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## Screening of chickpea germplasm for resistance against wilt caused by *Fusarium oxysporum* f. sp. *ciceri*

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### Abstract

Chickpea (*Cicer arietinum* L.) is one of the important pulse crop widely grown in Maharashtra as rainfed and irrigated crop during *rabi* season. Among various biotic constraints wilt is one of the major yield limiting factors to chickpea. Development of new sources of resistant cultivar/germplasm/genotype is one of the most economical and feasible option to overcome the problems of wilt. Therefore, the present experiment was conducted in *rabi* 2018-19 and 2019-20 to screen different germplasm lines against wilt. Total 52 germplasm lines were screened along with susceptible check JG 62 and resistant check JG 315 against wilt in sick plot at Agricultural Research Station, Badnapur during 2018-19. Out of 52 germplasm lines none of entry shown disease free reaction, whereas, 25 entries were found resistant and 8 entries were found susceptible.

**Keywords:** Chickpea, germplasm, wilt, screening

### Introduction

Amongst the several biotic and abiotic constraints responsible for low productivity of chickpea, Diseases are the most serious constraints causing up to 100% losses of crop. The crop is infected by 172 causal agents of biotic stresses, about 67 fungi, three bacteria, 22 viruses and 80 nematodes reported from 55 countries of the world (Nene *et al.*, 1996) [26].

*Fusarium* wilt results in major economic losses ranging from 10-40% worldwide (Nene *et al.*, 1984) [25]. It causes 100% loss under specific conditions (Jalali and Chand, 1992) [14]. The wilt caused by *Fusarium oxysporum* f. sp. *ciceri* is most devastated, widespread and important throughout the world (Gupta *et al.*, 1997) [11]. The fungus is facultative parasite and primarily survives in the soil. Once the disease occurs in the field, it multiplies rapidly resulting in increase of inoculum level. Repeated cultivation of chickpea every year increases the wilt intensity. Incidence of wilt in grower's field is directly related to inoculum level. The soil borne fungus *Fusarium oxysporum* f. sp. *ciceri* causing wilt in chickpea was first reported from India by Butler (1918) [5]. It infects chickpea at seedling as well as at flowering and pod forming stage (Grewal, 1969) [10]. The pathogen colonizing the xylem vessels and blocking them completely to affect wilting (Cho and Muehlbauer, 2004) [7]. The pathogen survives in soil in the form of spores, chlamydospores and mycelia (Singh *et al.*, 2007) [30]. The nature of pathogen was soil as well as seed-borne (Pande *et al.*, 2007 and Jimenez-Fernandez *et al.*, 2011) [27, 16]. Fungal chlamydospores can survive in soil up to 6 years in the absence of the host plants and causing losses up to 100%. (Iqbal *et al.*, 2010) [13]. *Fusarium* wilt is seed borne as well as soil borne pathogen (Pandey *et al.* 2018) [28]. Chickpea wilt caused by *Fusarium oxysporum* f. sp. *ciceris* is one of the important diseases and causes up to 90% losses depending on weather conditions. (Venkataramanamma *et al.*, 2018) [33]. In early stage of crop wilt incidence is 77-94% whereas, late wilting 24-65% was observed (Sunkad *et al.*, 2019) [31]. The most effective practical and economical method for management of *Fusarium* wilt of chickpea is the use of resistant cultivars (Nene and Haware, 1980; Nene and Reddy, 1987; Bakhsh *et al.*, 2007; Ahmad *et al.*, 2010 and Karimi, *et al.* 2012) [23, 24, 1, 3, 17]. Disease resistance developed by evaluation of genetic variation and selection in genetic improvement in chickpea varieties (Ayana *et al.*, 2019) [2]. Present day it is necessary to overcome the disease by using chickpea cultivars/varieties/germplasm/entries as an alternative ecofriendly disease management strategy. Therefore present investigation was planned for screening of

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Chickpea germplasm for resistance against wilt caused by *Fusarium oxysporum* f. sp. *ciceri* so that to obtain resistant source against pathogen.

### Material and methods

The field experiments were conducted on wilt sick plot at Agricultural Research Station, Badnapur under VNMKV, Parbhani during *rabi* seasons of 2018-19 and 2019-20 to assess the reactions of chickpea varieties / cultivars, germplasm lines, elite lines and disease resistant donors against *Fusarium oxysporum* f. sp. *ciceri*.

