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Ascochyta Blight of Chickpea

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ABSRACT

Ascochyta blight (*Ascochyta rabiei*) which is also called as anthracnose is the most important yield increasing fungal disease in chickpea production over the world and usually depends on winter rains. Symptoms of disease usually appear around flowering and podding time as patches of blighted plants in the field. Typical circular spots appear on leaves and pods, elongated lesions on stem, and deep cankerous lesions on seeds. Present research was made to an evaluation of ascochyta blight, main symptoms, disease cycle, combating etc. subjects on the light of United States of America model where the country is a good model in terms of pulse production besides powerful agricultural economy and to try finding issues about increasing the pulse production for better health and economic development. Survey questions were gathered between 2011 and 2015 in 10 States of USA by reporting the answers of totally 300 farmers. Results of the study showed that, the managed areas are relatively bigger, growers have close collaborations with agricultural foundations and especially with the universities and legumes act in rotation. Certified seed using is rare while seed treatments for diseases is applied but the farmers are suffering from anthracnose still. Main aspects of the farmers are disease control and yield stability. According to the results of the present research, there is need to well planned rotation, development of new chickpea cultivars for the desired characteristics especially for disease resistance and wide adaptation ability by consider economic development and sustainability in agriculture, growers should not use the seeds which harvested from ascochyta-infested crop, treat seed with fungicides, deep farming of chickpea fields to bury infested debris and removing of remaining debris from the field is necessary as well.

1. Introduction

Chickpea (*Cicer arietinum* L.) is an ancient pulse which is also called as "garbanzo bean" or "Bengal gram" names. Origin of chickpea is South-East part of Turkey and North of Syria (Van der Maesen, 1987). Chickpea have big importance in the world economy and as a legume crop it is known reducing poverty and hunger, improving human health and nutrition, enhancing ecosystem life besides not elsewhere specified as well. Present day, chickpea is grown over than 50 countries over the world, and has the third place by view of pulse production following to dry bean and field pea. Main reason for growing chickpea such a wide range is due to be one of the highest nutritional valued crops of any of the dry legumes (Ceyhan et al., 2008). According to the FAO statistics, during 2009-2013, the global chickpea production area was about 12.53 million ha, with production of 11.60 million metric tons and average yield of 924.72 kg ha^{-1} besides the global chickpea trade was about $771.2530.000 for import and $748.788.000 for export values During 2007-2011 years.

There are different types of *Ascochyta spp*. that are pathogen on legumes. Identification of them is made successfully by *MAT* locus (Turgeon, 1998). *Ascochyta rabiei* (Pass.) Labr., is a serious phytopathogen that chickpea is known as only host. There are two other suggested scientific name for anthracnose in chickpea; *Phyllostica rabiei* (Pass.) (Sprague, 1930), *Phoma rabiei* (Pass.) (Khune and Kapoor, 1980, Singh et al., 1999, Anonymous, 2008).

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Ascochyta rabiei is quite more in the large seed type-*kabuli* which has higher nutritional value, higher fiber ratio and better conditions for the fungi compared with small seed type-*desi* chickpeas. Disease resistance is a quantitative feature which means a continuous variation and non-feasible to usage of Mendel rules directly. Development of resistant chickpea varieties is under the desired levels due to the difficulty of providing high and stable resistance. Main reasons for that are the high degree of variability, existence of sexual period which are give rise to emerging of new races in the pathogen besides poly-gene controlled in the plants (Singh and Reddy, 1993; Muehlbauer and Kaiser, 1994).

Furthermore, anthracnose or Ascochyta blight by scientific name is the most serious disease effecting chickpea production. Disease is shown on all the part of chickpea (from seed to habitus), cause to losing of whole yield in many cases and seen in most of chickpea producing countries such as Turkey, Bulgaria, India, Russia, Greece and Pakistan (Karahan, 1968; Nene, 1982). Present research was made to find issues for chickpea growers and breeders due to demand for information about the symptoms, cycle, management etc. characteristics of anthracnose by view of an important agricultural model United States of America and basically on the North States where the legume production has considerable values.

2. Materials and Methods

Present research was made for 5 years (from 2011 to 2015) in 10 States (California, Idaho, Minnesota, Montana, Nebraska, North Dakota, Oregon, South Dakota, Washington, Wyoming) of United States of America which have good environment conditions for plant production and showing an increased tendency for pulse growing besides North Dakota had become the largest producer of pulse crops in USA by 2009 as it implicated by “USA Dry Pea and Lentil Council” reports.

