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SCREENING OF CHICKPEA GENOTYPES AGAINST DRY ROOT ROT CAUSED BY *MACROPHOMINA PHASEOLINA* (TASSI) GOID

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ABSTRACT
In the present study, Chickpea entries were screened against dry root rot disease in sick plot maintained at All India Co-ordinated Research project on chickpea, Bengaluru during *Rabi*, 2011-12. Only thirteen entries *viz.*, GNG 1958 (AVT-2), GNG 1999, CSJ 303, BG 3004, CSJ 753, RSG 888, Phule G 04305, IPCK 07-62, RVSSG 12, HK 08-212, Phule G 09305, AKG 2002-1K and ICCV 08317 showed resistant reactions under field condition. The dry root rot fungus has a wide host range can infect several crops. It is difficult to manage by chemicals. Management can be made feasible and cost effective by identification of new resistant sources that is the only alternative method. Investigation attempt has been made to find out the resistance sources for dry root rot will be useful for control disease in future.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the world's third most important pulse crop, after dry beans (*Phaseolus vulgaris* L.) and field pea (*Pisum sativum* L.). It is one of the most important pulse crops of India. It is cultivated in about 8.56 million hectares with a production of 7.35 million tonnes and productivity 858 kg per hectare (Anonymous 2010). Occurrence of root rot disease in chickpea has become a major constraint for cultivation of chickpea (Dhingani *et al.,* 2013). Dry root rot of chickpea caused by nectrotropic fungus *Macrophomina phaseolina* is emerging as a serious threat to the chickpea production worldwide (Pande and Sharma, 2010). (Bagri *et al.,* 2004) observed that Chickpea suffers from seed and soil borne fungal diseases *viz*, black root rot, dry root rot, wet root rot, seed rotting, root rot, stem rot, crown rot, foot rot, sclerotinia wilt and gray mould. Amongst these diseases, dry root rot has been reported to cause severe losses right from seedling to maturity of the crop. It has a wide host range and is responsible for causing losses on more than 500 cultivated and wild plant species (Khan, 2007). Dry root rot generally appears during late flowering and podding stage. Affected plants showed various types of symptoms *viz.*, yellowing, drooping, drying and shredding of leaves, the root system of infected plant showed dark and extensive rotting. Roots became brittle and bark was peeled off easily lateral roots were destroyed. The diseased plants could be very easily pulled out from the soil and showed discoloration of roots by presence of black colored micro sclerotia on roots. Chemical control of dry root rot is not effective has a broad host range and survives in soil for longer periods in the form of sclerotia. The scleratia can survive up to 10 months even in the absence of the host plants and under prevailing dry soil conditions (Pande *et al.,* 2004). Mishra *et al*. (2005) have tested 470 germplasm lines are found KG-86 KWR-4, KWR-108 and KWR-277 as a resistant genotype. Chaturvedi and Dua (2009) have reported 25 resistant cultivars including KPG-59, Radhey and K-50 against dry root rot. Aghakhani *et al*. (2009) twenty – three isolates of *R. bataticola* causing dry root rot of chickpea (*Cicer arietinum* collected from 10 different major chickpea growing states of India were highly variable in their morphological and cultural characters as well as pathogenicity /virulence. The virulence analysis of the isolates on a set of chickpea cultivars namely ICC12441, ICC1224, ICC12450, Pusa 362, BGD112, Pusa1103, Pusa212, Pusa1088 and under blotter paper as well as sick soil. The most virulent isolate (RBI from Bangalore, Karnataka) was fast growing and produced largest Sclerotia. A set of cultivars was proposed for the first time for differentiating the pathotypes of *R. bataticola* causing dry root rot of chickpea. Use of host plant resistance is the most economical approach for management of dry root in chickpea. The present investigations were undertaken it is difficult to manage by chemicals, management can be made feasible and cost effective by identification of new resistant sources that is the only alternative method.

MATERIALS AND METHODS

The present investigation was conducted at the Agricultural Research Station, G.K.V.K., Bengaluru, during *Rabi* season of 2011-2012. Screened separately in field for host plant resistance for dry root rot in sick plot conditions. One hundred ninety two genotypes of desi and Kabuli, supplied by IIPR

Kanpur, seventeen genotypes of local germplasm and thirty seven chickpea ICRISAT entries supplied by CWRRN Patancheru Hyderbad, The field experiments were laid out in a randomized block design with two replications. Each genotype was sown in five meter row length. After every five test entries one line of susceptible check A1, L 550 and BG 212 were sown. Observations on per cent dry root rot incidence were recorded from pod formation to maturity stage. The following formula used to calculate dry root rot disease incidence. After estimating disease incidence, the entries were categorized into different disease reactions as mentioned below.

$$\% \text{ disease incidence} = \frac{\text{No. of plants infected}}{\text{Total no. of plants}} \times 100$$

Categorization of chickpea genotypes into different disease reactions used the ICRIP scale.

