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Sustainable Management of Chickpea Fusarium Wilt: Integrating Host Resistance and Microbial Biocontrol

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Chickpea (Cicer arietinum L.) is an important pulse crop cultivated worldwide and serves as a major source of dietary protein. However, its production is severely constrained by Fusarium wilt caused by *Fusarium oxysporum f. sp. ciceris*, a soil-borne pathogen capable of surviving in soil and plant residues for several years. The disease causes significant yield losses ranging from 10% to 100% depending on environmental conditions, cultivar susceptibility, and pathogen virulence. Typical symptoms include yellowing, drooping, vascular discoloration, wilting, and eventual plant death. Conventional management strategies, including chemical control, have shown limited effectiveness and may pose environmental concerns. Therefore, biological control has emerged as a sustainable alternative for disease management. Plant growth-promoting rhizobacteria (PGPR) such as Bacillus spp. and Pseudomonas spp., along with fungal antagonists like Trichoderma harzianum, have demonstrated substantial potential in suppressing Fusarium wilt through mechanisms including root colonization, competition, antibiosis, induction of systemic resistance, and enhancement of plant growth. These biological agents not only reduce disease incidence but also improve nutrient uptake, plant vigor, and crop productivity. The present study reviews the occurrence, biology, disease cycle, geographical distribution, yield losses, and management strategies of chickpea Fusarium wilt, with particular emphasis on environmentally friendly biological control approaches. The findings highlight the importance of integrating resistant cultivars with effective biocontrol agents for sustainable management of chickpea wilt and improved crop production.

Keywords: Chickpea; Cicer arietinum; Fusarium wilt; Biological control; PGPR

1 Introduction

1.1 History and Symptomology

Chickpea wither has moreover been found in Asian country, Australia, India, Asian nation and Ethiopia (Shakoor, 1991), Spain, Mexico, Nepal Bangladesh Burma, Malawi, Tunesia, South American country and USA (Iqbal *et al.,* 2005). shrivel ailment was first revealed from Bharat by pantryman (1918). shrivel ailment irresistible specialist will damage the product severely (Halila and Strange, 1996) or cause genuine yearly yield misfortunes. In Bharat chickpea shrink

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misfortunes were ten every year (Singh et al., 2007) and four-hundredth in African country (Bouslama, 1980). In Pakistan the unwellness might reason 10-50% product misfortunes once per year (Khan et al., 2002). 2 pathotypes (shrinking and Yellowing) and eight morbific races are discovered in any case (Jimenez et al., 2002). The unwellness appears as expiry of youthful seedlings (in a measure of twenty-five to thirty days while spreading) to wither of grown-up plants. The plant FOC could be a mostly soil-borne irresistible operator, in any case, few rumors demonstrate that it might be exchanged finished seeds (Haware *et al*., 1978). Youthful plants that bite the dust with plant infection might be mistaken for elective ailments of shrink progressed if not found appropriately. shrink ailment contaminated seedlings fold and lie level on the base holding their uninteresting unpracticed shading. Grown-up plants indicate unmistakable shrink side effects of hanging of petioles, flyers and rachis. The establishments of the shriveling plants don't demonstrate any outside rotting in any case once half open vertically, diminish dim shaded recoloring inside vascular tissue is understood.. The living being abused the establishment structure, progressed finished the stratum, cortex and unavoidably into the vascular tissue vessel of the spigot root from wherever it unfurls. in this way level roots may weaken off (Murumkar and Chavan 1985). Cases from the floppy florae look strong yet seeds tinier in gauge, wrinkled and recolored. Seeds from the wilted plants once alloyed with the kernels from sound plants might know in develop recoil in new districts. Item upheaval for a broadened time or extra is that the principal technique to clear the irresistible specialist inside the occasion that it develops inside the earth (Haware and Nene, 1982). *F. oxysporum* remain as plant part in seed and conjointly inside the dirt, moreover conjointly on tainted roots, edit buildups and contaminated plants covered inside the dirt vi years (Singh et al., 2007)

1.2 Pathogen Biology:

Fusarium oxysporum could be an un-mistakable soil resident and made 3 sorts of parthenogenetic spores; large scale conidia, little conidia and chlamydospores. the enormous scale conidia thin, to some degree underact to straight, and thin walled for the greater get rid of 3 or four septation, a foot-shaped basal cell and sliced and underact finest cell. they're for the first half made from phialides on conidiophores. they're vital in helper ailment (Fravel et al., 2003). The microconidia zone unit ellipsoid and what is more don't have any septum. they're crucial in auxiliary contamination. Chlamydospores have thick dividers and that they zone unit worldwide. These spores zone unit confined by the administration of hyphal cells. Chlamydospores region unit fundamental as length organs in soils wherever they are going seeing as issue in basic disease (Fravel et al., 2003). The fleshly regenerative segment of *Fusarium oxysporum* is nameless (Leslie and summerell, 2006).

1.3 Biological control of chickpea Fusarium wilt:

Utilization of safe assortments is that the greatest made system for the administration of ailment (Jimenez-Gasc, 2003, Jimenez-Diaz), while novel straining of the infective operator hopes to curb safe qualities. In addition, synthetic administration isn't viable; subsequently, natural administration is a productive procedure for the administration of this ailment (Anjajah *et al*., 2003). Utilization of Plant growth promoter are regularly AN adequate system in concealment of illness (Schmidt *et al*., 2004). PGPR, relating to Bacillus and sort bacteria genus} strains, kind provinces on the roots (Josep *et al*., 2007; Manikanda *et al*., 2010). Bacillus and class Pseudomonas have a noteworthy possible in concealment of chickpea plant malady (Landa *et al*., 199; Anjajah *et al*., 2003;). *Pseudomonas fluorescens* has changed the circle of organic administration of soil-borne infective parasites (Burr *et al*., 1998). Numerous microbes comparing to the Burkholderia, Bacillus, Pseudomonas, and *Trichoderma* were disengaged and situated to broaden the yield and illness administration of phytopathogen underneath field conditions (Wani *et al*., 2007; Niranjana, Hariprasad 2009). *Bacillus subtillis* and *Trichoderma harzianum* productively switch the Fusarium wither and increment the protein comfortable and β-1, 3-

glucanase impetus movement that initiate the general obstruction (Moradi *et al*., 2012).

