International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(6): 1195-1201

Received: 20-09-2020
Accepted: 22-10-2020

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Cultural, morphological and pathogenic variability among the different isolates of *Fusarium oxysporum* f. sp. *ciceri*

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DOI: https://doi.org/10.22271/chemi.2020.v8.i6q.10927

Abstract
Chickpea (*Cicer arietinum* L.) is an important pulse crop, which belongs to family *Leguminaceae*, chickpea having 2n=16 number of chromosomes. Chickpea is native of India and tropical, subtropical and temperate regions. It is ranked 3rd after common bean. Pulses play an important role not only from economical point of view but also due to their nutritional value. 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 vitamins 2.44 per cent. Variability among the ten isolates of *Fusarium oxysporum* f. sp. *ciceri* (FOC), collected from different locations of Parbhani district in Maharashtra. Ten isolates were studied in respect of cultural, morphological characters and Pathogenic variability.
Result of the above study reveals that pathogenic variability has been established by inoculating ten days old seedlings of different cultivars individually with the *Fusarium oxysporum* f. sp. *ciceri* isolates. JG 62 exhibited susceptible reactions to FOC isolates with highest percentage of seedling mortality whereas, JG 315 and BCP-160 were exhibited resistant reactions to the FOC isolates with lowest mortality percentage due to wilt varied within the cultivars. Cultural studies of all isolates of *F. oxysporum* f. sp. c*iceri* resulted that isolates differ in the growth rate, types of colony, sporulation, and pigmentation on Potato Dextrose Agar is being favorable for luxuriant growth for all the isolates and dry weight of mycelia mat growing them on Potato Dextrose Broth medium. Morphological studies of different isolates of *Fusarium oxysporum* f. sp. c*iceri* concluded resulted in the variations in size, septation and formation of chlaymadospores.

Keywords: Cultural, morphological, pathogenic, *Fusarium oxysporum* f. sp. *ciceri*

Introduction
Chickpea (*Cicer arietinum* L.) is a native of Asian plant species grown as a pulse crop throughout tropical and subtropical Asia. Though India is a home of pulses yet they are to be imported from foreign countries because of low production and mostly stagnant. There are various reasons for low yield of chickpea. Amongst them, diseases play a vital role in reducing the yield more than 70 pathogens have been reported on chickpea. *Fusarium oxysporum* f. sp. *ciceri*, *Rhizoctonia bataticola* and stunt are important (Zote and Dhutraj, 1996) [18].
Present investigation was undertaken with a view to know the morphological, cultural and pathogenic variation of *Fusarium oxysporum* f. sp. c*iceri* from ten locations of Parbhani district from Maharashtra.

Material and Methods
Collection purification and identification of *Fusarium oxysporum* f.sp. *ciceri* and collection of seed
A survey of chickpea wilt was carried out in some of the chickpea growing areas of Parbhani district covering 10 locations *viz.*, Purna, Parbhani, Pathari, Palam, Gangakhed, Selu, Manwat, Jintoor, Sonpeth and VNMKV, Parbhani campus. Chickpea exhibiting typical symptoms of wilt (*Fusarium oxysporum* f. sp. *ciceri*) disease samples were collected from the chickpea fields from each location and brought to the laboratory for further studies. Isolated successfully on Potato Dextrose Agar (PDA) medium was used as basal culture media for isolation in the pathology laboratory. The single spore technique was used to purify the cultures of *Fusarium oxysporum* f.sp. *ciceri.* The purified cultures were maintained on P.D.A. slants and kept at 4°C

for further studies and designated them as Foc-1, Foc-2, Foc-3, Foc-4, Foc-5, Foc-6, Foc-7, Foc-8, Foc-9, and Foc-10, respectively.

The isolates from different localities were identical on the basis of morphological characters with the help of monograph on Fusarium by Booth (1971) [2].

Chickpea seeds of different varieties (Kirpa, Virat, Vijay, Digvijay, Jaki, Saki-9516, BCP-10, BCP-160, Akash-797, and JG-315) were collected from ARS, Badnapur, Dist, Jalna, (M.S.) and seeds of JG-62 variety were collected from AICRP on chickpea, Sihore, (M.P.). The seeds were air dried and kept in paper bags and stored at room temperature for further studies.