Reaction	Dry root rot incidence
Resistant	0 - 10
Moderately resistant	11 - 20
Moderately susceptible	21 - 30
Susceptible	31 - 50
Highly susceptible	51-100

Blotter paper technique

One hundred ninety two genotypes of desi and Kabuli, supplied by IIPR Kanpur and seventeen genotypes of local germplasm along with susceptible checks A1, L 550 and BG 212 were screened separately under blotter paper method for host plant resistance for dry root rot by the following procedure.

The fungus was cultured on PDB. 250 ml of PDB was poured into 500 ml conical flasks and sterilized. The flasks were then inoculated and incubated for seven days. The mycelial mat from the flask was removed and macerated in a waring blender along with distilled water for a minute. The inoculum was later collected in a beaker. In the mean time, the chickpea seedlings were raised in polythene bags containing sterilized sand mixed soil. One week old seedlings were uprooted and the roots were immersed in sterile water in order to remove the adhered soil particles. The seedlings were then immersed completely in the inoculum in a beaker for a minute. The seedlings particularly the root portion were then placed side by side on a blotter paper (45 cm × 25 cm with one fold); in such a way that only the cotyledons and roots are covered and the green tops of seedlings remained outside and then blotter paper was folded. The folded blotter paper were then placed in trays, and kept in an incubator at 35° C for eight days provide 12- hr artificial light, the blotters were moistened with sterile water every day. At the end of the incubation period, the seedlings were examined for the extent of root damage. One folder blotter paper will have seedlings of one test line and along with susceptible check. Keep folded blotter one on top of the others, in heaps of ten in a tray. One of these ten blotters should have the seedlings of susceptible check. At the end of the incubation period (8 days), examine the seedlings for the extent of root damage, and score for the disease, the dry root rot severity was scored on a 1-9 rating scale on the 8th day after inoculation. (Nene *et al.,* 1981) Fifteen seedlings of each accession were considered as one replication, Based on the disease score the genotypes were grouped into different reactions as mentioned.

Categorization of chickpea genotypes into different disease ratings and categories. Rating scale used for disease scoring (1-9)

Rating	Category	Symptoms
1	Resistant	No infection on roots
3	Moderately resistant	Very few small lesions on roots
5	Moderately susceptible	Lesions on roots clear but small, new roots free from infection
7	Susceptible	Lesions on roots many, new roots generally free from lesions
9	Highly susceptible	Roots infected and completely discolored

Categorization of chickpea genotypes into different disease ratings and categories. Rating scale used for disease scoring (1-9)

RESULTS AND DISCUSSION

Field screening

Different chickpea entries were screened for dry root rot disease in dry root rot sick plot maintained at All India Co-ordinated Research project on chickpea, Bengaluru during Rabi, 2011-12. Among one hundred and one desi entries screened for dry root rot, six entries *viz.*, GNG 1958 (AVT-2), GNG 1999, CSJ 303, BG 3004, CSJ 753 and RSG 888 showed resistant reactions with 0-10 per cent disease incidence, whereas thirteen entries *viz.*, GL 27104, GNG 1581, JG 24, RVSSG 10, GNG 2065, H 08-18, IPC 06-127, JG 27, JG 14, H 08-75, GNG 1996, Phule G 09103 and BG 3029 showed moderately resistant reactions, remaining twenty three entries showed moderately susceptible reaction, forty three entries showed susceptible reaction and sixteen entries were showed highly susceptible reactions (Table 1, Plate 1 and 2)

Among sixty four entries screened for dry root rot, six entries *viz.*, Phule G 04305, IPCK 07-62, RVSSG 12, HK 08-212,