2 Importance of chickpea crop

Chickpea (*Cicerarietinum L.*) has a place with Cicer, clan Cicereae, Fabaceae, and taxon reside dicot family. The name rosid dicot variety is of Latin inception, got from the Greek word 'kikus' which implies power or quality. Duschak (1871) duplicated the beginning of the word to the Hebrew 'kirkes', wherever 'kikar' implies that round. (Van der Maesen, 1972). The word arietinum is moreover Latin, deciphered from the Greek 'krios', another name for each crush and chickpea, a say to the condition of the seed that sounds like the pioneer of a hammer. The first prepared report with respect to this species was 5450 BC (Helbaek, 1959) and it's been created for no under 7000 years (Van der Maesen, 1972). it's A yearly diploid (2n=16) thick plant with fuzzy units and incorporates of some of the time 2 seeds (Toker *et al*., 2012). On the present of construction and composition chickpea edit is part into 2 sorts, Kabuli and Desi (Hameed *et al*., 2012). In mild zones for the most part Kabuli chickpea is big while in semi-bone-dry and tropic locales here and there Desi chickpea is developed (Naghavi and Jahansouz, 2005; Upadhyaya *et al.,* 2006). Kabuli chickpea choice is regularly supported over Desi anyway Kabuli chickpea is completely developed exclusively 15 August 1945 of aggregate generation of chickpea i.e. 0.83 ton ha-1. Chickpea (*Cicer arietinum L.*) might be a noteworthy heartbeat yield of, Central America, South America, South East Asia and Africa (Iqbal *et al.,* 2006). it's developed in the primary in, Pakistan, Turkey, Persia, and Asian nation. Chickpea trim is completely developed from mid-September to mid-Nov in Asian country. the satisfactory time for development is that the additional seven day stretch of Gregorian date-book month. Chickpea is frequently developed in land region, trailed by KPK and Sindh. inside the glob, Asian country has subsequent vigorous in space and third ongoing (FAO, 2013). In Asian country yearly four hundred and seventy-five thousand ton of chickpea seed is acquired from nine hundred and seventy-five thousand hectares (GOP, 2013-14). In geological region ninetieth chickpea is developed underneath down poured districts. it's normally completely developed in, Layyah, Attock Mianwali Bhakhar, and Khushab, regions (Haqqani *et al.,* 2000).

2.1 Occurrence of the disease

The infective operator of chickpea shrivel is soil tolerated and, in some writing, it had been moreover to the extent that a seed borne and it has a place with Fusarium mintage (Kraft *et al*., 1994). directly it had been spoken to by Dastur (1935) that chickpea shrivel isn't caused by some physical disturbance produced by soil setting, this is a result of Fusarium. The chickpea shrivel (*F. oxysporum f. sp. ciceris*) could be a greatest harming ailment all round the world. it's broadly dispersed in Asian nation (Hameed *et al.,* 2012; Andrabi *et al*., 2011; Getachew and Merkuz, 2012), North American nation (Arvayo-Ortiz et al., 2012), (Harveson, 2011; Haware, 1990; Moradi *et al*., 2012), Sudan (Ali at *el*., 2002) and wherever always chickpea is developed. Chickpea shrink is produced by *Fusarium* oxysporum was first agreeing by Pad-wick in 1940. wither ailment was major concurring from sub-continent by attendant (1918).

2.2 Symptoms of chickpea wilt disease

Basic side effects of chickpea shrivel involve hanging, ventilation of the leaves, yellowing and framework staining (Luthra et al., 1943). The assortments that were in danger of this infection show manifestations twenty-five days once sowing. The manifestations of sickness plant disease can be requested with plant ailment if not identified mindfully. stale plants presented hanging and bloom of greeneries and invention level on the base. Decrease of the stem might be conjointly observed and in this manner the roots didn't show outer rot and appearance well. once the roots were grafted vertically then cooking or change of shade of inner tissues are regularly observed. Develop plants unveiled common debilitating which could occur inside the field up to unit arrangement organize. the principal indication of chickpea shrivel was hanging of the aggregate plant (Chavan, Murumkar1985).

2.3 Pathogen

Basic side effects of chickpea shrivel involve hanging, ventilation of the greeneries, yellowing and framework staining (Luthra *et al.*, 1943). The assortments that were in danger of this infection show manifestations twenty-five days once sowing. The manifestations of sickness can be requested with plant ailment if not identified mindfully. stale plants presented hanging and yellowing of greeneries and lie level on the base. Decrease of the shoot might be conjointly experiential and in this manner the roots didn't display outer rot and appearance well. once the roots were grafted vertically then cooking or change of shade of inner tissues are regularly observed. Develop plants unveiled common debilitating which could occur inside the field up to unit arrangement organize. the principal indication of chickpea shrivel was hanging of the aggregate plant (Murumkar and Chavan, 1985). 2 styles of shrink side effects were found in chickpea trim; in beginning one *Rhizoctonia bataticola* was associated with *F. oxysporum f. sp. ciceris* and it aggravates exclusively develop florae and greeneries of develop plants bent rising and wind-up figurine, pamphlets fall initial, spigot root and parallel branches went away. just if there should be an occurrence of second wither, the essential side effect showed up as hanging of delicate higher components of plant; i.e., leaves and shoots that postponed down sadly, leaves weren't just shed anyway with the branches it snared (Dastur, 1935). The side effects of shrink contained bloom and debilitating of leaf and gangrene of framework (Echandi, 1970). it had been pronounced that chickpea shrink in American state was characterized by yellowing of leaves and vascular tissue gangrene. Leaves of stale plants flip unpracticed to dark at that point turn out to be exhausting yellow and inside the last entire plant winds up stale (Erwin, 1957). The water leading tissues i.e., vascular tissue and essence were found to demonstrate dull and recolored (Snyde and Erwin 1958). Chickpea shrivel (*F. oxysporum f. sp. ciceris*) is seed-borne and seeds gathered from stale plants once blended with solid ones will communicate the shrivel vegetation to novel locales and may jump the ailment inside the dirt to monetary edge heights among 3 developing periods (Pande *et al.,* 2007). The affliction happens at spermatophyte and blooming phase of plant development. The manifestations of chickpea shrivel which might be seen inside the arena square measure hanging of petioles and rachis, bloom and ventilation of greeneries from descending to rising, cooking of tube materials, ill-advised spreading, wilting of entire herbal and lastly passing of plant happens (Westerlund *et al.*, 1974). Chickpea wither microorganism goes into the vascular tissue ampules and possesses entire framework and cause yellowing of leaves and debilitating of plants. It will make due 6 years in soil inside the nonattendance of the host plant (Haware, 1993). once the stem and foundations of the tainted plant grafted vertically, they indicate staining of inner tissues in substance and vascular tissue (Saxena & Singh, 1987). Chickpea wilt indications might be mistaken for elective illness side effects if not found demandingly (Nene *et al.*, 1996). chlorophyl substance of chickpea plants lessened once this microorganism assaults, though natural corrosive, starches and polyphenols will increment. The verdure entered the establishment framework, made it’s over the fingernail skin, cortex and last into vascular tissue vessel of the spigot root from wherever it unfurls. Therefore, the horizontal roots would conceivably become scarce (Chavan *et al.*, 2009).

