Screening of various chickpea varieties against *fusarium oxysporum* f.sp.*ciceri* under field conditions

Abstract; A field experiment was conducted by of Mansarovar Global University, Sehore at KVK Satna in 2020 to 2021 and 2021-2022. To assessed the "**Screening of various chickpea varieties against *fusarium oxysporum* f.sp.*ciceri* under field conditions"** All the 30 chickpea cultivars used in the study expressed varied response when screened for host reaction against *Fusarium oxysporum* f. sp. *ciceri* during both the two consecutive years of planting. On the basis of 0-5 rating scale, 07 varieties (JG-315,JG-12,JG-36,RVG-202,RVG-205,JG-412,RVSSG-74) were recorded to be resistant, 12 as moderately resistant, 09 as tolerant and the remaining 02 susceptible varieties. JG 315variety revealed wilt severity during both years which was least while highest severity of disease with a score of 7.25 and 7.12 % was expressed by the variety JG-315 when planted consecutively for two years. Findings also suggested that wilt severity directly affected the per cent wilt incidence as varieties unveiling higher severity had higher wilting percentage. Besides, a negative correlation was drawn when varieties sowing higher rate of severity and wilting had lower crop yield. Variety named JG 315 revealed lowest disease severity and wilting with maximum crop produce and was thus the best amongst all the test varieties

Keywords; Chickpea(*Cicer arietinum*), *Fusarium oxysporum* f.sp.*ciceri*, chickpea varieties , Rating scale, Disease incidence

Introduction; Chickpea (*Cicer arietinum* L.) is an important pulse crop belong s to Leguminoceae family. It is grown throughout the world with different names i.e. Chickpea (UK), Garbanzo (Latin America), Bengal gram (India), Hommes, Hamaz (Arab world), Shimbra (Ethiopia) and Nohud and Loblebi (Turkey). It is a self-pollinated rabi season crop but Smithson et al., (1985) and Singh (1987) reported cross-pollination up to 1%. It provides a high quality protein to the people in developing countries. Chickpea is valued for their nutritive seeds with high protein content, 25.3 - 28.9 per cent after dehulling carbohydrate 61.5 per cent, fat 4.5 per cent and vitamin 2.44 per cent. (Hulse,. 1991).

Chickpea being growing over 45 countries in the world. The world's total production of chickpea is around 8.5 m tones annually and is grown over 11.2 m. ha. of land approximately. (Annon,2018). India is the largest producer of chickpea contributing around 70 per cent (6.2 m. tones) of the world's total production. Apart from India, Turkey (7%), Pakistan (5%), Iran (3%), Mexico (3%), Australia (2%), Canada (2%) and Ethopia (2%) were found to be the other major chickpea producing countries of the world (Annon,2018).

In India Chickpea is grown in 8.57 m ha with 7.8 m. tones production and 900-920 kg/ha productivity. Madhya Pradesh is the major chickpea growing states as compare, Rajasthan, Maharashtra, Gujarat, Andhra Pradesh, and Karnataka, Madhya Pradesh ranks 1st in both area (106 lakh ha.) and production (112 lakh tones) and the average productivity is estimated 1063 kg / ha. in Madhya Pradesh (DPD, Annual Progress Report 2017-18).Satna is the major chickpea growing district as compare to Vindhyachal region of Madhya Pradesh. Satna rank seventh in both area (1.9 lakh ha.) and production (127 M.tones) and the average productivity is 1162 kg /ha.in Vindhya region. (DPD, Annual Progress Report 2017-18). It is a self-pollinated rabi season crop but Smithson et al., (1985) and Singh (1987) reported cross-pollination up to 1%.

The pathogen *(F. oxysporum)* survive as mycelium and chlamydospores in seed and soil, and also on infected crop residues, roots and stem tissue buried in the soil for up to 6 years and yield losses of up to 72.16 per cent may occur under favorable condition (Kumar and Bourai, 2012). Maximum vascular wilt disease incidence 22.5 % in chickpea genotype was observed in December month .where as, during that period the temperature ranged from 7.40 c to 24.90 c and relative humidity, 24.0 to 89 percent Jagre and Gupta (2012).