Plate 1: Multiplication of *Macrophomina phaseolina* in different substrate

Table 1: Reaction of desi entries for dry root rot under sick plot condition

Reaction	Entries	No. of entries
Resistant (0-10%)	GNG 1958 (AVT-2), GNG 1999, CSJ 303 , BG 3004, CSJ 753, RSG 888	6
Moderately resistant (11-20 %)	GL 27104, GNG 1581, JG 24, RVSSG 10, GNG 2065, H 08-18, IPC 06-127, JG 27, JG 14, H 08-75, GNG 1996, Phule G 09103, BG 3029	13
Moderately susceptible (21-30%)	GJG 0809, PBG 5, GL 26054, BGD 1068, GJG 0906, GJG 0809, IPC 08-11, JG 23, BGD 1071, CSJ 697, H 08-25, JG 28, GNG 2066, PG 0101, IPC 2006-84, BG 3031, GNG 2081, RSG 888, RSG 931, Vijay, GJG 0814, BG 3030, RSG 931	23
Susceptible (31-50%)	BG212, NBeG 49, Phule G 07102, GNG 1936, GL 27091, H 07-163, GNG 469, BG 3024, BDNG 2010-1, PG 0105, Phule G 0204-4, CSJ 0564, GNG 2064, AKG 1001, GNG 1991, GNG 1995, Phule G 0204-16, GJG 0922, P 57, Phule G 06102, NDG 1105, IPC 07-56, RVSSG 8, BGD 1072, IPC 2006-77, RSG 963, BGM 572, GJG 0910, BGM 572, BCP 60, CSJ 730, JG 25, CSJ 513, JG 26, H 08-93, GJG 0904, BGD 1069, GJG 0825, H 08-71, GNG 2068, GNG 2085, IPC 07-09, BGD 1061	43
Highly susceptible (51-100%)	BG 3013, Phule G 0215-2, RVSSG 9, GJG 0907, CSJ 313, BG 3023, IPC 07-19, H 08-13, RSG 963, BG 3032, CSJ 515, BGD 1070, GNG 2002, IPC 08-68, A1, L550	16
Total No. of genotypes		101

Table 2: Reaction of Kabuli entries for dry root rot under sick plot conditions

Reaction	Entries	No. of entries
Resistant (0-10%)	Phule G 04305, IPCK 07-62, RVSSG 12, HK 08-212, Phule G 09305, AKG 2002-1K	6
Moderately resistant (11-20 %)	HK 94-134, GNG 1888, HK 06-152, GNG 2112, HK 06-171, Phule G 09316, CSJK 74, JGK 13, CSJK 70	9
Moderately susceptible (21-30%)	CSJK 6, Phule G 0027, JGK 2003-304, JGK 1, CSJK 6, GNG 2034, IPCK 06-56, Phule G 09311, GLK 26167, JGK 19	10
Susceptible (31-50%)	JGK 2005-301, CSJK-1, GNG 1969, GLK 26155, SC-RS-1, IPCK 113, IPCK 06-78, GNG 1969, Vihar, HK 08-231, CSJK 68, BG 3025, RVSSG 11, CSJK 54, GNG 2104, GNG 2047, IPC 06-143, HK 06-163, GLK 28127, Kripa (Phule G 0517), JGK 17, IPCK 08-136, BG 3012, HK 08-206, Vihar (Phule G 95311), IPCK 08-120, JGK 18, CSJK 72, JGK 16, IPCK 08-130, Kripa (Phule G 0517), BG212	32
Highly susceptible (51-100%)	HK 07-234, CSJK 42, GLK 26162, CSJK 66, BG 3027, A1, L550	7
Total No. of genotypes		64

Table 3: Reaction of local germplasm for dry root rot under sick plot conditions

Reaction	Entries	No. of entries
Resistant (0-10%)	-	-
Moderately resistant (11-20%)	-	-
Moderately susceptible (21-30%)	HIR 60	1
Susceptible (31-50%)	BBG1, BBG2, BG256, Vishal, HIR 70, HIR 55, PG 95111, KAK 2, JOCKY 9218, K 850, JG11, BG 212	12

Table 4: Reaction chickpea CWRRN entries for dry root rot under sick plot condition

Reaction	Entries	No. of entries
Resistant (0-10%)	ICCV 08317	1
Moderately resistant(11-20 %)	ICCV 04514, ICCV 4951, ICCV 08315, ICCV 08125, ICCV 08310, ICCV 07111, ICCV4951	7
Moderately susceptible (21-30%)	ICCV 07311, ICCV 1132, ICCV 07107, ICCV 07105, ICCV 4951, ICCV 08321, ICCV 07309, ICCV 07306, ICCV 08311, ICCV 08305, ICCV 08116, ICCV 08124	12
Susceptible (31-50%)	ICCV 98505, ICCV 08113, ICCV 4951, ICCV 07135, ICCV 08123, ICCV 08120, ICCV 08323, ICCV 08319, ICCV 5003, ICCV 08117, ICCV 93706, ICCV 07118, ICCV 07305, A1, BG212,	15
Highly susceptible(51-100%)	ICCV 96854, L550	2
Total No. of genotypes		37

