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Multiple disease resistance — a solution for encouraging chickpea (*Cicer arietinum*) cultivation in various climatic zones in India

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ABSTRACT

A study was conducted during 2001–06 at Ludhiana, to evaluate 2 250 chickpea (*Cicer arietinum* L.) genotypes for Fusarium wilt, Dry root rot (DRR), Foot rot, Ascochyta blight and Botrytis gray mold resistance. Over the years increase in resistance for Fusarium wilt was from 6.6 to 19.3%, for Dry root rot 10.4 to 17.4%, for Foot rot 10.9 to 12.0% in *desi*; from 7.6 to 4.7% for Fusarium wilt, 7.6 to 12.6% for Dry root rot and 7.6 to 8.0% for Foot rot in *kabuli* AICRP genotypes. Whereas for Ascochyta blight, increase was from 2.7 to 6.9% in *desi* but workable resistance was identified in *kabuli* from AICRP chickpea material. This increase in PAU material for *desi* genotypes was from 35.1 to 68.2% for Fusarium wilt, 53.7 to 85% for Dry root rot and 53.7 to 60% for Foot rot; for *kabuli* this increase varied from 57.8 to 46% for Fusarium wilt, 63.1 to 54% for Dry root rot and 68.4 to 66.4% for Foot rot. However, for Ascochyta blight resistance increased from 2.7 to 11.1 in *desi* and remained between 3.5 and 5.2% in *kabuli*. Seventy genotypes were found promising to Fusarium wilt, Dry root rot and Foot rot as these were either immune or showed less than 5% wilting/rotting. 'GL90168', 'GL91137', 'GL92015', 'GL88341' and 'PGL167' were free from root wilt/rotting diseases and resistant to Ascochyta blight. Another 24 genotypes scored 3.0 for Ascochyta blight and less than 3% in aggregate or individually for Fusarium wilt, Dry root rot and Foot rot and can be considered as multiple disease-resistant genotypes.

Key words: Ascochyta blight, Chickpea, Multiple disease resistance, Dry root rot, Foot rot, Fusarium wilt

In spite, India being the target producer of chickpea (*Cicer arietinum* L.) in the world, average productivity in the country is mere 780 kg/ha compared to the best in the world of 1 300 kg/ha. The major limitations in achieving potential target are biotic and abiotic stresses. India is a big country with different climatic zones each with its own complexity of associated diseases. Ascochyta blight is the predominant disease in north-west plains zone, botrytis gray mold in north-east zone, fusarium wilt and dry root rot in central zone and dry root rot in southern zone. Ascochyta blight and botrytis gray mold are damaging in cool, humid and rainy conditions, wilt and dry root rot in hot dry soil as well as in rainfed areas. *Kabuli* varieties are more susceptible than *desi* varieties to these diseases (Ahmad *et al.* 2006). The current inclination for extra bold seed *kabuli* varieties may accentuate the existing problems.

There seems to be wide scope of potential gains in chickpea productivity, if region-specific biotic and abiotic stresses are alleviated through genetic improvement or management practices. The best strategy is through development of multiple disease-resistant varieties. The host plant resistance is the most important component of integrated disease management, especially in India where chickpea is grown in different cropping systems under a wide range of agroecological conditions and the farmers have limited resources. Research efforts have been made in development of varieties suitable for winter sowing in West Asia and short duration varieties that are able to escape terminal drought and are resistant to fusarium wilt (Gowda and Gaur 2003). The present investigation illustrates the genotypes having long-term multiple disease resistance.

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MATERIALS AND METHODS

In the present investigation advance breeding material developed at Punjab Agricultural University, Ludhiana, and its Research Stations at Faridkot and Gurdaspur and that obtained from other State Agricultural Universities (SAUs) and National Agricultural Research Centres (NARCs) under All-India Co-ordinated Research Project for Chickpea Improvement were evaluated against Fusarium wilt, Dry root rot, Foot rot, Ascochyta blight and Botrytis gray mold from 2001–06.

