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Role of Agricultural Constraints and Ascochyta Blight Disease in Low Yield of Chickpea Crop in Pakistan: A Review

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ABSTRACT

Chickpea (*Cicer arietinum* L.) has played a vital role in increasing the economy of any chickpea cultivated country. Nowadays, the production of chickpea is becoming low as compared to the previous year. The main reason for this low production are environmental constraints (soil salinity, waterlogging, soil fertility depletion, soil erosion, climate impacts), irrigation water management constraints (inequitable canal water distribution, improper conjunctive use of the canal and groundwater, low water use efficiency) and, agronomic constraints (traditional methods of cultivation, inadequate availability of improved quality seed). Besides these constraints, fungal diseases are causing severe loss to chickpea crop. Ascochyta blight or chickpea blight caused by the fungal pathogen *Ascochyta rabiei*, causing severe annual loss to chickpea field and their production in Pakistan and worldwide. This review article highlights and summarized the main agricultural constraints on the way of low production and Ascochyta blight (AB) disease of chickpea in Pakistan and their management through different aspects.

Keywords: Chickpea; Agri Constraints; Water logging; Soil Erosion; Ascochyta blight.

INTRODUCTION

Grains and legumes play an important nutritional role in the nutrition of millions of people in developing countries, so they are sometimes referred to as the meat of the poor. Since legumes are an important source of protein, calcium, iron, phosphorus, and other minerals, they form an important part of the diet of vegetarians, since other foods they eat do not have a high protein content (Qamar *et al.,* 2020; Semba *et al.,* 2021). Beans are multi-purpose crops that can be consumed directly in many agricultural systems as food or in various processed forms or as feed (Kumara Charyulu and Deb, 2014). Because of the role of legumes in nitrogen fixation, they are often used as crops with crops. However, legume yields in developing countries have stagnated in recent decades. Among these countries, agricultural research and development efforts in many countries have focused on increasing crop production and reducing crop losses to ensure food security. Since legumes

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play a different role in crop systems and in food security, research on legumes will have a major impact on food security and soil fertility (Kulkarni *et al.,* 2018).

Chickpeas are one of the oldest known legumes and cultivated in ancient Asia and Europe. It is currently growing in Pakistan, India, Italy, Greece, Romania, Russia, Egypt, North Africa, and many other countries in the world. Chickpeas are valued for their nutrient-rich seeds, which after peeling have a high protein content of 25 to 28% (Muehlbauer and Tullu, 1997). Chickpea seeds can be eaten fresh like green vegetables, diced, fried, roasted, and cooked, as snacks, sweets, and spices, the seeds are grated and the flour can be used as soup and bread. Made from pepper, salt, and lemon, it can be used as a side dish, and puma is very popular. There are two main types of chickpeas, which differ in seed size, shape, and color (Shah *et al.,* 2007). The first relatively small seed is called Desi and the larger seed is called Kabuli. Desi chickpeas are mainly grown on the Indo-Pakistan subcontinent. Chickpeas are used in rural and urban areas for human consumption and as animal feed (Shad *et al.,* 2009; Muehlbauer and Sarker, 2017).

Worldwide chickpea demand

There are currently around 6.5 billion people living on the planet, and by 2050 this number is expected to increase by almost 50% to over 9 billion. We will increasingly have to face the need to produce more food for more people with fewer resources, and we will have to rely more on quality plants to meet this growing demand. Chickpeas are way ahead in this agricultural competition. Chickpeas are a good source of energy, protein, minerals, vitamins, and fiber and contain health-promoting phytochemicals (Wood and Grusak, 2007). Chickpeas play a leading role in global food security by compensating for the deficiencies in the daily quantitative food protein of the people of India and Sub-Saharan Africa. The design of the aftercare formula for babies based on chickpeas meets the WHO/FAO requirements for food supplements and complies with the supplementary provisions of the EU regulations for food supplements with minimal addition of oil, minerals, and vitamins. It uses chickpeas as a common source of carbohydrates and protein, making developing countries more economical and affordable without sacrificing nutritional quality (Malunga *et al.,* 2014). Opportunities in large growing areas depend both on reducing crop risk and increasing productivity (Redden and Berger, 2007). However, chickpeas have become more and more important among legumes and occupy second place in terms of area (15.3% of the total) and third place in production (15.42%) (Wood and Grusak, 2007).