Cultural and Morphological variation among the different isolates of *Fusarium oxysporum* f. sp. *ciceri*

Cultural variations within the isolates were studied with regard to growth rate, type of colony; sporulation and pigmentation, dry weight of the mycelial mat by growing them on potato dextrose broth. The morphological characters were studied with regard to type of mycelium, size of macro and micro conidia and their septation, formation of chlamydospores.

Pathogenic variability among the different isolates of *Fusarium oxysporum* f. sp. *ciceri*

Before conducting pathogenic variability test, standardization of time required for maximum sporulation by culture of *Fusarium oxysporum* f. sp. *ciceri* was done by inoculating PDA Petriplates with 5 mm disc of the inoculum. Petriplates containing culture of Foc incubated at 25^0C for five and seven days and observations record on sporulation. For this purpose, 5 mm disc was cut from cultures and transferred in to the tube containing 10 ml of sterilized water. The suspension was prepared by shaking the tubes gently. The spores were counted per ml of suspension with the help of Haemocytometer. To see the reaction of chickpea differential genotypes of *Fusarium oxysporum* f. sp. *ciceri* culture of Foc were tested in the net house following root dip inoculation technique (Pande *et al*. 2007) [11]. This is a modification of method given by Nene *et al*. (1981) [9]. Seeds of differential genotypes collected from ARS, Badnapur pre-treated with 2% sodium hypochlorite for 2 min, were rinsed in sterilized water and germinated for ten days in plastic pots containing sterilized sand. Ten days old seedlings were carefully uprooted and the roots washed under running water to remove excess sand. Root tips around 0.5 cm long were cut off to facilitate the entry of the pathogen into the roots. The roots of the seedlings were dipped separately in the Foc inoculums for 1-2 min to enable conidia to adhere to the roots.

Result and discussion

Isolation of pathogen

Within 4-5 days of incubation, partially submerged, white spores dense growth with smooth margin mycelial mat was developed in the plates. After 10 to 15 days of incubation, conidia developed in the culture plates were initially bright white coloured and minute in size, which later with ageing turned dark white coloured.

Cultural and Morphological variations of *Fusarium oxysporum* f.sp. *ciceri*

Cultural characters

The cultural characters of different isolates isolated from diseased specimen collected from different locations of Parbhani district were studied. The cultural characters *viz.*, growth rate, types of colony, sporulation and pigmentation, dry weight of mycelia mat by growing them on potato dextrose broth were recorded.

The data presented in the table 2 indicated that all the isolates showed wide variation in colony diameter.

Data regarding growth rate of various isolates of *Fusarium oxysporum* f. sp. *ciceri* on PDA medium at different intervals is depicted in table 2, which denotes that the maximum growth *i.e.* 87.00 mm has been obtained in isolate Foc-10 followed by isolate Foc-8 which showed mycelial growth 84.33 mm, Foc-9 *i.e.* 83.73 mm, Foc-1 *i.e*. 83.50 mm whereas, minimum growth *i.e.* 78.20 mm was observed in isolate Foc-5 followed by isolate Foc-7 *i.e.* 78.53 mm, Foc-2 *i.e.* 79.43 mm & Foc-6 *i.e.* 82.33 mm on 9th day of incubation. Almost all the isolates attained the maximum growth of colony diameter.

The data presented in table 3 indicated that all the isolate showed wide variation in types of colony, sporulation, pigmentation on PDA plate and dry weight of mycelia by growing them on potato dextrose broth.

The data presented in above table indicated that all the isolate showed wide variation in types of colony, the isolate Foc-1, Foc-3, Foc-7 and Foc-8 produced white cottony types of colonies on 9th day after incubation, whereas; the isolate Foc-6 and Foc-10 produced partially appressed type colonies, however, the isolate Foc-4, Foc-5 and Foc-9 produced appressed types of colonies and isolate Foc-2 produced partial submerged type of colony on 9th day after incubation.

The sporulation induced by all the test isolates was varied from moderate (+) to very good (+++) sporulation. Very good sporulation (+++) was induced by the isolates Foc-2, Foc-5, and Foc-9, whereas; good sporulation (++) was recorded by the isolates Foc-1, Foc-6 and Foc-10, however, moderate sporulation (+) was induced by the isolates Foc-3, Foc-7 and Foc-8, and scanty (-) sporulation observed in Foc-4 on 9th day after incubation.

