

Original Research Article

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## Reaction of Some Chickpea Germplasm Lines against Root Knot Nematode, *Meloidogyne incognita* (Kofoid and White) Chitwood

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### ABSTRACT

#### Keywords

Root knot nematode, Chickpea, Germplasm, *Meloidogyne incognita*, Resistant, Susceptible, Root gall index

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Chickpea (*Cicer arietinum*) is one of the most important food legumes grown worldwide. Its cultivation in India is hampered considerably due to regular occurrence of root knot nematode and reported to reduce the chickpea yield by 9-40%. The present study was conducted to evaluate some chickpea germplasm for resistance against root knot nematode, *Meloidogyne incognita*. The experimental result revealed that none of the germplasm was found highly resistant against the root knot nematode, however 9 germplasm lines were recorded resistant having 1.1 to 2.0 root gall index. 12 germplasm lines exhibited moderately resistant with root gall index 2.33 to 3.0, 7 were found susceptible showing root gall index between 3.1 to 4.0 and thirty-two lines were found to be highly susceptible having root gall index between 4.1 to 5.0. Susceptible cultivars developed heavier root systems because of root galling compared to resistant cultivars. Similarly, resistant plants have shown more growth in shoot attributes conforms that the growth of root length, shoot length, fresh shoot weight and dry shoot weight is negatively correlated to the root knot index ( $r = -0.688, -0.773, -0.658, -0.705$  respectively) while fresh root weight and dry root weight, were positively correlated with root knot index ( $r = 0.716, 0.296$  respectively).

### Introduction

Pulse crops possess an important position in India as they contain nearly three times as much protein as in the cereals. Basically, these are the main source of dietary protein (Jeswani and Vanchaik, 1986; Chand and Srivastava, 1982) for a large vegetarian population in our country. On an average, pulses contain 22 to 24 per cent protein as

against 8 to 10 per cent in cereals. Chickpea (*Cicer arietinum* L), a pulse crop belonging to the family Fabaceae, is always cultivated as a winter (Rabi) crop throughout India. Chickpea is a good source of protein (25.3-28.9%), fibre (3.0%), oil (4.8-5.5%), ash (3.0%), calcium (0.2%), phosphorus (0.3%). In India the important chickpea producing states are Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra and Andhra Pradesh

(Jodha and Subb Rao, 1987). In India, chickpea was grown on 9.01 million hectares area with total production of 7.58 million tones and an average productivity of 841 kg /ha (Anonymous, 2011). India is world's largest consumer as well as world's largest producer of chickpea and contributing over 70% of total global chickpea production (FAO, 2017). The world average chickpea yield is less than 1 t/ha which is far less than the potential yield of 6 t/ha under favorable and irrigated conditions (Varshney *et al.*, 2017). This enormous disparity between the actual and expected yield of chickpea is due to biotic stresses, caused by insects, bacteria, fungi, nematodes and viruses, and abiotic stresses, such as drought, nutrient deficiencies, salinity and chilling (Roorkiwal *et al.*, 2016). Plant-parasitic nematodes constrain chickpea production, with annual yield losses estimated to be 14% of total global production. Chickpea is a host for over 100 species of plant-parasitic nematodes (Nene *et al.*, 1996; Sikora *et al.*, 2018). Ali (1995) listed 97 nematode species associated with chickpea on global basis, out of which 64 have been reported from India, but the major damage is caused by three endoparasitic nematodes viz., *Meloidogyne* spp., *Heterodera* spp. and *Rotylenchulus reniformis*, which are known to inhabit inside the roots (Ali *et al.*, 2003). Three species of the root-knot nematode, *M. incognita*, *M. javanica* and *M. arenaria* are associated with chickpea. Of these species, *M. incognita* is apparently the most predominant which is closely followed by *M. javanica* (Sharma and Sharma, 1998). Due to nematode infection plant shows various morphological responses like severe stunting, chlorosis, wilting and drooping of leaves, delay in flowering, fruit formation and yield, aggregation of nutrition deficiencies and retardation of growing point of shoot and root system with severe root galling due to hypertrophic and hyperplasia activities in the root tissues under the