Survey questions were asked to a total of 300 pulse growers by face to face and using web. Main aspect of the research is combat with ascochyta blight in chickpea. Results of the survey were gathered comparing by the related scientific researches to find issues.

3. Results and Discussion

Survey questions which were asked to 300 farmers in total are summarized in this section. According to results, 86.77% of farmers are managed more than 60 ha area while all of them getting agricultural information from related foundations especially by universities (93.33%). Legumes act in the rotation models for 4 years (53.86%). Most of the growers are treating to the seeds (80%) but they still suffering from disease and insects (39.18%) which can be explained by low using ratio of certified varieties (13.33%). As an answer to asking what is the most important aspect of production for their operation; growers reported that yield stability, disease and insect controlling with a part of 52.51%. In general, chickpea farmers demand for determination of ascochyta blight as soon as possible the disease started to damage. For this purpose, the following lines are described to the concepts of ascochyta blight.

3.1. Disease cycle

Ascochyta fungi develops very fast among 15-25ºC and wet conditions. Higher moisture and periods of morning dew also favor disease development and spread. Besides those, hot and dry conditions can stop disease development, but spread can continue once conditions become favorable again. In spring season, sexual spores (ascospores) are produced on field stubble or seed and dispersed by wind. Spreading of ascospore can continue for several weeks and usually occurs before or during flowering period. Spores are able to travel up to eight kilometers. Germination of ascospores that land on chickpea leaves and stems need to two hours of surface moisture (dew) at least, but the probability of infection rises in case of leaves and stems are wet for more than six hours. Symptoms of disease may not seen for several days after infection. If the pycnidia is formed in lesion, it is able to producing of asexual spores (conidia). Conidia spreads by rain or by moisture on the plants. Recurrent infection cycles may appears when conditions are favorable.

Anthracnose has a wide range especially in winter sowing and/or excessive rainfall. Epidemy of anthracnose realized by the effects of temperature, rainfall, wind etc. environmental conditions. A long period of relatively cold and humidity cause to the disease as well. For epidemy of anthracnose in chickpea, the minimum weather conditions of previous month is defined as 8ºC temperature and 40 mm precipitation in average while optimum values are known as 20ºC temperature and 7 hours for the leaf moisture. Additionally, infection and disease development is limited under 5ºC and above 30ºC temperatures (Casas and Kaiser, 1992). *Ascochyta rabiei* shows a seasonal epidemy which means that the pathogen has effective mechanism to survive. In fact, the fungi survives on the infected crop residues, the capsules which are infected by spores and seeds of the infected plants (Tu and Hall, 1984) which can survive for 5 years during the storage. A total of 150 mm or more precipitation from October to April causes to dramatically increase in the disease. A few days precipitation during podding or flowering may give rise to lose of whole product, conversely; the disease can not develop or completely stop in case of none precipitation (Açıkgöz, 1994). Disease may also spread by human, animal and various tools (Vail, 2005).

3.2. Symptoms and Signs

Main symptoms of disease appears by fading on leaf terminal, leaf lesion, stem lesions causing to breaking, pod lesions causing to seed disease. The most important damages are stem breakings and pod diseases (Reddy and Singh, 1990a; Madakbaş and Ellialtıoglu, 2005). Fungal lesions appear as curved or elongated brown-red lines on leaflets, nested concentric curves of picnidia on green pods which are converted by black lines, 3-4 cm length of brown lesions with black spots on stem and petioles (Abbo et al., 2003). Disease appears on small areas of the field at first and spreads very fast in case of optimum conditions (Kaiser, 1973).

Ascochyta blight can appears anytime after emergence of crop. The concentric circles of pycnidia are large and quite easy to identify on unifoliate or large kabuli varieties, while leaf lesions on desi-type varieties are smaller and may exist a small magnifying glass. Concentric rings of pycnidia are the most diagnostic characteristic of the disease. Infected seed may be discolored, shrunken or shriveled and, when severe, lesions with dark pycnidia may be seen on the seed.

3.3. Fungicide using

Protective fungicides should be performed just before to flowering and before developing of disease in the field. This application will supply a barrier on the plant surface which prevents infection of spores and delaying to attack of epidemic. It is essential to do a regular controlling of the field for ascochyta blight. When disease appeared or during flowering time, *rotated*-systemic fungicides should be performed according to the instructions on the label and weather conditions to decrease resistance of the fungi. Namely, frequency of fungicide using may be decreased in case of low density of disease besides hot and dry weather conditions.

