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Rahul V
Department of Plant Pathology, College of Agriculture, University of Agricultural Sciences, Raichur, Karnataka, India

Mallikarjun Kenganal
Department of Plant Pathology, College of Agriculture, University of Agricultural Sciences, Raichur, Karnataka, India

Govindappa MR
Department of Plant Pathology, College of Agriculture, University of Agricultural Sciences, Raichur, Karnataka, India

Sreedevi S Chavan
Department of Plant Pathology, College of Agriculture, University of Agricultural Sciences, Raichur, Karnataka, India

SR Doddagoudar
Department of Seed Science and Technology, College of Agriculture, University of Agricultural Sciences, Raichur, Karnataka, India

Ravikumar A
Department of Agricultural Entomology, Agriculture Research Station, Hagari, Ballari, Karnataka, India

Corresponding Author:
Rahul V
Department of Plant Pathology, College of Agriculture, University of Agricultural Sciences, Raichur, Karnataka, India

Assessment of host resistance in chickpea against rust disease caused by *Uromyces ciceris-arietini*

Rahul V, Mallikarjun Kenganal, Govindappa MR, Sreedevi S Chavan, SR Doddagoudar and Ravikumar A

Abstract
Rust of chickpea caused by *Uromyces ciceris-arietini* is an obligate pathogen and is an economically important emerging disease of chickpea influenced by climate change factors. It causes drastic reduction in grain yield of the crop worldwide. The present study aims to find sources of resistance in chickpea against the rust disease. The reaction of 277 chickpea genotypes/entries against rust pathogen was monitored under field condition, of which, 169 entries showed susceptible reaction and the remaining 104 genotypes recorded highly susceptible reaction. Out of 277 genotypes/entries only four *viz*., BG 4032, BG 4029, IPCKB 2016-149 and GL 19607 showed moderately susceptible reaction. These genotypes could be considered as a source of partial resistance against rust and may delay the onset of disease. The outcomes also necessitate to sourcing resistance against rust outside the host genera or create artificially.

Keywords: *Uromyces ciceris-arietini*, chickpea, chickpea rust

Introduction
Chickpea (*Cicer arietinum* L.) is the most sought popular, short duration, drought resilient leguminous *rabi* crop grown across tropical and sub - tropical regions around the world (Rani *et al*., 2020) [10] and is a self-pollinating, diploid (2n=2x=16) with a genome size of 740 Mbp. It is the third most important pulse crop after bean (*Phaseolus vulgaris* L.) and pea (*Pisum sativum* L.) around the world and has prime importance in Mediterranean basin and South Asia. It belongs to the family *Fabaceae* and subfamily *Faboideae*. It is grown in more than 50 countries across Asia, Africa, Europe, Australia, North America, and South America of which Australia, Canada, Ethiopia, India, Iran, Mexico, Myanmar, Pakistan, Turkey, and USA are the major producers (Gaur *et al*., 2012; Archak *et al*., 2016; Dixit *et al*., 2019; Rani *et al.*, 2020) [6, 3, 4, 10].

The origin of chickpea is thought to have been in the area of present day South Eastern Turkey and neighboring Northern Syria. It has since spread to many other geographical regions of the world because of its ability to grow in diverse environments. There are two main commercial types of chickpea, the "*Desi*" type with smaller size and dark colored seeds which may vary from yellow to black and the "*Kabuli*" type with big size, smooth and light colored seeds (Rubio *et al.*, 2011) [11].

The highest production and consumption of chickpea is in South Asia. India is the leading producer of chickpeas with 73 per cent share in the global production (11 million metric tons) accounting for over two third of the global area, production and consumption in 2020. Globally chickpea is cultivated on an area of 17.9 million ha with a production of 17.2 million tonnes and has an average productivity of 965 kg/ha. India is the largest producer of chickpea in the world, accounting for 66 per cent of the total world's production. It is cultivated on an area of 9.69 million hectares with a production of 11.91 million tonnes and productivity of 1142 kg/ha. In India, Karnataka stands fifth in cultivation from an area of 0.86 million ha with a production of 0.67 million tons and productivity of 782 kg/ha (Anon, 2021) [2]. In Karnataka, Kalaburagi district occupies first position in area, production and productivity followed by Bijapur, Bidar, Gadag and Dharwad. However, the crop cultivation is hindered by both biotic and abiotic stresses every year. The chickpea wilt, dry root rot and pod borer are major constraints each year observed. In the last decade, chickpea rust is an additional fungal disease taking major toll of the crop across many parts of the state.

The chickpea rust caused by *Uromyces ciceris-arietini* is documented from several parts of South India including Karnataka, Maharashtra, Andhra Pradesh and Tamil Nadu and in North India it is common in Bihar, Uttar Pradesh and Punjab. Chickpea rust has started appearing in epidemic form in Northern Karnataka and has become major threat leading to drastic reduction in yield. Since 2015, the disease has been a major concern for growers especially in late sown situations. The wide spread sever chickpea rust disease necessitated to identify suitable host resistance for its management. Presently all the cultivated cultivars were found highly susceptible and identification of host resistance has become necessary.

