an omnivorous soil borne fungus, parasitizing root and collar region of the plant

thus, producing wilt like symptoms. Generally, the disease is severe in loamy soil regions and more prevalent in soybean- paddy based cropping system, when soil moisture is high and temperature is warm at the seedling stage. Affected seedlings turn yellow and die. The seedlings generally collapse and show rotting at the collar region and below. Root disease severity is strongly influenced by soil type, soil pH, soil temperature, moisture, and the biological activity of suppressive microorganism. The present study was conducted to ascertain the role of different soil parameters viz., soil type, texture and pH on population dynamics of *S. rolfsii* in the development of collar rot of chickpea.

Materials and Methods

Isolation of pathogen *Sclerotium rolfsii* from diseased samples

Isolation was made from the fresh diseased plant samples collected from research farm at seedling and vegetative stage of the crop. The roots of diseased plant showing symptoms were washed thoroughly with water, small pieces of infected roots were cut with the help of sterilized blade. These pieces were surface sterilized with 1:1000 mercuric chloride (HgCl_2) solution for one minute followed by three washings with sterilized distilled water to remove traces of HgCl_2 . The pieces were then transferred aseptically to Petri plates containing sterilized PDA and incubated at $25 \pm 2^\circ\text{C}$ for three to five days and examined at frequent intervals to see the growth of the fungus developing from different pieces. As and when fungal colony appears they were transferred to PDA slant for purification of culture.

Mass multiplication of *Sclerotium rolfsii*

The *S. rolfsii* was mass multiplied in wheat grain media. Wheat grains were soaked in

water for 6 hrs then little boiled, drained excess water, air dried and supplemented with 50 g calcium carbonate in 1 kg wheat grains. Two hundred gram wheat grains were filled in 6 x 11 inches polythene bags and plugged with non absorbent cotton with the support of one inch diameter PVC ring (length 1.5 inch). These bags were sterilized in autoclave with 1.02 kg/cm^2 pressure for 25-30 minutes. The sterilized bags were inoculated with 2-3 mycelial discs (5 mm) taken from the periphery of the with 5 days old culture of *S. rolfsii* previously grown on PDA. The inoculated bags were incubated in BOD incubator at $25 \pm 2^\circ\text{C}$ for 15 days. Multiplied culture of *S. rolfsii* utilized for development of artificially sick pot of *S. rolfsii* use in different trials.

Effect of soil type

The four soil types viz., (Alfisol (Dorsa), Inceptisol (Matasi), Vertisol (Kanhar) and Entisol (Bhata)) were obtained from adjoining fields of College of Agriculture, Raipur. The inoculum of *S. rolfsii* was allowed to multiply on wheat grain media. The inoculum of *S. rolfsii* was added @ 25g/kg in each soil texture mixed thoroughly and left for 5 days, for establishment of inoculum. Five surface sterilized seeds of chickpea were sown in each pot and data on per cent mortality were recorded 15 days after sowing. Treatment details are given in Table 1.

Soil texture

Soil sample was taken in a beaker and 15 ml sodium hexametaphosphate (10 %) was added and stirred for 10 minutes in a 1000 ml beaker. The contents were transferred to 1000 ml measuring cylinder with volume make up. At 5 minutes and 5 hours, temperature and hydrometer reading were taken. Percentage of sand, silt and clay were determined with the help of Bouyoucos hydrometer (Piper, 1950)

and the textural classes were determined with the help of textural diagram (International system). In the present study seven textures were under taken viz., sandy, sandy loam, loam, clay, clay loam, silt clay and silt loam.

The inoculum of *S. rolf sii* was allowed to multiply on wheat grain media. The inoculum of *S. rolf sii* was added @ 25g/kg in each soil texture mixed thoroughly and left for 5 days, for establishment of inoculum. Five surface sterilized seeds of chickpea were sown in each pot and data on per cent mortality were recorded 15 days after sowing.