Mertect is a seed treatment that can be used to control ascochyta blight. While there is a foliar spray for ascochyta blight, growers often find it cost prohibitive. Agronomists recommend burning of pre-harvest or burning of previous stubble due to the ascochyta blight survives in infected seeds and residues. Seed treatment with carbendazim and thiram (1:1) combined with 2-3 sprays of captan, mancozeb or chlorothalonil 2-3 g L^{-1} water can effectively manage the disease. Thiabendazole fungicide is used to prevent transmission of the seed pathogens. This application will not protect to the post-emergent infections. Additionally, Lichtenzveig et al. (2002) suggested to maneb, tebucanazole or difenoconazole using.

Foliar fungicide application is necessary when using of medium level resistant genotypes is deficient to controlling of disease. For this purpose, many parts of North Dakota State in United States were licensed the preventer and wide spectrum specialized pesticides called as chlorothalonil and maneb (Mcmullen and Markell, 2008).

3.4. Related researches

In general, sowing of chickpea is made during spring season on Mediterranean region. But, lower precipitation during drought summer months cause to decrease in seed yield. Nevertheless, chickpea growers prefer to sowing on spring to prevention of anthracnose due to the disease spreads rapidly under cold and moist weather conditions (Singh and Reddy, 1996; Millan et al., 2006).

Singh (1997) reported that sowing of chickpea is made on spring season on Mediterranean region although the trials chickpea of ICARDA showing 50-100% increase in seed yield in case of using ascochyta and cold resistant genotypes sown on winter season.

In the last years, Countries - United States of America, Canada, Australia and Turkey that are important chickpea producers pays intensive attention to breeding of anthracnose resistant chickpeas. Culture forms of chickpea (*Cicer arietinum* L.) have very limited genotypes to tolerance on anthracnose. For this reason, only a few lines such as ILC482, ILC3279, FLIP84-92C and FLIP84-79C have been used for crossing. Search for resistance genes to fungal pathogens canalized to the wild species that 8 of them are annual and 34 of them are perennial. *Cicer arietinum* is able to be crossed with only *C. reticulatum* and *C. echinospermum* wild species. *Cicer reticulatum* and culture hybrid form - *Cicer arietinum* are wholly fertile and there is not any barrier to prevention of gene flowing between them. But, progeny of *C. arietinum* x *C.echinospermum* are highly sterile. Crossing with perennial species such as *C. songaricum* and *C. anatolicum* were mostly resulted with failure as well. Therefore, they cannot be used as gene sources for resistance (Tivoli, 2006).

Plants are able to local or systemic response to pathogens by structural and biochemical compounds. Main plant mechanisms are salisilic acid (SA) based systemic acquired resistance-SAR) and jasmonic acid (JA) based induced systemic resistance (ISR) (Cho and Muehlbauer, 2004).

For greenhouse trials; there is need to 15-22ºC temperature, 3-4 weekly plants, inoculation with 2 x 10^5 spore ml^{-1} concentrated solution for 48 hours by covering the upside of plants under high moisture conditions (Tivoli et al., 2006). Scoring should be start as soon as disease appeared meanly 8-10 days after inoculation. The common method for scoring is developed by Reddy and Singh (1984) which has a range from 1 to 9 and based the ratio of diseased tissue to whole plant.

Nkalubo et al. (2009), used 6 resistant and 3 susceptible parents and found 70% for heredity degree. They reported that the discovered degree may be beneficial to a simple selection or backward crossing. Additionally, the result which was showed lower reciprocal effect means that cytoplasmic genes are not main factors on heredity.

Hou et al. (2010) made a research to do a pyramid in an anthracnose and bacterial blight resistant variety. Results of the study showed that both of artificial inoculation and molecular indicator based selection methods should be used for determination of the mentioned diseases. Same results were also reported for anthracnose of bean (Madakbas, 2007).

Two strains of ascochyta have been identified and the varieties; Sanford and Dwelly are resistant to anthracnose but they cannot provide immunity. Two more varieties have been released as well; Sierra and Troy. Chickpea growers should also apply at least a 4-year rotation and maintain at least a 3 mile distance from a field previously planted to chickpea (Anonymous, 2015).