Screening for fusarium wilt, dry root rot, foot rot was done using sick plot technique (Gurha *et al.* 2003). The sick plot used was 35 years old. The sickness of plot was

maintained through incorporation of diseased stubble of the crop after harvest, keeping the plot closed (unploughed, uncultivated) during summer as well as by supplementing with fresh fungal cultures of *Fusarium oxysporum* f. sp *ciceris* during the crop season. The material was sown as 4 m rows, 40 cm apart in end of October each year. The 'JG62' susceptible variety was used as check and was planted after every 4 test rows. The observations were recorded on number of symptomatic plants, phenotyped for Fusarium wilt, Dry root rot and Foot rot wilted plants. First observation was taken one month after sowing and subsequent at one-month interval till maturity of crop. The percentage of plants killed due to each disease was calculated and categorized into resistant/susceptible following the scale given by Gurha *et al.* (2003). The lines with no mortal plants or < 5% plants wilted were rated as resistant.

Screening for Ascochyta blight was done following field-screening technique (Gurha *et al.* 2003). The material was sown as 2m rows, 40 cm apart in second week of November each year. The bed-to-bed distance was kept as 1 m to adjust the sprinkler pipes to sprinkle the water for creating relative humidity above 85%. Inoculum consisted of *A. rabiei* conidial suspension 4×10^4 ml^1 multiplied on potato dextrose agar broth for inoculation on the crop at maximum branching and flower initiation during the first fortnight of February in the evening. Irrigation prior to inoculation maintained 100% humidity during the period of infection. After inoculations, day's relative humidity was maintained above 85% by misting the atmosphere by running water sprinkler system, run by 7 KVA engine for 10 min. at 1–1.5 hr interval from 10 AM to 4.30 PM. During night there was sufficient dew to maintain a thick film of water on leaves. The disease appeared after 8–10 days of inoculation and attained maximum proportion after 21 days. The disease rating was done using 1–9 point scale (Gurha *et al.* 2003). Disease rating from 1 to 3 was considered as highly resistant to resistant.

Screening for Botrytis gray mold was done in the controlled growth room. Ten seedlings, 25 days old of test material were raised in polyethylene bags of 9"x 4" size filled with sandy loam soil. The seedlings were spray inoculated with *Botrytis cinerea* conidial suspension $1x10^{4\text{-}1ml}$ and placed in growth room maintained at 22 ± 2°C for 16 hr light with 1500 lux light intensity and 8 hr darkness. The plants were covered with polyethylene cover supported by iron frame cage, by this way 95–100% relative humidity could be maintained in given polyethylene cover. The disease severity was recorded 6 days post inoculation when the susceptible check variety was 100% killed. The disease severity was recorded on 1–9 point scale (Gurha *et al.* 2003). The disease from 1 to 3 was considered as highly resistant to resistant.

RESULTS AND DISCUSSION

Out of the 2 250 genotypes evaluated for resistance to the major diseases Fusarium wilt, Dry root rot, Foot rot, Ascochyta blight and Botrytis gray mold, none of the genotype from AICRP or PAU material showed resistance against Botrytis gray mold. Over the years based on the disease response shown by the genotypes in various trials against these diseases, the enhancement in level of resistance for each disease was calculated. It was noticed that the increased percentage resistance for Fusarium wilt was from 6.6 to 19.3%, Dry root rot 10.4 to 17.4%, Foot rot 10.9 to 12.0% in *desi* and 7.6 to 4.7% for Fusarium wilt, 7.6 to 12.6% for Dry root rot and 7.6 to 8.0% for Foot rot in *kabuli* AICRP material. In PAU material, percentage increase in resistance for *desi* material for Fusarium wilt was from 35.1 to 68.2%, for Dry root rot 53.7 to 85.6% and for Foot rot 53.7 to 60.0%, whereas in *kabuli* material percentage resistance for Fusarium wilt varied from 57.8 to 46.0%, for Dry root rot 63.1 to 54.0% and for Foot rot 68.4 to 66.4%. Percentage increase of resistance for Ascochyta blight was from 2.7 to 6.9% in *desi* but workable resistance was identified in *kabuli* chickpea from AICRP material. However, in PAU material the percentage resistance increased from 2.7 to 11.1 in *desi* and remained between 3.5 and 5.2% in *kabuli* (Table 1).