Cultivation of Chickpea varieties worldwide

There are two different types of chickpeas. Desi chickpeas: Chickpeas and thick seed pods are called Desi types. Common seed colors are different shades and combinations of brown, yellow, green, and black. The seeds are usually small and have a rough surface. The flowers are usually pink and the plants show varying degrees of anthocyanin pigmentation, although some types of Desi flowers are white and there is no anthocyanin pigmentation on the stem. The Desi type makes up 80-85% of the chickpea area. The skin (Dal) and the flour (Besan) are always of the Desi type. Kabuli chickpeas: Kabuli chickpeas are characterized by white or beige seeds with the shape of a ram's head, a thin seed coat, a smooth seed surface, and white flowers and stem without anthocyanin pigmentation. Compared to the Desi 3 type, the Kabuli type has a higher sucrose content and a lower fiber content. Compared to the Desi type, Kabuli type seeds usually have larger seeds and fetch higher market prices. The price premium of the Kabuli type usually increases with increasing seed size (Shah *et al*., 2007; Zia-Ul-Haq *et al*., 2007; Shad *et al*., 2009).

Cultivation of chickpea and it's constraints in Pakistan

Pakistan is the third-largest country in the world in chickpea production (Bank, 2011; Azeem *et al*., 2019). The annual production of dried seeds from 1.094 million hectares of land is seven, 600 billion tons are missing, which corresponds to about 4.7% of the country's economy (Shah *et al*., 2007; Akhtar *et al*., 2018). The global daily availability of chickpeas per capita is 3.4 grams, compared to 16.23 grams in Pakistan. Beans are the main source of vegetable protein. The total acreage of the plant is 5%. Due to the overwhelming population growth, the demand for beans is increasing daily. There is an urgent need to invent new high-yielding legumes and better farming practices to meet the increased demand for legumes. In Pakistan, chickpeas, lentils, mung beans, black grams or mashed potatoes, and bitter melon are the main crops grown (Vijayaprakash and Dandin, 2005; Neumann *et al.,* 2010). However, chickpea production depends solely on the concentration of rainfall. This crop is produced in large quantities in the Pakistani region of Thal (Shah *et al.,* 2007). There are two main types of chickpeas, which differ in seed size, shape, and color. The first relatively small seed is called Desi and the larger seed is called Kabuli. Desi chickpeas are mainly grown on the Indian-Pakistani subcontinent (Malunga *et al.,* 2014). From 2005 to 2006, the total annual area of chickpeas in Pakistan was 102.89 million hectares (this corresponds to 4.3% of the total arable area), which corresponds to 6% of the total bean area of the country. This resulted in a color of 479,500 tons with an average yield of 466 kg/ha. In the years 1996-2006, the overtime productivity of chickpeas decreased from 617 kg/ha to 466 kg/ha. On average Punjab contributed about 80% to the production, and Sindh, Northwest Frontier, and Baluchistan produced the remaining 20% (Hassan *et al.,* 2010; Rashid *et al.,* 2019).

In Punjab, the Khushab area contributed 28% to gram production, the rest came from all other areas in Punjab. No other plants have grown so successfully in the Noorpur Thal desert in the Khushab area of Punjab and it plays as an important role in the agricultural system of subsistence farmers (Shah *et al.,* 2007). It gains most of the nitrogen through symbiotic N2 fixation, helping to control soil fertility, especially in the dry areas of the Thar Desert. Chickpeas can cover 80% of their nitrogen requirements with symbiotic nitrogen fixation and keep 140 kg N ha-1 out of the air. It leaves a large amount of residual nitrogen for subsequent crops and increases the organic substance required to maintain and improve soil health, long-term fertility, and the sustainability of the ecosystem (Mahdi and Meryem, 2017). The enormous pressure on our economy to feed more people has increased the importance of using the potential rainy areas of Pakistan to improve food security (Mahmood *et al.,* 1991). Chickpeas are drought-tolerant crops and therefore the main wealth of the population of Noorpur, Thal. All social activities in agriculture, such as marriage, human diseases, and animal husbandry, are related to this harvest. There are an enormous potential and actual production gap, which can be due to various restrictions, namely restrictions regarding plant management, labor management, and infrastructure (Ahmad *et al.,* 2014; Ahmad *et al.,* 2014). Chickpeas are the main legumes grown mainly in irrigated and rain-fed areas in Punjab, especially resource-poor farmers in drought-prone areas. Significant progress has been made in developing improved chickpea varieties that are suitable for certain niche cultivars. Chickpeas are grown on fallow land because the harvest can now escape extreme drought.