influence of endoparasitic sedentary nematodes. Plant-parasitic nematodes contribute to decreased plant vigor by reducing Rhizobium root nodulation and nitrogen-fixing ability of the host plant (Tiyagi and Parveen, 1992; Vovlas *et al.*, 1998; Wood *et al.*, 2018). Furthermore, plant-parasitic nematodes exacerbate crop damage caused by other biotic stresses. Nematode infection leads to enhanced severity of infection with soil-borne fungal pathogens causing Fusarium wilt (*Fusarium oxysporum* f. sp. ciceris) (Castillo *et al.*, 1998, 2003) and dry root rot (*Rhizoctonia bataticola*) (Ali and Sharma, 2003). Integration of resistant crops with appropriate agronomic practices is recognized as the long term safest and most practical, economic and effective control strategy for plant-parasitic nematodes. Resistance is the ability of a plant to reduce nematode reproduction such that, no nematode reproduction occurs in a highly resistant plant, a low level of reproduction occurs in a moderately resistant plant and unhindered nematode reproduction occurs in a susceptible plant (Roberts, 2002). Keeping in mind the above information available the present experiment was conducted to find the resistance in some chickpea germplasm against root knot nematode, *M. incognita*.

## Materials and Methods

Pot experiments were conducted with 60 chickpea germplasm in the net house condition at the Directorate of Research, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, Nadia, West Bengal, during December 2018 – February, 2019 to investigate response of the germplasms against root knot nematode, *Meloidogyne incognita* (Kofoid and White) Chitwood race 2 following completely randomized block design. The net house is located at 22° 56' N latitude 88° 32' E and at 9.75 meter above mean sea level. The germplasm lines were

collected from the Project coordinating cell, AICRP on nematodes, ICAR New Delhi. To perform this experiment during the period of research, pure culture of *M. incognita* race- 2 was maintained on brinjal roots in the net house. Extraction of nematode eggs was done by using modified method (Hussey and Barker, 1973). Juveniles were also extracted from infested brinjal roots, using modified Baermann tray method. Counting was done three times to obtain the mean number of juveniles. Potting medium used was comprised of soil, sand and vermicompost in 3:1:1 ratio. The required amount of media was sterilized by 10% formaldehyde solution to make the media free from nematodes. The potting media was ready to use after three weeks of sterilization. The earthen pots (6 ") were filled with sterilized soil @ 1000 cc pot. Sowing of chickpea seeds was done. Three seeds were sown in each pot and only one plant per pot was allowed to grow after one week of germination. The inoculation was done at 3-4 leaves stage (15 days after sowing) @ one J2 per cc of soil i.e. 1000 J2 per pot collected from the pur culture maintained in brinjal roots. For the inoculation three to four holes to a depth of 3-5 cm were made with the help of glass rod near the rhizosphere. The second stage juveniles (J2) of *Meloidogyne incognita* @ 1000 J2 plant per pot were released with the help of 10 ml pipette. Holes were subsequently covered with soil and pots were watered after inoculation. Four replications for each entry was maintained. The chickpea plants were uprooted after 45 days of inoculation carefully to avoid the damage of roots and other plant parts. The observations on shoot length, root length, fresh root weight, dry root weight, fresh shoot weight, dry shoot weight, root knot index (0-5 scale), egg masses per plant were taken. After uprooting the roots were gently washed in tap water and made cut at the junction of the shoot and root. Observation on length (cm) of

shoot and root, weight (g) of shoot and root were recorded thereafter. Roots were brought to the laboratory for further studies. Counting of galls and egg masses were carried in the laboratory under stereozoom binocular. After counting roots as well as shoots were kept in paper packets for drying in dry air oven at 45°C for 4-5 days and then dry weight was taken. The degree of resistance was indicated by the root knot index and it was done as per Heald *et al.*, The critical difference (CD) at 5% level of significance was worked out from the data recorded during experiment and compared according to Duncan's Multiple Range Test at 5% level of probability; the data was analyzed in CRD.