Materials and Methods

The present investigation was carried out to find the reliable host resistance against the rust disease. Field experiment was conducted to screen 277 chickpea entries and genotypes against the rust disease. These entries comprised different varieties of chickpea released across the country, germplasm lines from AICRP network research project, IIPR Kanpur and ICRISAT.

The experiment was implemented at Agricultural Research Station, Hagari a hot spot for chickpea rust under natural epiphytotic conditions. Each entry was sown in single row of 4 m length following 30 cm spacing between the entries and 10 cm between the plants respectively. Rust severity was recorded at ten days interval starting form first appearance of the symptoms. The disease incidence on test entries was scored using 0-9 scale (Mayee and Datar, 1986) [7]. Later Per cent Disease index (PDI) was calculated by using formula given by Wheeler (1969) [14].

$$PDI = \frac{\text{Sum of individual disease rating}}{\text{Total no of plants observed X Maximum disease rating}} \times 100$$

Scale (0-9) for recording observations

Rating Scale	Description	Reaction
0	No symptoms on leaves	Immune (I)
1	Uredosori covering 1% or less of leaf area	Resistant (R)
3	Uredosori covering 1-10% leaf area	Moderately Resistant (MR)
5	Uredosori covering 11-25% leaf area	Moderately Susceptible (MS)
7	Uredosori covering 26-50% leaf area	Susceptible (S)
9	Uredosori covering 51% or more leaf area	Highly Susceptible (HS)

R =0-3; MR =3; S =7; HS =9 AICRP on Chickpea

Result and Discussion

The results from the present investigation revealed that, out of 277 genotypes and entries screened, none of them were immune, resistant and moderately resistant to rust. However, four genotypes *viz*., BG 4032, BG 4029, IPCKB 2016-149 and GL 19607 showed moderately susceptible reaction. Though these entries couldn't avoid the rust incidence but could slow down the infection process, disease occurrence, perpetuation and spread of the disease. Their adoption shall help in reducing the chemical sprays required in control of rust disease (Table 1 and 2 and Plate 1).

Among the 277 entries, 169 entries showed susceptible reaction *viz*., Nbeg 1149, BG 4030, RKG 21-1, IPCD 2016-127, IPC 2017-373, Nbeg 1423, RVSSG-106, IG 2021-01, PG265, BDNG2017-01, PG 289, BDNG2020-68, JG 2021-71, BG 4031, IG 21-06, Phule G 1302-3-5, RSGD-1119, GL18018, DC 2021-1664, H 19-16, GNG-2555, RG 2020-10, IPC 2018-131, RSGD-1155, BRC-8, BC-4, GJG1801, IG 21-05, DBGC 3, PG 281, RKG 21-3, IPCB2016-25, GL16026, GL18149, PG 282, GNG-2549, BDNG 2018-16, NBeG 1634, H 19-12, IG 2018-111, GNG2513, GRKG 21-2, RVSSG-105, GJG 1913, RVSSG-109, GL 18148, IPC 2018-38, PBC590, RKG 21-4, JG 2021-68, KCD 19-05, IPCD2019-222, NBeG 1509, RSGD 1137, DK 21-1311, CSJK-132, NBeG 1428, HK 20-5, RLBGMH-3, IGK 21-01, RVSSG-107, BDNG 2020-20, RVSSG-107, IPC2017-141, IG2020-16, RVSSG-108, H 16-04, IPC2017-292, Phule G 201301, IG 21-04, PBC 501, NBeG146, PBC582, Phule G181312, BG 4033, HK 19-67, RSGD 1174, RKGK 19-9, DBGC 3, IPCK 2016-12, H13-03, H 07-120, RSGD 834, NBeG 1532, GJG 1916, Phule G 1327-10-12, BG 4034, PBC 509, COC-18-01, ADBG 581, RKG13-125, GLK18087, KCK 20-9, GL 17020, GJG1810, KCMH20-15, H 12-55, IPC L 4-14, IPCB 2018-39, GL 13001, RSGD-965, AKG 1030, DCP 92-3, RSG 963, PKV 4-1, NC 9, IG 21-07, RG 2020-03, BGM 10221, GNG 1581, GNG 2299, Phule Vikram, JG 315, GJG 1914, RSGD-997, Annigeri 1, DMHC 21-1108, Phule G201114, IPC 2006-77, BDNGK 798, IPC MB 21-1, RVSSG-110, RKG 21-9, BGM 20215, RSG 931, GCP 101, MNK 1, GNG 2171, KCMH20-17, NBeG 1632, GL 17033, RSG 888, BGM 20211, Pant Gram 5, JAKI 9218, IPC 2017-351, PG 296, H 19-36, CSJ 515, KPG 59, RVG 204, DMHC 21-1104, GJG 1917, RG 2020-12, NBeG 506, KAK 2, GNG 2144, GBM 2, BG 372, Phule G 201113, RVG 202, Phule G 0517, RG 2015-08, RKG 21-10, H 18-08, Pant G 186, NC 7, Indira Chana 1, Phule G 0405, RKG 13-414, RKG 20-3, RKGM 20-1, PBG 574, CSJ 174, Vihar, IPCK 02-29, JG 16 and JG 24 (Table 1).