The pigmentation induced by all the test isolates was varied from light yellow, light pink to black and white. The isolate Foc-1 and isolate Foc-3 produced light yellow pigmentation, whereas; isolate Foc-2 produced light brown pigmentation. Isolate Foc-4 produced pink pigmentation; whereas; isolate Foc-5 produced light pink pigmentation and isolate Foc-6 and Foc-10 produced white pigmentation. Isolate Foc-7 produced dark red pigmentation and isolate Foc-8 produced dark yellow pigmentation, whereas; the isolate Foc-9 produced black pigmentation on 9th day after incubation.

Cultural variations were also studied in respect of growth of ten isolates on potato dextrose broth. Observations on oven dry weight of mycelia mat were recorded after 9th day of incubation. The data revealed that the isolates differed in their dry weight. On the basis of dry weight of mycelial mat the maximum dry weight was observed in isolate Foc-5 *i.e.* 0.86 gm followed by isolate Foc-4 *i.e.* 0.75 gm, Foc-3 *i.e.* 0.68 gm and Foc-6 *i.e.* 0.61 gm, whereas; minimum dry weight of isolates was observed in isolate Foc-1 *i.e.* 0.41 gm followed by Foc-2 and Foc-10 0.44 gm, Foc-7 *i.e.* 0.45 gm after 9th day of incubation.

The result in confirmation with most of earlier scientists as Dubey *et al.* (2010) who reported that the isolates of *Fusarium oxysporum* f. sp. *ciceri* were highly variable in their colony growth pattern, size of colony and pigmentations. The size of microconidia varied from 5.1-12.8 x 2.5-5.0µm, whereas macroconidia ranged from 16.5-37.9 x 4.0-5.9µm with 1-5 septations.

The results were similar with most of earlier scientists like Mahesh *et al.* (2010) [7] who studied the variability among the forty one isolates of *Fusarium oxysporum* f. sp. *udum* of Pigeonpea collected from different states of India in respect of cultural characters. They distinguished all isolates on the basis of growth and virulence produced pigmentation like, dark yellow, light yellow, white, brown and pink colour. Based on colony character these isolates produced partial appressed and appressed growth.

Singh and Chaudhari (2010) [15] who studied the dry weight of mycelium mat and categorized into lowest and hightest weight.

Mahsane (2013) [8] studied the cultural characteristics in 18 isolates of *Fusarium udum* among these isolates, three isolates produced light pink, five creamy, one was light brown, six were light yellow, three having light to dark coloured pigmentation. Colonies of six isolates were found fluffy, six suppressed and six partially suppressed.

Table 1: Survey and collection of wilted plants of chickpea from different locations of Parbhani district

Isolate No.	Isolate code	Blocks	Varieties	Types of soil	Crop stage	Cropping pattern
1	Foc-1	Purna	Vijay	Medium and deep black	Flowering	Sole
2	Foc-2	Parbhani	Digvijay	Alluvial	Flowering	Sole
3	Foc-3	Pathari	Kabuli	Medium and deep black	Podding	Mixed
4	Foc-4	Palam	Kabuli	Mixed red and black	Flowering	Mixed
5	Foc-5	Gangakhed	Annegiri	Alluvial	Flowering	Sole
6	Foc-6	Selu	Vijay	Medium and deep black	Podding	Mixed
7	Foc-7	Manwat	Annegiri	Mixed red and black	Podding	Sole
8	Foc-8	Jintur	Kabuli	Alluvial	Flowering	Sole
9	Foc-9	Sonpeth	Digvijay	Medium and deep black	Podding	Mixed
10	Foc-10	VNMKV, Parbhani campus	Digvijay	Mixed red and black	Flowering	Mixed

Table 2: Growth rate of various isolates of *Fusarium oxysporum* f. sp. *ciceri* on potato dextrose agar medium at different intervals

Sr. No.	Isolates	Colony diameter (mm)*			
		3rd day	5th day	7th day	9th day
1	Foc-1	12.09	31.09	44.73	83.50
2	Foc-2	10.65	27.67	40.23	79.43
3	Foc-3	11.65	29.70	41.59	82.87
4	Foc-4	11.86	30.53	42.65	83.17
5	Foc-5	9.67	26.68	39.02	78.20
6	Foc-6	11.13	28.57	41.06	82.33
7	Foc-7	10.38	27.12	39.55	78.53
8	Foc-8	13.40	33.43	47.05	84.33
9	Foc-9	12.65	32.52	45.85	83.73
10	Foc-10	14.55	34.91	50.48	87.00
SE (m)		0.13	0.36	0.18	0.91
CD @ 1%		0.53	1.47	0.73	3.70