Of the 2 250 only 70 genotypes showed < 5% wilting in aggregate to Fusarium wilt, Dry root rot and Foot rot. Five genotypes, viz 'GL 88341', 'GL 90168', 'GL 91137', 'GL 92015' and 'PGL 167' were free from Fusarium wilt, Dry root rot, Foot rot and resistant to Ascochyta blight, hence possess multiple disease resistance and thus may be used as donors for resistance breeding programme or as cultivars. Precisely 'GL88341' was released as variety 'PBG 5' for cultivation in north western plain zone. Another 24 genotypes scored ≥ 3.0 for Ascochyta blight and less than 3% in aggregate or individually for Fusarium wilt, Dry root rot and Foot rot. These genotypes were 'GL84038', 'GL 84098', 'GL 84100', 'GL 87016', 'GL 87045', 'GL 89035', 'GL 90137', 'GL 90169', 'GL 90178', 'GL 91058', 'GL 91061', 'GL 92014', 'GL 94011', 'GL 96020', 'GL 96036', 'GL 96044', 'GL 96047', 'GL 96055', 'GL 96081', 'GL 96113',

Table 1 Percentage increase in resistance against various diseases in chickpea

Disease	*Desi* chickpea		*Kabuli* chickpea	
	2001–02	2005–06	2001–02	2005–06
AICRP material				
Fusarium wilt	6.6	19.3	7.6	4.7
Dry root rot	10.4	17.4	7.6	12.6
Foot rot	10.9	12.0	7.6	8.0
Ascochyta blight	2.7	6.9	1.5	1.5
PAU material				
Fusarium wilt	35.1	68.2	57.8	46.0
Dry root rot	53.7	85.6	63.1	54.0
Foot rot	53.7	60.0	68.4	66.4
Ascochyta blight	2.7	11.1	3.5	5.2

Table 2 Average disease reaction of elite chickpea germplasm against various diseases during 2001–02 to 2005–06