However, a large-scale acquisition cannot be sustained due to several socio-economic and technological constraints. The low productivity growth of chickpeas has led to a decline or stagnation in the per capita supply of this culture in the main growing areas (Abbas *et al.,* 2012). An important political question is whether the decline in the per capita pulse supply a restriction of supply or demand is. In the short to medium term, the supply of chickpeas will be more restricted than the demand. Population and income growth and the positive income elasticity of demand will ensure the current level of consumption. In the long run, demand will be more limited due to changes in taste, preferences and urbanization (Elamin and Madhavi, 2015). Her general interests go far beyond income generation for resource-poor farmers. For the long-term sustainability of the system, the future should further improve yields through improved varieties resistant to pests and diseases and better agronomic management. In Pakistan, chickpeas make up the largest area of legumes with 5% of the acreage. In 2015-16. The acreage is 945,000 hectares and the production is 312,000 tons, a decrease of 17.7% compared to the previous year. Overtime productivity of chickpeas decreased from 439 kg per hectare to 330 kg in the period 2001-2015 (Abbas *et al*., 2012). The decline in chickpea production over time is mainly due to a variety of factors such as growing other crops such as wheat, less rainfall in the desert region, lack of education, lack of access to the latest chickpea varieties, lack of certified seeds and no support price (Hussain *et al*., 2015). Pakistani government and disease attack. Various studies have shown mortality from chickpea disease (Malik and Tufail, 1984; Bokhari *et al.,* 2011). Fusarium wilt (Fusarium oxysporum f.sp. ciceris) is a severe chickpea disease that is common in India, Pakistan, Myanmar, Nepal, Mexico, Spain and Tunisia. In Pakistan, diseases cause 10% to 50% of losses each year (Nazir *et al.,* 2012). Chickpeas are mainly drought-resistant plants. Self-sufficient farmers have successfully grown chickpeas in various regions of Punjab under rain-fed and irrigated conditions. In rural areas in the Thal valley, Punjab, chickpeas are the main source of livelihood for residents (Shah *et al.,* 2007). The Layyah and Bakhar areas in Punjab are desert areas and other crops have not been successfully planted. They play an important role in maintaining farmers' food security and adapting them to farming systems. In Pakistan, only Punjab contributed 80% to chickpea production, and its production increased by almost 90% under rain-fed conditions (Hussain *et al.,* 2015). In the past, significant progress has been made in developing new types of chickpeas, particularly chickpeas for rain-fed areas that are suitable for growing. Many measures were considered, such as the cultivation of fallow land with rain food as part of chickpea cultivation. However, large-scale production cannot be achieved due to different technologies, socio-economic constraints and environmental factors. Over time, the per capita supply of chickpeas in the main growing areas stagnated or decreased due to the low yield of this culture.

Major Constraints to Agricultural Productivity

Environmental Constraints

Land degradation causes huge reduction in land productivity. Soil salinity, waterlogging, soil nutrient deficiency and soil erosion hugely degrade the land's productive capability. Soil salinity: Salinization of the soil has severely affected the country's productivity and has led to a significant reduction in crop yields. The saline land area in Pakistan is currently around 4.5 million hectares. This is because the groundwater of the saline land is close to the surface and the irrigation water quality is poor for farmland (Qureshi *et al*., 2008). Due to the use of inferior groundwater for irrigation, second salinization occurred. About 70% of the pipe wells in the Indus Basin pump soda water or brine, causing 2.3 million hectares of land to become soda water/saline (Qureshi and Barrett-Lennard, 1998). The salinity loss is estimated to be 28,000 to 40,000 hectares, and the salinity annual reduction in crop yield brings about $ 230 million in income (Haider *et al.,* 1999; Aslam *et al.,* 2006).

Waterlogging: Waterlogging is another environmental problem that reduces land productivity. Currently, about 5 Mha (30%) of the irrigated area (17 Mha) can be flooded within 3 m above the ground, while the 2 Mha (12%) area has a groundwater depth of 1.5 m and is heavily flooded (Iqbal and Ahmad, 2005; Aslam *et al.,* 2008). Kahlown and Azam (Kahlown and Majeed, 2004) reported that the water table rose from 1 to 2 m to less than 1 m, leading to a 27% and 33% decrease in wheat and sugar cane production, respectively. For cotton, an increase in the water table from 2-3 m to less than 1 m leads to a production loss of 60%. Soil fertility depletion: In Pakistan, low fertilizer use efficiency causes low soil fertility which results in low land productivity. Every crop harvest results in depletion of more nutrients from soils compared to addition of nutrients to soils due to imbalanced use of fertilizers (Iqbal and Ahmad, 2005). Soil Erosion: In rain-fed and mountainous areas soil erosion results in huge soil nutrients depletion causing low soil fertility which results in low agricultural productivity (Iqbal and Ahmad, 2005). Climate impacts: Unfavorable climatic conditions such as heavy rains, floods and droughts adversely affects agricultural productivity. About 20% reduction in crop productivity occurs due to adverse climatic situations in Pakistan (Sattar, 2012).