* Mean of three replications

Table 3: Colony characters of various isolates of *Fusarium oxysporum* f. sp. *ciceri* on potato dextrose agar medium

Sr. No.	Location	Isolate code	Types of colony	Sporulation	Pigmentation	Dry weight of mycelia (gm)
1	Purna	Foc-1	White colony	++	Light yellow	0.41
2	Parbhani	Foc-2	Partial submerged	+++	Light brown	0.44
3	Pathari	Foc-3	White cottony	+	Light yellow	0.68
4	Palam	Foc-4	Appressed	-	Pink	0.75
5	Gangakhed	Foc-5	Appressed	+++	Light Pink	0.86
6	Selu	Foc-6	Partial appressed	++	White	0.61
7	Manwat	Foc-7	White cottony	+	Dark red	0.45
8	Jintur	Foc-8	White cottony	+	Dark yellow	0.53
9	Sonpeth	Foc-9	Appressed	+++	Black	0.46
10	VNMKV Parbhani	Foc-10	Partial appressed	++	White	0.44
SE (m)						0.013
CD @ 1%						0.053

(-) scanty, (+) moderate sporulation, (++) good sporulation and (+++) very good sporulation.

1. 40-50 = micro and macroconidia/ microscopic field – very good
2. 30-40 = micro and macroconidia/ microscopic field –Good
3. 20-30 = micro and macroconidia/ microscopic field –Moderate

Below 20 = micro and macroconidia/ microscopic field – scanty

Morphological characters among the different isolates of *Fusarium oxysporum* f. sp. *ciceri*

Variation in morphological characters *viz.,* size of macro and microconidia and their septation, formation of chlaymadospores of different isolates of *Fusarium oxysporium* f. sp. *ciceri* have been studied and summarized in table 4. The morphological characters of ten different isolates of *Fusarium oxysporum* f. sp. *ciceri* collected from different locations of Parbhani district showed significant variation in respect to size and septation of macro, microconidia on PDA medium. Variations were also observed regarding the

formation of chlamydospores and types of mycelium in all isolates.

The data indicated that all the isolate showed wide variation in size and septation of conidia.

The above table depicts average size of micro-conidia of the test isolates was ranged from 3.18 x 1.9 µm (Foc-3) to 10.64 x 3.8 µm (Foc-10), however, maximum micro-conidial size *i.e.* 10.64 x 3.8 µm was recorded in isolate Foc-10 followed by Foc-8 and Foc-2 which shows similar size of microconidia *i.e.* 7.6 x 3.8 µm, Foc-9 shows conidial size *i.e.* 7.6 x 2.8 µm, and Foc-5 shows conidial size *i.e.* 7.6 x 1.9 µm. Minimum micro-conidial size of isolate Foc-3 *i.e.* 3.18 x 1.9 µm followed by Foc-1 *i.e.* 4.7 x2.31 µm, Foc-6 *i.e.* 6.0 x 3.8 µm, Foc-4 *i.e.* 6.3 x 2.6 µm and Foc-7 i.e. 6.5 x 2.7 µm after 9th day of incubation.

Average size of macro-conidia of the test isolates was ranged from 15.2 x 3.8 µm Foc-8 to 34.2 x 4.6 µm Foc-7. Maximum macro-conidial size *i.e.* 34.2 x 4.6 µm was recorded in isolate Foc-7 followed by Foc-9 *i.e.* 31.5 x 4.6 µm, Foc-2 *i.e.* 30.4 x 5.7 µm, Foc-10 *i.e.* 30.4 x 3.8 µm, and Foc-1 *i.e.* 26.0 × 3.8 µm, whereas; minimum macro-conidial size of isolate Foc-8 *i.e.* 15.2 x 3.8 µm followed by Foc-6 *i.e.* 19.7 x 3.8 µm, Foc-3 *i.e.* 20.5 x 4.5 µm, Foc-5 *i.e.* 23.9 x 4.9 µm and Foc-4 *i.e.* 25.4 x 4.5 µm after 9th day of incubation.

The macro-conidia were typically sickled shaped to curved, varied in the size and number of septation (1-6). Isolates Foc-1, Foc-2, Foc-3 and Foc-5 shows 1-4 septation, whereas; isolate Foc-4 and Foc-7 shows 3-4 septation. Isolate Foc-8 which was collected from Jintur showed minimum septation *i.e.* 1-2, whereas; maximum septation *i.e.* 3-6 were observed in isolate Foc-9 which was collected from Sonpeth.