The remaining 104 genotypes recorded highly susceptible reaction *viz*., BRC 2021-09, RKG 19-1, GJG1803, PG 290, H05-24, NBeG924, GJG1810, IPCB 2014-88, NDG17-6-2, GNG 2562, DC 2021-1, Phule G 13143-3-27, RLBG-10, DCD 20-09, GJG 1093, JG 2021-69, Phule G 181609, PBC 539, H 19-21, GL 16056, RLBG 9, RSGD1116, KCD2019-05, H 16-21, GJG 1907, IPC 2016-231, RSGD-984, NBeG 1328, GNG2557, KCD 19-05, RSGD-1125, JG 2021-67, Phule G1216-10-17, IGK 2020-02, IPCB2015-132, GL15003, BG4027, PhuleG 1221-2-6, GNG 2479, GJG 1910, IG2020-05, CSJ 138, IPCKB 2016-133, GJG1913, GNG2518, RKGKD 17-09, Phule G 171313, COC-18-02, RLBGK-7, H 16-17, RSGD 1068, KCD 20-8, IG 2020-15, GNG 2546, GNG 2461, NBeG 1430, IPC2017-253, KCD20-3, NBeG1137, IPC 2017-361, BG 4035, PG 252,CSJK-169, RVSSG-112, BGD166, CSJ-824, IPC 2017-04, RLBGMH-4, NBeG1267, KCK 20-17, IPCK 2010-124, IG 21-03, RVSSG 96, RKGM 20-2, RKG 21-8, BDNG 2020-8, GNG 2550, RKG 21-5, RKG 13-416, GJGK 1824, IPCMB 19-3, AKG 1402, NBeG 1427, RSGD-997, RLBGMH-6, BG 4037, BRC2021-10, NBeG 119, BG 4036, BG3043, GNG 2207, JG 2021-70, GNG 1958, RLBGMH-5, IPC 2018-59, NC 8, HC 5, IG 21-08, PG 298, RVSSG-111, CSG 8962, BGM 10222, NBeG 810 and Pusa 10216 (Table 1).

Host resistance in chickpea against rust is very rare and in earlier efforts by Gallegos *et al*. (1965) [5] and Nargund *et al*. (2011) [8], all the entries screened were found susceptible to

rust. Whereas, in cowpea Anil Kumar *et al*. (1989) [1] screened twenty-one promising genotypes against rust and found only five genotypes *viz*., V-105, V-154, V-276, V-282 and V-385 were resistant and remaining genotypes were susceptible to rust disease. In a recent report by Upadhyay *et al*., (2017) [13] out of 46 genotypes screened against pea rust, none was resistant to rust disease, only two genotypes P 244 and Pant P 42 showed moderately resistant reaction, 13 were moderately susceptible, 29 were susceptible and two were highly susceptible. Hence from the results it is evident that resistance against chickpea rust is very scarce and rare. It is essential to create genetic variability.

Plate 1: General view of screening plot of chickpea rust disease

Table 1: Response of host resistance against *U. ciceris-arietini* in chickpea during 2021-22

Sl. No.	Entries	Codes	Rust Disease (PDI)				
			RI (%)	RII (%)	Mean (%)	Score	Reaction
1	Nbeg 1149	P-12101	45.36	41.52	43.44	7	S
2	BG 4030	P-12102	39.13	36.54	37.84	7	S
3	BRC 2021-09	P-12103	79.25	84.21	81.73	9	HS
4	RKG 19-1	P-12104	85.19	76.64	80.91	9	HS
5	GJG1803	P-12105	76.30	70.11	73.20	9	HS
6	PG 290	P-12106	52.71	50.26	51.49	9	HS
7	RKG 21-1	P-12107	38.67	36.25	37.46	7	S
8	IPCD 2016- 127	P-12108	31.85	34.94	33.40	7	S
9	IPC 2017-373	P-12109	38.96	35.71	37.34	7	S
10	Nbeg 1423	P-12110	33.33	29.27	31.30	7	S
11	RVSSG-106	P-12111	34.11	31.76	32.94	7	S
12	IG 2021-01	P-12112	33.33	38.44	35.89	7	S
13	PG265	P-12113	35.93	30.24	33.09	7	S
14	BDNG2017-01	P-12114	36.67	39.45	38.06	7	S
15	PG 289	P-12115	37.78	41.55	39.66	7	S
16	BDNG2020-68	P-12116	39.87	34.22	37.05	7	S
17	JG 2021-71	P-12117	30.21	37.65	33.93	7	S
18	BG 4031	P-12118	44.31	42.11	43.21	7	S
19	IG 21-06	P-12119	39.26	36.79	38.03	7	S
20	Phule G 1302-3-5	P-12120	35.38	30.21	32.80	7	S
21	RSGD-1119	P-12121	36.84	32.74	34.79	7	S
22	GL18018	P-12122	36.49	31.66	34.08	7	S
23	DC 2021-1664	P-12123	38.72	35.68	37.20	7	S
24	H 19-16	P-12124	43.66	37.59	40.63	7	S
25	GNG-2555	P-12125	39.88	36.21	38.05	7	S
26	RG 2020-10	P-12126	41.54	37.39	39.47	7	S
27	H05-24	P-12127	53.22	48.33	50.78	9	HS
28	NBeG924	P-12128	52.73	55.64	54.19	9	HS
29	IPC 2018-131	P-12129	48.65	45.13	46.89	7	S
30	GJG1810	P-12130	53.32	49.36	51.34	9	HS
31	RSGD-1155	P-12131	38.44	36.14	37.29	7	S