### Reactions of chickpea desi, kabuli and donor entries state level elite entries

Twenty eight desi, ten kabuli and sixteen wilt resistant donor lines entries of chickpea were screened during *rabi* 2018-19 and 2019-2020, respectively in wilt sick plot at ARS, Badnapur, along with resistant check JG 315. After every two test entries one line of wilt susceptible cv. JG 62 was sown on dated 25 October 2018 and 18 October 2019 for two *rabi* seasons, respectively. The experiment was replicated twice. First count of plant stand was taken after 30 DAS. The final wilt count was taken at adult stage after 90 DAS. The experiment was replicated twice. Observations on wilt incidence in all of the above three screening experiments were recorded at 30, 60 and 90 DAS and cumulative averages for per cent wilt incidence were computed. Based on average wilt incidence, these test entries were categorized (as per AICRP scale) as given below

| Rating | Wilt percentage | Reaction type          | Abbreviation |
|--------|-----------------|------------------------|--------------|
| 1      | 00.00 -1 0.00 % | Resistant              | R            |
| 2      | 10.10 -30.00 %  | Moderately resistant   | MR           |
| 3      | 30.10-50.00 %   | Moderately susceptible | MS           |
| 4      | > 50.00 %       | Susceptible            | S            |

### Results and discussion

Evaluation of promising chickpea varieties /cultivars /genotypes /entries of Maharashtra

The present investigation results (Table 1 and 2 and Fig.1) revealed that all the 28 entries of chickpea showed different reactions against wilt disease during *rabi* 2018-19 and 2019-20, respectively. To find out the sources of host resistance against wilt, in chickpea during *rabi* 2018-19 and 2019-20, the total 28 chickpea entries were screened against wilt disease in wilt sick plot. On the basis of wilt incidence, genotypes / cultivar were categorized for their reaction to wilt as per rating. Accordingly the genotypes were grouped as Disease free / Immune, Resistant, Moderately Resistant, Susceptible and Highly Susceptible. In *Rabi* 2018 -19 all the entries were found effective to reduce incidence of wilt. Wilt incidence (mortality) were ranged from 3.44 to 22.50 per cent, as against susceptible check JG 62 with 100.00 per cent disease incidence. Among these 28 test entries, none of the genotype was found to be immune, eight entries *viz.*, Phule G-0819-43, BDNG 17-21, AKG 1301, AKG1303, Phule Vikram, Phule Vikrant, PDKV Kanchan and JG 315 showed resistant reaction against wilt. Sixteen entries *viz.*, Phule G-16101, Phule G-15109, Phule G-1010-14, Phule G-1022-3, BDNG 17-06, BDNG 17-23, BDNG 17-44, BDNG 17-49, BDNG 2016-2, BDNG 2015-1, AKG 1401, AKG 1402, AKG 1506, Vijay, Digvijay, JAKI 9218 showed moderately resistant reaction, whereas, two entries *viz.*, BDN 9-3, BDNG 797 showed susceptible reaction and BDNG 21-1, JG 62 were found highly susceptible against wilt.

The similar trend was observed in *Rabi* 2019 -20 among all the tested entries. None of the genotype was found to be immune, ten entries *viz.*, Phule G-0819-43, Phule G-1010-14, BDNG 2017-21, BDNG 2017-44, BDNG 2017-49, AKG 1301, AKG 1303, Phule Vikram, PDKV Kanchan and JG 315 showed resistant reaction against wilt, whereas, sixteen entries *viz.*, Phule G-16101, Phule G 15109, Phule G-1022-3, BDNG 2017-06, BDNG 2017-23, BDNG 2016-2, BDNG 2015-1, BDNG 21-1, AKG 1401, AKG 1402, AKG 1506, Vijay, Digvijay, Phule Vikrant, BDN 9-3, BDNG 797 and JAKI 9218 showed moderately resistant reaction. Two entries *viz.*, BDN 9-3 and JG 62 were highly susceptible reaction against wilt.