Irrigation Water Management Constraints

Inequitable canal water distribution: Irregular water distribution in the canal and changes in outlet flow rates have led to inefficient irrigation applications, which has resulted in a significant decrease in crop yields. Adequate and reliable water supply and water distribution are essential for increasing agricultural productivity. Studies have shown that unreliable and inadequate sewer water supply and an unfair water distribution lead to lower crop yields (Hussain *et al.,* 2003).

Improper conjunctive use of canal and groundwater: About 8.4 MAF of public tube wells water and 37 MAF of private tube wells water are being used for irrigation by Pakistani farmers (Aslam *et al.,* 2006). Direct use of saline-sodic tube well water cannot be made for crop productivity without having a proper soil, water and crop management system in place (Rashid *et al.,* 1997). Majority of the farmers do not follow proper conjunctive use patterns and also use poor quality groundwater for irrigation without considering a proper soil, water and crop management. This results in secondary salinization which causes low land productivity (Ghafoor *et al.,* 1998). Low water use efficiency: Watto and Mugera (Watto and Mugera, 2016) reported that in Pakistan, water use efficiency of wheat is 0.76 kg/m3 which is 24% lower than the world average of 1.0 kg/m3 and water use efficiency of rice is 0.45 kg/m3 which is 55% less than the Asian average of 1.0 kg/m3. Water use efficiency for cereal crops is 0.13 kg/ m3 which is very low compared to India's 0.39 kg/m3 of India and 0.82 kg/m3 of China. It reflects that in Pakistan, potential water productivity is not realized, and this is largely due to poor irrigation management and low irrigation water quality (Hussain *et al.,* 2003).

Agronomic Constraints

Traditional methods of cultivation: Small poor farmers use traditional methods of cultivation (Raza, 2019). This results in low crop yield, despite investing more on inputs and increased application of fertilizers. Lack of awareness about modern farming practices and technologies, poverty and high prices of modern technologies are the main reasons for using traditional methods of cultivation (Manzoor *et al.,* 2019).

Inadequate availability of improved quality seed: In Pakistan, inadequate supply of improved quality seed (high yielding variety seed) is also a big constraint for enhanced agricultural productivity. As shown in Table 7, during 2012-13, only 24, 24, 81 and 39% of wheat, cotton, rice and maize seed requirement, respectively was made available to farmers (Manzoor *et al.,* 2019). Clearly, there is a huge gap between requirement and supply of good quality crop seed which results in low crop productivity (Baig *et al.,* 2020). Farmers' chickpea productivity is still variable, and efforts are needed to assess the factors that lead to differences in productivity. Blight (the disease caused by Ascochyta rabiei (Pass.) Lab.) is the main limiting factor that limits chickpea productivity worldwide. The disease occurs in large chickpea-producing regions of the world (Akem, 1999; Chongo *et al.,* 2003). The disease significantly reduces the yield and quality of chickpea seeds and destroys chickpea cultures when the weather conditions are favorable for disease development (Armstrong-Cho *et al.,* 2008).

Ascochyta blight disease

With an area of 11.67 million hectares and 9.31 million tons of feed, chickpea (Cicer arietinum L.) is the third most important legume feed in the world (Pande *et al*., 2011). India accounts for approximately 64% of global chickpea production. More recently, chickpeas have experienced export-driven expansion in Australia, Canada and the USA. Despite the large acreage of chickpeas, the overall production and productivity of most chickpea growing countries is still very small, and there is a large gap between potential production (5 T ha-1) and actual production (0.8 T ha-1). The main reason for the low yield of chickpeas is their sensitivity to many biological and abiotic loads. In case of biological stress, Blight wilts due to rabies (Ascochyta rabiei (AB) (pass.) Labr. It is a common leaf disease. In most parts of the world, where plants are normally grown, plants cause many losses (up to 100%) (Pande *et al.,* 2005). Several epidemics have been reported in Pakistan, India, European countries and the Mediterranean that resulted in complete AB loss (Hawtin and Singh, 1984; Singh *et al.,* 1984; Kaiser *et al.,* 2000). AB is currently the most important yield limiting factor in Australia and Canada, which can affect 95% of the area planted with chickpeas (Knights and Siddique, 2002; Gan *et al*., 2006). Latin America (Kaiser *et al.,* 2000) and North Africa (Akem, 1999) have also reported AB. The occurrence and severity of AB in chickpeas depend on the weather. Areas with cool (15–25 °C) and wet weather (> 150 mm precipitation) during sowing have devastating effects. The type of inoculum, the concentration of the inoculum and the physiological growth of the plant also influence the degree of infection and the loss of harvest. The fungicidal treatment of AB is not economical and environmentally harmful since