2.4 Survival and mode of dissemination of *Fusarium*

F. oxysporum spreads through the dirt to a tiny low equal as plant part. The microorganisms are conveyed inside the dirt water, removes, on ranch instrumentation, seeds and rhizomes of a few hosts, carvings of dismal plants and in a few things by abnormal sclerotic. wither ailment greenery will live saprophytically inside the dirt, essentially steadily, making administration through harvest pivot or diverse social practices eccentric or ineffective (Agrios, 1984). The greenery is soil tolerated and endures through chlamydospores in seed and in expired plants scrap inside the dirt. Lentil, pea and columbiform feathered creature pea were perceiving as manifestation low-loaders of the verdure. diverse plant classes can likewise be manifestation less bearers. Chlamydospores cause the principal disease. 25°C is ideal infection for greenery and for disease. fundamental soils appear to support the predominance of wither (Saxena & Singh, 1987). interim the verdure may make due inside the dirt for a long time and moreover in side effect less transporters. it's not promising to deal with the ailment through normal harvest turns). Gupta et al., (1986), Saxena and Singh (1987) found that chlamydospores of the irresistible operator continued reasonable even the high infections inside the mid-year months through the non-editing sum in normally tainted underlying foundations of chickpea at 15cm of soil profundities. The irresistible operator neglected to make due inside the roots set on the superficial of the dirt. Khune and Patel (1992) segregated the greenery from neckline area, tap source, principle, branches and seed of horrible plant anyway not from leaves or unit structures. The exudates that were start up from root grants plant part development and chlamydospores grow inside the presence of host plant (Schroth and Hildebrand, 1964) though, the greenery will persevere by arrangement of chlamydospores inside the nonattendance of host plant (Schippers and Van Eck, 1981).

2.5 Yield losses due to *Fusarium oxysporum*

The chickpea plant sickness irresistible specialist is seed tolerated (Pande *et al*., 2007) other than its conjointly soil borne (Fernandez-Jimenez *et al*., 2011) and irresistible operator will act soil for a half year or extra inside the nonappearance of host and may make noteworthy misfortune trim yield (Haware *et al*., 1986). Chickpea edit is tormented by a few unwellness anyway shrink caused by is that the frightfully extreme infection and causes misfortunes up to ten % in yield (Dubey*et al.,* 2007). The exact actualities in regards to misfortunes due to plant illness weren't sure in any a piece of the planet be that as it may, a few researchers took a shot at scheming the evaluated misfortune in a few parts of the planet. In West Pakistan, up to fifty percent edit generation is influenced per annum in light of chickpea plant sickness (Hanif *et al*., 1999; Khan *et al*., 2002). An overview was depleted India measurable seventy-two.16 % misfortunes on account of chickpea plant illness (Bourai and Kumar, 2012). In North American country 60 misfortune in produce were measurable by (Gomez, 2004), though in Spain the misfortunes were inside the run from 12-15 % yearly (Landa *et al.,* 2004) and with regards to Animisha *et al*., (2012) it had been 20-70 %. In Sonora chickpea wither caused yield misfortunes up to sixty percent while, in elective areas of the planet, it's measurable from 12-15 % once every year (Ortiz-Arvayo *et al.,* 2012). Chickpea generation is gravely tormented by plant sickness of chickpea (Buddenhagen *et al*., 1988). Misfortunes in chickpea in view of plant illness shift from 10-20 % (Jalali and Chand, 1992). with regards to Muehlbauer, Sharma (2007) the measurable un-wellness misfortune as a result of chickpea wither was high that were 10-90 %. In West Punjab, due to chickpea plant malady misfortunes, chickpea agriculturists of watered zones of geographic region had halted the apply of developing chickpea on their territories (Jamil *et al*., 2010). Paul and Grewal (1970) express that on account of dry spell states of pervasiveness chickpea shrivel is developing as an unsafe un-wellness in West Pakistan. information in regards to misfortunes by chickpea plant malady isn't out there, be that as it may, with regards to a review; in regards to ten misfortunes in grain yield due to this un-wellness is considered a day-by-day highlight. The yield misfortunes fluctuate from 10-100% retribution on the natural conditions. occurrence of ran from 0-60 %, with a middle un-wellness frequency of thirty one percent.

2.6 Geographical distribution and variability of pathogen

The best sparing strategy for prevailing the chickpea wither is developing of safe assortments, that weren't uncommon inside the chickpea germplasm. Ahmad *et al*., (2010) known the obstruction sources in open chickpea germ-plasmin contradiction of shrink of chickpea. To play out that test three hundred and twenty-one genotypes were adult underneath skillfuldisorder. Obstruction in geno-types were renowned at 2 phases seed plant organize and productive phase, consequence demonstrated that "one hundred and two" and "one hundred and seventy-three" genotypes were indicated safe reaction all through vegetative and productive stages independently. xxxii genotypes indicated stable opposition reaction at both developing phase. These genotypes strength be used for the extension of safe cultivars in contradiction of wither. amid a totally unique investigation, out of 249 morphological mutants of four cultivars, safe response appeared by seventy-five mutants thirty-one mutants safe (11-20 percent), thirty-four mutants respectably safe/tolerant (21-30 percent), thirty-five mutants slanted (31-50 percent) and seventy-five mutants were to a great degree slanted (50-100 percent) (Shah *et al*., 2009). Comparative sensibly try was directed by Bakhsh *et al.*, (2007). relate degree test was led to evaluate 158 genotypes against chickpea shrivel underneath wiped-out plot condition. exclusively 3 genotypes indicated safe in each developing stages, while high affliction rate extent was learned all through the productive stage. Khan *et al*., (2005) learned six to a great degree safe and 4 safe lines with zero and seventeen p.c disorder rate severally against chickpea shrivel.

2.7 Control of *Fusarium oxysporum* through BCAs

Utilization of safe assortments is that the maximum triple-crown system for the administration of ailment (Jimenez-Diaz, Jimenez-Gasco 2003), though new straining of the microorganism appears to stifle safe qualities. In addition, compound administration isn't compelling; along these lines, natural administration is a productive procedure for the administration of this infection (Anjajah *et al.*, 2003). Utilization of PGPR might be relate appropriate procedure in concealment of disorder (Schmidt et al., 2004). PGPR, similar to genuine microscopic organisms and bacteria genus strains, kind states on the roots (Figure 1) (Joseph *et al*., 2007; Manikanda *et al*., 2010). Pseudomonas have a noteworthy possible in concealment of chickpea plant sickness (Landa *et al*., 1997; Anjajah*et al*., 2003). Family *Pseudomonas* fluorescens has changed the part of organic administration of soil-borne infective parasites (Burr *et al*., 1998). Compant*et al.,* (2008) found that PsJN microorganism will flourishes relate entophytes inside numerous portions of the plants. With grapevine strain PsJN will lives as vegetation and endophytic tenants with in-vitro plantlets. Zuniga *et al*., (2013) found that root development of Arabidopsis evoked by PsJN was including the development controller corruption size of bacterium. Other rumors have said the job of development controller fabricating *rhizobacteria* in development of plant (**Figure 2)** (Joo *et al*., 2005).