Chickpea is infected by 67 fungal pathogens and several of them are of economic importance. Some of the fungus soil borne nature pathogens like *Fusarium oxysporum* f.sp. *ciceri* (wilt), *Rhizoctonia bataticola* (dry root rot) and *Sclerotium rolfsii* (collar rot). Nene and Reddy, (1987) is reported Fusarium wilt caused by *Fusarium oxysporum* f.sp. *ciceri* is the most important disease of chickpea throughout the world particularly in the Indian subcontinent, the Mediterranean basin and California. Padwick (1940).

Identified the causal agent of Fusarium wilt as *Fusarium orthoceras* and Wollr var. cicer. Fusarium wilt is a serious disease, especially in low rainfall areas, where weather conditions are

favorable for disease development. It has been reported from 33 countries of the world (Nene et al., 1996).The first report of occurrence of *fusarium oxysporum* in chickpea along with wilt was made by Padwick (1948). In chickpea *fusarium oxysporum* 2 to 5 per cent yield losses every year in India, but it could go as high as 60 per cent Grewal et al., (1974).Chickpea wilt incited by *Fusarium oxysporum* f. sp. ciceris is one of the serious diseases causes annual loss at 10 per cent in yield (Dubey et al., 2007).

Chickpea vascular wilt disease incidence ranging 3.58 to 20.63 percent in 30 villages of Northern Madhya Pradesh The disease is more severe at pod formation and grain filling stage especially under stress condition and causes forced maturity resulting reduced seed size Gupta et al., (1983).Vascular wilt disease can occur at all the stage of plant growth right from seedling to maturity and causes annual yield losses of 10-90 per cent annually (Jalali and Chand, 1992,).

In susceptible genotypes, under favorable environmental conditions, wilt causes 100 per cent yield losses (Jimmez *et al*. 1989).*Fusarium oxysporum* f.sp.ciceri in symptoms of chickpea wilt as sudden drooping of leaves and petioles with external rotting of roots Nene et al. (1979). Discoloration occurs inside tissues from the root to the aerial parts. Yellowing and wilting of the foliage occur and finally there is necrosis (Leslie and Summerell, 2006)

Evaluated eighty one chickpea genotypes for their reaction to wilt. Out of these 10 genotypes were resistant to (JG-22, JG 33, KPG 316 and SAKI 93130) showing a stable resistant reaction and being suitable for use in breeding programmes Yadav et al., (2000).Extracts of Allium sativum, Allium cepa and Mentha arvensis were evaluated for their effect on the inhibition of mycelial growth and spore germination of *F. oxysporum*. Nisa et al.(2011).

Material & Method

Collection of diseased plant/root sample; The collection of 30 varieties Seeds of chickpea, *Cicer arietinum* (L.) were procured from the Pulse Breeding Centre of Indian Institute of Pulses Research (IIPR), Kanpur, UP, JNKVV, Jabalpur and RVSKVV Gwalior MP. The samples of Vascular wilt of chickpea were collected from different site of Vindhya Region of Madhya Pradesh. Following are the names of Varieties procured:JG-315,JG-12,JG-36,RVG-202,RVG-205,JG-412,RVSSG-74,JG-6,JG-16,JG-63,RVSSG-68,JGG-1,JG-11,JG-

322,RVSSG-31,JG-74,JG130,RVSSG-33,JGK-3,JGK-1,RVSSG-75,JG-14,Dindori,JGK-2,JG-63,JG-226,JG-130,JG-64,JG-218,RVSSG-36,JAKI-9218,JG62. Laid out in Randomize block design. The chickpea pathology laboratory received samples for isolation and additional research.

Isolation of plant sample; The diseased parts of the root were cut with a sharp razor and rinsed with sterilized water to remove the dirt. The pieces were surface sterilized by dipping in mercuric chloride (1:1000) for 1 minute, followed by three changes of sterilized water, drying in sterilized blotter paper, and then being transferred aseptically on PDA plates. The plates were incubated at 2510C. The observations were made from developing colonies. The fungus was subcultured, purified, identified, and maintained on PDA slants.