**Table 1:** Evaluation of promising chickpea entries of Maharashtra against wilt disease in wilt sick plot during *Rabi* 2018-19 and 2019-20

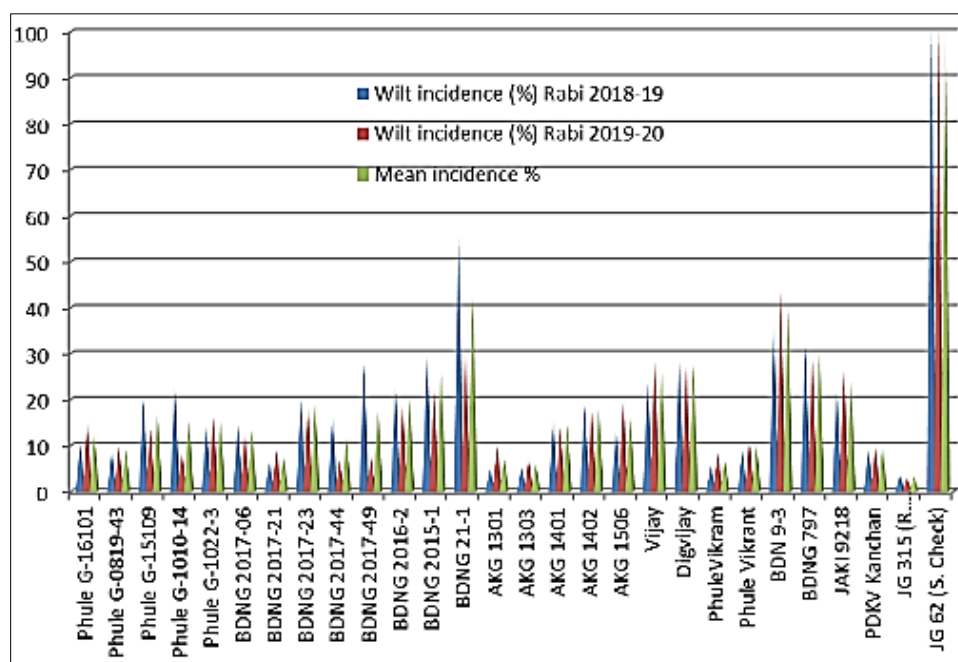
| Sr. No. | Entries         | <i>Rabi</i> 2018-19 | <i>Rabi</i> 2019-20 | Mean incidence (%) | Reaction |
|---------|-----------------|---------------------|---------------------|--------------------|----------|
|         |                 | Wilt incidence (%)  | Wilt incidence (%)  |                    |          |
| 1       | Phule G-16101   | 10.33               | 14.66               | 12.50              | MR       |
| 2       | Phule G-0819-43 | 08.46               | 09.56               | 09.01              | R        |
| 3       | Phule G-15109   | 19.81               | 13.46               | 16.64              | MR       |
| 4       | Phule G-1010-14 | 22.50               | 8.43                | 15.47              | MR       |
| 5       | Phule G-1022-3  | 14.03               | 16.12               | 15.08              | MR       |
| 6       | BDNG 2017-06    | 14.24               | 12.00               | 13.12              | MR       |
| 7       | BDNG 2017-21    | 06.11               | 08.85               | 07.48              | R        |
| 8       | BDNG 2017-23    | 20.00               | 18.25               | 19.13              | MR       |
| 9       | BDNG 2017-44    | 15.91               | 06.66               | 11.29              | MR       |
| 10      | BDNG 2017-49    | 27.50               | 07.31               | 17.41              | MR       |
| 11      | BDNG 2016-2     | 22.50               | 18.50               | 20.50              | MR       |
| 12      | BDNG 2015-1     | 29.44               | 21.85               | 25.65              | MR       |
| 13      | BDNG 21-1       | 54.76               | 29.44               | 42.10              | S        |
| 14      | AKG 1301        | 04.72               | 09.75               | 07.24              | R        |
| 15      | AKG 1303        | 05.13               | 06.86               | 06.00              | R        |
| 16      | AKG 1401        | 15.10               | 13.77               | 14.44              | MR       |
| 17      | AKG 1402        | 18.47               | 17.12               | 17.80              | MR       |
| 18      | AKG 1506        | 12.91               | 19.23               | 16.07              | MR       |
| 19      | Vijay           | 23.74               | 28.10               | 25.92              | MR       |
| 20      | Digvijay        | 28.04               | 26.82               | 27.43              | MR       |
| 21      | Phule Vikram    | 05.41               | 8.19                | 06.80              | R        |
| 22      | Phule Vikrant   | 08.82               | 11.33               | 10.08              | R        |
| 23      | BDN 9-3         | 36.11               | 43.12               | 39.62              | S        |