## **Results and Discussion**

The experimental result revealed that the chickpea accession DBGV 218 was recorded for the greatest plant height, 95 cm and the lowest height, 24 cm was obtained in chickpea accession HK 16-30. It was also found that in reference to plant height 3 accessions were having no significant difference with DBGV 218 and 22 accessions had no significant difference with HK 16-30. Height of rest of the plants was significantly different from the tallest and the smallest ones. Chickpea accession IPCK 09-145 was recorded for the greatest fresh shoot weight, 18.05 g and the lowest weight, 0.86 g was obtained in chickpea accession H 05-23. It was also found that in reference to fresh shoot weight 1 accession was having no significant difference with IPCK 09-145 and 36 accessions had no significant difference with H 05-23. Fresh shoot weight of rest of the plants was significantly different from the heaviest and the lightest ones. It was observed that the chickpea accession IPCK 09-145 was recorded for the greatest dry shoot weight, 4.38 g and the lowest weight, 0.05 g was obtained in chickpea accession MABC-WR-SA 1. It was also found that in reference to

dry shoot weight 1 accession was at par with IPCK 09-145 while 37 accessions had no significant difference with MABC-WR-SA 1.

Dry shoot weight of rest of the plants was significantly different from the heaviest and the lightest ones.

**Table.1** Evaluation of different chickpea germplasms against root knot nematode

| Germplasm      | Shoot Parameters |                    |                  | Root parameters |                   |                 | Root Knot Index | Reaction |
|----------------|------------------|--------------------|------------------|-----------------|-------------------|-----------------|-----------------|----------|
|                | Shoot length     | Fresh shoot weight | Dry shoot weight | Root length     | Fresh root weight | Dry root weight |                 |          |
| JG 2018 -54    | 48.667           | 4.01               | 1.11             | 9               | 0.25              | 0.11            | 2               | R        |
| Pant G 5       | 68.33            | 8.68               | 2.48             | 13              | 0.93              | 0.2             | 2               | R        |
| GJG 1603       | 56.33            | 3.5                | 0.93             | 8.33            | 1.26              | 0.5             | 2.33            | MR       |
| PhuleG 16111   | 59               | 5.51               | 1.63             | 9.33            | 1.8               | 0.38            | 4.66            | HS       |
| GL 17101       | 60               | 5.78               | 1.31             | 9               | 0.61              | 0.06            | 2               | R        |
| PG 186         | 53.67            | 4.26               | 0.85             | 8.33            | 0.51              | 0.03            | 2               | R        |
| NBeG 620       | 64.33            | 5.18               | 1.15             | 10              | 1.15              | 0.13            | 2.33            | MR       |
| H 15-13        | 70.33            | 8.4                | 2.15             | 10              | 0.9               | 0.16            | 2               | R        |
| PhuleG 1010-14 | 68.33            | 6.58               | 1.93             | 13.33           | 1.73              | 0.3             | 3.66            | S        |
| VIJAY          | 62.67            | 4.81               | 1.16             | 9               | 1.2               | 0.18            | 3               | MR       |
| GL 29098       | 64.33            | 3.6                | 0.86             | 10.33           | 0.8               | 0.06            | 2               | R        |
| Phule G 15109  | 54.33            | 5.96               | 1.46             | 7               | 0.95              | 0.11            | 3.66            | S        |
| CSJ 881        | 62.33            | 11.78              | 2.1              | 10              | 1.53              | 0.23            | 3.66            | S        |
| GJG 1611       | 91.67            | 16.65              | 3.85             | 10.67           | 1.76              | 0.23            | 2.66            | MR       |
| BDNG 16-2      | 84               | 11.31              | 2.01             | 10.67           | 2.01              | 0.33            | 3.33            | S        |
| DBGV 218       | 95               | 11.68              | 2.83             | 9.33            | 1.06              | 0.11            | 2.33            | MR       |
| BDNG 21-1      | 55.67            | 9.63               | 1.46             | 9               | 0.5               | 0.06            | 3               | MR       |
| CSJ 515        | 60.67            | 4.66               | 0.96             | 10              | 0.55              | 0.06            | 2.33            | MR       |
| VIJAY          | 61.67            | 8.26               | 1.7              | 11              | 1.2               | 0.15            | 2               | R        |
| NBeG 778       | 80.66            | 11.1               | 3.41             | 9               | 2.06              | 0.33            | 2.33            | MR       |
| H 15-18        | 76.33            | 7.75               | 1.46             | 9.66            | 0.76              | 0.06            | 2.33            | MR       |
| RLBGK 1        | 66               | 11.68              | 1.58             | 14              | 1.4               | 0.3             | 2               | R        |
| GLK 28127      | 68               | 6.31               | 1.73             | 12              | 1.33              | 0.1             | 2               | R        |
| Phule G 0517   | 65               | 3.35               | 1.1              | 11.33           | 1.25              | 0.2             | 3               | MR       |
| NBeG 810       | 77.33            | 10.16              | 2.58             | 13              | 1.58              | 0.16            | 2.33            | MR       |
| IPCK 09-145    | 85.33            | 18.05              | 4.38             | 10              | 1.76              | 0.23            | 2.66            | MR       |
| GLK 28127      | 26.67            | 2.55               | 0.1              | 30              | 1.56              | 0.04            | 4.66            | HS       |
| PF219          | 25               | 2.36               | 0.06             | 9.67            | 3.01              | 0.01            | 3.66            | S        |
| CSJK 142       | 28.33            | 1.26               | 0.18             | 26.33           | 2.26              | 0.11            | 5               | HS       |
| HK 16-30       | 24               | 2.55               | 0.28             | 19.33           | 0.86              | 0.26            | 3.66            | S        |
| HK 13-114      | 27.67            | 1.06               | 0.13             | 18              | 2.21              | 0.15            | 5               | HS       |
| Phule G 0517   | 37.33            | 3.1                | 0.5              | 21.67           | 5.18              | 0.38            | 5               | HS       |
| PG220          | 26.33            | 1                  | 0.08             | 13.33           | 1.71              | 0.11            | 4.66            | HS       |
| BG 4009        | 30               | 1.16               | 0.11             | 18.67           | 2.15              | 0.11            | 5               | HS       |
| NBeG 723       | 30               | 1.2                | 0.15             | 19              | 1.41              | 0.26            | 4.66            | HS       |
| GLK 17316      | 36               | 1.38               | 0.1              | 17.33           | 3.91              | 0.67            | 4.66            | HS       |
| Phule G 8108   | 40.67            | 2.06               | 0.3              | 14.67           | 5.16              | 0.3             | 5               | HS       |