32	BRC-8	P-12132	34.07	31.57	32.82	7	S
33	IPCB 2014-88	P-12133	62.96	58.93	60.95	9	HS
34	BC-4	P-12134	43.70	41.47	42.59	7	S
35	NDG17-6-2	P-12135	67.41	65.14	66.27	9	HS
36	GJG1801	P-12136	46.67	50.31	48.49	7	S
37	GNG 2562	P-12137	77.78	80.46	79.12	9	HS
38	DC 2021-1	P-12139	73.33	71.39	72.36	9	HS
39	Phule G 13143-3-27	P-12140	51.11	55.62	53.37	9	HS
40	RLBG-10	P-12141	57.78	60.73	59.25	9	HS
41	IG 21-05	P-12142	46.67	44.69	45.68	7	S
42	DCD 20-09	P-12143	56.78	53.64	55.21	9	HS
43	GJG 1093	P-12144	68.89	71.69	70.29	9	HS
44	JG 2021-69	P-12145	58.47	54.98	56.73	9	HS
45	Phule G 181609	P-12146	51.36	55.19	53.28	9	HS
46	DBGC 3	P-12147	39.74	43.21	41.48	7	S
47	PBC 539	P-12148	54.33	49.77	52.05	9	HS
48	H 19-21	P-12149	54.65	52.89	53.77	9	HS
49	PG 281	P-12150	46.33	44.81	45.57	7	S
50	GL 16056	P-12151	55.38	58.39	56.88	9	HS
51	RKG 21-3	P-12152	37.78	41.87	39.82	7	S
52	RLBG 9	P-12153	53.33	50.09	51.71	9	HS
53	RSGD1116	P-12154	59.88	62.42	61.15	9	HS
54	KCD2019-05	P-12155	77.78	72.66	75.22	9	HS
55	H 16-21	P-12156	60.00	65.18	62.59	9	HS
56	GJG 1907	P-12157	80.39	85.15	82.77	9	HS
57	IPC 2016-231	P-12158	69.33	74.37	71.85	9	HS
58	RSGD-984	P-12159	57.62	61.86	59.74	9	HS
59	NBeG 1328	P-12160	63.72	58.85	61.29	9	HS
60	IPCB2016-25	P-12161	37.78	34.61	36.19	7	S
61	GL16026	P-12162	28.44	36.25	32.35	7	S
62	GL18149	P-12163	34.95	30.76	32.86	7	S
63	PG 282	P-12164	31.11	37.88	34.50	7	S
64	GNG-2549	P-12165	44.44	54.69	49.57	7	S
65	GNG2557	P-12166	56.69	51.54	54.12	9	HS
66	KCD 19-05	P-12167	56.13	52.98	54.56	9	HS
67	RSGD-1125	P-12168	66.74	59.87	63.31	9	HS
68	BDNG 2018-16	P-12169	38.64	45.78	42.21	7	S
69	NBeG 1634	P-12170	31.11	36.55	33.83	7	S
70	H 19-12	P-12171	26.67	31.55	29.11	7	S
71	IG 2018-111	P-12172	40.58	44.91	42.75	7	S
72	GNG2513	P-12173	43.70	38.57	41.14	7	S
73	GRKG 21-2	P-12174	31.85	35.74	33.80	7	S
74	RVSSG-105	P-12175	45.36	48.66	47.01	7	S
75	GJG 1913	P-12176	27.41	32.17	29.79	7	S
76	RVSSG-109	P-12177	31.11	36.42	33.77	7	S
77	GL 18148	P-12178	28.15	32.84	30.49	7	S
78	IPC 2018-38	P-12179	36.55	28.54	32.55	7	S
79	BG 4032	P-12180	16.30	21.65	18.97	5	MS
80	BG 4029	P-12181	19.66	17.04	18.35	5	MS
81	PBC590	P-12182	35.92	33.65	34.79	7	S
82	RKG 21-4	P-12183	37.78	43.87	40.82	7	S
83	JG 2021-68	P-12184	39.65	45.69	42.67	7	S
84	JG 2021-67	P-12185	55.56	60.22	57.89	9	HS
85	Phule G1216-10-17	P-12186	52.14	58.47	55.31	9	HS
86	KCD 19-05	P-12187	41.66	45.71	43.69	7	S
87	IPCD2019-222	P-12190	38.99	45.38	42.19	7	S
88	NBeG 1509	P-12191	38.52	34.24	36.38	7	S
89	RSGD 1137	P-12192	46.67	51.46	49.06	7	S
90	IGK 2020-02	P-12193	49.63	54.39	52.01	9	HS
91	IPCB2015-132	P-12194	74.81	79.68	77.25	9	HS
92	GL15003	P-12195	68.89	75.66	72.27	9	HS
93	BG4027	P-12196	61.48	58.98	60.23	9	HS
94	PhuleG 1221-2-6	P-12197	48.51	54.69	51.60	9	HS
95	DK 21-1311	P-12198	39.88	41.24	40.56	7	S
96	GNG 2479	P-12199	57.04	60.22	58.63	9	HS
97	GJG 1910	P-12200	55.56	52.87	54.21	9	HS
98	CSJK-132	P-12201	36.30	40.19	38.24	7	S
99	NBeG 1428	P-12202	28.99	36.28	32.64	7	S