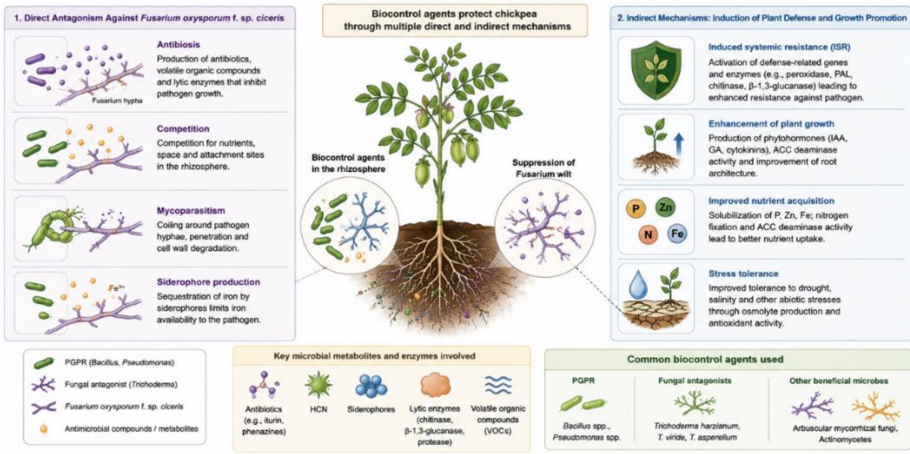

Figure 1: Mechanisms of biocontrol agents in suppressing Fusarium wilt and promoting chickpea growth

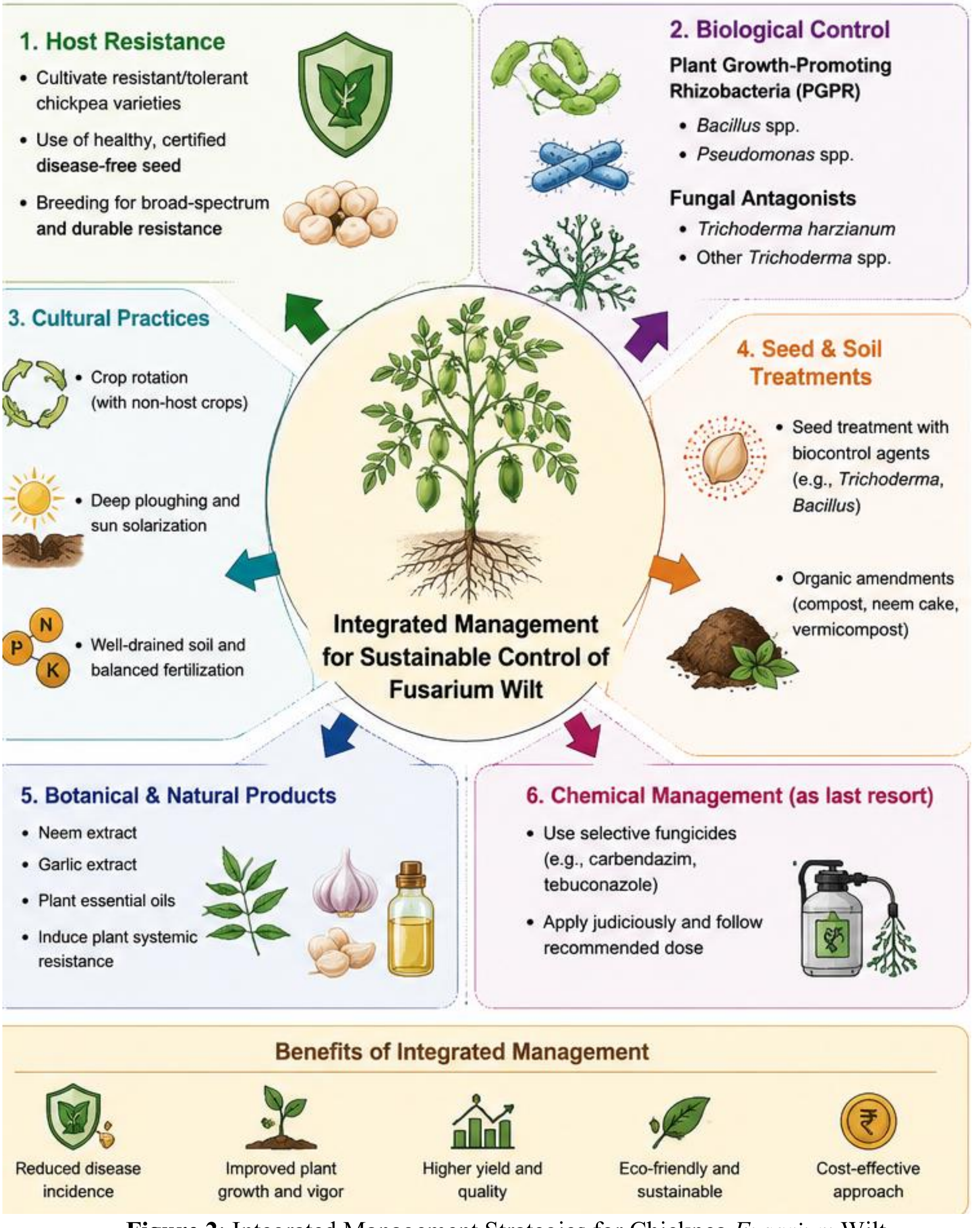

Figure 2: Integrated Management Strategies for Chickpea *Fusarium* Wilt

3 Conclusion and Future Perspectives

Fusarium wilt, caused by *Fusarium oxysporum* remains one of the most destructive diseases affecting chickpea production worldwide, causing substantial yield losses and threatening food security. The pathogen's ability to survive in soil and plant residues for extended periods makes its management particularly challenging. Traditional control measures, especially chemical fungicides, often provide limited and inconsistent results while raising environmental and health concerns. Therefore, sustainable and environmentally friendly management strategies are essential for long-term disease control. The present review highlights the effectiveness of integrating host plant resistance with biological control approaches for managing chickpea Fusarium wilt. Resistant cultivars serve as the first line of defense and significantly reduce disease incidence under field conditions. At the same time, beneficial microorganisms such as *Bacillus* spp., *Pseudomonas* spp., and *Trichoderma harzianum* contribute to disease suppression through mechanisms including antibiosis, competition, root colonization, induction of systemic resistance, and enhancement of plant growth. The combined use of resistant genotypes and microbial biocontrol agents offers a promising strategy for reducing dependence on chemical inputs while improving crop productivity and soil health. Future research should focus on identifying and developing chickpea cultivars with durable, broad-spectrum resistance against multiple races of the pathogen. Advances in genomics, molecular breeding, and marker-assisted selection can accelerate the development of resistant varieties. Furthermore, the exploration of microbial consortia and next-generation bioformulations may improve the consistency and efficacy of biological control under diverse environmental conditions. Research on plant microbe pathogen interactions, microbiome engineering, and climate-resilient disease management strategies will further strengthen integrated disease management programs. Finally, large-scale field validation, farmer adoption studies, and supportive agricultural policies are needed to promote the widespread implementation of sustainable Fusarium wilt management practices, ensuring enhanced chickpea productivity, environmental protection, and agricultural sustainability in the future.

References

Ahmad, M. A., Iqbal, S. M., Ayub, N., Ahmad, Y., & Akram, A. (2010). Identification of resistant sources in chickpea against Fusarium wilt. *Pakistan Journal of Botany*, *42*(1), 417–426.