Phule G 09305 and AKG 2002-1K showed resistant reactions with 0-10 per cent disease incidence, nine entries *viz*., HK 94-134, GNG 1888, HK 06-152, GNG 2112, HK 06-171, Phule G 09316, CSJK 74, JGK 13 and CSJK 70 showed moderately resistant reactions with 11-20 per cent disease incidence, ten entries showed moderately susceptible reaction, thirty two entries were showed susceptible reaction and seven entries showed highly susceptible reaction (Table 2).

Among seventeen entries screened for dry root rot, none were showed resistant and moderately resistant reaction, only one entry HIR 60 showed moderately susceptible reaction with 21-30 per cent disease incidence, twelve entries showed

Plate 2: General view of screening plot

Seedlings inoculations

Incubation chamber

Plate 3. Screening of chickpea genotypes by blotter paper technique

Table 5: Reaction of desi entries for dry root rot under blotter paper method

Reaction	Entries	No. of entries
Resistant	-	-
Moderately resistant	-	-
Moderately susceptible	GNG 1958 (AVT-2), GL 27104, GNG 1581, GNG 1991, CSJ 753, GJG 0910, GJG 0825, RSG 888	8
Susceptible	NBeG 49, GJG 0809, Phule G 07102, BG 3013, PBG 5, GNG 1936, GL 27091, H 07-163, GNG 469, GL 26054, GNG 1999, BG 3024, JG 24, RVSSG 9, CSJ 313, GNG 2065, Phule G 0204-4, GJG 0906, CSJ 0564, GNG 2064, GJG 0809, H 08-13, BG 3004, IPC 08-11, RSG 963, GNG 1995, Phule G 0204-16, CSJ 697, H 08-25, JG 28, GNG 2066, JG 27, IPC 07-56, PG 0101, IPC 2006-84, BGD 1072, GNG 2081, RSG 888, CSJ 515, RSG 931, GNG 1996, Vijay, BGM 572, GJG 0814, CSJ 513, H 08-93, BG 3030, GJG 0904, BGD 1069, RSG 931, GNG 2002, H 08-71, GNG 2068, BG 3029, GNG 2085, A1, BG 212	57
Highly susceptible	BDNG 2010-1, Phule G 0215-2, BG 3023, CSJ 303, AKG 1001, IPC 07-19, BG 3032, GJG 0922, Phule G 06102, IPC 06-127, NDG 1105, IPC 2006-77, RSG 963, H 08-75, BG 3031, CSJ 730, JG 25, JG 26, IPC 08-68, Phule G 09103, BGD 1061, L550	22
Total No. of genotypes		87

Table 6: Reaction of Kabuli entries for dry root rot under blotter method

Reaction	Entries	No. of entries
Resistant	-	-
Moderately resistant	-	-
Moderately susceptible	JGK 2005-301, JGK 2003-304, GNG 1969, SC-RS-1, HK 94-134, IPCK 113, JGK 1, HK 07-234, Phule G 04305, IPCK 06-78, CSJK 42, GNG 2034, IPCK 06-56, GNG 1969, HK 06-152, Phule G 09316, GLK 28127, Kripa (Phule G 0517), J GK 13, Kripa (Phule G 0517), CSJK 66, JGK 19, BG 3027	23
Susceptible	CSJK 6, Phule G 0027, CSJK-1, GLK 26155, GNG 1888, CSJK 6, GLK 26162, HK 08-231, CSJK 68, RVSSG 11, GNG 2112, IPCK 07-62, CSJK 54, HK 08-212, GNG 2047, IPC 06-143, HK 06-163, GLK 26167, Phule G 09305, JGK 17, IPCK 08-136, BG 3012, HK 08-206, Vihar (Phule G 95311), JGK 18, AKG 2002-1K, JGK 16, IPCK 08-130, A1, BG 212	30
Highly susceptible	Vihar, GNG 2104, CSJK 74, IPCK 08-120, CSJK 72, CSJK 70, L550	7
Total No. of genotypes		61

Table 7: Reaction of local germplasm for dry root rot under blotter method

Reaction	Entries	No. of entries
Resistant	-	-
Moderately resistant	-	-
Moderately susceptible	-	-
Susceptible	BBG1, BBG3, Vishal, HIR55, PG 95111, HIR60, K850, WR315, BG212, A1	10
Highly susceptible	BBG2, BG256, HIR70, KAK2, JOCKY 9218, JG11, L550	7
Total no. of genotypes		17

Plate 4: Dry root rot disease reaction under blotter paper technique

susceptible reactions with 31-50 per cent disease incidence and four entries showed highly susceptible reaction with 51-100 per cent disease incidence (Table 3).