The data presented in table 5 indicated that all the isolate showed wide variation in types of mycelium and formation of chlymadospores.

In all the isolates, mycelium was formed hyaline, septate and more branched. In isolates Foc-1, Foc-3, Foc-4 and Foc-9 septate mycelium was formed, whereas; in isolates Foc-2, Foc-6 and Foc-10 hyaline mycelium formed, however, in isolate Foc-5, Foc-7 and Foc-8 more branched mycelium.

Chlamydospors are formed in all the isolates. They were terminal, intercalary or at both. In isolates Foc-1, Foc-7, Foc-9 and Foc-10 were chlaymadospores formed at intercalary and terminal, whereas; in isolate Foc-3 and Foc-6 chlaymadospores formed at terminal and intercalary, however, in isolate Foc-2, Foc-4, Foc-5 and Foc-8 it was formed at intercalary.

These results are in agreement with those reported by morphological variability of different isolates with respect to septations, size of macro conidia and micro conidia, mycelium type and formation of chalymadospores are in conformity with Mandhare *et al*. (2011) who found variation among 20 isolates of Fusarium wilt with respect to macroconidia were 2-4 septate, the mean length microconidia ranged from 2.3 to 13.8 µm and 0.69 to 4.6 µm chlymadospores also was observed whereas, such variations were reported by earlier worker like Kumar *et al*. (2012) who reported that formation of chlymadospores was formed like intercalary type.

Table 4: Size and septation of conidia of different isolates of *Fusarium oxysporum* f. sp. *ciceri.*

Sr. No.	Location	Isolate code	*Dimensions		Septation
			Micro conidia L×B (µm)	Macro conidia L×B (µm)	
1	Purna	Foc-1	4.7× 2.31	26.0× 3.8	1-4
2	Parbhani	Foc-2	7.6× 3.8	30.4 ×5.7	1-4
3	Pathari	Foc-3	3.8 ×1.9	20.5× 4.5	1-4
4	Palam	Foc-4	6.3 ×2.6	25.4× 4.5	3-4
5	Gangakhed	Foc-5	7.6× 1.9	23.9 ×4.9	1-4
6	Selu	Foc-6	6.0 ×3.8	19.7× 3.8	1-3
7	Manwat	Foc-7	6.5× 2.7	34.2 ×4.6	3-4
8	Jintur	Foc-8	7.6 ×3.8	15.2 ×3.8	1-2
9	Sonpeth	Foc-9	7.6 ×2.8	31.5× 4.6	3-6
10	VNMKV, Parbhani campus	Foc-10	10.64× 3.8	30.4× 3.8	1-6

*Average of ten microscopic observations L: length, B: breadth

Table 5: Types of mycelium and formation of chlaymadospores by various isolates of *Fusarium oxysporum* f. *sp. cicero*

Sr. No.	Location	Isolate code	Type of mycelium	Formation of chlymadospores
1	Purna	Foc-1	Septate	Intercalary and terminal
2	Parbhani	Foc-2	Hyaline	Intercalary
3	Pathari	Foc-3	Septate	Terminal and intercalary
4	Palam	Foc-4	Septate	Intercalary
5	Gangakhed	Foc-5	More branched	Intercalary
6	Selu	Foc-6	Hyaline	Terminal and intercalary
7	Manwat	FOC-7	More branched	Intercalary and terminal
8	Jintur	Foc-8	More branched	Intercalary
9	Sonpeth	Foc-9	Septate	Intercalary and terminal
10	VNMKV, Parbhani campus	Foc-10	Hyaline	Intercalary and terminal

Table 6: Reaction of chickpea differential genotypes of *Fusarium oxysporum* f. sp. *ciceri* against root dip method

Sr. No.	Varieties	*Germination percentage	*Mortality percentage	Reaction
1	JG-315	80.00	20.00	resistant
2	JG-62	30.00	70.00	susceptible
3	Saki-9516	50.00	50.00	Moderately resistant
4	Vijay	40.00	60.00	Moderately susceptible
5	Digvijay	66.67	33.33	Moderately resistant
6	Jaki	53.33	46.67	Moderately resistant
7	Virat	60.00	40.00	Moderately resistant
8	Kirpa	56.67	43.33	Moderately resistant
9	Akash	60.00	40.00	Moderately resistant
10	BCP-10	50.00	50.00	Moderately resistant
11	BCP-160	70.00	30.00	Resistant
SE (m)		0.174	0.174	
CD @ 5%		0.70	0.70	