Identification and purification; Isolation of vascular wilt symptoms from infected chickpea plants on potato dextrose agar medium. *Fusarium oxysporum* f. sp. *ciceri* was discovered in the diseased plants' roots. A microscope was used to identify the pathogen based on morphological characteristics. PDA slants were used to keep purified cultures.

Fusarium oxysporum f. sp. ciceri cultures were purified by sub-culturing them using the sclerotia single spore and hyphal tip techniques, and then mass transferred to PDA slants at 25+2 oC for further study.

Pathogenicity test; Pot culture technique was employed for proving the pathogencity test. Mass culture of the fungus was prepared on the chickpea straw inoculated with seven days old culture *Fusarium oxysporum* and incubated at 25+10C for 15 days. The inoculum was thoroughly mixed in sterilized soil (sand + soil 1:1) @ 25 g/kg soil. The pots filled with inoculated soil were kept at pot house. Ten seeds of susceptible (JG 62) and resistant (JG 315) varieties were sown in pots along with uninoculated control in three replications. The observations were recorded on per cent mortality due to wilt and the associated pathogen was isolated.

Experimental Detail

- 1 Design - RBD 2. Replications -2 3. Genotypes - 30
- 4. Spacing - 30x10cm^2

- Thirty chickpea varieties will be evaluate under natural conditions in the rabi of 2020-21 and 2021-22 against *fusarium oxysporium* in the field, Observation on disease severity of

Fusarium wilt will be recorded after and 40 days after sowing using 0-5 disease rating scale given by Mckinney formula (1923).

- The per cent disease Index (Mckinney, 1923) will be calculated as.

$$PDI = \frac{\text{Sum of all individual rating}}{\text{Total no. of plants assessed x maximum rating}} \times 100$$

Chart 1: Use in Disease rating scale for vascular wilt (Mckinney, 1923)

Rating	Category	Reaction type	Percent mortality (%)
0-1	R	Resistant	0-10
1-2	MR	Moderately resistant	10.1-20
2-3	TR	Tolerant	20.1-40
3-4	S	Susceptible	40.1-60
4-5	HS	Highly susceptible	60.0 and above

Result & Discussion;

Field trial for screening of different chickpea varieties was carried in naturally infested soil with *Fusarium oxysporum* f. sp. *ciceri* in the fields of the Department of Plant Pathology, Majhgawan, Satna MP. Three rows of each of the 30 varieties were maintained having 30cm row to row spacing and 15cm plant to plant distance. Plants were regularly observed since 20 days after sowing up to maturity and accordingly the disease severity and disease incidence on each variety was noticed

Symptoms;

The infected plants exhibited typical wilting symptoms starting from 25-30 days after sowing with yellow dried leaves from base to top along with drooped petiole and rachis, withered plants inflicting improper branching with plant height shorter than normal healthy plants.

Percent mortality; Percent mortality was calculated by using the following formula;

$$\text{Percent mortality} = \frac{\text{Number of diseased plants}}{} \times 100$$

Total number of seedlings

All the 30 chickpea cultivars used in the study expressed varied response when screened for host reaction against *Fusarium oxysporum* f. sp. *ciceri* during both the two consecutive years of planting. On the basis of 0-5 rating scale, 07 varieties (JG-315,JG-12,JG-36,RVG-202,RVG-205,JG-412,RVSSG-74) were recorded to be resistant, 12 as moderately resistant, 09 as tolerant and the remaining 02 susceptible varieties. JG 315variety revealed wilt severity during both the years which was least while highest severity of disease with a score of 7.25 and 7.12 % was expressed by the variety JG-315 when planted consecutively for two years. The overall sequence of wilt severity followed by the varieties in descending order was:

JG-315>JG-12>JG-36>RVG-202>RVG-205>JG-412>RVSSG-74>JG-6>JG-16>JG-63>RVSSG-68>JGG-1>JGK-2>JG-11> JG-322>RVSSG-31>JG-74>JG130> RVSSG-33>JGK-3>JGK-1>RVSSG-75>JG-14>Dindori>JG-74>JGK-2>JG-63JG-226>JG-130>JG-64>GK-1>JG-218>RVSSG-36>JAKI-9218>JG62.