fungicides have to be used several times (Chang *et al.,* 2007). Also, the use of fungicides with a specific mode of action at the site, such as QoI fungicides (Azoxystrobin), increases the risk of drug resistance in Anopheles Arabica (Gossen and Anderson, 2004; Wise *et al.,* 2009). Therefore, the resistance of the host plant alone or as a main component of the integrated AB management is the most economical way to control the disease. The prerequisite for the use of resistance to host plants is the development of reliable and reproducible resistance screening techniques. Many field and greenhouse screening techniques have been reported, but the response to AB is different (Nene, 1988; Sharma *et al.,* 1995; Li *et al.,* 2015; Wiesner-Hanks and Nelson, 2016; Li *et al.,* 2017). The difference in response to AB using these screening techniques is due to factors such as inoculum concentration, inoculation method, plant age when inoculated, and environmental conditions (such as temperature, humidity, and photoperiod). A major change in any of these ingredients will reduce the effectiveness of the screening technology, leading to the failure of the disease to develop. Therefore, the identification and standardization of various factors affecting AB infection and development are of great importance for the development of the effective field and greenhouse screening technologies for international comparison. In general, screening for AB resistance is usually done around Northern India (Dhaulahuan and Ludhiana) and these environmental conditions are conducive to the development of AB. However, the consistency of AB development and field resistance techniques in field screening techniques depends on the existing environmental conditions, which leads to different host responses to AB (Wiesner-Hanks and Nelson, 2016).

Symptoms of Ascochyta Blight

According to Spoel *et al*. (2007) the fungus responsible for chickpea AB can be regarded as a semi-living organism, which is characterized by the initial stage of vegetative organisms followed by the stage of necrotic nutrition.

Therefore, after an incubation period of 3-4 days, the characteristic symptoms of the disease can appear. AB symptoms can appear in all parts of the air of chickpeas. The characteristic symptom of AB is the development of pycnidia on concentric areas causing circular lesions on leaves and pods in the concentric area in the middle of the lesion and round lesions on the leaves and pods. Elongated lesions can be observed on the petioles and petioles (Nene, 1982). Sick pods usually cannot develop into seeds, and pod infections usually lead to infection of the seeds by the testicles and cotyledons. Infected seeds can fade and have deep, round or irregular bulbs and sometimes botulism that is visible to the naked eye (Armstrong-Cho *et al.,* 2004). Infection in the ripe stage of the pods often leads to seed atrophy (Nene, 1982; Singh *et al.,* 1984; Akem, 1999). The lesions developed on the branches, twigs, and stems of the root tip vary in size and bind the affected parts of the plant at a later stage. The area above the ring beam part is killed and can break.

Table 1 . Examples of biological control of *Ascochyta rabiei* of chickpea.

Biocontrol agent	Identity of Biocontrol	Condition	Percent inhibition	References
Aureobasidium pullulans	Fungal	*In vivo*	37.9%	(Dugan *et al.*, 2009)
Pseudomonas spp.	Bacteria	*In vitro*	99.77%	(GÜLER and KÜÇÜK, 2010)
Garlic and thuja	Plant extract	*In vitro*	44.4%and 59.93%	(Jargees *et al.*, 2010)
Monimiaceae family	Plant extract	*In vitro*	100%	(Švecova *et al.*, 2010)
T. harzianum	Fungal	*In vitro*	100% /7d	(Benzohra *et al.*, 2011)
Gliocladium virens	Fungal	*In vitro*	75%	(Agarwal *et al.*, 2011)
Saccocalyx satureioides	Essential oil	*In vitro*	100% /6mg	(Zerroug *et al.*, 2011)
Bacillus megaterium	Bacteria	*In vitro*	88.89%	(Zerroug *et al.*, 2011)
Thyme, sage and rosemary	Essential oil	*In vitro*	20, 17, 19mm	(Waithaka *et al.*, 2018)
Trichoderma viride	Fungal	*In vitro*	74.44%	(Gadhi *et al.*, 2020)

With good temperatures and relative humidity, the disease quickly spreads throughout the culture. The plant can be affected at any stage of plant growth but is most pronounced from flowering too early pods (Manjunatha *et al.,* 2018).