|                       |       |       |       |       |       |       |      |           |
|-----------------------|-------|-------|-------|-------|-------|-------|------|-----------|
| <b>JG 2016-24</b>     | 42    | 3.85  | 0.6   | 23    | 5.41  | 0.23  | 5    | <b>HS</b> |
| <b>Phule G 16105</b>  | 38.33 | 2.06  | 0.3   | 18.33 | 4.8   | 0.33  | 5    | <b>HS</b> |
| <b>PhuleG 1012-15</b> | 38    | 2.03  | 0.3   | 19.66 | 4.11  | 0.18  | 5    | <b>HS</b> |
| <b>RG 2015-01</b>     | 40.33 | 4.81  | 0.58  | 15.66 | 6.55  | 0.21  | 5    | <b>HS</b> |
| <b>CSJ 995</b>        | 35    | 2.01  | 0.31  | 15.66 | 4.21  | 0.66  | 5    | <b>HS</b> |
| <b>NBeG 779</b>       | 48    | 2.7   | 0.26  | 19.33 | 6.11  | 0.21  | 5    | <b>HS</b> |
| <b>H 05-23</b>        | 26    | 0.86  | 0.08  | 14.33 | 2.56  | 0.18  | 4.66 | <b>HS</b> |
| <b>H15-04</b>         | 29    | 1.67  | 0.2   | 14    | 2.86  | 0.21  | 5    | <b>HS</b> |
| <b>PG 217</b>         | 32.33 | 2.05  | 0.13  | 16.33 | 4.4   | 0.28  | 5    | <b>HS</b> |
| <b>CSJ 515</b>        | 34.67 | 2.78  | 0.13  | 21    | 4.83  | 0.31  | 5    | <b>HS</b> |
| <b>CSJ 996</b>        | 39    | 2.08  | 0.31  | 16.33 | 4.3   | 0.28  | 5    | <b>HS</b> |
| <b>GL 16056</b>       | 30.67 | 1.78  | 0.23  | 14    | 2.43  | 0.83  | 5    | <b>HS</b> |
| <b>PG 218</b>         | 47.33 | 2.58  | 0.33  | 19.33 | 4.41  | 0.3   | 5    | <b>HS</b> |
| <b>BGM 10218</b>      | 42.33 | 3.33  | 0.21  | 25.33 | 5.36  | 0.28  | 5    | <b>HS</b> |
| <b>BG 3097</b>        | 39    | 3.43  | 0.46  | 23.67 | 5.73  | 0.31  | 5    | <b>HS</b> |
| <b>BGM 10216</b>      | 29    | 1.76  | 0.28  | 16.67 | 3.23  | 0.16  | 5    | <b>HS</b> |
| <b>MABC-WR-SA 1</b>   | 31.33 | 1.55  | 0.05  | 17.33 | 2.13  | 0.05  | 5    | <b>HS</b> |
| <b>MABC-WR-SA 2</b>   | 32.67 | 0.86  | 0.16  | 15    | 0.78  | 0.23  | 4    | <b>S</b>  |
| <b>MABC-66-266</b>    | 31.33 | 0.95  | 0.1   | 12.33 | 2.16  | 0.15  | 5    | <b>HS</b> |
| <b>WRC 41-111</b>     | 28    | 1.03  | 0.11  | 13.33 | 2.1   | 0.1   | 5    | <b>HS</b> |
| <b>BGM 20211</b>      | 33.33 | 1.93  | 0.08  | 22.67 | 3.43  | 0.23  | 5    | <b>HS</b> |
| <b>BGM20212</b>       | 25    | 0.9   | 0.06  | 11    | 1.13  | 0.03  | 4.66 | <b>HS</b> |
| <b>ANNEGIN</b>        | 34.67 | 2.16  | 0.13  | 15.67 | 3.66  | 0.21  | 5    | <b>HS</b> |
| <b>Lsd(5%)</b>        | 12.59 | 3.50  | 0.98  | 6.69  | 1.75  | 0.27  | 0.18 | -         |
| <b>CV</b>             | 16.10 | 46.73 | 65.21 | 28.40 | 44.21 | 80.42 | 4.85 | -         |