Akila, R., Rajendran, L., Harish, S., Saveetha, K., Raguchander, T., & Samiyappan, R. (2011). Combined application of botanical formulations and biocontrol agents for the management of Fusarium oxysporum f. sp. cubense (Foc) causing Fusarium wilt in banana. *Biological Control*, *57*(3), 175–183. https://doi.org/10.1016/j.biocontrol.2011.02.010

Andrabi, M., Vaid, A., & Razdan, V. (2011). Evaluation of different measures to control wilt causing pathogens in chickpea. *Journal of Plant Protection Research*, *51*(1), 55–59. https://doi.org/10.2478/v10045-011-0010-3

Animisha, S. Z., Jaiswal, K. K., & Pandey, P. (2012). Integrated management of chickpea wilt incited by Fusarium oxysporum f. sp. ciceris. *International Journal of Agricultural Research*, *7*(5), 284–290. https://doi.org/10.3923/ijar.2012.284.290

Anjaiah, V., Cornelis, P., & Koedam, N. (2003). Effect of genotype and root colonization in biological control of Fusarium wilts in pigeonpea and chickpea by Pseudomonas aeruginosa PNA1. *Canadian Journal of Microbiology*, *49*(2), 85–91. https://doi.org/10.1139/w03-011

Anwar, W., Subhani, M. N., Haider, M. S., Shahid, A. A., Mushtaq, H., Rehman, M. Z., ... Javed, S. (2016). First record of Trichoderma longibrachiatum as entomopathogenic fungi against Bemisia tabaci in Pakistan. *Pakistan Journal of* Phytopathology, *28*(2), 287–294.

Arvayo-Ortiz, R. M., Esqueda, M., Acedo-Felix, E., Gonzalez-Rios, H., & Vargas-Rosales, G. (2012). New lines of chickpea against Fusarium oxysporum f. sp. ciceris wilt. *American Journal of Applied Sciences*, *9*(5), 686–693. https://doi.org/10.3844/ajassp.2012.686.693

Arvayo-Ortiz, R. M., Esqueda, M., Acedo-Felix, E., Sanchez, A., & Gutierrez, A. (2011). Morphological variability and races of Fusarium oxysporum f. sp. ciceris associated with chickpea (Cicer arietinum) crops. *American Journal of Agricultural and Biological Sciences*, *6*(1), 114–121. https://doi.org/10.3844/ajabssp.2011.114.121

Aslam, M. (1984, March). A review of research studies on chickpea blight fungus in Pakistan. In *Proceedings of the Workshop on Ascochyta Blight and Winter Sowing of Chickpea* (pp. 237–246).

Barfa, H. (2008). *Studies on management of wilt (Fusarium oxysporum f. sp. ciceri) of chickpea*

[Doctoral dissertation, Jawaharlal Nehru Krishi Vishwa Vidyalaya].

Bouslama, M. (1980). Chickpea improvement in Tunisia. In *Proceedings of the International Workshop on Chickpea Improvement, 28 February–2 March 1979* (pp. 277–280). International Crops Research Institute for the Semi-Arid Tropics.

Chowdappa, P., Kumar, S. M., Lakshmi, M. J., & Upreti, K. K. (2013). Growth stimulation and induction of systemic resistance in tomato against early and late blight by Bacillus subtilis OTPB1 or Trichoderma harzianum OTPB3. *Biological Control*, *65*(1), 109–117. https://doi.org/10.1016/j.biocontrol.2012.11.009

Demers, J. E., Garzón, C. D., & Jiménez-Gasco, M. M. (2014). Striking genetic similarity between races of Fusarium oxysporum f. sp. ciceris confirms a monophyletic origin and clonal evolution of the chickpea vascular wilt pathogen. *European* Journal of Plant Pathology, *139*(2), 309–324. https://doi.org/10.1007/s10658-014-0387-8

DeVay, J. E., Gutierrez, A. P., Pullman, G. S., Wakeman, R. J., Garber, R. H., Jeffers, D. P., ... Roberts, P. A. (1997). Inoculum densities of Fusarium oxysporum f. sp. vasinfectum and Meloidogyne incognita in relation to the development of Fusarium wilt and the phenology of cotton plants (Gossypium hirsutum). *Phytopathology*, *87*(3), 341–346. https://doi.org/10.1094/PHYTO.1997.87.3.341

Echandi, E. (1970). Wilt of chickpeas or garbanzo beans (Cicer arietinum) incited by Fusarium oxysporum. *Phytopathology*, *60*, 1539. [Abstract].

Enkerli, J., Bhatt, G., & Covert, S. F. (1997). Nht1, a transposable element cloned from a dispensable chromosome in Nectria haematococca. *Molecular Plant-Microbe Interactions*, *10*(6), 742–749. https://doi.org/10.1094/MPMI.1997.10.6.742

Erwin, D., & Snyder, W. (1958). Yellowing of garbanzo beans: Aphid-spread yellowing virus needs different control though visibly similar to Fusarium wilt caused by soil-borne fungus. *California Agriculture*, *12*(11), 6–16.

Farooq, M., Bajwa, A. A., Cheema, S. A., & Cheema, Z. A. (2013). Application of allelopathy in crop production. *International Journal of Agriculture and Biology*, *15*(6), 1367–1378.

Fravel, D., Olivain, C., & Alabouvette, C. (2003). Fusarium oxysporum and its biocontrol. *New Phytologist*, *157*(3), 493–502. https://doi.org/10.1046/j.1469-8137.2003.00700.x

Giri, A. P., Harsulkar, A. M., Deshpande, V. V., Sainani, M. N., Gupta, V. S., & Ranjekar, P. K. (1998). Chickpea defensive proteinase inhibitors can be inactivated by podborer gut proteinases. *Plant Physiology*, *116*(1), 393–401. https://doi.org/10.1104/pp.116.1.393

Gopalakrishnan, S., Pande, S., Sharma, M., Humayun, P., Kiran, B. K., Sandeep, D., ... Rupela, O. (2011). Evaluation of actinomycete isolates obtained from herbal vermicompost for the biological control of Fusarium wilt of chickpea. *Crop Protection*, *30*(8), 1070–1078. https://doi.org/10.1016/j.cropro.2011.03.006

Govil, J. N., & Rana, B. S. (1994). Stability of host plant resistance to wilt (Fusarium oxysporum f. sp. ciceri) in chickpea. *International Journal of Tropical* Plant Disease*s*, *2*, 55–60.

Hafizi, R., Salleh, B., & Latiffah, Z. (2013). Morphological and molecular characterization of Fusarium solani and F. oxysporum associated with crown disease of oil palm. *Brazilian Journal of Microbiology*, *44*(3), 959–968. https://doi.org/10.1590/S1517-83822013000300047

Hameed, A., Saddiqa, A., Nadeem, S., Iqbal, N., Atta, B. M., & Shah, T. M. (2012). Genotypic variability and mutant identification in Cicer arietinum L. by seed storage protein profiling. *Pakistan Journal of Botany*, *44*(4), 1303–1310.