Limitation of AB in Pakistan

Chickpeas (Cicer arietinum L.) are the third most important legume in the world and rank first on the Indian subcontinent and in the Mediterranean (Jamil *et al.,* 2000). It is one of the main sources of protein in developing countries like Pakistan and can even grow on poor sandy soils. Therefore, it is a dry outskirt in Asia, Africa, and Central and South America. Chickpeas are not only an important source of human food and animal feed but also nitrogen fertilizers and contribute to the management of soil fertility, especially in arid areas (Suzuki and Konno, 1982; Akram *et al.,* 2008). One of the most important limiting factors for chickpea production is the AB. The resulting fusarium wilt caused massive yield losses (JAN and Wiese, 1991; Davidson and Kimber, 2007). The asexual phase of this pathogen repeatedly causes secondary disease cycles throughout the growing season (Aveskamp *et al.,* 2010). Although the perfect period for rabies has been reported in many parts of the world: AB (Millan *et al.,* 2006; Nene *et al.,* 2012), its effects on the epidemiology of diseases and the variety of pathogens is unclear. Long-range variants can be more extensive than previously thought, and ascospores in the air can be the main inoculum (Chen *et al.,* 2015). If virulent inoculum, favorable environmental conditions, and susceptible host plants coexist, epiphytic conditions prevail. Since the first report in 1911, Fusarium has appeared with common epiphytic diseases in northern Pakistan (Villanueva Cáceda, 2018). Disease-resistant varieties have been released, but due to the appearance of pathogenic virulent strains, they become susceptible after just a few growing seasons (Jamil *et al.,* 1993; Jamil *et al.,* 2000). The pathogenicity of Ab from India, Syria, Lebanon, Tunisia, Italy, and Pakistan has been reported (JAN and Wiese, 1991). By recording the severity of the infection symptoms of different types of chickpeas to determine the causative factors of AB (Gan *et al.,* 2006). It has been found that the pathogenic potential of rabies bacteria is very different. However, understanding the disease mechanisms and developing correct breeding strategies require the biological and genetic properties of pathogens. The analysis of the genetic variation of pathogen populations is an important prerequisite for understanding the coevolution of plant-pathogen systems. Changes in virulence do not necessarily reflect the genetic variation (van der Waals *et al*., 2004). Fungal genotypes are most reliably characterized using DNA markers and have revolutionized many areas of plant breeding and biology. DNA polymorphisms such as RFLP analysis, oligonucleotide-based nucleotide printing, or PCR-based methods can be used for marker-supported breeding, development of link cards, isolation of resistance genes and structural analysis of plant populations (Sampayo *et al.,* 2009). In recent years, DNA polymorphisms have been used increasingly to supplement traditional markers for analyzing the genetic identity, variability, and correlation of fungi. For example, the hybridization of genomic DNA digested with restriction enzyme with probes with one and/or more locus clones can distinguish between special morphologies, races, and pathogens of different types of fungi (Ruangsuttapha *et al*., 2007). Detects a variation between AB isolates by synthesizing DNA fingerprints of oligonucleotides (e.g. (GATA) 4, (GTG) 5, (CA) 8 and (TCC) 5) (complementary to simple repeat sequences) (Singh *et al.,* 2008). RAPD analysis using random oligonucleotide primers has also been successfully used to distinguish Aspergillus rabies isolates, with a wide range of genomic DNA diversity being demonstrated.

Physiological specialization in *Ascochyta rabiei*

In Pakistan, India and around the world, information about the variety of AB is very limited. A better understanding of the variability in pathogen populations is therefore very important for the formulation of breeding strategies in integrated disease management (McDonald and Mundt, 2016). To determine the genetic variability of rabies bacteria, molecular techniques, molecular markers, pathological types and phylogenetic relationships were used in some studies (Agrama and Tuinstra, 2003). Due to the cultural and morphological diversity, an important genetic diversity was observed in AB isolates native to India (Naz *et al.,* 2007). Randomly amplified polymorphic DNA (RAPD) has become increasingly popular and is often used to identify or differentiate the Acchi Arabia virus (Fischer *et al.,* 1995; Peever *et al.,* 2004).

Pathogenicity of *Ascochyta rabiei*

Many pathogenic fungi produce one or more toxic metabolites that are harmful to plants and cause disease (Vanderplank, 2012) because they can trigger most or all of the symptoms of the disease. It is known that early symptoms of rabies can cause sagging and swelling of petioles and young twigs (Campbell and Vederas, 2010). AB quickly kills the affected plant parts on the ground in all stages of plant growth and by penetrating the microspore epidermis or spores after spores, it quickly collapses the tissue and spreads the necrotic lesions (Shtienberg *et al.,* 2000). Germination, lengthening of the germ tube, and formation of indented infection structures (Höhl *et al.,* 1990). The genital channels of rabies excrete a large amount of mucus-like secretions that are in close contact with the stratum corneum, and the host cell deforms and destroys its subcellular structure (Höhl *et al.,* 1990). Pycnogenol usually develops near the vascular area of plant tissues and can support the structure by destroying all other cell tissues within the lesion (Köhler *et al.,* 1995). AB have an effective mechanism to break down the antibacterial isoflavones and phylloxanthines present in chickpeas. Pathogens produce four different types of phytotoxins: solanine (A, B and C) (Oikawa and Tokiwano, 2004), cytochalasin D (Latif *et al*., 1993) and protein phytotoxins determined by High-performance liquid chromatography (Phan *et al*., 2002). The more aggressive rabies strains are, the more toxic and susceptible genotypes are more sensitive to toxins.