R=Resistant, MR= Moderately resistant, S= Susceptible and HS=Highly susceptible

**Table.2** Correlation between root knot index and other parameters

| Parameters             | Root length | Shoot length | Fresh root weight | Fresh shoot weight | Dry root weight | Dry shoot weight |
|------------------------|-------------|--------------|-------------------|--------------------|-----------------|------------------|
| <b>Root Knot Index</b> | -0.688      | -0.773       | 0.716             | -0.658             | 0.296           | -0.705           |

With regard to root length, the chickpea accession, GLK 28127 exhibited longest root length, 30 cm whereas the smallest root length 7 cm was recorded with the accession Phule G 15109. It was also recorded that another 3 accessions and 29 accessions were statistically indifferent with the accessions GLK 28127 and Phule G 15109 respectively. Root length of rest 26 accessions was statistically different from both the longest and smallest root. With regard to root length, the chickpea accession, GLK 28127 exhibited longest root length, 30 cm whereas the

smallest root length 7 cm was recorded with the accession Phule G 15109. It was also recorded that another 3 accessions and 29 accessions were statistically indifferent with the accessions GLK 28127 and Phule G 15109 respectively. Root length of rest 26 accessions was statistically different from both the longest and smallest root. Performance trend of germplasms with regard to dry root weight of the plants was same as was noted in case of the fresh root weight. The greatest dry root weight 0.83g, the smallest dry root weight 0.01 g, were

recorded for GLK 16056 and GLK 28127 respectively. 2 accessions were at par with GLK 16056 while 41 were statistically indifferent with the accession GLK 28127. In reference to root-knot index, 9 germplasms were recorded resistant, 12 were moderately resistant and 7 germplasms were susceptible and 32 highly susceptible. However, interestingly nine germplasms exhibited no statistically significant difference with the smallest value of root-knot index (Table 1). The correlation of root knot index with both root and shoot attributes conforms that the growth of root length, shoot length, fresh shoot weight and dry shoot weight is negatively correlated to the root knot index ( $r = -0.688, -0.773, -0.658, -0.705$  respectively) while fresh root weight and dry root weight, were positively correlated with root knot index ( $r = 0.716, 0.296$  respectively) (Table 2).

According to El-Sherif *et al.*, (2007), root-knot nematode increases root weight for the most susceptible cultivar compared to resistant cultivar. This is because root-knot functions as metabolic sinks similar to a developing fruit as nutrients produced in the leaves are re-distributed rapidly to the roots and into the bodies of the nematodes.

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