|     |                   |        |        |        |    |
|-----|-------------------|--------|--------|--------|----|
| 24  | BDNG 797          | 31.66  | 28.56  | 30.11  | MR |
| 25  | JAKI 9218         | 21.56  | 26.12  | 23.84  | MR |
| 26  | PDKV Kanchan      | 08.92  | 09.58  | 09.25  | R  |
| 27  | JG 315 (R. Check) | 03.44  | 02.78  | 03.11  | R  |
| 28  | JG 62 (S. Check)  | 100.00 | 100.00 | 100.00 | S  |
| LSI |                   | 21.06  | 19.16  |        |    |

R: Resistant, MR: Moderately Resistant, MS: Moderately Susceptible and S: Susceptible

**Table 2:** Assortment based on reaction of chickpea entries of Maharashtra against wilt disease in wilt sick plot during *Rabi* 2018-19 and 2019-20.

| S. No. | Disease reaction              | Scale (%)  | No. of varieties |         | Chickpea varieties  |   |
|--------|-------------------------------|------------|------------------|---------|---|---|
|        |                               |            | 2018-19          | 2019-20 | <i>Rabi</i> 2018-19   | <i>Rabi</i> 2019-20   |
| 1      | Immune(I) / Disease free (DF) | 0          | 00               | 00      | --  | --  |
| 2      | Resistant (R)                 | 1 to 10    | 08               | 10      | Phule G-16101, Phule G-0819-43, BDNG 2017-21, AKG 1301, AKG 1303, Phule Vikram, Phule Vikrant, PDKV Kanchan and JG 315.   | Phule G-0819-43, Phule G-1010-14, BDNG 2017-21, BDNG 2017-44, BDNG 2017-49, AKG 1301, AKG 1303, Phule Vikram, PDKV Kanchan and JG 315.  |
| 3      | Moderately Resistant (MR)     | 11 to 30   | 16               | 16      | Phule G-1010-14, Phule G 15109, Phule G-1022-3, BDNG 2017-06, BDNG 2017-23, BDNG 2017-44, BDNG 2016-2, BDNG 2015-1, AKG 1401, AKG 1402, AKG 1506, Vijay, Digvijay, JAKI 9218 and BDNG 2017-49 | Phule G-16101, Phule G 15109, Phule G-1022-3, BDNG 2017-06, BDNG 2017-23, BDNG 2016-2, BDNG 2015-1, BDNG 21-1, AKG 1401, AKG 1402, AKG 1506, BDN 9-3, Vijay, Digvijay, Phule Vikrant, BDNG 797 and JAKI 9218. |
| 4      | Susceptible (S)               | 31 & above | 04               | 02      | BDNG 21-1, BDN 9-3, BDNG 797 and JG 62  | BDNG 21-1 and JG 62   |
| Total  |                               |            | 28               | 28      |   |   |



#### Evaluation of promising Kabuli chickpea entries of Maharashtra against wilt disease in wilt sick plot during *Rabi* 2018-19

In order to find out the sources of host resistance against wilt, in kabuli genotype of chickpea during *Rabi* 2018-19 and 2019-20, total ten genotype (including resistant and susceptible check) of chickpea entries were screened against wilt disease in wilt sick plot. The data presented in Table 3 and 4 revealed that in *rabi* 2018-19 all the kabuli entries were found effective to reduce incidence of wilt. Wilt incidence (mortality) were ranged from 15.91 to 87.50 per cent, as against resistant check with 3.44 per cent, whereas, susceptible check JG 62 with 100.00 per cent. Among these

10 cultivar, none of the genotype was found to be immune/disease free and resistant reaction against wilt respectively. Only three cultivar *viz.*, Phule G-0739, Virat, PKVK-4 showed moderately resistant reaction, whereas, five entries *viz.*, Phule G-16312, BDNG 2018-1, Kripa, BDNGK 798, PKVK -2 along with JG 62 showed highly susceptible reaction against wilt (Table 3 and 4). In *Rabi* 2019-20 all the kabuli entries were found effective to reduce incidence of wilt. Wilt incidence (mortality) were ranged from 18.53 to 56.00 per cent, as against resistant check with 5.60 per cent whereas, susceptible check JG 62 with 100.00 per cent. The similar result were observed in *Rabi* 2019-20 among all the tested kabuli entries, none of the genotype was found to be

immune/ disease free reaction and resistant reaction respectively. Only three cultivar viz., Phule G-0739, Virat, PKVK -4 showed moderately resistant reaction. Whereas, five

entries Viz., Phule G-16312, BDNG 2018-1, Kripa, BDNGK 798, PKVK -2 along with JG 62 were found highly susceptible against wilt.

