

Full Length Research Paper

Source of resistance to chickpea *Fusarium* wilt (*Fusarium oxysporum* f.sp. *ciceris*) under field conditions in Ethiopia

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Fusarium wilt is one of the economical important vascular root diseases affecting chickpea. A total of 427 chickpea germplasms were grouped into two types, desi type (385) and kabuli. 42 genotypes were evaluated to identify fusarium wilt resistant sources in Debre Zeit sick plot under natural infected field. The genotypes were grown in 2017/18 main cropping season and augmented design was used without replications; highly susceptible differential checks (JG-62) was replicated as indicator for disease appearance. The disease incidences were assessed three times at different growth stage and genotypes were graded as per ICRISAT rating scale. The fusarium wilt incidences revealed that five lines were resistant and ten had moderately resistant reaction in desi; five were resistant and 14 genotypes were moderately resistant in kabuli type of chickpea respectively. This implies that source of variability in desi type chickpea has low resistance to wilt/root rot and other major chickpea diseases. Most accession lines are early wilting type, which makes it difficult to identify slow wilting type of lines in chickpea. Thus, the promising genotypes indicate that it is most suitable for exploitation in breeding and its directly used in severely wilt affected areas as well as transfer of their gene to a commercial cultivar on the basis of resistance type.

Key word: Chickpea, *Fusarium* wilt, incidence, inheritance, slow wilting.

INTRODUCTION

Fusarium wilt (*Fusarium oxysporum* f. sp. *ciceris*) is one of the most important root diseases that affects chickpea and is wide spread in chickpea growing areas such as Asia, Africa and Southern Europe where the chickpea-growing season is dry and warm (Asrat and Tolesa, 2018); inflicting accountable quantitative as well as qualitative losses (Thaware et al., 2016; Khilare et al., 2009). Attacks from *Fusarium* wilt pathogen can destroy

a crop completely (Shivalingappa et al., 2018) or cause significant annual yield losses. The average yield reduction of chickpea due to *Fusarium* wilt globally varies from 10 to 15% and under severe conditions, the wilt infection can damage the crop completely and cause 100% yield loss in some countries (Navas-Cortés et al., 2000; Sharma et al., 2005). Early wilting is reported to cause 77-94% yield loss (Haware and Nene, 1980).

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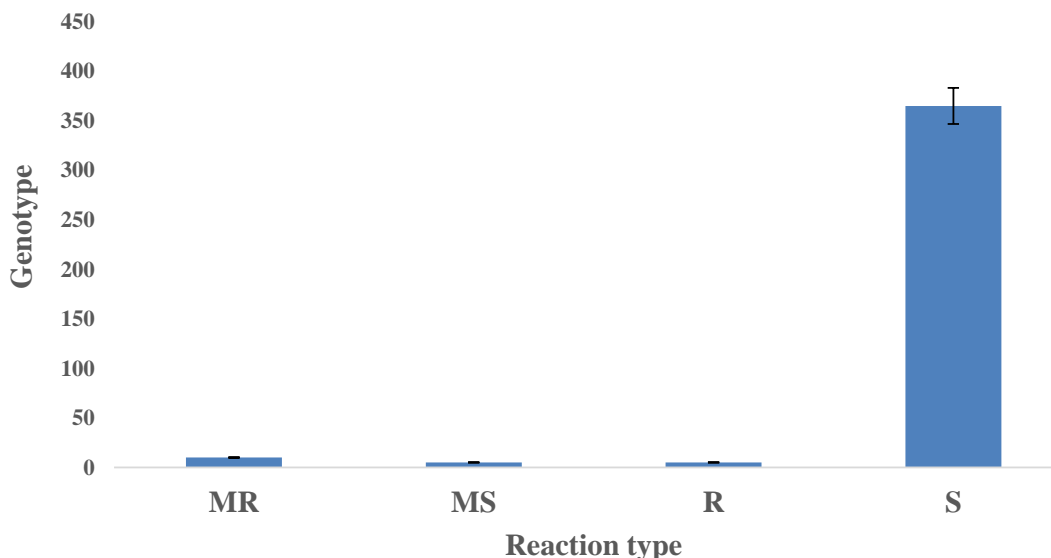


Figure 1. Reaction level of desi type of chickpea genotypes to fusarium wilt incidence. R= Resistant; MR= Moderately resistant; MS= Moderately susceptible; S= susceptible; HS= Highly susceptible.