Out of thirty seven entries screened for dry root rot only one entries ICCV 08317 showed resistant reaction with 0-10 per cent disease incidence, seven entries *viz*., ICCV 04514, ICCV 4951, ICCV 08315, ICCV 08125, ICCV 08310, ICCV 07111 and ICCV 4951 showed moderately resistant reactions with 11-20 per cent disease incidence, twelve entries showed moderately susceptible reaction with 21-30 per cent disease incidence, fifteen entries showed susceptible reaction with 31-50 per cent disease incidence and two entries *viz*., ICCV 96854 and L 550 showed highly susceptible reaction with 51-100 per cent disease incidence (Table 4).

The present findings are well supported by the field screening. Similarly Muhammad Saifulla *et al*. (2011) screened chickpea dry root rot pathogen under field condition found, out of 196 found 21 entries *viz*., GNG 1861, Phule G07112, BGD1056(R), RSG 931, PhuleG 07101, Vijay, RSG 888 ,GJG 0825, PG064, GNG 1947, JG 1307, GBC 6 (AVT-1), GNG 2002, GNG 1936, CSJ 313, JG 18, HIR 60 and JG 11, ICCV 07107 and ICCV 08323 were resistant and 36 entries were found moderately resistant to dry root rot disease of chickpea.

Out of sixty germplasm lines screened only nine lines namely, KGD-1189, KGD-1201, KGD-1209, KGD-1215, KGD-1217, KGD-1220, KGD-1221, KGD-1248 and KGD-1289, were found resistant. Ten lines namely KWR-7, KWR-26, KWR-28, KWR-50, KGR-18, KGR-48, KGR-159, KKG-103, KKG-111 and KGD-1201 were found moderately resistant (Riyaz Ahmad Khan *et al*., 2013). (Mayek-Perez *et al*., 2002; Gangwar *et al*, 2002; Om G. and Anitha, B. (2006) and Al Shareef *et al*., 2009)

Blotter paper method

Among eighty seven desi entries screened against dry root rot, none of the entries were showed resistant reaction and moderate resistant reaction, eight entries *viz*., GNG 1958 (AVT-2), GL 27104, GNG 1581, GNG 1991, CSJ 753, GJG 0910, GJG 0825 and RSG 888 showed moderately susceptible reaction, whereas fifty seven entries showed susceptible reaction and twenty two entries showed highly susceptible reactions (Table 5) (Plate 3 and 4).

Out of sixty one genotypes screened for dry root rot, none of entries showed resistant reaction and moderate resistant reaction, twenty three entries showed moderately susceptible reaction, thirty entries showed susceptible reaction and seven entries *viz*., Vihar, GNG 2104, CSJK 74, IPCK 08-120, CSJK 72, CSJK 70 and L550 showed highly susceptible reactions (Table 6).

Out of seventeen entries screened for dry root rot in, none of entries showed resistant reaction and ten entries showed susceptible reaction and seven entries showed highly susceptible reaction (Table 7).

Om G., Rathi, M. and Mishra, M. (2012) screened 170 genotypes for dry root rot at JNKVV, Jabalpur during the year 2007-10 under blotter paper method. 68 genotypes exhibited resistant reaction (<10% mortality), out of which 26 are the promising lines namely JG 1–14, 2–125, 2-4-110, 14–11, 14–10, 2001–13, 2001–13, 2001–18, 2001–80, 2001-115, 2002–20, 2003–95, 2003-14-16, 2004-110, 210, 9605, 1–9, 99–115, 2001–04, 2003-14-2, JG 2000–07, JSC 37, MPJG 89–11551, MPJG 89–9023, CSJ 592 and Rajas. These lines further evaluated for their performance in sick field for three consecutive years and revealed six lines *viz*., JG 2000-07, JSC 37, MPJG 89–11551, MPJG 89–9023, CSJ 592 and Rajas as resistant exhibiting <10 per cent mortality.

Out of 47 lines screened against dry root rot of chickpea under

blotter paper method, 3 genotypes showed resistant, 22 were moderately resistant, 19 where susceptible and 3 were highly susceptible Pande *et al*. (2004).

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