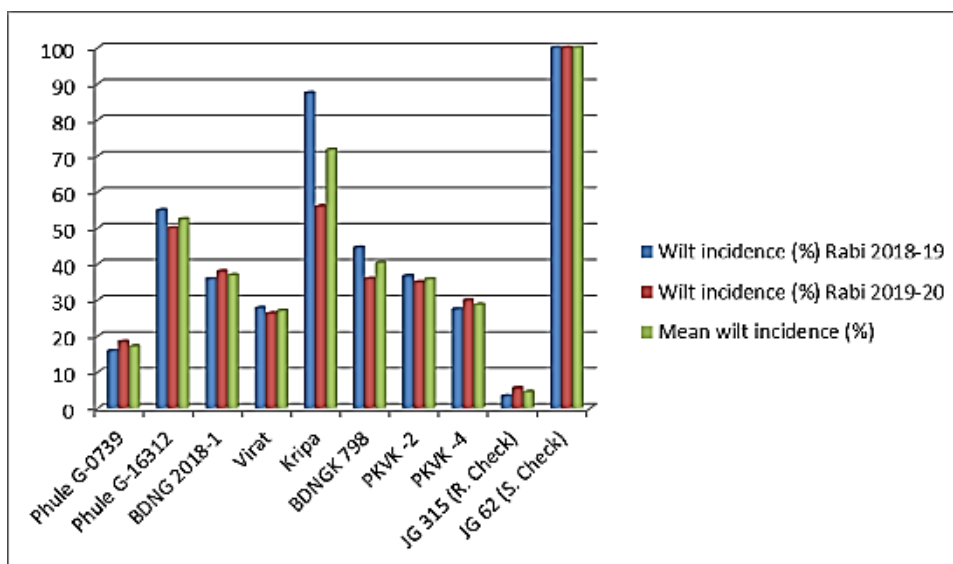
**Table 3:** Evaluation of promising kabuli chickpea entries of Maharashtra against wilt disease in wilt sick plot during *Rabi* 2018-19 and *Rabi* 2019-20

| S. No. | Entries           | <i>Rabi</i> 2018-19<br>Wilt incidence (%) | <i>Rabi</i> 2019-20<br>Wilt incidence (%) | Mean   | Reaction |
|--------|-------------------|---|---|--------|----------|
| 1      | Phule G-0739      | 15.91                                     | 18.53                                     | 17.22  | MR       |
| 2      | Phule G-16312     | 55.00                                     | 50.00                                     | 52.50  | S        |
| 3      | BDNG 2018-1       | 35.91                                     | 38.00                                     | 36.96  | S        |
| 4      | Virat             | 27.84                                     | 26.34                                     | 27.09  | MR       |
| 5      | Kripa             | 87.50                                     | 56.00                                     | 71.75  | S        |
| 6      | BDNGK 798         | 44.60                                     | 36.00                                     | 40.30  | S        |
| 7      | PKVK -2           | 36.73                                     | 35.00                                     | 35.87  | S        |
| 8      | PKVK -4           | 27.50                                     | 30.00                                     | 28.75  | MR       |
| 9      | JG 315 (R. Check) | 03.44                                     | 05.60                                     | 4.52   | R        |
| 10     | JG 62 (S. Check)  | 100.00                                    | 100.00                                    | 100.00 | S        |
|        | LSI               | 43.44                                     | 39.55                                     |        |          |

R: Resistant, MR: Moderately Resistant, MS: Moderately Susceptible and S: Susceptible

**Table 4:** Assortment based on reaction of Kabuli chickpea entries of Maharashtra against wilt disease in wilt sick plot during *Rabi*2018-19 and 2019-20.