100	HK 20-5	P-12203	45.69	50.47	48.08	7	S
101	IG2020-05	P-12204	70.33	65.78	68.06	9	HS
102	CSJ 138	P-12205	48.73	54.69	51.71	9	HS
103	RLBGMH-3	P-12206	36.54	41.38	38.96	7	S
104	IGK 21-01	P-12207	37.87	33.61	35.74	7	S
105	RVSSG-107	P-12208	44.58	50.12	47.35	7	S
106	BDNG 2020-20	P-12209	33.33	40.87	37.10	7	S
107	RVSSG-107	P-12210	41.59	36.69	39.14	7	S
108	IPCKB 2016-133	P-12211	65.37	58.45	61.91	9	HS
109	GJG1913	P-12212	56.98	48.33	52.66	9	HS
110	IPC2017-141	P-12213	42.65	39.88	41.27	7	S
111	IG2020-16	P-12214	28.89	33.65	31.27	7	S
112	GNG2518	P-12215	53.14	58.74	55.94	9	HS
113	RVSSG-108	P-12216	39.85	45.69	42.77	7	S
114	RKGKD 17-09	P-12217	60.14	57.41	58.78	9	HS
115	H 16-04	P-12218	40.33	36.73	38.53	7	S
116	IPC2017-292	P-12219	39.77	45.46	42.62	7	S
117	Phule G 201301	P-12220	45.17	40.91	43.04	7	S
118	Phule G 171313	P-12221	58.66	62.83	60.75	9	HS
119	IG 21-04	P-12222	47.36	50.41	48.89	7	S
120	PBC 501	P-12223	41.96	46.55	44.26	7	S
121	COC-18-02	P-12224	57.50	60.13	58.82	9	HS
122	NBeG146	P-12225	41.39	44.78	43.09	7	S
123	PBC582	P-12226	38.77	42.19	40.48	7	S
124	RLBGK-7	P-12227	58.44	62.11	60.28	9	HS
125	Phule G181312	P-12228	43.51	48.77	46.14	7	S
126	H 16-17	P-12229	54.27	50.28	52.28	9	HS
127	BG 4033	P-12230	47.36	42.76	45.06	7	S
128	RSGD 1068	P-12231	63.22	67.34	65.28	9	HS
129	KCD 20-8	P-12232	57.48	53.74	55.61	9	HS
130	HK 19-67	P-12233	41.33	45.67	43.50	7	S
131	RSGD 1174	P-12234	48.65	51.24	49.95	7	S
132	IG 2020-15	P-12235	65.12	59.37	62.25	9	HS
133	RKGK 19-9	P-12236	44.74	51.65	48.20	7	S
134	GNG 2546	P-12237	54.77	61.39	58.08	9	HS
135	GNG 2461	P-12238	61.53	63.18	62.36	9	HS
136	DBGC 3	P-12239	37.81	40.74	39.28	7	S
137	NBeG 1430	P-12240	61.24	67.86	64.55	9	HS
138	IPCK 2016-12	P-12241	38.44	41.33	39.89	7	S
139	H13-03	P-12242	45.34	53.42	49.38	7	S
140	IPC2017-253	P-12243	54.12	60.82	57.47	9	HS
141	KCD20-3	P-12244	46.33	53.81	50.07	9	HS
142	NBeG1137	P-12245	71.45	68.43	69.94	9	HS
143	IPC 2017-361	P-12246	63.74	61.33	62.54	9	HS
144	BG 4035	P-12247	70.11	72.65	71.38	9	HS
145	PG 252	P-12248	66.31	59.46	62.89	9	HS
146	H 07-120	P-12249	45.78	52.77	49.28	7	S
147	CSJK-169	P-12250	60.75	58.39	59.57	9	HS
148	RSGD 834	P-12251	45.66	51.48	48.57	7	S
149	RVSSG-112	P-12252	57.17	65.73	61.45	9	HS
150	BGD166	P-12253	71.48	66.48	68.98	9	HS
151	CSJ-824	P-12254	53.64	50.42	52.03	9	HS
152	IPC 2017-04	P-12255	55.47	61.49	58.48	9	HS
153	NBeG 1532	P-12256	34.81	40.33	37.57	7	S
154	RLBGMH-4	P-12257	48.15	52.62	50.38	9	HS
155	NBeG1267	P-12258	52.67	60.27	56.47	9	HS
156	GJG 1916	P-12259	50.38	45.36	47.87	7	S
157	KCK 20-17	P-12260	70.14	66.84	68.49	9	HS
158	IPCK 2010-124	P-12261	68.47	75.69	72.08	9	HS
159	RKG 20-2	P-12262	42.52	50.23	46.38	7	S
160	IG 21-03	P-12263	53.33	60.47	56.90	9	HS
161	Phule G 1327-10-12	P-12264	46.67	52.14	49.40	7	S
162	BG 4034	P-12265	38.41	33.75	36.08	7	S
163	RVSSG 96	P-12266	57.49	52.31	54.90	9	HS
164	RKGM 20-2	P-12267	60.00	62.33	61.17	9	HS
165	RKG 21-8	P-12268	55.37	51.78	53.58	9	HS
166	BDNG 2020-8	P-12269	58.52	60.44	59.48	9	HS
167	GNG 2550	P-12270	62.96	68.41	65.69	9	HS