Hasan, S. A., Hayat, S., Ali, B., & Ahmad, A. (2008). 28-Homobrassinolide protects chickpea (Cicer arietinum) from cadmium toxicity by stimulating antioxidants. *Environmental Pollution*, *151*(1), 60–66. https://doi.org/10.1016/j.envpol.2007.03.006

Haware, M. P. (1990). Fusarium wilt and other important diseases of chickpea in the Mediterranean area. In M. C. Saxena, J. I. Cubero, & J. Wery (Eds.), *Present status and future prospects of chickpea crop production and improvement in the Mediterranean* *countries* (pp. 61–64). CIHEAM.

Haware, M. P., Nene, Y. L., & Mathur, S. B. (1986). *Seed-borne diseases of chickpea*. Danish Government Institute of Seed Pathology for Developing Countries; International Crops Research Institute for the Semi-Arid Tropics.

Haware, M. P., Nene, Y. L., & Natarajan, M. (1996). The survival of Fusarium oxysporum f. sp. ciceri in the soil in the absence of chickpea. *Phytopathologia Mediterranea*, *35*, 9–12.

Haware, M. P., Nene, Y. L., & Rajeshwari, R. (1978). Eradication of Fusarium oxysporum f. sp. ciceri transmitted in chickpea seed. *Phytopathology*, *68*(9), 1364–1367. https://doi.org/10.1094/Phyto-68-1364

Haware, M. P., Nene, Y. L., Pundir, R. P. S., & Rao, J. N. (1992). Screening of world chickpea germplasm for resistance to Fusarium wilt. *Field Crops Research*, *30*(1–2), 147–154. https://doi.org/10.1016/0378-4290(92)90063-F

Hiremath, P. J., Farmer, A., Cannon, S. B., Woodward, J., Kudapa, H., Tuteja, R., ... Krishnamurthy, L. (2011). Large-scale transcriptome analysis in chickpea (Cicer arietinum L.), an orphan legume crop of the semi-arid tropics of Asia and Africa. *Plant Biotechnology Journal*, *9*(8), 922–931. https://doi.org/10.1111/j.1467-7652.2011.00625.x

Ilyas, M. B., Chaudhry, M. A., Javed, N., Ghazanfar, M. U., & Khan, M. A. (2007). Sources of resistance in chickpea germplasm against Ascochyta blight. *Pakistan Journal of Botany*, *39*(5), 1843–1847.

Iqbal, S. H., Ghafoor, A., & Ayub, N. (2005). Relationship between SDS-PAGE markers and Ascochyta blight in chickpea. *Pakistan Journal of Botany*, *37*(1), 87–96.

Jain, M., Misra, G., Patel, R. K., Priya, P., Jhanwar, S., Khan, A. W., ... Yadav, M. (2013). A draft genome sequence of the pulse crop chickpea (Cicer arietinum L.). *The Plant Journal*, *74*(5), 715–729. https://doi.org/10.1111/tpj.12173

Jalali, B. L., & Chand, H. (1992). Chickpea wilt. In U. S. Singh, H. S. Chaube, J. Kumar, & A. N. Mukhopadhyay (Eds.), *Plant diseases of international importance: Vol. 1. Diseases of cereals and pulses* (pp. 429–444). Prentice Hall.

Jalota, S. K., Sood, A., & Harman, W. L. (2006). Assessing the response of chickpea (Cicer arietinum L.) yield to irrigation water on two soils in Punjab (India): A simulation analysis using the CROPMAN model. *Agricultural Water Management*, *79*(3), 312–320. https://doi.org/10.1016/j.agwat.2005.02.014

Jamil, F. F., Sarwar, M., Sarwar, N., Khan, J. A., Zahid, M. H., Yousaf, S., ... Haq, I. (2010). Genotyping with RAPD markers resolves pathotype diversity in the Ascochyta blight and Fusarium wilt pathogens of chickpea in Pakistan. *Pakistan Journal of Botany*, *42*(2), 1369–1378.

Jayalakshmi, S. K., Raju, S., Rani, S. U., Benagi, V. I., & Sreeramulu, K. (2009). Trichoderma harzianum L1 as a potential source for lytic enzymes and elicitor of defense responses in chickpea (Cicer arietinum L.) against wilt disease caused by Fusarium oxysporum f. sp. ciceri. *Australian Journal of* Crop Science, *3*(1), 44–52.

Jiménez-Díaz, R. M., Basallote-Ureba, M. J., & Rapoport, H. (1989). Colonization and pathogenesis in chickpeas infected by races of Fusarium oxysporum f. sp. ciceri. In E. C. Tjamos & C. H. Beckman (Eds.), *Vascular wilt diseases of plants: Basic studies and control* (pp. 113–121). Springer. https://doi.org/10.1007/978-3-642-73166-2_7

Jiménez-Gasco, M. M., & Jiménez-Díaz, R. M. (2003). Development of a specific polymerase chain reaction-based assay for the identification of Fusarium oxysporum f. sp. ciceris and its pathogenic races 0, 1A, 5, and 6. *Phytopathology*, *93*(2), 200–209. https://doi.org/10.1094/PHYTO.2003.93.2.200

Jiménez-Gasco, M. M., Milgroom, M. G., & Jiménez-Díaz, R. M. (2002). Gene genealogies support Fusarium oxysporum f. sp. ciceris as a monophyletic group. Plant Pathology, 51(1), 72–77. https://doi.org/10.1046/j.0032-0862.2001.00610.x-i1

Jiménez-Gasco, M. M., Navas-Cortés, J. A., & Jiménez-Díaz, R. M. (2004). The Fusarium oxysporum f. sp. ciceris/Cicer arietinum pathosystem: A case study of the evolution of plant-pathogenic fungi into races and pathotypes. *International Microbiology*, *7*(2), 95–104.

Jiménez-Gasco, M. M., Pérez-Artés, E., & Jiménez-Díaz, R. M. (2001). Identification of pathogenic races 0, 1B/C, 5, and 6 of Fusarium oxysporum f. sp. ciceris with random amplified polymorphic DNA (RAPD). *European Journal of Plant Pathology, 107*(2), 237–248. https://doi.org/10.1023/A:1011294204630

Kaiser, W. J., Hannan, R. M., & Weller, D. M. (1989). Biological control of seed rot and preemergence damping-off of chickpea with fluorescent pseudomonads. *Soil Biology and Biochemistry*, *21*(2), 269–273. https://doi.org/10.1016/0038-0717(89)90104-1

Karimi, K., Amini, J., Harighi, B., & Bahramnejad, B. (2012). Evaluation of biocontrol potential of Pseudomonas and Bacillus spp. against Fusarium wilt of chickpea. *Australian Journal of* Crop Science, *6*(4), 695–703.