| S. No. | Disease Reaction             | Scale (%) | No. of Varieties    |                     | Chickpea varieties  |   |
|--------|------------------------------|-----------|---------------------|---------------------|---|---|
|        |                              |           | <i>Rabi</i> 2018-19 | <i>Rabi</i> 2019-20 | <i>Rabi</i> 2018-19   | <i>Rabi</i> 2019-20   |
| 1      | Immune(I)/ Disease free (DF) | 0         | 00                  | 00                  | --  | --  |
| 2      | Resistant (R)                | 1 – 10    | 01                  | 01                  | JG 315  | JG 315  |
| 3      | Moderately Resistant (MR)    | 11 – 30   | 03                  | 03                  | Phule G-0739, Virat, PKVK -4                                    | Phule G-0739, Virat, PKVK -4                                    |
| 4      | Susceptible (S)              | (>31.00)  | 06                  | 06                  | Phule G-16312, BDNG 2018-1, Kripa, BDNGK 798, PKVK -2 and JG 62 | Phule G-16312, BDNG 2018-1, Kripa, BDNGK 798, PKVK -2 and JG 62 |
|        | Total                        |           | 10                  | 10                  |   |   |



**Fig 2:** Evaluation of promising kabuli chickpea entries of Maharashtra against wilt disease

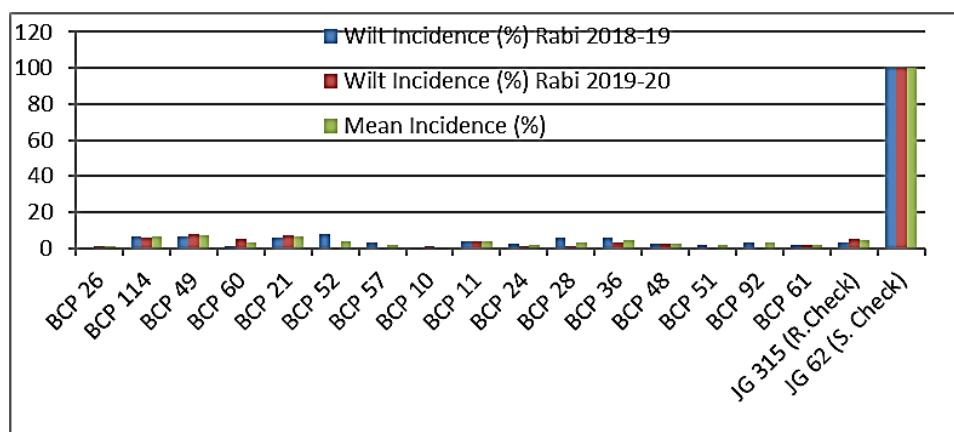
**Evaluation of chickpea resistant donors**

Total 16 chickpea resistant donors of Agricultural Research Station, Badnapur were screened for two years during *rabi* 2018-19 and 2019-20 against chickpea wilt in wilt sick plot along with resistant check JG 315 and susceptible check JG

62. During *Rabi* 2018-19 and 2019-20 all entries were found most effective to reduce incidence of wilt. Mean wilt incidence (mortality) were ranged from 01.00 to 06.42 per cent, as against resistant check with 4.22 per cent whereas, susceptible check JG 62 with 100.00 per cent (Table 5 & 6).

**Table 5:** Evaluation of chickpea resistant donors against wilt disease in wilt sick plot during *Rabi* 2018-19 and 2019-20.

| S. No. | Entries          | Wilt Incidence (%)  |                     | Mean Incidence (%) | Reaction    |
|--------|------------------|---------------------|---------------------|--------------------|-------------|
|        |                  | <i>Rabi</i> 2018-19 | <i>Rabi</i> 2019-20 |                    |             |
| 1      | BCP 26           | 0.00                | 1.00                | 1.00               | Resistant   |
| 2      | BCP 114          | 6.36                | 6.00                | 6.18               | Resistant   |
| 3      | BCP 49           | 6.58                | 8.00                | 7.29               | Resistant   |
| 4      | BCP 60           | 1.00                | 5.00                | 3.00               | Resistant   |
| 5      | BCP 21           | 5.84                | 7.00                | 6.42               | Resistant   |
| 6      | BCP 52           | 8.13                | 0.00                | 4.07               | Resistant   |
| 7      | BCP 57           | 2.93                | 0.00                | 1.47               | Resistant   |
| 8      | BCP 10           | 0.00                | 1.16                | 0.58               | Resistant   |
| 9      | BCP 11           | 3.57                | 3.58                | 3.58               | Resistant   |
| 10     | BCP 24           | 2.77                | 1.04                | 1.91               | Resistant   |
| 11     | BCP 28           | 5.71                | 1.09                | 3.40               | Resistant   |
| 12     | BCP 36           | 5.89                | 3.46                | 4.68               | Resistant   |
| 13     | BCP 48           | 2.70                | 2.31                | 2.51               | Resistant   |
| 14     | BCP 51           | 1.67                | 0.00                | 1.67               | Resistant   |
| 15     | BCP 92           | 2.93                | 0.00                | 2.93               | Resistant   |
| 16     | BCP 61           | 1.83                | 1.47                | 1.65               | Resistant   |
| 17     | JG 315 (R.Check) | 3.44                | 5.00                | 4.22               | Resistant   |
| 18     | JG 62 (S. Check) | 100.00              | 100.00              | 100.00             | Susceptible |
|        | LSI              | 14.92               | 14.88               |                    |             |