* Mean of three replications

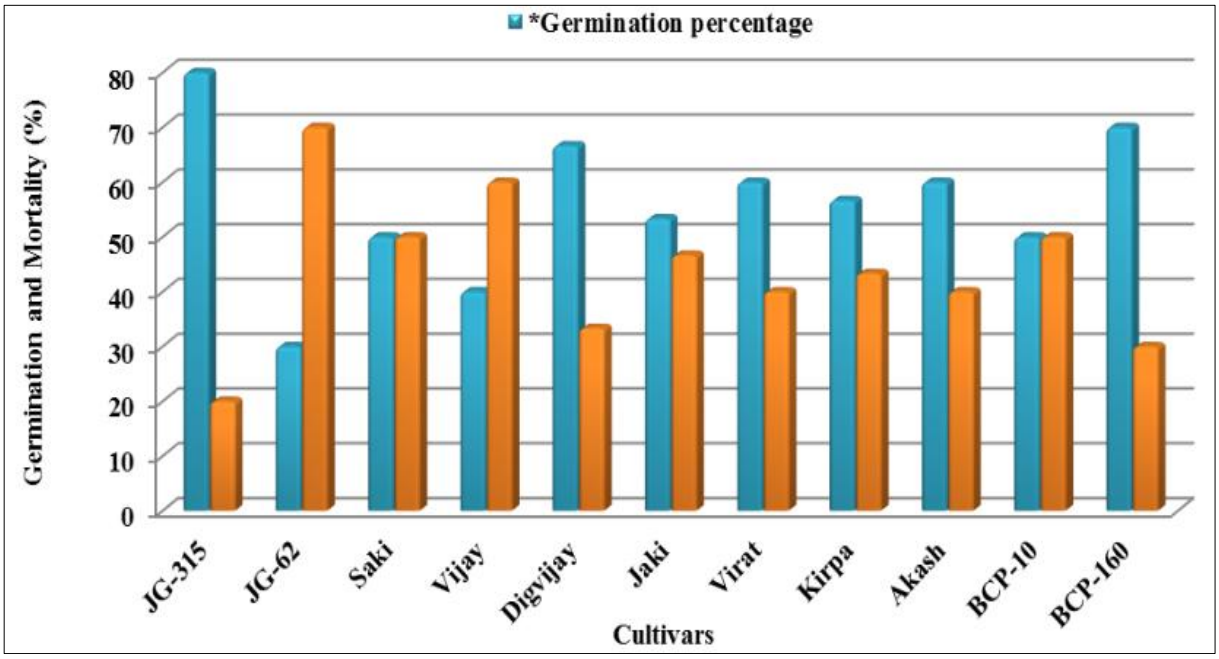

Fig 1: Pathogenic variability against *Fusarium oxysporum* f. sp. *ciceri* of different cultivars on the basis of per cent seed germination and seedling mortality