In Ethiopia, about 30% yield loss of chickpea due to chickpea wilt has been reported (Meki et al., 2008). This pathogen can cause infection at all stages of plant growth with more incidences in flowering and podding stage (Maitlo et al., 2014). It is one of the major soil and seed borne disease of chickpea worldwide (Jalali and Chand, 1992). The most efficient method for the management of disease is using resistant cultivars (Karimi et al., 2012). To control these diseases, host plant resistance mechanism should be exploited and the sources of resistance in existing chickpea germplasm identified (Bakhsh et al., 2007; Duzdemir et al., 2014; Tariq et al., 2015). However, the problem is that the resistance mechanism is not stable, due to the introduction of new pathotypes/isolates. Considering the nature of damage and survival ability of the pathogen, use of resistant varieties is only economical and practical solution. Most of the resistant varieties have been found to be susceptible after some years, because of breakdown of their resistance due to evolution of variability in the pathogen (Arunodhayam et al., 2014). However, evolution of new races poses a serious threat to deployment of wilt resistance in chickpea. Wilt/root rot is more severe on sandy soil and less severe on clay loam soil. Therefore, there is continuous need to screen new source of germplasm and find further durable resistance source and slow wilting genotypes. The present study identifies the chickpea genetic source of resistance to fusarium wilt.

MATERIALS AND METHODS

The experiment was conducted in Debre Zeit sick plot which is

artificially infested field in 2017/2018 main cropping season. A wilt sick plot was prepared with a mixture of isolates representing different chickpea growing areas. A total of 427 chickpea germplasms were grouped in two chickpea type which is desi type (385) received from Ethiopian Bio-diversity Institute (EBI) and kabuli (42) genotypes introduced from International Center for Agricultural Research in the Dry Areas (ICARDA) for their reaction to Fusarium wilt disease. The design was an augmented design without replication. Each genotype was planted in a 2 m plot. Row to row and plant to plant distances were maintained at 30 cm and 10 cm, respectively. A highly wilt susceptible genotype, JG-62, was repeatedly planted after every two test entries. The disease incidences were assessed at different growth stage three times and the genotypes were graded as per ICRISAT rating scale that is Resistant (R) = 0-10% mortality; moderately resistant (MR) = 10.1-20% mortality; moderately susceptible (MS) = 20.1-30% mortality; Susceptible (S) = 30.1-50% mortality; and highly susceptible (HS) above 50% mortality.

RESULTS AND DISCUSSION

In the present screening test, 385 lines were executed; five were resistant, ten were moderately resistant, five were moderately susceptible and three hundred and sixty five were susceptible to fusarium wilt. The resistant accessions were lines 41016, 41276, 41177, 41046 and 41227 (Figure 1). Govil and Rana (1984) evaluated 239 cultivars representing a range of variability among Indian and Iranian germplasm in wilt sick plot for years, which is consistent with the findings on desi type of chickpea accessions. None was found to be immune, but maximum resistance was shown by Indian cultivars such as P-597, P-621, P-3649, P4128 and P-4245. The resistance source of Fusarium wilt in chickpea germplasm is not uncommon and a number of other workers have also reported the occurrence against high