Wilt incidence; Significant variation (at P≤0.05) in per cent wilt incidence ranging from 7.25-42.67% (2020-21) and 7.12 -43.10 (2021-22) was recorded during the two years of crop planting. None of the varieties screened turned out to be highly resistant in their response towards the wilting pathogen. However, chickpea cultivar JG-315 exhibited lowest per cent disease incidence (PDI) of 7.25% and 7.12%. It was followed by JG12 cultivar that displayed 8.15% and 7.69 % of PDI. Next to these varieties were JG36(8.22&8.65%), RVG202(8.45&8.95%),RVG 205,JG 412 (8.65&8.89%)and RVSSG74(9.65&9.82). Of all these 30 varieties screened, only two varieties, namely JG62 (24.67& 43.10)and JAKI 9218(41.20& 42.82) were observed to be the highly susceptible. Highest PDI was registered the plots having JG 62 variety displaying 42.25 % and 43.10% disease incidence respectively, during 2020-21 and 2021-22 **(Table-A).**

Table (A),Screening of indigenous germplasm of chickpea grown in field plots against Fusarium wilt disease caused by *Fusarium oxysporum* f. sp. *ciceri.*

S.No.	Genotype		2020-21			2021-22	
		PDI	PDI	Yield (kg/ha)	PDI	PDI	Yield (kg/ha)
1	JG -36	8.22	R	1820.78	8.65	R	1850.75

2	JG-315	7.25	R	2190.65	7.12	R	2142.62
3	JG-74	24.82	TR	1670.25	25.23	TR	1754.35
4	JG-12	8.15	R	2045.35	7.69	R	2085.25
5	JG-11	17.65	MR	1680.69	18.10	MR	1710.45
6	JG-16	15.22	MR	1820.05	14.29	MR	1795.22
7	JG-130	28.42	TR	1623.35	27.95	TR	1650.65
8	JG-63	26.75	MR	1765.25	26.20	MR	1785.35
9	JG-6	13.65	MR	1950.10	14.02	MR	1825.45
10	JG-226	25.60	TR	1670.59	27.42	TR	1625.52
11	JG-412	8.65	R	1860.40	8.89	R	1862.33
12	JG-14	19.05	MR	1950.26	18.69	MR	1965.10
13	RVG-202	8.45	R	1644.20	8.95	R	1689.25
14	JG-64	29.72	TR	1590.25	27.44	TR	1632.20
15	RVSSG-31	17.52	MR	1764.85	18.24	MR	1712.36
16	RVSSG-36	32.15	TR	1825.45	34.15	TR	1905.25
17	JG-218	29.10	TR	1625.10	26.45	TR	1595.20
18	JG-62	42.67	S	1365.10	43.10	S	1385.90
19	JGK-1	29.45	TR	1645.29	28.22	TR	1542.06
20	JGK-2	26.27	TR	1685.20	27.36	TR	1625.78
21	JGK-3	18.14	MR	1925.42	18.47	MR	1895.30
22	RVSSG-68	16.96	MR	1836.75	16.25	MR	1815.65
23	RVG-205	8.35	R	1682.56	9.15	R	1725.12
24	RVSSG-75	19.50	MR	1652.40	18.23	MR	1675.25
25	RVSSG-74	9.65	R	1764.25	9.82	R	1187.50
26	JAKI-9218	41.20	S	1452.20	42.82	S	1486.20
27	JGG-1	16.85	MR	1540.15	16.56	R	1610.24
28	RVSSG-33	18.84	MR	1729.88	19.05	MR	1719.06
29	JG-322	17.10	MR	1650.21	18.49	MR	1694.52
30	Dindori	24.04	TR	1522.82	26.42	TR	1605.21
	F-value	**642.35**		**2145.42**	**232.05**		**1842.90**
	LSD	**1.64**		**8.22**	**2.09**		**11.65**

Crop yield; Wilt severity and wilt incidence noticeably influenced the crop yield of the different screened varieties. Those varieties that exhibited highest disease severity along with highest PDI reportedly gave less produce in comparison to those varieties which acted as the resistant cultivars. Amongst all, plots having variety JG315 yield maximum crop (2190.65kg/ha and 2115.42kg/ha) followed by those in which JG-12 variety was sown. 1452.20kg/ha and 1486.20kg/ha (Table. A) of crop yield was obtained from the variety JAKI-9218 while the least yielding variety recorded was JG-62 that gave only 1365.10 kg/ha and 1385.90 kg/ha of the crop yield.