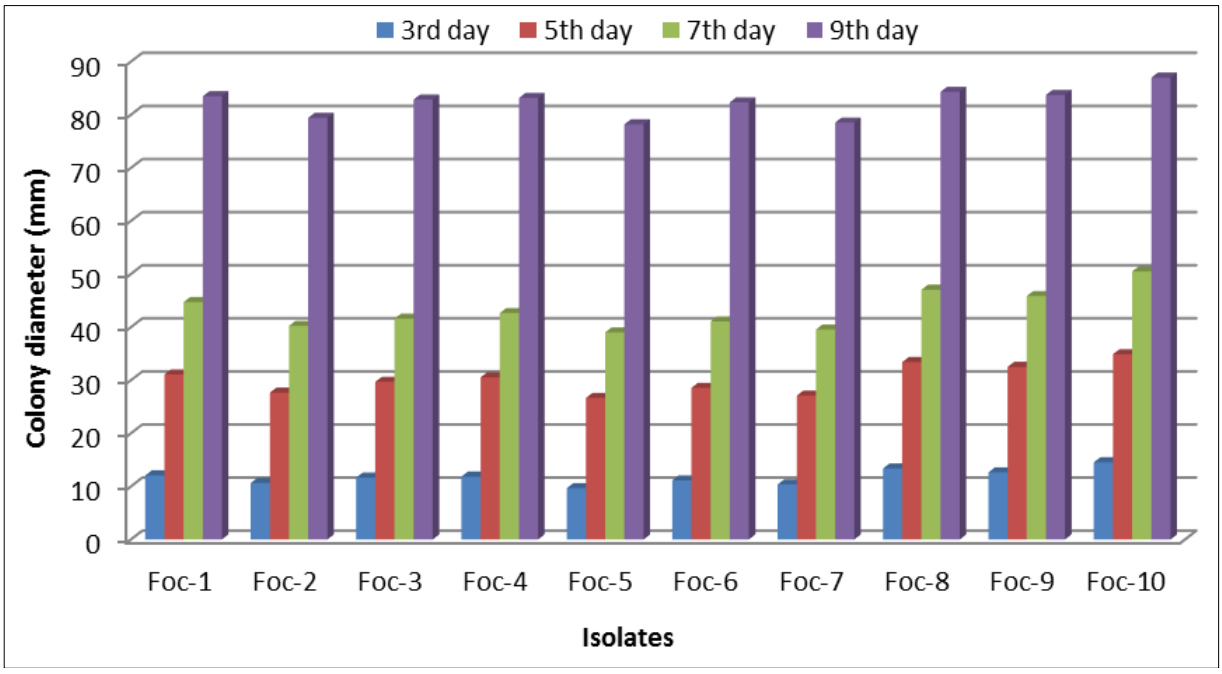

Fig 2: Growth rate of various isolates of *Fusarium oxysporum* f. sp. *ciceri* on PDA medium at different intervals

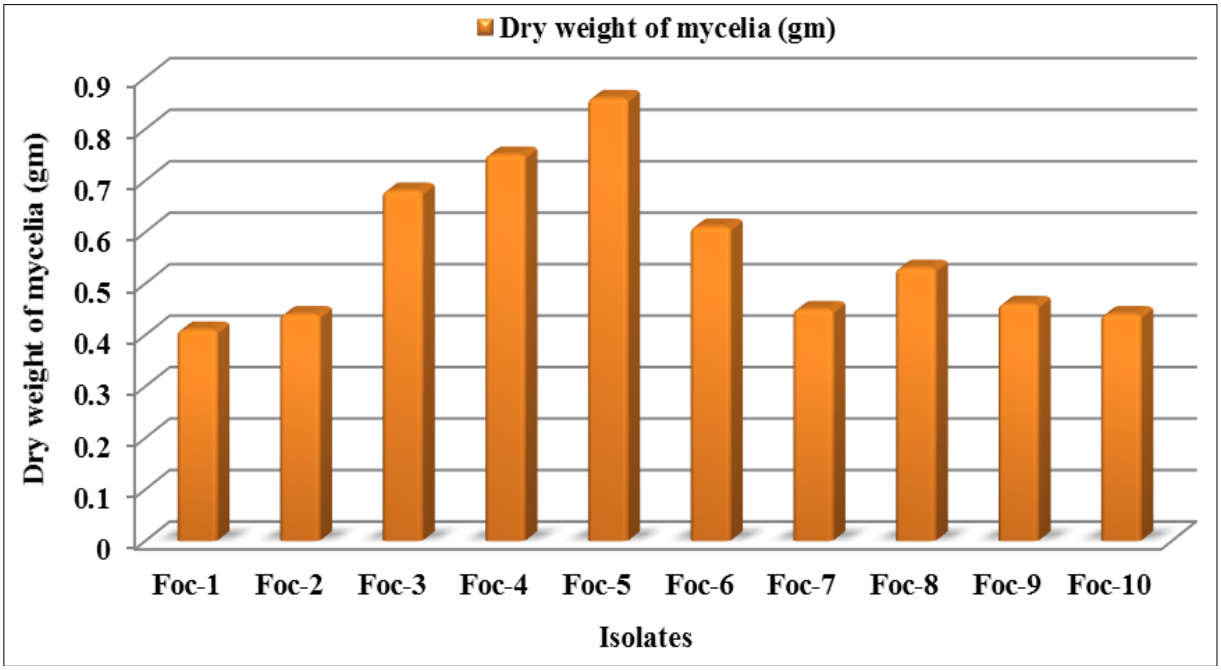

Fig 3: Dry weight of mycelia mat of different ten isolates growing them on potato dextrose broth

Pathogenic variability among the different isolates of *Fusarium oxysporum* f. sp. *ciceri*