4. Conclusions

Fungicide using - a non-economical method, that are used for *Ascochyta spp.* are not enough to whole protection but acceptable as the most economical approach to provide developing of resistant lines, increasing of production and stabilization (Muehlbauer and Kaiser, 1994; Chen et al., 2004). Researchers should identify the pathogenic variation on the production areas to develop an effective program of developing resistant lines. More than 100 races of the fungi were identified in the literature. Using of resistant lines is the most practical way to controlling anthracnose, therefore developing of genetic resistance is the main purpose of chickpea breeding programs over the world (Reddy and Singh, 1990b). Genomic structure in chickpea is quite limited for anthracnose and genetic diversity of chickpea is very narrow (Vail, 2005). Resistance to ascochyta blight in wild species of chickpeas were found on *C. echinospermum* P. H. Davis (Collard et al., 2001; 2003), *C. reticulatum* Ladizinsky (Collard et al., 2001; 2003), *C. bijigum* Rech. Fil. (Collard et al., 2001; Collard et al., 2003; Harware et al., 1992), *C. judaicum* Boiss (Singh and Reddy, 1983; Collard et al., 2001) and *C. pinnatifidum* Jaub Et Spach (Singh and Reddy, 1996; Collard et al., 2001) ecotypes. Singh and Ocampo (1993) and Singh et al. (1999) reported that both of *C. reticulaum* and *C. echinospermum* showed compatible crosses with *C. arietinum*. As a solution of sterile progenies of the other chickpea species, in-vitro culture is supposed as promising method (Singh and Ocampo, 1997).

As a summary, it can be suggested that an integrated system is required such as developing resistant/tolerant genotypes, applying of a well planned rotation, using of certified varieties, seed treatment, using of fungicides, protection of genetic diversity is essential to management of anthracnose.

5. References

Abbo S, Berger J, Turner NC (2003). Evolution of cultivated chickpea: four bottlenecks limit diversity and constrain adaptation. *Fungal Plant Pathology* 30: 1081-1087.

Açıkgöz N (1994). Nohutta antraknoza dayanıklılık ıslahı. *Ege Tarımsal Araştırma Enstitüsü Müdürlüğü Yayınları*, No:91, İzmir.

Anonymous (2008). Ascochyta blight of chickpea, in: Plant Disease Management. *NDSU Extention Service*, ND, USA.

Anonymous (2015). 69.93.14.225/wscpr/Library Docs/Chickpea.pdf.

Casas TA, Kaiser WJ (1992). Influence of temperature, wetness period, plant age, and inoculum concentration on infection and development of Ascochyta blight of chickpea. *Phytopathology* 82: 589-596.

Ceyhan E, Harmankaya M, Avcı MA (2008). Effects of Sowing Dates and Cultivars on Protein and Mineral Contents of Bean (*Phaseolus vulgaris* L.). *Asian Journal of Chemistry*, 20 (7): 5601-5613.

Chen W, Coyne CJ, Peever T L, Muehlbauer FJ (2004). Characterization of chickpea differentials for pathogenicity assay of ascochyta blight and identification of chickpea accessions resistent to *Didymella rabiei. Plant Pathology* 53: 759-769.

Cho S, Muehlbauer FJ (2004). Genetic effect of differentially regulated fungal response genes on resistance to necrotropic fungal pathogens in chickpea (*Cicer arietinum* L.). *Physiological and Molecular Plant Pathology* 64: 57-66.

Collard BCY, Ades PK, Pang ECK, Brouwer JB, Taylor PWJ (2001). Prospecting for sources of resistance to ascochyta blight in wild Cicer species. *Austrian Plant Pathology* 30: 271–276.

Collard BCY, Pang ECK, Ades PK, Taylor PWJ (2003). Preliminary investigation of QTLs associated with seedling resistance to ascochyta blight from *Cicer echinospermum*, a wild relative of chickpea. *Theoretical and Applied Genetics* 107: 719-729.

Corp M, Machado S, Ball D, Smiley R, Petrie S, Siemens M, Guy S (2004). Chickpea Production Guide, in: Dryland Cropping Systems. *Oregon State University, Extention Service*, USA.

Gaur PM, Tripathi S, Gowda CLL, Ranga RGV, Sharma HC, Pande S, Sharma M (2010). *Chickpea Seed Production Manual*. Patancheru, Andhra Pradesh, India: ICRISAT. 28 pp.

Harware MP, Varayana RJ, Pundir RPS (1992). Evalution of wild *Cicer* species for resistance to four chickpea disease. *International Chickpea Newsletter* 27: 16-18.

Hou A, Balasubramanian PM, Conner RL, Yu K, Navabi A (2010). Marker asisted pyramiding of resistance to common bacterial blight and anthracnose in Navy bean. *Annual Report Bean Improvement Cooperative* 53: 38-39.

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

Kaiser WJ (1973). Factors affecting growth sporulation, pathogenicity and survival of *Ascochyta rabiei*. *Mycologia* 65: 444-457.