168	PBC 509	P-12271	41.36	50.18	45.77	7	S
169	COC-18-01	P-12272	33.33	39.46	36.40	7	S
170	RKG 21-5	P-12273	53.91	51.79	52.85	9	HS
171	ADBG 581	P-12274	40.58	32.14	36.36	7	S
172	RKG13-125	P-12275	47.85	51.28	49.57	7	S
173	RKG 13-416	P-12276	70.19	65.12	67.66	9	HS
174	IPCKB 2016-149	P-12277	18.65	13.68	16.17	5	MS
175	GLK18087	P-12278	26.39	30.44	28.42	7	S
176	KCK 20-9	P-12279	30.37	38.16	34.27	7	S
177	GL 17020	P-12280	35.56	42.57	39.06	7	S
178	GJGK 1824	P-12281	58.13	64.42	61.28	9	HS
179	GJG1810	P-12282	42.22	50.88	46.55	7	S
180	KCMH20-15	P-12285	31.85	36.19	34.02	7	S
181	H 12-55	P-12286	25.93	31.47	28.70	7	S
182	IPC L 4-14	P-12287	27.41	36.22	31.81	7	S
183	IPCB 2018-39	P-12288	33.33	30.64	31.99	7	S
184	IPCMB 19-3	P-12289	56.48	61.87	59.18	9	HS
185	GL 13001	P-12290	41.72	45.81	43.77	7	S
186	RSGD-965	P-12291	28.15	32.56	30.35	7	S
187	AKG 1402	P-12292	56.82	60.27	58.55	9	HS
188	AKG 1030	P-12293	37.04	42.58	39.81	7	S
189	DCP 92-3	P-12294	42.18	46.05	44.12	7	S
190	RSG 963	P-12295	36.71	40.35	38.53	7	S
191	PKV 4-1	P-12296	42.15	51.27	46.71	7	S
192	NC 9	P-12297	31.85	39.46	35.66	7	S
193	IG 21-07	P-12298	42.54	49.31	45.93	7	S
194	RG 2020-03	P-12299	34.81	40.85	37.83	7	S
195	BGM 10221	P-12300	51.36	48.32	49.84	7	S
196	GNG 1581	P-12301	36.44	41.58	39.01	7	S
197	GNG 2299	P-12302	37.78	41.65	39.71	7	S
198	Phule Vikram	P-12303	33.33	40.94	37.14	7	S
199	JG 315	P-12304	39.26	45.57	42.41	7	S
200	NBeG 1427	P-12305	50.77	55.12	52.95	9	HS
201	GJG 1914	P-12306	30.37	38.29	34.33	7	S
202	GL19607	P-12307	22.22	19.04	20.63	5	MS
203	RSGD-997	P-12308	26.67	31.88	29.27	7	S
204	RSGD-997	P-12309	57.81	61.65	59.73	9	HS
205	Annigeri 1	P-12310	37.78	41.33	39.55	7	S
206	RLBGMH-6	P-12311	59.25	66.45	62.85	9	HS
207	DMHC 21-1108	P-12312	37.84	45.68	41.76	7	S
208	Phule G201114	P-12313	33.33	40.18	36.76	7	S
209	IPC 2006-77	P-12314	39.26	46.95	43.10	7	S
210	BDNGK 798	P-12315	27.41	33.24	30.32	7	S
211	IPC MB 21-1	P-12316	31.85	44.63	38.24	7	S
212	RVSSG-110	P-12317	40.74	37.58	39.16	7	S
213	BG 4037	P-12318	52.59	60.17	56.38	9	HS
214	RKG 21-9	P-12319	36.30	40.39	38.34	7	S
215	BGM 20215	P-12320	41.84	45.61	43.73	7	S
216	RSG 931	P-12321	53.29	46.57	49.93	7	S
217	GCP 101	P-12322	33.33	40.86	37.10	7	S
218	MNK 1	P-12323	28.15	33.42	30.78	7	S
219	GNG 2171	P-12324	39.33	43.68	41.51	7	S
220	KCMH20-17	P-12325	46.67	51.42	49.04	7	S
221	BRC2021-10	P-12326	60.73	54.18	57.46	9	HS
222	NBeG 1632	P-12327	34.07	30.14	32.11	7	S
223	GL 17033	P-12328	45.78	42.89	44.34	7	S
224	RSG 888	P-12329	36.00	41.35	38.68	7	S
225	NBeG 119	P-12330	56.41	60.47	58.44	9	HS
226	BGM 20211	P-12331	33.33	38.69	36.01	7	S
227	Pant Gram 5	P-12332	40.74	44.19	42.47	7	S
228	BG 4036	P-12333	50.26	56.48	53.37	9	HS
229	JAKI 9218	P-12334	48.15	44.35	46.25	7	S
230	IPC 2017-351	P-12335	45.51	50.28	47.90	7	S
231	PG 296	P-12336	42.22	47.93	45.08	7	S
232	H 19-36	P-12337	37.78	41.66	39.72	7	S
233	CSJ 515	P-12338	38.54	33.81	36.18	7	S
234	BG3043	P-12339	54.36	50.22	52.29	9	HS
235	KPG 59	P-12340	40.74	35.76	38.25	7	S