Similar study in Kumar and Bourai, 2012 in this study, 30 chickpea varieties were assessed for the host reaction of which the variety JG-315 was found to be the most resistant as it has wilt severity of 1.2 on 0-5 scale with 7.25 and 7.12 per cent disease incidence value, while JG-62 and JAKI-9218 were noted as highly susceptible varieties. Varied response of different chickpea varieties to *Fusarium oxysporum* f. sp. *ciceri* have been reported by different researchers. Maximum disease incidence rate of 13% was recorded by Nikam et al., (2011) on local chickpea cultivar while an average of 7.6% wilt incidence was seen in variety Annegri-1.

Among 81 desi chickpea genotypes tested for wilt disease resistance, 35 genotypes demonstrated resistance with a disease incidence of 0-10%. Fifty-seven Kabuli chickpea genotypes were examined for Fusarium wilt disease and found to have zero AUDPC and 'r' values, indicating that they were free of the illness. Out of 57 Kabuli chickpea genotypes tested for wilt disease resistance, 24 genotypes demonstrated resistance with a disease incidence of 0-10% was recorded by Rajan and Muhammad (2012).

The pathogen *(F. oxysporum)* survive as mycelium and chlamydospores in seed and soil, and also on infected crop residues, roots and stem tissue buried in the soil for up to 6 years and yield losses of up to 72.16 per cent may occur under favorable condition. **Barbate *et al.* (2006)** Found that 39 genotypes were resistant to Fusarium wilt, while 9 were somewhat resistant, one was moderately sensitive, and one was severely susceptible. Wilt was completely absent from Phule G-97311, Phule G-96325, and Phule G-97315.

Jagre and Gupta (2012) is reported Maximum vascular wilt disease incidence 22.5 % in chickpea genotype was observed in December month. Where as, during that period the temperature ranged from 7.40 c to 24.90 c and relative humidity, 24.0 to 89 percent Besides, a negative correlation was drawn when varieties sowing higher rate of severity and wilting had lower crop yield. Variety named JG 315 revealed lowest disease severity and wilting with maximum crop produce and was thus the best amongst all the test varieties.

Conclusion;

After two years of testing, researchers concluded that none of the 30 varieties tested for resistance to *Fusarium oxysporum* f. sp. *ciceri* stood out as highly resistant. They all expressed a degree of wilt severity on a 0-5 scale ranging from 1.2 to 4.7 (wilt incidence ranging from 7.25-

42.67% (2020-21) and 7.12 -43.10 (2021-22) was recorded during the two years of crop planting.) and were classified as resistant, moderately resistant, tolerant, and highly susceptible. The findings also suggested that wilt severity had a direct effect on the percent wilt incidence, with higher severity varieties having a higher wilting percentage.Furthermore, a negative correlation was found when varieties sowing at a higher rate of severity and wilting had lower crop yield. JG315 had the lowest disease severity and wilting with the highest crop yield of any of the test varieties.

