



***In vivo* assessment of correlation between soil moisture and incidence of *Rhizoctonia bataticola* causing dry root rot disease in chickpea**

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Abstract

Chickpea (*Cicer arietinum* L.) is an important pulse crop cultivated mainly under rainfed conditions. Dry root rot (DRR), caused by *Rhizoctonia bataticola* has emerged as a major threat to chickpea production, particularly under moisture-stress conditions. To study the influence of soil moisture on disease development, a pot experiment was conducted at the Zonal Agricultural Research Station (ZARS), Kalaburagi, under natural field temperature conditions. The chickpea cultivar JG-11 was grown in pathogen-infested soil maintained at four soil moisture levels, namely 40, 60, 80 and 90 per cent soil moisture content (SMC). Wilt incidence was recorded at 45 days after sowing. The results showed that soil moisture played a crucial role in both plant survival and disease development. Complete wilting (100.0%) was observed at 40 per cent SMC in both inoculated and uninoculated pots, indicating that severe moisture stress alone was sufficient to cause plant death under such dry conditions. At 60 per cent SMC, inoculated pots recorded a mean wilt incidence of 80.5 per cent, while uninoculated pots showed 52.7 per cent wilt incidence. As soil moisture increased, wilt incidence decreased considerably. At 80 per cent SMC, the mean wilt incidence in inoculated pots was 38.8 per cent compared to 19.4 per cent in uninoculated pots. The lowest wilt incidence was recorded at 90 per cent SMC, where inoculated and uninoculated pots showed mean wilt incidences of 11.06 and 8.3 per cent, respectively. Overall, the findings indicated that moisture-deficit conditions create a favourable environment for dry root rot development, whereas adequate soil moisture helps limit disease incidence. The study highlights the importance of maintaining optimum soil moisture as a practical approach for reducing dry root rot and improving chickpea productivity under rainfed conditions.

Keywords: Chickpea, Dry root rot, *Rhizoctonia bataticola*, *Macrophomina phaseolina*, Soil moisture content, Moisture stress, Wilt incidence, Disease development

Introduction

Chickpea (*Cicer arietinum* L.) is the world's most widely cultivated grain legume and an important pulse crop in India. It is a cool-season food legume cultivated as a winter crop in tropical regions and as a spring or summer crop in temperate environments. The crop grows best under cool, dry, and sunny weather conditions (Gaur *et al.*, 2010) [5]. Grown in 57 countries across the globe, chickpea plays a vital role in food and nutritional security. In recent years, its cultivation has expanded steadily in response to increasing consumer demand and the growing preference for plant-based diets (Merga and Haji, 2019) [8]. Chickpea is an affordable and valuable source of dietary protein, often referred to as the "poor man's meat," owing to its high protein content and good digestibility after cooking. India is the leading producer of chickpea, followed by Australia, Turkey, Ethiopia and Myanmar (FAO, 2024). In addition to its nutritional importance, the crop also helps the soil fertility through symbiotic nitrogen fixation and can benefit succeeding crops when included in crop rotations (Zehara *et al.*, 2020) [17].

Despite its importance, chickpea production is affected by several biotic and abiotic stresses. Mostly chickpea is grown on residual soil moisture. Drought and elevated temperatures are two of the major climatic stresses affecting

chickpea production. The reproductive stage of chickpea is highly sensitive to heat stress, which can lead to yield losses of up to 100 per cent (Canci and Toker, 2009) [1]. These conditions can severely impair plant growth and development and are estimated to account for a substantial proportion of yield losses. Diseases and drought are among the major factors responsible for yield reduction, accounting for approximately 45% and 30% of yield losses, respectively (Endes, 2023; Gaur *et al.*, 2014) [2, 4]. Among the important diseases, dry root rot (DRR) has become increasingly serious, particularly in rainfed chickpea-growing regions of India and other parts of the world (Ghosh *et al.*, 2013) [6]. Dry root rot is caused by fungus *Rhizoctonia bataticola* (Taub.) Butler, commonly referred to as *Macrophomina phaseolina* (Tassi) Goid which is soil and seed-borne in nature. The pathogen persists in soil and infected crop residues for extended periods through the production of microsclerotia. Its ability to infect numerous host species reduces the effectiveness of crop rotation when used as the sole disease management strategy (Yesil and Bastas, 2016; Gupta and Sharma, 2015) [7]. The disease has subsequently been recorded in chickpea-growing regions of Asia, Africa and the Americas. Under rainfed conditions, soil moisture generally declines as the crop progresses towards flowering and pod setting. Such moisture-deficit

conditions, together with high temperatures, favour the development of dry root rot. Disease development is generally favoured by warm and dry conditions, particularly when daytime temperatures exceed 30°C and soil moisture falls to 60 per cent or below during flowering and pod setting (Sinha *et al.*, 2019) ^[12]. Depending on disease severity and environmental conditions, yield losses may range from minor reductions to 60–80% during severe outbreaks, while highly susceptible cultivars may suffer almost complete crop failure (Rai *et al.*, 2022) ^[9].