236	RVG 204	P-12341	45.19	41.28	43.23	7	S
237	GNG 2207	P-12342	54.07	61.73	57.90	9	HS
238	DMHC 21-1104	P-12343	28.15	34.66	31.40	7	S
239	GJG 1917	P-12344	46.59	49.42	48.01	7	S
240	JG 2021-70	P-12345	68.19	63.75	65.97	9	HS
241	RG 2020-12	P-12346	34.81	40.32	37.57	7	S
242	NBeG 506	P-12347	54.28	51.67	52.98	9	S
243	KAK 2	P-12348	36.54	32.49	34.52	7	S
244	GNG 1958	P-12349	48.15	52.46	50.30	9	HS
245	GNG 2144	P-12350	32.61	38.57	35.59	7	S
246	GBM 2	P-12351	39.26	30.91	35.08	7	S
247	BG 372	P-12352	36.30	42.55	39.42	7	S
248	RLBGMH-5	P-12353	57.46	61.38	59.42	9	HS
249	Phule G 201113	P-12354	42.22	40.56	41.39	7	S
250	IPC 2018-59	P-12355	61.48	57.31	59.40	9	HS
251	RVG 202	P-12356	34.81	40.56	37.69	7	S
252	Phule G 0517	P-12357	36.30	39.45	37.87	7	S
253	RG 2015-08	P-12358	46.67	50.78	48.72	7	S
254	RKG 21-10	P-12359	42.22	46.61	44.42	7	S
255	H 18-08	P-12360	34.81	39.54	37.18	7	S
256	NC 8	P-12361	50.95	55.37	53.16	9	HS
257	Pant G 186	P-12362	34.81	41.25	38.03	7	S
258	NC 7	P-12363	42.68	39.56	41.12	7	S
259	HC 5	P-12364	69.38	66.43	67.91	9	HS
260	IG 21-08	P-12365	56.71	51.36	54.04	9	HS
261	PG 298	P-12366	56.37	52.49	54.43	9	HS
262	RVSSG-111	P-12367	58.17	55.64	56.91	9	HS
263	Indira Chana 1	P-12368	36.30	40.88	38.59	7	S
264	CSG 8962	P-12369	54.35	59.57	56.96	9	HS
265	Phule G 0405	P-12370	20.74	26.89	23.82	7	S
266	RKG 13-414	P-12371	38.69	41.57	40.13	7	S
267	RKG 20-3	P-12372	42.53	39.42	40.98	7	S
268	RKGM 20-1	P-12373	39.26	46.87	43.06	7	S
269	PBG 574	P-12374	37.78	40.55	39.16	7	S
270	BGM 10222	P-12375	62.30	58.16	60.23	9	HS
271	NBeG 810	P-12376	52.59	58.33	55.46	9	HS
272	CSJ 174	P-12377	35.29	40.11	37.70	7	S
273	Vihar	P-12378	37.04	41.89	39.46	7	S
274	Pusa 10216	P-12379	52.59	55.34	53.97	9	HS
275	IPCK 02-29	P-12380	46.32	49.72	48.02	7	S
276	JG 16	P-12381	34.15	38.67	36.41	7	S
277	JG 24	P-12382	42.36	39.53	40.95	7	S