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Fig1 ., Screening of indigenous germplasm of chickpea grown in field plots against Fusarium wilt disease caused by *Fusarium oxysporum* f. sp. *ciceri.*

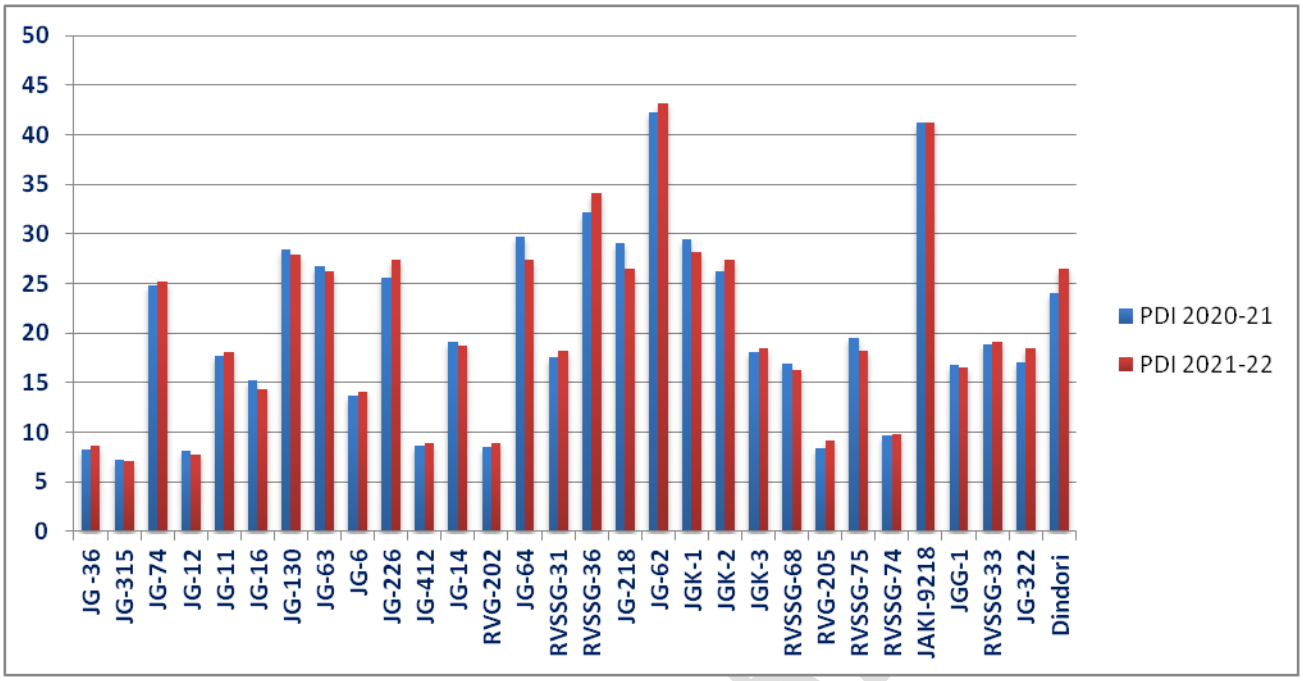
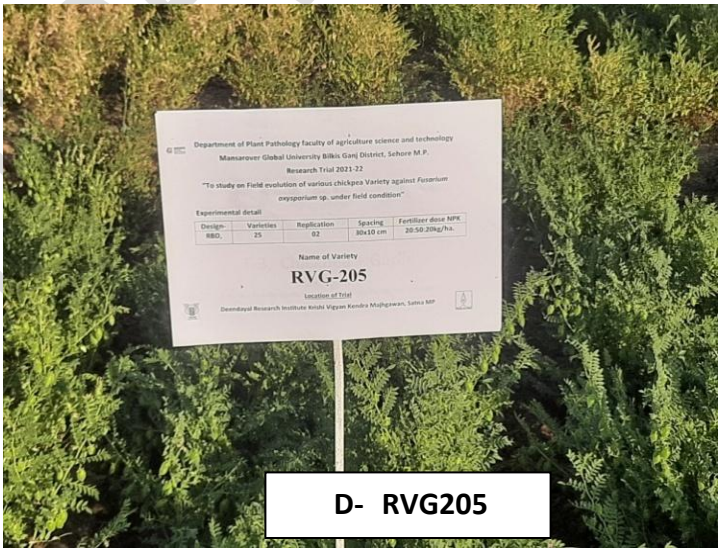


Image ; Screening of various chickpea varieties against *fusarium oxysporum* f.sp.*ciceri* under field conditions

A- JG-315

B- JG-12

C- JG-36



D- RVG205