In pathogenic variability test, pot culture experiment by root dip inoculation technique was employed. It showed wilt variation in differential genotypes causing wilt therefore, it was proved that pathogen caused wilt disease in all entries of chickpea. Based on the per cent seed germination and seedling mortality of all 11 varieties categorised (Kirpa, Vijay, Virat, Digvijay, Jaki, Saki-9516, BCP-10, BCP-160, Akash-797, JG-315) collected from Agricultural Research Station, Badnapur and JG-62 from AICRP on chickpea, Sihore, (M.P.). These cultivars were cultivated under artificial inoculation condition in pots at screen house, College of Agriculture, Parbhani, during *Rabi* 2018-19.

The data presented in the table 6 indicated that all the isolates showed wide variation in per cent seed germination and per cent seedling mortality, in pot culture experiment by root dip inoculation technique.

Seedling mortality of eleven chickpea differential genotypes against *Fusarium oxysporum* f. sp. *ciceri* revealed the existence of pathogenic variability among these cultivars, the maximum seedling mortality was recorded in cultivars JG-62 i.e. 70% followed by cultivars Vijay *i.e.* 60%, whereas; in cultivars Saki-9516 and BCP-10 50% mortality was observed. In cultivars Jaki which showed 46.67% mortality. Minimum seedling mortality was observed in cultivars JG-315 (20%) followed by BCP-160 30%, Digvijay 33.33%, Virat and Akash 40% and Kirpa 43.33%.

These results revealed that, under pot culture, all the 11 chickpea entries exhibited different reactions against *Fusarium oxysporum* f. sp. *ciceri*, however, on the basis of mortality percentage they were grouped into four categories *i.e.*, susceptible (above 60% mortality), moderately resistant (30-50% mortality), moderately susceptible (50-60% mortality) and resistant (20-30% mortality).

Seedling reaction of eleven chickpea differential genotypes against *Fusarium oxysporum* f. sp. *ciceri* revealed the existence of pathogenic variability among these cultivars. The cultivars JG-62 exhibited susceptible reaction to *Fusarium oxysporum* f. sp. *ciceri* whereas; the cultivars JG-315 and BCP-160 exhibited resistant reaction to *Fusarium oxysporum* f. sp. *ciceri.* The cultivar Vijay exhibited moderately susceptible reaction to *Fusarium oxysporum* f. sp. *ciceri* and the cultivars Saki-9516, BCP-10, Jaki, Kirpa, Virat, Akash and Digvijay exhibited moderately resistant reactions to *Fusarium oxysporum* f. sp. *ciceri*.

The results in present investigation are in agreement with the works of Sharma (2009) [14], who proved pathogenicity of same treatment by root dip technique.

Bayratkar *et al.* (2012) [1] collected the isolates of *Fusarium oxysporum* f. sp. *ciceri* representing eight provinces located in four regions of Turkey and analyzed for pathogenic variability on a set of 10 differential cultivars of chickpea *viz*., JG 62, C 104, JG 74, CPS 1, BG 212, WR 315, Annigeri, Chafa, L 550, 850-3/27 and all isolates categorized as race 0, 2 and 3.

Conclusion

From the results obtained on various aspects during present investigations on cultural, morphological and pathogenic variability among the different isolates of *Fusarium oxysporum* f. sp. *ciceri* it can be concluded that, wilt of chickpea caused by *Fusarium oxysporum* f. sp. *ciceri* (Padwick) Synder and Hans. Is one of the most important pathogen responsible for inducing accountable yield losses. The wilt disease of chickpea was of commonly occurred in almost all talukas of Parbhani district. Among the cultivars of chickpea grown in Marathwada, maximum disease was reported on local cultivar. The pathogen could grow and proliferated better on Potato Dextrose Agar media (PDA). The pathogen produced white cottony, appressed, and partial appressed type of colony with fluffy growth and smooth margin, light yellow to light pink and dark red colour pigmentation were observed. The mycelium was septate, hyline and more branched. Micro-conidia and macro-conidia have different sizes and formation of chlymadospores. Different types of cultivars produced reaction in their pathogenic variability on the same type of pathogen on the basis of mortality per cent. Maximum mortality was caused by Foc on JG-62 cultivar and found most susceptible reaction followed by Vijay, Saki-9516 and BCP-10, Jaki, Kirpa, Virat and Akash, BCP-160, Digvijay, and JG-315.

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