Table 2: Reaction of chickpea genotype against rust during *Rabi* 2021-22

Reaction	Rating Value	Genotype	Frequency
Immune	0	Nil	-
Resistant	1	Nil	-
Moderately resistant	3	Nil	-
Moderately susceptible	5	BG 4032, BG 4029, IPCKB 2016-149 and GL 19607.	4
Susceptible	7	Nbeg 1149, BG 4030, RKG 21-1, IPCD 2016- 127, IPC 2017-373, Nbeg 1423, RVSSG-106, IG 2021-01, PG265, BDNG2017-01, PG 289, BDNG2020-68, JG 2021-71, BG 4031, IG 21-06, Phule G 1302-3-5, RSGD-1119, GL18018, DC 2021-1664, H 19-16, GNG-2555, RG 2020-10, IPC 2018-131, RSGD-1155, BRC-8, BC-4, GJG1801, IG 21-05, DBGC 3, PG 281, RKG 21-3, IPCB2016-25, GL16026, GL18149, PG 282, GNG-2549, BDNG 2018-16, NBeG 1634, H 19-12, IG 2018-111, GNG2513, GRKG 21-2, RVSSG-105, GJG 1913, RVSSG-109, GL 18148, IPC 2018-38, PBC590, RKG 21-4, JG 2021-68, KCD 19-05, IPCD2019-222, NBeG 1509, RSGD 1137, DK 21-1311, CSJK-132, NBeG 1428, HK 20-5, RLBGMH-3, IGK 21-01, RVSSG-107, BDNG 2020-20, RVSSG-107, IPC2017-141, IG2020-16, RVSSG-108, H 16-04, IPC2017-292, Phule G 201301, IG 21-04, PBC 501, NBeG146, PBC582, Phule G181312, BG 4033, HK 19-67, RSGD 1174, RKGK 19-9, DBGC 3, IPCK 2016-12, H13-03, H 07-120, RSGD 834, NBeG 1532, GJG 1916, Phule G 1327-10-12, BG 4034, PBC 509, COC-18-01, ADBG 581, RKG13-125, GLK18087, KCK 20-9, GL 17020, GJG1810, KCMH20-15, H 12-55, IPC L 4-14, IPCB 2018-39, GL 13001, RSGD-965, AKG 1030, DCP 92-3, RSG 963, PKV 4-1, NC 9, IG 21-07, RG 2020-03, BGM 10221, GNG 1581, GNG 2299, Phule Vikram, JG 315, GJG 1914, RSGD-997, Annigeri 1, DMHC 21-1108, Phule G201114,	169

		IPC 2006-77, BDNGK 798, IPC MB 21-1, RVSSG-110, RKG 21-9, BGM 20215, RSG 931, GCP 101, MNK 1, GNG 2171, KCMH20-17, NBeG 1632, GL 17033, RSG 888, BGM 20211, Pant Gram 5, JAKI 9218, IPC 2017-351, PG 296, H 19-36, CSJ 515, KPG 59, RVG 204, DMHC 21-1104, GJG 1917, RG 2020-12, NBeG 506, KAK 2, GNG 2144, GBM 2, BG 372, Phule G 201113, RVG 202, Phule G 0517, RG 2015-08, RKG 21-10, H 18-08, Pant G 186, NC 7, Indira Chana 1, Phule G 0405, RKG 13-414, RKG 20-3, RKGM 20-1, PBG 574, CSJ 174, Vihar, IPCK 02-29, JG 16 and JG 24.	
Highly susceptible	9	BRC 2021-09, RKG 19-1, GJG1803, PG 290, H05-24, NBeG924, GJG1810, IPCB 2014-88, NDG17-6-2, GNG 2562, DC 2021-1, Phule G 13143-3-27, RLBG-10, DCD 20-09, GJG 1093, JG 2021-69, Phule G 181609, PBC 539, H 19-21, GL 16056, RLBG 9, RSGD1116, KCD2019-05, H 16-21, GJG 1907, IPC 2016-231, RSGD-984, NBeG 1328, GNG2557, KCD 19-05, RSGD-1125, JG 2021-67, Phule G1216-10-17, IGK 2020-02, IPCB2015-132, GL15003, BG4027, PhuleG 1221-2-6, GNG 2479, GJG 1910, IG2020-05, CSJ 138, IPCKB 2016-133, GJG1913, GNG2518, RKGKD 17-09, Phule G 171313, COC-18-02, RLBGK-7, H 16-17, RSGD 1068, KCD 20-8, IG 2020-15, GNG 2546, GNG 2461, NBeG 1430, IPC2017-253, KCD20-3, NBeG1137, IPC 2017-361, BG 4035, PG 252,CSJK-169, RVSSG-112, BGD166, CSJ-824, IPC 2017-04, RLBGMH-4, NBeG1267, KCK 20-17, IPCK 2010-124, IG 21-03, RVSSG 96, RKGM 20-2, RKG 21-8, BDNG 2020-8, GNG 2550, RKG 21-5, RKG 13-416, GJGK 1824, IPCMB 19-3, AKG 1402, NBeG 1427, RSGD-997, RLBGMH-6, BG 4037, BRC2021-10, NBeG 119, BG 4036, BG3043, GNG 2207, JG 2021-70, GNG 1958, RLBGMH-5, IPC 2018-59, NC 8, HC 5, IG 21-08, PG 298, RVSSG-111, CSG 8962, BGM 10222, NBeG 810 and Pusa 10216.	104
Susceptible check	9	JG-11 and BGD-103	2

Conclusion

Legumes have limited resistance against the rust disease and chickpea is not an exception as noticed in the present study. Among the 277 chickpea entries screened against rust none was resistant. Only four genotypes *viz*., BG 4032, BG 4029, IPCKB 2016-149 and GL 19607 were found moderately susceptible and rest were either susceptible to highly susceptible. The findings guide us towards developing future breeding strategies and exploring the source of resistance outside the cultivated genera or induce genetic variability artificially. In the absence of host resistance against rust disease, early sowing and chemical control were found most ideal and are proposed for recommendation among the growers.

Future Scope

Source of resistant needs to be identified in wild species and diversity shall be created among cultivated through mutations. An integrated approach for timely management of disease needs to be developed to reduce the yield losses.

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Conflict of Interest: None

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