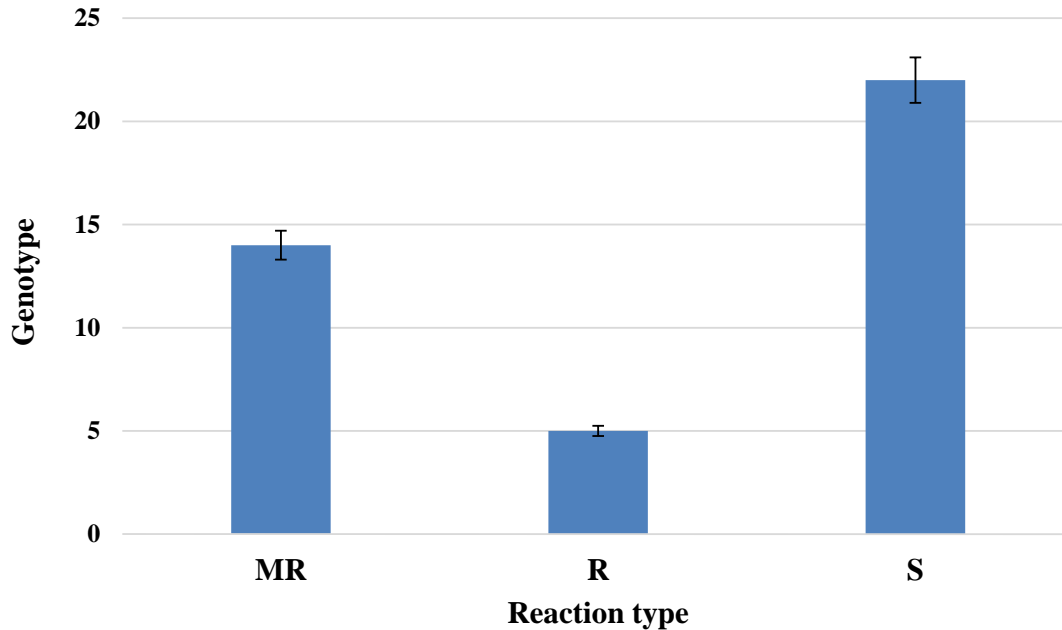


Figure 2. Reaction level of kabuli type of chickpea genotypes to fusarium wilt incidence. R= Resistant; MR= Moderately resistant; MS= Moderately susceptible; S= susceptible; HS= Highly susceptible.

level of resistance of Fusarium wilt (Iqbal et al., 1993; Iftikhar et al., 1997; Chaudhry et al., 2006, 2007). Iqbal et al. (2005) also report the sources of resistance against wilt/root rot in chickpea germplasm originating from national and international research institutes. The results are also consistent with those reported by Nazir et al. (2012) who screened 178 chickpea lines against fusarium wilt and observed that none of the test lines is immune.

The resistances were related to plant age and growth stage which is a vital source of parental materials to identify slow wilting type. Development of disease is slow in resistant lines and fast in susceptible lines. As the resistant lines at reproductive stage also became susceptible, field screening at reproductive stage seems to be more reliable (Muhammad et al., 2010).

Zote et al. (1986) reported that only five chickpea lines out of 15 tested for three successive years showed less than 10% wilt incidence. Similar earlier findings have also been reported by several workers from India (Nene et al., 1981; Haware et al., 1992; Reddy et al., 1991). Most of lines experienced early wilting than late wilting type.

Tullu (1996) reported variation in chickpea for wilting time. He also reported a genotype that was consistently and uniformly resistant, the use of these resistance genotypes as donors for disease resistance in breeding program and further study on their mode of inheritance.

However, in kabuli type of chickpea, it was observed that 5 genotypes were resistant, 14 genotypes were moderately resistant, while 22 were susceptible to the wilt disease (Figure 2). Among these resistant sources are FLIP-10-106C, FLIP-10-63C, FLIP-10-253C, FLIP-10-

107C and FLIP-10-136C. According to Korde (2011), Mandhare et al. (2011) and Kumar et al. (2012) have screened a number of chickpea genotypes and identified promising genotypes, which are in line with these findings on chickpea kabuli types. Similarly, Iqbal et al. (2005) screened 145 chickpea genotypes against *F. oxysporum* f.sp *ciceris* and found that no one was resistant at reproductive stage, but 14 were resistant at seedling stage. Sarwar et al. (2012) evaluated 41 chickpea cultivars and observed that only 2 were highly resistant and 8 were resistant. The resistance source of Fusarium wilt in chickpea germplasm is not uncommon and a number of other workers have also reported the occurrence against high level of resistance of Fusarium wilt (Zote et al. 1983; Iqbal et al., 1993; Iftikhar et al., 1997; Chaudhry et al., 2006; Chaudhry et al., 2007). The findings of the research are in accordance with Bajwa et al. (2000) found that out of 32 genotypes, only one line was resistant, 4 lines were moderately resistant, and 27 were susceptible. Iqbal et al. (2005) also report the sources of resistance against wilt/root rot in chickpea germplasm originating from national and international research institutes. On the other hand, the genotypes that showed resistance are most suitable for exploitation in breeding programs or for direct sowing in wilt prone areas. Prior to such transfer of their resistance to a commercial cultivar, the genetic basis of resistance (vertical or horizontal) must be determined against the virulences of *F. oxysporum* f. sp. *ciceris*. The disease-free, resistant lines and moderately resistant can be utilized in resistant breeding programme towards

incorporations of resistant genes in releasing cultivars or hybrids.