During *Rabi* 2018-19, among all the sixteen donors only 02 donors *viz.*, BCP 26 and BCP 10 were shown disease free reaction. Rest of all the donors were found resistant to wilt, as against resistant check with 3.44 per cent whereas, susceptible check JG 62 with 100.00 per cent Whereas, 2019-20, among

all the sixteen donors only 04 donors *viz.*, BCP 52 BCP 57 BCP 51 and BCP 92 were shown disease free reaction. Rest of all the donors were found resistant to wilt, as against resistant check with 3.44 per cent whereas, susceptible check JG 62 with 100.00 per cent (Table 6).

**Table 6:** Assortment based on reaction of chickpea resistant donors against wilt disease in wilt sick plot during *Rabi* 2018-19 and 2019-20.

| S. No. | Disease Reaction            | Scale (%) | No. of Donors |         | Chickpea Donors  |   |
|--------|-----------------------------|-----------|---------------|---------|--|---|
|        |                             |           | 2018-19       | 2019-20 | <i>Rabi</i> 2018-19  | <i>Rabi</i> 2019-20   |
| 1      | Immune(I)/Disease free (DF) | 0         | 02            | 04      | BCP 26 and BCP 10  | BCP 52 BCP 57 BCP 51 and BCP 92   |
| 2      | Resistant (R)               | 1 - 10    | 15            | 13      | BCP 51, BCP 92 BCP 114, BCP 49 BCP 60, BCP 21, BCP 52, BCP 57, BCP 11, BCP 24 BCP 28, BCP 36 BCP 48, BCP 61 and JG 315 | BCP 26, BCP 114, BCP 49 BCP 60, BCP 21, BCP 10, BCP 11, BCP 24 BCP 28, BCP 36 BCP 48, BCP 61 and JG 315 |
| 3      | Moderately Resistant (MR)   | 11 - 30   | 00            | 00      | --   | --  |
| 4      | Susceptible (S)             | (>31.00)  | 01            | 01      | JG 62  | JG 62   |
| Total  |                             |           | 18            | 18      |  |   |

These results are in conformity with the findings of those reported earlier by several workers against *Fusarium oxysporum* f. sp. *ciceri* like Chauhan (1956) [6], Mathur *et al.* (1960) [19], Nene *et al.* (1980) [22] and Muhammad *et al.* (2001) [20].

Dubey *et al.* (2004) [8] screened four hundred eighty one chickpea genotypes in wilt sick field at Research Farm, IARI

and found resistant sources against *Fusarium oxysporum* f.sp. *ciceri*. Similarly, Kumar *et al.* (2013) [18] screened one hundred one genotypes of chickpea against *Fusarium* wilt disease at Student Institutional Farm at Narendra Deva university of Agriculture and technology, Faizabad (U.P.) and recorded 28 tolerant and 16 susceptible lines to the wilt disease at seedling stage. Other workers also reported data of

screening of chickpea genotypes/lines/cultivars against wilt viz., Fatima *et al.* (2015)<sup>[9]</sup>, Belaidi (2016)<sup>[4]</sup>, Saabale *et al.* (2017)<sup>[29]</sup>, Thaware *et al.* (2017)<sup>[32]</sup>, Hotkar *et al.* (2018)<sup>[12]</sup>

and Nathawat *et al.* (2018)<sup>[21]</sup> and found resistant sources for chickpea wilt.



**Plate 1:** Field showing response of different entries in wilt sick plot.

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