Kaur, N. P., & Mukhopadhyay, A. N. (1992). Integrated control of chickpea wilt complex by Trichoderma and chemical methods in India. *International Journal of Pest Management*, *38*(4), 372–375. https://doi.org/10.1080/09670879209371730

Kausar, A. G. (1977). Development of disease-resistant chickpea. In A. Muhammed, R. Aksel, & R. C. von Borstel (Eds.), *Genetic diversity in plants* (pp. 213–220). Springer. https://doi.org/10.1007/978-1-4684-2886-5_19

Khan, H. A., Siddique, K. H. M., Munir, R., & Colmer, T. D. (2015). Salt sensitivity in chickpea: Growth, photosynthesis, seed yield components and tissue ion regulation in contrasting genotypes. *Journal of* Plant Physiology, *182*, 1–12. https://doi.org/10.1016/j.jplph.2015.05.002

Khan, I. A., Alam, S. S., Haq, A., & Jabbar, A. (2002). Selection for resistance to Fusarium wilt and its relationship with phenols in chickpea. *International Chickpea and Pigeonpea Newsletter*, *9*, 19–20.

Khan, M. R., Khan, S. M., & Mohiddin, F. A. (2004). Biological control of Fusarium wilt of chickpea through seed treatment with the commercial formulation of Trichoderma harzianum and/or Pseudomonas fluorescens. *Phytopathologia Mediterranea*, *43*(1), 20–25.

Kumar, M., Mishra, S., Dixit, V., Kumar, M., Agarwal, L., Chauhan, P. S., & Nautiyal, C. S. (2016). Synergistic effect of Pseudomonas putida and Bacillus amyloliquefaciens ameliorates drought stress in chickpea (Cicer arietinum L.). *Plant Signaling & Behavior*, *11*(1), Article e1071004. https://doi.org/10.1080/15592324.2015.1071004

Ladizinsky, G., & Adler, A. (1975). The origin of chickpea as indicated by seed protein electrophoresis. *Israel Journal of Botany*, *24*, 183–189.

Li, L., Tilman, D., Lambers, H., & Zhang, F. S. (2014). Plant diversity and overyielding: Insights from belowground facilitation of intercropping in agriculture. *New Phytologist*, *203*(1), 63–69. https://doi.org/10.1111/nph.12778

Li, Y., Jiang, B., Zhang, T., Mu, W., & Liu, J. (2008). Antioxidant and free radical-scavenging activities of chickpea protein hydrolysate (CPH). *Food Chemistry*, *106*(2), 444–450. https://doi.org/10.1016/j.foodchem.2007.04.067

Lim, S. S., Vos, T., Flaxman, A. D., Danaei, G., Shibuya, K., Adair-Rohani, H., ... Aryee, M. (2012). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: A systematic analysis for the Global Burden of Disease Study 2010. *The Lancet*, *380*(9859), 2224–2260.

Lodhi, N. A. K., Abbas, A., Waris, W., Asad, M., & Aslam, M. M. (2016). Chickpea wilt and its management strategies: A review paper. *Imperial Journal of Interdisciplinary Research*, *2*(11).

Mahmood, Y., Khan, M. A., Javed, N., & Arif, M. J. (2015). Comparative efficacy of fungicides and biological control agents for the management of chickpea wilt caused by Fusarium oxysporum f. sp. ciceris. *Journal of Animal and Plant Sciences*, *25*(4), 1063–1071.

Malik, S. R., Bakhsh, A., Asif, M. A., Iqbal, U., & Iqbal, S. M. (2010). Assessment of genetic variability and interrelationship among some agronomic traits in chickpea. *International Journal of Agriculture and Biology*, *12*(1), 81–85.

Marathe, S. A., Rajalakshmi, V., Jamdar, S. N., & Sharma, A. (2011). Comparative study on antioxidant activity of different varieties of commonly consumed legumes in India. *Food and Chemical Toxicology*, *49*(9), 2005–2012. https://doi.org/10.1016/j.fct.2011.04.039

Mariana, M., & Budi, I. S. (2013). Exploration of antagonistic fungi against Ganoderma sp. as causal agent of basal stem rot disease in oil palm. *Agroscientiae*, *20*(2).

Mayer, M. S., Tullu, A., Simon, C. J., Kumar, J., Kaiser, W. J., Kraft, J. M., & Muehlbauer, F. J. (1997). Development of a DNA marker for Fusarium wilt resistance in chickpea. *Crop Science*, *37*(5), 1625–1629. https://doi.org/10.2135/cropsci1997.0011183X003700050036x

Mehmood, Y. (2014). *Characterization of soil and environmental factors conducive for chickpea wilt caused by Fusarium oxysporum f. sp. ciceris (Padwick) and its management* [Doctoral dissertation, University of Agriculture Faisalabad].

Merkuz, A., & Getachew, A. (2012). Management of chickpea wilt (Fusarium oxysporum f. sp. ciceris) using Trichoderma spp. *International Journal of Current Research*, *4*(5), 128–134.

Miao, M., Zhang, T., & Jiang, B. (2009). Characterisations of kabuli and desi chickpea starches cultivated in China. *Food Chemistry*, *113*(4), 1025–1032. https://doi.org/10.1016/j.foodchem.2008.08.056

Moradi, H., Bahramnejad, B., Amini, J., Siosemardeh, A., & Haji-Allahverdipoor, K. (2012). Suppression of chickpea (Cicer arietinum L.) Fusarium wilt by Bacillus subtilis and Trichoderma harzianum. *Plant Omics Journal*, *5*(2), 68–74.

Mukherjee, P. K., & Haware, M. P. (1993). Biological control of Botrytis gray mold of chickpea. *International Chickpea and Pigeonpea Newsletter*, *28*, 14–15.

Murumkar, C. V., & Chavan, P. D. (1985). Physiological changes in chickpea leaves infected by Fusarium wilt. *Biovigyanam*, *11*(1), 118–120.

Naghavi, M. R., & Jahansouz, M. R. (2005). Variation in the agronomic and morphological traits of Iranian chickpea accessions. *Journal of Integrative Plant Biology*, *47*(3), 375–379. https://doi.org/10.1111/j.1744-7909.2005.00058.x

Nasir, N., Pittaway, P. A., & Pegg, K. G. (2003). Effect of organic amendments and solarisation on Fusarium wilt in susceptible banana plantlets transplanted into naturally infested soil. *Australian Journal of Agricultural Research*, *54*(3), 251–257. https://doi.org/10.1071/AR02099

Nene, Y. L. (1982). A review of Ascochyta blight of chickpea. *International Journal of Pest Management*, *28*(1), 61–70. https://doi.org/10.1080/09670878209370675

Nene, Y. L., & Haware, M. P. (1980). Screening chickpea for resistance to wilt. *Plant Disease*, *64*(4), 379–380. https://doi.org/10.1094/PD-64-379

Nene, Y. L., & Reddy, M. V. (1976). Preliminary information on chickpea stunt. *Tropical Grain Legume Bulletin*, *5*, 31–32.

Nikam, P. S., Jagtap, G. P., & Sontakke, P. L. (2007). Management of chickpea wilt caused by Fusarium oxysporium f. sp. ciceri. *African Journal of Agricultural Research*, *2*(12), 692–697.

Oakenfull, D. (1981). Saponins in food: A review. *Food Chemistry*, *7*(1), 19–40. https://doi.org/10.1016/0308-8146(81)90019-4

Pachauri, S. D., Tota, S., Khandelwal, K., Verma, P. R. P., Nath, C., Hanif, K., ... Dwivedi, A. K. (2012). Protective effect of fruits of Morinda citrifolia L. on scopolamine-induced memory impairment in mice: A behavioral, biochemical and cerebral blood flow study.