CONCLUSION AND RECOMMENDATION

Fusarium wilt is one the most destructive vascular disease of chickpea. In the present study, desi type of chickpea genotypes has low source of variability among different collections of land races and most lines experience early wilting type, which makes it difficult to identify slow wilting type of lines. The kabuli type of chickpea is more resistant to fusarium wilt and consistence in their reaction response. Results from the present study reveals that considerable variations were resistant in both desi and kabulit type of chickpea against fusarium wilt diseases. Kabuli germplasm proved to be a better source of resistance compared to the desi material. Besides cultivar variability, there is pathogen evolution that resulted in race variability in fusarium wilt and the resistant line will be evaluated further for their yield potential. On the other hand, the genotypes that showed resistance are most suitable for exploitation in breeding programs or for direct sowing in wilt prone areas. Thus, that consistently resistant line will be used as donors of disease resistance source in breeding programs. Resistance genotypes are used as donors of disease resistance in breeding program and further study on their mode of inheritance. Continuous mass screening genotypes under field and pot will be suggested as a result of break source resistance and phenotyping of major races in major chickpea growing regions. Although little information on the mechanism of resistance is available, a detailed research based on this material is needed to throw light on it.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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REFERENCES

Arunodhayam K, Reddy NPE, Madhuri B (2014). Pathogenicity and management of Fusarium wilt of chickpea, *Cicer arietinum* L.- A review. *Current Biotica* 7(4):343-358.
Asrat Z, Tolesa B (2018). Evaluation of improved chickpea varieties for

resistance to Fusarium wilt (*Fusarium oxysporum*) under field condition in sick plot. *African Journal of Agricultural Research* 13(52):2930-2935.
Bakhsh A, Iqbal SM, Haq IK (2007). Evolution of chickpea germplasm for wilt resistance. *Pakistan Journal of Botany* 39(2):583-593.
Bajwa KM, Khan IA, Alam SS, Ahmad I, Gill MA (2000). Screening against phytotoxins for resistance to Fusarium wilt. *Pakistan Journal of Phytopathology* 12:66-70.
Chaudhry MA, Muhammad F, Afzal M (2006). Screening of chickpea germplasm against fusarium wilt. *Journal of Agricultural Research* 44:307-312.
Chaudhry MA, Ilyas MB, Muhammad F, Ghazanfar MU (2007). Sources of resistance in chickpea germplasm against fusarium wilt. *Mycopathology* 5(1):17-21.
Duzdemir O, Selvi B, Yanar Y, Yildirim A (2014). Sources of resistance in chickpea (*Cicer arietinum* L.) land races against *Ascochyta rabiei* causal agent of Ascochyta blight disease. *Pakistan Journal of Botany* 46(4):1479-1483.
Haware MP, Nene YL (1980). Sources of resistance to wilt and root rots of chickpea. *International Chickpea Newsletter* 3:11-12.
Haware MP, Pundir RPS, Narayana RJ (1992). Screening of world chickpea germplasm for resistance to fusarium wilt. *Field Crop Sciences* 30:147-154.
Govil JN, Rana BS (1984). Stability of host plant resistance to wilt (*Fusarium oxysporum* f.sp. *ciceris*) in chickpea. *International Journal of Tropical Plant Disease* 2(1):55-60.
Iftikhar K, Kahlid T, Ilyas MB (1997). Field screening of chickpea germplasm for the sources of resistance against Fusarium wilt. *Pakistan Journal of Phytopathology* 9(1):31-33.
Iqbal MJ, Iftikhar K, Ilyas MB (1993). Evaluation of chickpea germplasm for resistance against wilt disease (*Fusarium oxysporum*). *Journal of Agricultural Research* 31(4):449- 453.
Iqbal SM, Haq IU, Bukhari A, Ghafoor A, Haqqani AM (2005). Screening of chickpea genotypes for resistance against Fusarium wilt. *Mycopathology* 3(1-2):1-5.
Jalali BL, Chand H (1992). Chickpea wilt. *In Plant Diseases of International Importance. Diseases of Cereals and Pulses*. US Singh, AN Mukhopadhyay, J Kumar, HS Chaube (eds). Prentice Hall, Englewood Cliffs, pp. 429-444.
Karimi K, Amini J, Harighi B, Bahramnejad B (2012). Evaluation of bio control potential of *Pseudomonas* and *Bacillus* spp. against Fusarium wilt of chickpea. *Australian Journal of Crop Science* 6(4):695-703
Khilare VC, Ahmed R, Chavan SS, Kohire OD (2009). Management of *Fusarium oxysporum* f. sp. *ciceris* by different fungicides. *Bioinfolet* 6:4143.
Korde MG (2011). Studies on Fusarium wilt of chickpea caused by *Fusarium oxysporum* f. sp. *ciceris* (Padwik) Synder and Hansan. M. Sc. (Agri.) thesis submitted to VNMKV, Parbhani (India).
Kumar A, Lal HC, Akhtar J (2012). Morphological and pathogenic characterization of *Fusarium oxysporum* f. sp. *ciceris* causing wilt of chickpea. *Indian Phytopathology* 65(1):64-66.
Maitlo SA, Syed RN, Rustamani A, Khuhro RD, Lodhi AM (2014). Comparative efficacy of different fungicides against fusarium wilt of chickpea (*Cicer arietinum*.) *Pakistan Journal Botany* 46(6):2305-2312.
Mandhare VK, Deshmukh GP, Patil JV, Kale AA, Chavan UD (2011). Morphological, pathogenic and molecular characterization of *Fusarium oxysporum* f. sp. *ciceris* isolates from Maharashtra, India. *Indonesian Journal of Agricultural Sciences* 12(2):904.
Meki S, Seid A, Parshotam KS (2008). Pathogenic variability in Ethiopian isolates of *Fusarium oxysporum* f. sp. *ciceris* and reaction of chickpea improved varieties to the isolates. *International Journal of Pest Management* 54(2):143-149.
Muhammad AA, Sheikh MI, Najma A, Yasmin A, Abida A (2010). Identification of Resistance Sources in Chickpea against Fusarium Wilt. *Pakistan Journal of Botany* 42(1):417-426.
Navas-Cortes JA, Hau B, Jimenez-Diaz RM (2000). Yield loss in chickpeas in relation to development of Fusarium wilt epidemics. *Phytopathology* 90:1269-1278.
Nazir MA, Khan MA, Ali S (2012). Evaluation of national and international chickpea germplasm for resistance against Fusarium