Germplasm	Wilt (%)	Dry root rot (%)	Foot rot (%)	Ascochyta blight (1–9) scale
'GL 84038'	0.8	0	0	2.5
'GL 84098'	1.0	0.3	0	2.6
'GL 84100'	1.3	0.6	1.1	2.1
'GL 87016'	0.6	0.6	0	2.5
'GL87045'	0.6	0.0	0.0	2.2
'GL88341'	0.0	0.0	0.0	2.6
'GL89035'	0.6	0	0.4	3.0
'GL90137'	0	0.8	0.9	3.0
'GL90168'	0	0	0	2.9
'GL90169'	1.0	0.8	0.5	2.7
'GL90178'	0.6	0	0	2.5
'GL91058'	0.7	0.5	0.5	2.5
'GL91061'	0.3	0.3	0.6	2.5
'GL 91137'	0	0	0	3.0
'GL 92014'	2.2	0	0.3	2.7
'GL 92015'	0	0	0	2.5
'GL92016'	0.7	0.4	0.4	4.4
'GL 94011'	1.4	0.4	0	3.0
'GL94048'	0.8	0.8	0	3.4
'GL94049'	0.8	0	0	3.5
'GL94059'	5.2	0	0	3.5
'GLK 95091'	2.5	1.3	2.0	8.0
'GL 96020'	2.0	0.9	0	2.7
'GL 96036'	1.2	0.4	0	2.5
'GL 96044'	1.9	1.1	0	3.0
'GL 96047'	0.7	0	0.4	2.9
'GL 96055'	2.0	1.0	0	3.0
'GL96081'	0.6	0	0	2.8
'GL 96113'	0.7	0.8	0	2.0
'GL 97011'	1.9	0.0	1.1	3.7
'GL97015'	1.9	0.5	0	3.3
'GL 97016'	0	0	4.5	3.5
'GL 97017'	0	0.7	0.6	2.6
'GL97104'	2.0	0	0	2.7
'GL 98011'	3.1	0.7	1.2	4.3
'GL 98020'	0.6	0	0	3.3
'GL 21107'	0	0	0	4.0
'GL 22072'	0	0	0	4.5
'GL 23105'	0	0	0	6.0
'PBG 1'	12.1	4.1	5.7	3.5
'PBG 32'	1.3	0	1.2	5.3
'PBG 204'	1.8	0.7	0.3	4.5
'PGL 164'	1.9	2.7	0.8	3.6
'PGL 167 '	0	0	0	2.0
'PGL 725'	0.7	0.7	0	2.7
'PGL 977'	0	0.9	4.1	3.5
'GG 1268'	0.5	2.3	0	3.2
'FG 702'	0	0	0	6.0
'FG 721'	0	0.6	0	7.5
'FG 837'	3	0	0	5.5
'FG 974'	3.8	2.6	1.8	5.5
'FG 1056'	1.3	0	0	4.4
'FG 1217'	1.2	0	0	4.7
'BG 256'	2.1	0	0	9.0
'BGM 519'	0.8	1.3	0.8	9.0
'IPC 871'	0.5	0	0	5.7
'IPG 2006-36'	0.6	0	0.6	8.0
'CSJ 140'	0	0	0	7.7
'CSJ 916'	0	0	0	9.0
'JG 2000-14'	4.2	0	0	9.0
'RSG 931'	1.3	0	0.7	7.7
'H 82-2'	1	0	0	7.7
'H 00-02'	0	0	0	4.0
'H00-15'	0	0	0	4.7
'H00-126'	0	0	0	4.2
'H 01-8'	0	1.1	0.7	4.5
'H 01-80'	1.9	1.9	0	3.0
'HK 92-94'	1.6	1.8	1.8	8.5
'HK 0212'	0.7	1.1	5.0	4.9
'HK 00256'	0	0	0	4.8

'GL 97017', 'GL 97104', 'PGL 725' and 'H01 80' (Table 2). These genotypes were developed in 1980's and 1990's, from then onwards consistently showed resistant reaction towards these diseases and can be ascribed for durable resistance. Of these genotypes 'GL 96036', 'GL 96055' showed resistance to Wet root rot and genotypes 'GL 91061', 'GL 94011', 'GL 84100' and 'H01 80' to Ascochyta blight at Hisar (AICRP 2004). Dubey and Singh (2003) also described genotypes 'GL 84038', 'GL 84098', 'GL 90169' and 'PBG 1' as promising to Ascochyta blight. Eleven genotypes remained free from Fusarium wilt, Dry root rot and Foot rot but were not so good for Ascochyta blight. These genotypes were 'CSJ140', 'CSJ916', 'HK00 256', 'H01 08', 'H00 02', 'H00 15', 'H00 126', 'FG 702', 'GL 21107', 'GL 22072' and 'GL23105'. Dubey and Singh (2004) also reported wilt resistance for some of these genotypes. These genotypes can be recommended for Ascochyta blight free zones of India. 'H01 08' showed multilocation resistance at 7 locations, viz Badnapur, New Delhi, Faridkot, Kanpur, Junagarh, Gulbarga and Jabalpur for Fusarium wilt and for Collar rot at Jabalpur alone. 'CSJ 140' showed moderate resistance to collar rot at Jabalpur (AICRP 2005). Similarly 'H00 15', 'H00 126' and 'HK00 256' showed promise to Wet root rot and 'H00 126' to Collar rot as well (AICRP 2004). Considering the disease vulnerability of chickpea to these diseases, these 70 genotypes can be considered good sources of resistance to wilt/root-rot diseases. Some of these promising genotypes possessing resistance to Ascochyta blight as well are suggested for region-specific cultivation.

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