Effect of soil pH

In order to determine the effect of different soil pH on development of disease, soil was collected from experimental field of Department of Plant Pathology. Twenty gram of soil was taken and suspended in 40 ml sterile distilled water in 250 ml conical flask and stirred for 30 min. The soil pH was estimated 6.5. The soil pH was adjusted to 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0 and 8.5 by using NaOH and HCL (Kulkarni, 2007). The inoculum of *S. rolf sii* was allowed to multiply on wheat grain media. The inoculum of *S. rolf sii* was added @ 25 g/kg soil, mixed in each soil type, texture and pH amended soil and left for 5 days, for establishment of inoculum. Five surface sterilized seeds of chickpea were sown in each pot and data on per cent mortality were recorded 15 days of interval after sowing.

Observations on per cent mortality were started from ten days after inoculation and recorded at five day intervals upto maturity, finally computed as follows.

$$\text{Per cent incidence} = \frac{\text{Total infected plant}}{\text{Total emergence of plant}} \times 100$$

Results and Discussion

Effect of soil type on collar rot of chickpea

Four different soil types are found in Chhattisgarh region that were taken for study. Significantly least mortality per cent (15.27 %) was recorded in Matasi. However, highest mortality was observed in Kanhar 56.02 %. The soil type, Dorsa (31.94 %) and Bhata (41.66 %) were statistically at par among themselves.

Soil type also significantly influenced the germination per cent, root length and shoot length in chickpea when inoculated with *S. rolf sii* and data are presented in Table 2. Highest germination was observed in Kanhar (90 per cent) followed by Matasi and Bhata 86.65 per cent, which were found to be at par with each other. While, the lowest germination per cent was observed in Dorsa that is 83.33 per cent. Maximum root length was observed in Bhata (23.00 cm) and Khanar (22.00 cm) followed by Matasi (17.40 cm) which were at par with each other. Minimum root length was recorded in Dorsa that is 15.80 cm. Maximum shoot length was observed in Khanar (21.00 cm) followed by Bhata (17.80 cm) which were at par with each other. Minimum shoot length was recorded in Dorsa (16.00 cm) and Matasi (16.20 cm). Soil type also affects the vigour index of plant. The vigour index is multiplication of germination percentages and seedling length of the final day count. Maximum vigour index was found in Kanhar that is 3870 where as minimum vigour index was recorded in Dorsa (3536.14.) (Table 3).

Nene (1979) reported vertisol soil seems to favour the disease more than alfisol soil. The mortality was high in vertisol which was significantly influenced by soil type when compared to alfisol. Chauhan *et al.*, (2002) reported high wilt incidence in vertisol as it contain high clay content (64%). Hussain *et*

al., (2006a) studied the effect of soil type (clay, clay loam, sandy loam and sandy) on the incidence of collar rot disease in chickpea caused by *S. rolfisii* and found that the mortality of seedling was higher in clayey soil.

Effect of soil texture on collar rot of chickpea

Result showed in Table 4 indicated that least mortality per cent (20.74%) was recorded in sandy loam texture followed by sandy texture with mortality per cent of 26.67 % which were at par with each other. However, highest mortality was observed in clay texture soil 63.22 %, followed by Clay loam 45.83 %.

It is clear from the data which showed highest germination in sandy textured soil, (100.0 per cent) followed by Sandy loam (96.66%) and Silt loam (96.66%) which were significantly

superior with other treatments. Loam, Silt clay and Clay loam soil supported chickpea seed to germinate by 93.33, 90.00 and 86.33 per cent, respectively. While, lowest germination per cent was observed in Clay (83.33%).