North Karnataka is an important chickpea-growing region, where cultivation is largely dependent on semi-arid and rainfed conditions. Frequent dry spells and irregular rainfall may favour the development of dry root rot (DRR). Soil moisture strongly influences both pathogen activity and host susceptibility. However, limited information is available on DRR development under fluctuating field temperatures. Therefore, the present study evaluated the effect of 40, 60, 80 and 90 per cent soil moisture levels on DRR development in chickpea under sick-pot conditions at ambient field temperature at ZARS, Kalaburagi.

Materials and Methods

A pot culture experiment has been carried out in ZARS, Kalaburagi conducted under sick pot to study the effect of different soil moisture levels on the development of dry root rot of chickpea under field temperature conditions. The experiment was carried out using sterilized soil and a susceptible chickpea genotype. The pathogen, *R. bataticola*, was multiplied on sterilized sorghum grains following standard procedures to obtain sufficient inoculum. The pathogen-colonized sorghum grains will be mixed thoroughly with sterilized soil at the ratio of 1:5 (culture: soil) and filled into earthen pots. The inoculated soil was allowed to incubate for four days to ensure proper establishment of the pathogen. Healthy chickpea seeds susceptible to dry root rot is surface sterilized with 0.1 per cent sodium hypochlorite solution for one minute and washed two to three times with sterile distilled water. Twelve seeds were sown in each sick pot and three replications was maintained for each treatment. The seedlings were allowed to grow under normal conditions for 15 days after sowing. Four different soil moisture levels, namely 40, 60, 80 and 90 per cent soil moisture content (SMC), were maintained from 15 days after sowing to assess their influence on disease development. Soil moisture content was determined by the using a digital soil moisture meter.

Results and Discussion

Beyond its basic contribution to plant growth, soil moisture also governs whether soil-borne pathogens can persist, reproduce and successfully establish infection. To explore this link in the context of dry root rot caused by *R. bataticola*, a pot-based experiment was set up, the chickpea genotype JG-11 was grown in pots inoculated with the pathogen and maintained across several distinct moisture regimes under ambient field temperature, while a parallel set of pots left free of inoculum served as the comparison group. Wilt symptoms were scored forty-five days after sowing, with the corresponding figures compiled in Table 1

and Plate 1. The results showed that soil moisture had marked influence on the development of disease.

Among the four different moisture levels tested, the highest wilt incidence was observed at 40 per cent soil moisture in both sick and control pots. All the plants showed complete wilting with 100 per cent wilt incidence in all the replications was mainly due to physiological stress and pathogen stress. At 60 per cent soil moisture, the wilt incidence in sick pots ranged from 75.0 to 83.3 per cent with a mean wilt incidence of 80.5 per cent, whereas the control pots recorded wilt incidence ranging from 41.6 to 58.3 per cent with a mean of 52.7 per cent. Further increase in soil moisture resulted in reduction of disease incidence. At 80 per cent soil moisture, the wilt incidence in sick pots ranged from 33.3 to 41.6 per cent with a mean of 38.8 per cent, while the control pots recorded 16.6 to 25.0 per cent wilt incidence with a mean of 19.4 per cent. The minimum wilt incidence was seen at 90 per cent soil moisture. In sick pots, wilt incidence ranged from 8.3 to 16.6 per cent with a mean wilt incidence of 11.06 per cent, whereas the control pots recorded only 8.3 per cent wilt incidence in all the replications.