Host range of *Ascochyta rabiei*

Ascochyta rabiei naturally has a medium host specificity and is infected with Acerinumum and other Cicer species. As described by Pande et al. (2011). AB hosts are described to be pathogenic under controlled environmental conditions for lentils, peas, broad beans, beans, and cow beans. AB on cow beans (Vigna unguiculata), beans (Phaseolus vulgaris), barbed lettuce (Lactuca serriola), nettle (Lamium amplexicaule), alfalfa (Medicago sativa), sweet clover (Melilotus alba) and field beans (Thala) are pathogenic as reported by Kaiser (Kaiser, 1990). Except for the Cicer species, other hosts are rarely weakly attacked and show mild symptoms or latent infections. These random hosts are not required for the pathogen to complete its life cycle. However, such hosts can be used as potential vaccine reservoirs to trigger infections for the next season. Extensive research has been carried out on various aspects of AB. There is still a huge gap in the effects of changing weather conditions on the disease (Manjunatha *et al.,* 2018).

AB Disease Management

AB blight can be effectively combated through cultural practice, the use of chemicals, and comprehensive disease management. Diseased free seeds were found to be sown and non-host crops alternated with host crops, eliminating crop residues and planting plants in detail, which was the most effective in reducing disease incidence (Pande *et al*., 2005). Agronomic measures such as late sowing, reducing the sowing rate, and increasing the distance between plants and rows and rows also help to reduce the development of diseases. It has also been found that the majority of the use of potassium fertilizers can effectively delay the disease (Pande *et al*., 2005). Extensive cultivation methods can also prevent the production of ascospores and limit the development of the Ascomyce stage, which inhibits infection with diseases. Chemical control of diseases in cereal crops is usually avoided to prevent some of their negative effects on the grain from spreading. In serious illnesses, however, it is helpful to determine the use of chemicals. Several fungicides have been proposed to effectively control AB. Several researchers have reported that seed treatment with calixin-M, thiabendazole, isoproturon, One, and propiconazole is effective (Tivoli *et al.,* 2006). It has been found that the use of mancozeb, endosulfan, endosulfan, Bordeaux mixture, sulfur, dithione, chlorthalidone, and ferbam can be effectively reduced by repeated leaf sprays (Rubio *et al.,* 2006; Li *et al*., 2015). Integrated disease management (IDM) is important to use genotypes that are not highly resistant to AB. Management of IDM for AB has been proposed by many researchers, but that proposed by Pande et al. (2005) recommended practices are the most effective, including; (i) using clean seeds (pathogen-free) and (ii). deep tillage to eradicate the seeds (iii) use of leaf fungicides: It has been found that the control of the sowing date, the residual damage from previous crops, the seed treatment of fungicides, the rotation of non-host, cultures and the use of foliar fungicides most effectively control the disease.

Chemical control

Seed treatment with fungicides is one of several important disease control measures that limit the damage caused by AB (Benzohra *et al*., 2020; Zewdie and Gemachu, 2020). Leaf fungicides are used in many chickpea growing areas around the world to control AB, but even multiple uses do not always provide adequate control and yield losses are still high (Javaid *et al*., 2020; Ahmad *et al*., 2021). The control of AB is mainly based on cultural practices such as the treatment of fungicidal seeds and leaves and crop rotation (Zhang *et al*., 2006). Many fungicides, including Mancozeb, chlorothalonil, benomyl, carbendazim and thiabendazole, have been used to effectively control AB because these fungicides have the preventive and eradicating properties of fungi associated with AB has good residual activity (Bretag *et al*., 2006; Magar *et al*., 2020). Due to the high degree of infection of rabies seeds, the seeds are not suitable for planting, since the frequency of AB seeds is very high in seedlings. Chlorothalonil is applied twice with 1 kg ai/ha (early + medium flowering), two A second application of 125 g/ha azoxystrobin (Quadris®) or chlorothalonil + azoxystrobin can reduce AB and increase the yield. The effectiveness of Chlorthalonil Alternative Bravo Ultrex® is not as good as that of Bravo 500, but the effectiveness is better than that of Mancozeb (Dithane®) (Chongo *et al*., 2003). Although several fungicides are effective in controlling AB, repeated use of them often makes them uneconomical in areas with low crop yields. Although chemical fungicides are widely used as seed dressings and the level of seedling infection during the disease cycle, it is important to extend the monitoring of pathogenic bacterial populations to detect changes in fungicide sensitivity (Mahmood *et al*., 2019; Riccioni *et al*., 2019). The resistance of pathogens to a fungicide can very suddenly lead to resistance to other fungicides. The presence of heteroallallism and the intensive treatment of Aspergillus arabinus with fungicides require monitoring the fungicidal susceptibility to fungicide resistance.