- wilt (*Fusarium oxysporum* f. sp. *ciceris*) in Pakistan. Pakistan Journal of Phytopathology 24:149-151.
- Nene YL, Reddy MV, Pundir RPS (1981). Sources of resistance to selected chickpea diseases. ICRIASAT Pulses Pathology Progress Report No.15, ICRIASAT, Patancheru.
- Reddy MV, Raju, TN, Nene YL (1991). Evaluation of chickpea lines in all India coordinator varietal trials for wilt and root rots resistance. ICN 23:22.
- Sarwar N, Akhtar KP, Shah TM, Atta BM (2012). Evaluation of chickpea advance genotypes against blight and wilt diseases under field conditions. International Journal Agricultural Biology 14:993-996.
- Shivalingappa H, Jayalakshmi SK, Suhas PD (2018). Screening for resistant sources in chickpea entries against Fusarium wilt. Journal of Pharmacognosy and Phytochemistry 7(5):663-665.
- Sharma KD, Chen W, Muehlbauer FJ (2005). Genetics of chickpea resistance to five races of *Fusarium* wilt and a concise set of race differentials for *Fusarium oxysporum* f. sp. *ciceris*. Plant Disease 89:385-390.
- Tariq MS, Muhammad I, Babar MA, Muhammad S, Muhammad A, Khalid H (2015). Screening of chickpea advanced lines for sources of resistance against blight and wilt two major diseases of chickpea. Pakistan Journal of Botany 47(6):2443-2448.
- Thaware DS, Gholve VM, Ghante PH (2016). Screening of Chickpea Varieties. Cultivars and Genotypes against *Fusarium oxysporum* f. sp. *ciceris*. International Journal of Current Microbiology and Applied Sciences 5(12): 896-904.
- Tullu A (1996). Genetics of fusarium wilt resistance in chickpea. Ph.D. dissertation. Crop and Soil Science Department, Washington State University, Pullman, WA, USA.
- Zote KK, Khalikar PV, Dandnaik BP (1983). Source of resistance to chickpea wilt. International Chickpea Newsletter. Pant Pathology 63(5):20-95.
- Zote KK, Khalikar, PV, Dandnaik BP (1986). Reactions of chickpea varieties to Fusarium wilt. Indian Journal of Mycology and Plant Pathology 16(1):80-81