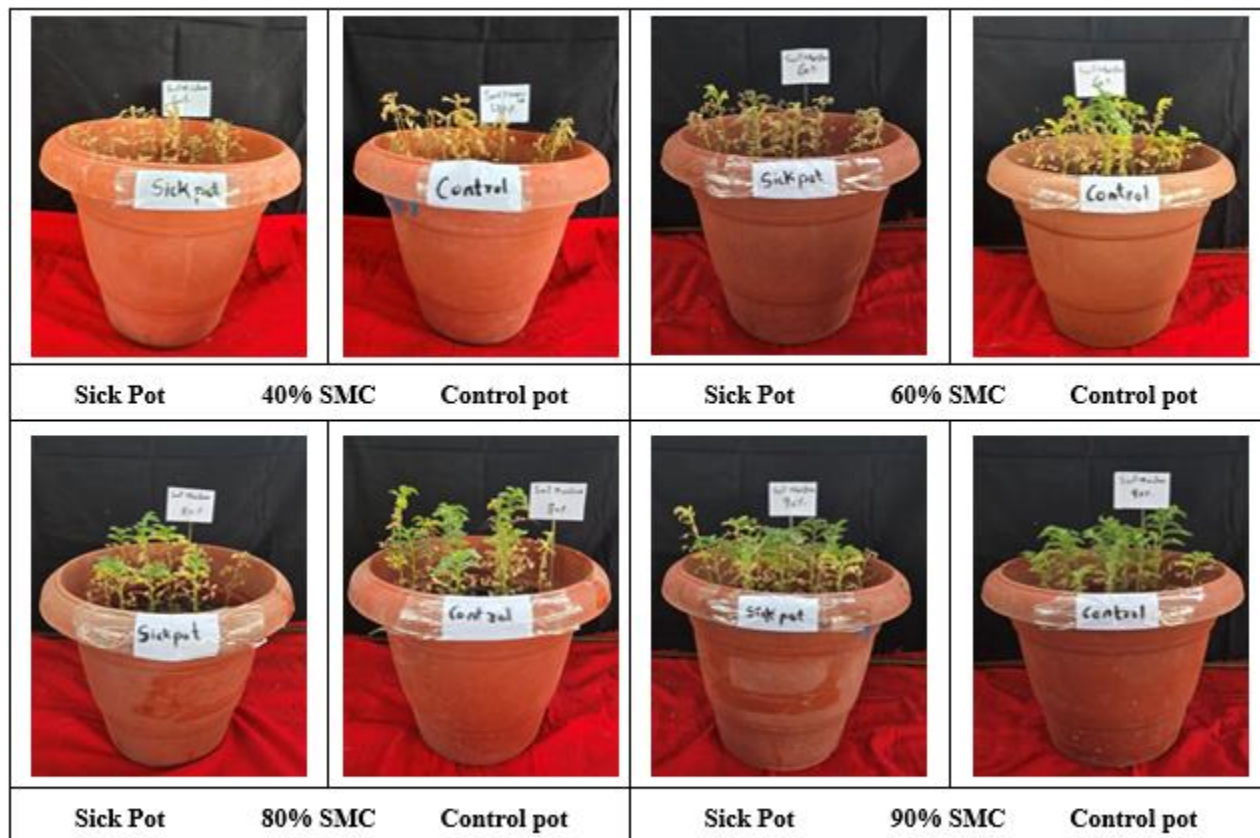
The Overall, the results clearly demonstrated that lower soil moisture levels favored the development of dry root rot, whereas increasing soil moisture considerably reduced disease incidence. Severe wilting and rapid disease development were observed under low soil moisture conditions, particularly at 40 and 60 per cent soil moisture. However, the complete wilting observed at 40 per cent soil moisture was also associated with severe physiological moisture stress, as even pathogen-free control plants failed to survive under such low moisture conditions. In contrast, no physiological stress was evident in control plants maintained at 60 per cent or higher soil moisture, suggesting that the increased wilt at these moisture levels was primarily due to infection by *R. bataticola*.

The findings of the present study are in close agreement with earlier reports emphasizing the role of soil moisture in dry root rot development. Rajkrishan *et al.* (1999) ^[10] demonstrated that moisture stress created by wider irrigation intervals significantly enhanced disease incidence, indicating the importance of reduced soil moisture in disease progression. Similarly, Sharma and Pande (2013) ^[6] reported that lower soil moisture levels favored rapid infection, increased pathogen population and greater disease severity, while higher moisture levels suppressed disease development. Srinivas (2016) and Soni *et al.* (2022) ^[13, 14] also observed that moisture stress conditions predisposed plants to severe infection, whereas increased soil moisture reduced disease intensity. Further, Sunkad *et al.* (2023) ^[15] confirmed that disease severity declined progressively with increasing soil moisture, highlighting that adequate moisture conditions limit pathogen activity and improve plant resistance. The higher disease incidence seen in low soil moisture conditions in the present study may be attributed to moisture stress, which predisposes chickpea plants to infection and enhances the pathogenic activity of *R. bataticola*. Thus, the present results confirm that moisture-deficit conditions favour the development of dry root rot in chickpea.

Table 1: Effect of soil moisture levels on incidence of dry root rot caused by *Rhizoctonia. bataticola* in chickpea

Moisture Level	Wilt incidence in sick pot at 45 DAS				Wilt incidence in healthy pot at 45 DAS			
	R1	R2	R3	Wilt incidence	R1	R2	R3	Wilt incidence
40%	100	100	100	100%	100	100	100	100%
60%	83.3	83.3	75	80.5%	58.3	41.6	58.3	52.7%
80%	33.3	41.6	41.6	38.8%	16.6	25	16.6	19.4%
90%	8.3	16.6	8.3	11.06%	8.3	8.3	8.3	8.3%

DAS – Days after sowing

**Plate 1:** Effect of different Soil Moisture Content (SMC) levels on incidence of dry root rot in chickpea caused by *Rhizoctonia bataticola*

Conclusion

Soil moisture was identified as one of the most critical factors influencing the development of dry root rot disease in chickpea. Pot experiments conducted under different soil moisture levels under natural field conditions revealed that lower soil moisture conditions significantly enhanced disease incidence. The highest wilt incidence (100 per cent) was recorded at 40 per cent soil moisture, a level that was also associated with severe physiological moisture stress, as even pathogen-free control plants failed to survive under such low moisture conditions. At 60 per cent soil moisture, high levels of disease incidence were still observed, whereas a further increase in soil moisture to 80 and 90 per cent resulted in a marked reduction in disease incidence. The lowest wilt incidence was recorded at 90 per cent soil moisture, indicating that adequate soil moisture suppresses disease development. These findings clearly demonstrate that moisture stress predisposes chickpea plants to infection and promotes rapid disease progression, highlighting the importance of maintaining optimal soil moisture regimes as a key cultural practice for managing dry root rot in chickpea-growing regions such as North Karnataka.

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