Maximum root length was observed in Sandy soil (22.80 cm) which significantly superior than other treatments. Minimum root length was recorded in Clay soil (14.20 cm). Maximum shoot length was recorded in Clay soil (19.80 cm) followed by Loam (17.80 cm), Silt clay (17.60 cm) and Silt loam (17.60 cm) which were at par with each other. Minimum shoot length was observed in Sandy and Clay loam (15.80 cm). Soil type also affects the vigour index of plant. Maximum vigour index was found in Sandy soil (3860) where as minimum vigour index was in Clay loam (2825.44) (Table 5).

Table.1

S.No.	Treatment	Soil	Common name	Scientific name
1	T1	Dorsa	Clayloam	Alfisol
2	T2	Matasi	Sandyloam	Inceptisol
3	T3	Kanhar	Clayey	Vertisol
4	T4	Bhata	Gravelly	Entisol

Table.2 Effect of soil type on development of collar rot disease in chickpea

S. No.	Soil type	Per cent mortality*
1	Matasi	15.27 (22.75)
2	Kanhar	56.02 (48.45)
3	Dorsa	31.94 (34.32)
4	Bhata	41.66 (40.15)
	SEm±	2.342
	CD (5%)	7.757
Figures in parentheses are angular transformation		

Table.3 Effect of soil type on germination and vigour index of chickpea in inoculated soil with *S. rolf sii*.

S.No.	Soil type	Germination (%)	Root length (cm)*	Shoot length (cm)*	Vigour index
1	Matasi	86.67 (9.3)	17.40	16.20	2912.11
2	Kanhar	90.00 (9.5)	22.00	21.00	3870.00
3	Dorsa	83.33 (9.1)	15.80	16.00	2649.89
4	Bhata	86.67 (9.3)	23.00	17.80	3536.14
	SEm±	0.264	1.673	0.721	
	CD (5%)	0.674	5.060	2.181	
* Average of five replication					
Figures in parentheses are square root transformation					

Table.4 Effect of different soil texture on development of collar rot disease in chickpea.

S.No.	Soil texture	Per cent mortality*
1	Sandy	26.67 (30.98)
2	Sandy loam	20.74 (27.07)
3	Loam	32.22 (34.56)
4	Clay	63.22 (53.05)
5	Clay loam	45.83 (42.57)
6	Silt clay	37.04 (37.42)
7	Silt loam	31.11 (33.88)
	SEm±	1.723
	CD (5%)	5.275
*Average of three replication		
Figures in parentheses are angular transformation		

Table.5 Effect of soil texture on germination and vigour index of chickpea in inoculated soil with *S. rolf sii*.

S.No.	Soil texture	Germination (%)	Root length (cm)	Shoot length (cm)	Vigour index
1	Sandy	100.0 (10.0)	22.80	15.80	3860.00
2	Sandy loam	96.66 (9.8)	18.80	16.00	3364.12
3	Loam	93.33 (9.7)	18.40	17.80	3378.55
4	Clay	83.33 (9.1)	14.20	19.80	2833.22
5	Clay loam	86.66 (9.3)	16.80	15.80	2825.44
6	Silt clay	90.00 (9.5)	19.00	17.60	3294.00
7	Silt loam	96.66 (9.8)	19.40	17.60	3576.79
	SEm±	0.147	0.475	0.374	
	CD (5%)	0.451	1.383	1.090	
* Average of three replication					
** Average of five replication					
Figures in parentheses are square root transformation					

Table.6 Effect of different pH on development collar rot disease in chickpea

S. No.	pH	Per cent mortality
1	5	47.62 (43.61)
2	5.5	53.96 (47.33)
3	6	80.75 (64.27)
4	6.5	63.69 (52.99)
5	7	43.98 (41.50)
6	7.5	38.42 (38.26)
7	8	24.07 (29.36)
8	8.5	19.90 (26.26)
SEm±		3.720
CD (5%)		11.24
*Average of three replication		
Figures in parentheses are angular transformation		

Table.7 Effect of different pH on germination and vigour index of chickpea in inoculated soil with *S. rolfsii*