Biological control

The control potential of fungal antagonists against rabies in vitro and in vivo was investigated by lysis, mycelium growth and spore formation. Many researchers have reported inhibition of dipyran spore germination and reduced colony development in Aspergillus rabies. Fungal antagonists such as Trichoderma viride affect the growth and survival of Aspergillus arabinosa. Among the sprays before and after inoculation, Arabidopsis thaliana (Chaetomium globosum) is the most effective antagonist. When used as a spray after inoculation, it can lower the disease index by 73.12%. Under in vitro conditions, C. Globosum reduced the colony diameter by 48.59%, which was 70.86% less than the germination of the myxospores spores (Abbes *et al*., 2010). When Trichoderma harzianum isolates are grown in a liquid culture that contains the cell wall of Aspergillus rabies, laminin and chitin as the sole carbon source to inhibit rabies growth, they produce higher amounts of metabolites, chitinase and β-1,3-glucanase. Plant extracts are used to control various pests and diseases. The onion water extract (Allium cepa) has an antifungal effect against Aspergillus rabies (Khan *et al*., 2009). Because of their dependence on environmental factors, slow mechanisms of action and growth properties, they are not effective in combating leaf blight diseases. Therefore, the biological control can be included as rabies bacteria (Manjunatha *et al*., 2018; Manzoor *et al*., 2019).

Integrated disease management

The goal of integrated disease management (IDM) is to help farmers successfully control disease. Various management strategies have been developed, but their application is limited. The adoption of the IDM approach is essential for a cost-effective control of AB (Kumar *et al*., 2020; Sangeetha *et al*., 2020; Vandana *et al*., 2020). The practices recommended by IDM for certain locations in India are as follows: (a) optimal planting date, thorough planting, optimized plant density, balanced nutrition and alternative planting methods, (b) follow 3 cereal crops (as Wheat or hardly any stubble reduction) are subject to annual crop rotation. (C) Only plant healthy seeds and use 2.5 g/kg of fungicide (such as Thiram or Carbendazim (Bavistin) before treatment, treat seeds and seeds, (d) chlorothalonil (2.0 g/l), Spray Mancozeb (2.5 g/l) and carbendazim (2.5 g/l) on the foliage 4-6 weeks after sowing. The agent is very effective, (e) plant tolerance/tolerance varieties such as G-543, Pusa-256 , Gaurav (H75-35), GNG-146, PBG-1, PBG-5, Himachal Channa-1, Himachal Channa-2, Vardhan, Samrat, GNG 1581 and BG 261 (f) Susceptible varieties must be kept during sprayed with fungicide at least every two weeks throughout the growing season (Srivastava *et al*., 2016).

Foliar application of fungicides

In the mid-1990s, growers in western Canada were able to use a partially resistant, adaptive chickpea variety. However, some of the resistance of these varieties decreased during flowering (Chongo and Gossen, 2001; Chongo *et al*., 2003), and the weather and canopy conditions at that time were generally conducive to the development of fusarium withered. Early partial resistance has slowed the development of epidemics and often reduced the severity of the epidemic later in the season. Under moist conditions, however, the development of the disease begins during vegetative growth and spreads rapidly as part of the resistance decreases during flowering. Before the development of adaptive varieties with partial resistance, chickpea production in the region was rarely successful because Fusarium severely affected yield and quality. Leaf fungicides are used in many regions of the world to control epidemics and wilting, but even multiple applications do not always offer enough control and the yield losses are still high. Other methods of treating diseases include using clean seeds, treating the seeds with fungicides, planting at least 4 years apart, and burying infected stubble through cultivation. Even after repeated use of normal cultivation equipment (rake, cultivator) in the region, the residue remains on the surface of the soil, which can be the source of the infection in the adjacent field (Davidson and Kimber, 2007; Elamin and Madhavi, 2015; Manjunatha *et al*., 2018; Benzohra *et al*., 2020).

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CONCLUSION AND FUTURE PROSPECTS

To overcome this setback, many scientists and researchers in the world practice several interventions. Furthermore, through molecular techniques, change in genetic by addition and deletion of some genes in Desi chickpea genotypes and crossing of Desi genotype with other chickpea cultivars is possible in developing new resistant variety against this major fungal disease. We also concluded that the bundle of systemic pesticides included in breakout the host plant resistant. The biological application of biocontrol agents is an effective and long term saving the host resistant and at the same time works against the multiple pathogens. Timely use of all growth required ingredients and proper irrigation in the absence of rain is possible to produce more per acre yield of chickpea.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this paper.

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