Journal of Ethnopharmacology, *139*(1), 34–41. https://doi.org/10.1016/j.jep.2011.09.057

Pande, S., Rao, J. N., & Sharma, M. (2007). Establishment of the chickpea wilt pathogen Fusarium oxysporum f. sp. ciceris in the soil through seed transmission. *Plant Pathology Journal*, *23*(1), 3–6. https://doi.org/10.5423/PPJ.2007.23.1.003

Parewa, H. P., Yadav, J., Rakshit, A., Meena, V. S., & Karthikeyan, N. (2014). Plant growth promoting rhizobacteria enhance growth and nutrient uptake of crops. *Agricultural Sustainable Development*, *2*(2), 101–116.

Patra, S., & Biswas, M. K. (2017). Eco-friendly management of Fusarium oxysporum f. sp. ciceri, the causal agent of chickpea wilt disease, under in-vitro condition. *International Journal of Current Microbiology and Applied Sciences*, *6*(3), 1852–1858. https://doi.org/10.20546/ijcmas.2017.603.211

Prasad, M. N. V. (2008). Essentiality of zinc for human health and sustainable development. In M. N. V. Prasad (Ed.), *Trace elements as contaminants and nutrients: Consequences in ecosystems and human health* (pp. 183–216). John Wiley & Sons. https://doi.org/10.1002/9780470370124.ch9

Ramachandran, S., Singh, S. K., Larroche, C., Soccol, C. R., & Pandey, A. (2007). Oil cakes and their biotechnological applications: A review. *Bioresource Technology*, *98*(10), 2000–2009. https://doi.org/10.1016/j.biortech.2006.08.002

Rao, N. S., Tilak, K. V. B. R., & Singh, C. S. (1986). Dual inoculation with Rhizobium sp. and Glomus fasciculatum enhances nodulation, yield and nitrogen fixation in chickpea (Cicer arietinum Linn.). *Plant and Soil*, *95*(3), 351–359. https://doi.org/10.1007/BF02374616

Saikia, R., Singh, T., Kumar, R., Srivastava, J., Srivastava, A. K., Singh, K., & Arora, D. K. (2003). Role of salicylic acid in systemic resistance induced by Pseudomonas fluorescens against Fusarium oxysporum f. sp. ciceri in chickpea. *Microbiological Research*, *158*(3), 203–213. https://doi.org/10.1078/0944-5013-00202

Sankaran, S., Khot, L. R., Espinoza, C. Z., Jarolmasjed, S., Sathuvalli, V. R., Vandemark, G. J., ... Pavek, M. J. (2015). Low-altitude, high-resolution aerial imaging systems for row and field crop phenotyping: A review. *European Journal of Agronomy*, *70*, 112–123. https://doi.org/10.1016/j.eja.2015.07.004

Saxena, M. C., & Singh, K. B. (Eds.). (1987). *The chickpea*. Commonwealth Agricultural Bureaux International.

Shahbaz, M., Ashraf, M., Akram, N. A., Hanif, A., Hameed, S., Joham, S., & Rehman, R. (2011). Salt-induced modulation in growth, photosynthetic capacity, proline content and ion accumulation in sunflower (Helianthus annuus L.). *Acta Physiologiae Plantarum*, *33*(4), 1113–1122. https://doi.org/10.1007/s11738-010-0639-y

Shakoor, M. A. (1991). *Screening of chickpea germplasm against Ascochyta blight, Fusarium wilt and chickpea stunt virus disease* [Master's thesis, University of Agriculture Faisalabad].

Sharma, K. D., & Muehlbauer, F. J. (2007). Fusarium wilt of chickpea: Physiological specialization, genetics of resistance and resistance gene tagging. *Euphytica*, *157*(1–2), 1–14. https://doi.org/10.1007/s10681-007-9401-y

Siddiqui, Z. A., & Akhtar, M. S. (2007). Biocontrol of a chickpea root-rot disease complex with phosphate-solubilizing microorganisms. *Journal of Plant Pathology*, *89*(1), 67–77.

Sindhu, S. S., Kein, K. F., Houdgs, H. F., & Nygust, W. E. (1974). Inheritance of protein and sulphur content of seed of chickpea. *Crop Science*, *14*, 649–653. https://doi.org/10.2135/cropsci1974.0011183X001400050012x

Singh, D., & Nema, K. G. (1987). Effect of soil amendment on Rhizoctonia bataticola causing dry root rot of chickpea. International Chickpea Newsletter, 17, 23–25.

Singh, K. B., & Reddy, M. V. (1991). Advances in disease-resistance breeding in chickpea. *Advances in Agronomy*, *45*, 191–222. https://doi.org/10.1016/S0065-2113(08)60041-3

Singh, K. B., & Saxena, M. C. (Eds.). (1993). *Breeding for stress tolerance in cool-season food legumes*. Wiley.

Sivasithamparam, K., & Ghisalberti, E. L. (1998). Secondary metabolism in Trichoderma and Gliocladium. In C. P. Kubicek & G. E. Harman (Eds.), *Trichoderma and Gliocladium: Vol. 1. Basic biology, taxonomy and genetics* (pp. 139–191). Taylor & Francis.

Tar'an, B., Warkentin, T. D., Tullu, A., & Vandenberg, A. (2007). Genetic mapping of Ascochyta blight resistance in chickpea (Cicer arietinum L.) using a simple sequence repeat linkage map. *Genome*, *50*(1), 26–34. https://doi.org/10.1139/g06-137

Toker, C., Ceylan, F. O., Inci, N. E., Yildirim, T., & Cagirgan, M. I. (2012). Inheritance of leaf shape in the cultivated chickpea (Cicer arietinum L.). *Turkish Journal of Field Crops*, *17*(1), 16–18.

Van der Maesen, L. J. G. (1972). *Cicer L., a monograph of the genus, with special reference to the chickpea (Cicer arietinum L.), its ecology and cultivation* [Doctoral dissertation, Agricultural University Wageningen]. H. Veenman & Zonen N.V.

Varshney, R. K., Song, C., Saxena, R. K., Azam, S., Yu, S., Sharpe, A. G., ... Cook, D. R. (2013). Draft genome sequence of chickpea (Cicer arietinum) provides a resource for trait improvement. Nature Biotechnology, 31(3), 240–246. https://doi.org/10.1038/nbt.2491

Verma, J. P., Yadav, J., Tiwari, K. N., & Jaiswal, D. K. (2014). Evaluation of plant growth promoting activities of microbial strains and their effect on growth and yield of chickpea (Cicer arietinum L.) in India. *Soil Biology and Biochemistry*, *70*, 33–37. https://doi.org/10.1016/j.soilbio.2013.12.001

Wani, P. A., & Khan, M. S. (2010). Bacillus species enhance growth parameters of chickpea (Cicer arietinum L.) in chromium-stressed soils. *Food and Chemical Toxicology*, *48*(11), 3262–3267. https://doi.org/10.1016/j.fct.2010.08.035