Karahan O (1968). Nohut antraknozu'nun [*Ascochyta rabiei* (Pass.) Labr.] mücadele metodunun tespiti üzerinde çalışmalar. *Bitki Koruma Bülteni* 8 (2): 77-110.

Khune NN, Kapoor JN (1980). *Ascochyta rabiei* synonymous with *Phoma rabiei*. Indian *Phytopathology* 33: 119-120.

Lichtenzveig J, Shtienberg D, Zhang HB, Bonfil DJ, Abbo S (2002). Biometric analysis of the inheritance of resistance to *Didymella rabiei* in chickpea. *Phytopathology* 92(4): 417-423.

Madakbas SY (2007). Fasulye Antraknozu (*Colletotrichum lindemuthianum* (Sacc & Magnus) Lambs. Scrib.) Hastalığına Dayanıklılığın Kalıtımı Üzerine Araştırmalar. Doktora Tezi, *Ankara Üniversitesi, Fen Bilimleri Enst*itüsü, Ankara.

Madakbas, S.Y., Ellialtıoğlu, Ş., 2005. Fasulye antraknozu (*Colletotrichum lindemuthianum*) hastalığına dayanıklılığın kalıtımı. *Alatarım* 4 (2): 1-12.

Mcmullen MP, Markell SG (2008). North Dakota Field Crop Fungicide Guide. North Dakota State University Extension Service Bulletin PP-622. *North Dakota State University*, Fargo, North Dakota.

Millan T, Clarke HJ, Siddique KHM, Buhariwalla HK, Gaur PM, Kumar J, Gil J, Kahl G, Winter P (2006). Chickpea molecular breeding: New tools and concepts. *Euphytica* 147: 81-103.

Muehlbauer FJ, Kaiser WJ (1994). Using host plant resistance to manage biotic stresses in cool season grain legumes. *Euphytica* 73:1-10.

Nene YL (1982). A review of *Ascochyta* blight of chickpea. *Tropical Pest Management* 28(1): 61-70.

Nkalubo ST, Melis R, Derera J, Laing MD, Opio F (2009). Genetic analysis of anthracnose resistance in common bean breeding source germplasm. *Euphytica* 167: 303-312.

Reddy MV, Singh KB (1984). Evaluation of world collection of chickpea germplasm accession of resistance to ascochyta blight. *Plant Disease* 68: 900-901.

Reddy MV, Singh KB (1990a). Relationship between ascochyta blight severity and yield lossin chickpea and identification of resistant lines. *Phytopathology Mediterrean* 29: 32-38.

Reddy MV, Singh KB (1990b). Management of ascochyta blight of chickpea through integration of host plant tolerance and foliar spraying of chlorothanohil. *Indian Journal of Plant Pathology* 18, 65-69.

Singh KB (1997). Chickpea (*Cicer arietinum* L.). *Field Crop Research* 53: 161- 170.

Singh KB, Ocampo B (1993). Interspesific hybridization in annual *Cicer* species. *Journal of Genetics and Breeding* 47: 199-204.

Singh KB, Reddy MV (1983). Inheritance of resistance to ascochyta blight in chickpea. *Crop Science* 23: 9-10.

Singh KB, Reddy MV (1993). Resistance to six races of *Ascochyta rabiei* in the world germplasm collection of chickpea. *Crop Science* 33: 186-189.

Singh KB, Reddy MV (1996). Improving chickpea yield by incorporating resistance to ascochyta blight. *Theoretical and Applied Genetics* 92: 509-515.

Singh NP, Singh A, Asthana AN (1999). Studies on inter-spesific crossability barriers in chickpea. *Indian Journal of Pulse Research* 12: 13-19.

Sprague R (1930). Notes on *Phyllosticta rabiei* on chickpea. *Phytopathology* 20: 591-593.

Tivoli B, Baranger A, Avila CM, Banniza S, Barbetti M, Chen W, Davidson J, Lindeck K, Kharrat M, Rubiales D, Sadiki M, Sillero JC, Sweedingham M, Muehlbauer FJ (2006). Screening techniques and sources of resistance to foliar diseases caused by major necrotrophic fungi in grain legumes. *Euphytica* 147: 223-253.

Tu JC, Hall RJ (1984). *Ascochyta rabiei* in Ontario, Canada. *Plant Disease* 68: 826.

Turgeon BG (1998). Applications of mating-type technology to problems in fungal biology. *Annual Review of Phytopathology* 36:115–137.

Vail SL (2005). Population studies of *Ascochyta rabiei* on chickpea in Saskatchewan, Master Thesis, *University of Saskatchewan*, Department of Plant Sciences, Saskatoon.