S. No.	pH	Germination (%)	Root length (cm)	Shoot length (cm)	Vigour index
1	5	63.33 (8.0)	13.60	16.60	1912.57
2	5.5	66.66 (8.2)	14.00	17.80	21119.79
3	6	70.00 (8.4)	12.60	19.80	2268.00
4	6.5	73.33 (8.6)	14.40	20.40	2551.88
5	7	90.00 (9.5)	18.60	21.80	3636.00
6	7.5	86.66 (9.3)	19.20	20.60	3449.07
7	8	83.33 (9.1)	19.60	20.80	3366.53
8	8.5	83.33 (9.1)	19.20	21.00	3349.87
SEm±		0.231	0.650	0.574	
CD (5%)		0.699	1.881	1.662	
* Average of three replication					
** Average of five replication					
Figures in parentheses are square root transformation					

In agreement to above findings, Hussain *et al.*, (2006) found that in clayey soil, seedling death was 94% whereas in clay loam, sandy loamy and sandy soils, it was 82, 78 and 60%, respectively. Seedling death in sandy soil was significantly less than that noted in all other types of soil. Mahato *et al.*, (2017) reported that incidence of collar rot varied with different soil textures. Maximum incidence

(100%) was observed in sandy clay loam followed by sandy clay (88.33%), silt clay loam (56.67%), Clay loam (43.33%) and minimum disease incidence recorded in silt loam (36.67%). Results revealed that Sandy clay loam soil was highly favorable for collar rot disease. Banyal *et al.*, (2008) also reported that lighter soils were more favourable to the collar rot disease of tomato caused by

Sclerotium rolfsii than the heavy textured soils.

Effect of different pH on collar rot of chickpea

Significantly least mortality per cent (19.90%) was recorded at pH 8.5 followed by pH 8 (24.07 %), pH 7.5 (38.42 %), pH 7 (43.98 %), pH 5 (47.62 %) and pH (53.96 %) which were next in order. However, significantly highest mortality was observed at pH 6.0 that is, 80.75 % followed by pH 6.5 (63.69). All the treatment differ significantly in terms of mortality per cent with each other, except pH 5, pH 5.5, pH 7 and pH 7.5 (Table 6).

Highest germination was observed in pH 7.0 that is 90.00 per cent, followed by pH 7.5 with 86.66 per cent which were at par with each other. Whereas lowest germination was observed in pH 5 that 63.33 per cent followed by pH 5.5 (66.66 per cent) which were at par with each other. Maximum root length was observed in pH 8.0 (19.60 cm) followed by pH 7.5, pH 8.5 (19.20 cm) and pH 7 (18.60 cm) which were at par, but significantly better than other treatments. Minimum root length was recorded in pH 5 that is 13.60 and pH 5.5 (14.00 cm) (Table 7).

Maximum shoot length was observed in pH 7.0 (21.80 cm) followed by pH 8.5. (21 cm), pH 8.0 (20.80 cm), pH 7.5(20.40 cm) and pH 6.5 (20.40 cm) which were at par with each other.

Whereas, minimum shoot length was recorded in pH 5.0 (16.60 cm). Highest vigour index was found in pH 7 that is 3636.00 whereas least was in pH 5 that is 1912.57. Similar findings were given by Mahato *et al.*, (2017) who reported that highest incidence (100%) was recorded at 6.5 and 7.0 pH level and lowest incidence (51.67%) was recorded at 8.0 pH level.

Prasad *et al.*, (1986) found the pH range of 5.0 to 7.0 as best for sclerotial formation at different temperatures *in vitro*. Wide range of pH with optimum near 6.0 for the growth of various isolates of *Sclerotium rolfsii* have been reported by Aycock (1966), Narasimhan (1969) and Sharma and Kaushal (1979). Banyal *et al.*, (2008) reported that maximum death of tomato caused by *Sclerotium rolfsii* at 6.5-7.5 pH level in green house experiments.

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