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Identification of diverse fungi related with selected cucurbitaceae vegetables

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Cucurbitaceae is a large group of summer vegetable crops, which includes 118 genera and 825 species. These vegetables contain rich protein, carbohydrates and water to the extent of 90%. In this study the seed borne fungi of cucurbitaceae family were isolated using the standard blotter method and deep-freeze method. Totally 26 genera and 39 species of fungal colonies were isolated and identified by morphological characteristics. Totally eight fungi were isolated from bottle and ridge gourd. Which include *Fusariumverticillioides,Fusariumoxysporum, Alternariacucumerina, Alternariaalternata,Chaetomiumglobosum, Chaetomiumindicum, Chaetomiumcrispatum*and *Chaetomiumfunicola*.*F. verticillioides and F. oxysporum*predominantly infected the seeds. From pumpkin seeds the two major fungal pathogens were isolated were *Fusariumoxysporum*and*Cladosporiumcucumerinum. Alternariacucumerina*and *Alternaria alternata* were isolated from bitter gourd seeds. The cultivar seed samples of bottle gourd (BG4), bitter gourd (BiG1), cucumber (Cu1), pumpkin (P1) and ridge gourd (RG4) showed more germination as well as high rate of vigour. It could be concluded that the blotter method is the most suitable technique for the isolation and detection of fungal pathogen rather than deep freeze method.

Keywords: Cucurbitaceae, Blotter method, Deep freeze method, Germination.

Introduction

Cucurbitaceae is an economically important family of vegetable and fruit crop for the farmers. It is mainly distributed in tropical and subtropical regions although a few of them are grown in temperate regions also (Jeffrey, 1990). India is the second largest producer of vegetables with 2.8 % of total cropped area and 13.38% of total vegetable production. Being the largest cash crop, about 4,929,400 million tonnes of cucurbits were produced in India (FAOSTAT, 2010). This family has been divided into five subfamilies comprising *Fevilleae*, *Melothrieae*, *Cucurbitaceae*, *Sicyoideae* and *Cyclanthereae* (Whitaker and Davis, 1962). Some major species included are

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Cucumissativus L. (cucumber), *Momordicacharantia* L. (bitter gourd), *Luffaactangua* L. Roxb (ridge gourd), *Cucumismelo* L. (muskmelon), *Cucurbitapepo* L. (pumpkin), *C. moschata*Duch. &Poir. (squash) and *Trichosanthescucumerina* L.(snake gourd) (Jeffrey, 1990). Wild varieties show rich genetic diversity within the family by adapting to specific environment condition and few of them can survive even in higher elevations (Rai *et al.,* 2008).

All parts of cucurbits (leaves, shoots, roots, flowers, seeds and fruits) can be used in the preparation of pickles, curries and salads (Upaganlawar and Balaraman, 2009). The seeds are rich source of oil and protein used in the preparation of pasta and animal feed (Nerson, 2007). Cucurbits are also used as ornamentals, sponges, boxes, musical instruments, utensils, fuels and in medicinal applications in the world over. They are useful to human health to purify blood, remove constipation and used as diuretic as well as antiperiodic, besides in the treatment of haemorrhages from internal organs, epilepsy and other nerve disease (Rahman *et al.,* 2008).

A wide range of pathogens affect the productivity of cucurbits. Wilt and rot are the major soil borne fungal diseases caused by *Fusarium* spp., damping-off by *Phytophthora* spp., *Acremonium* spp. and *Pythium* spp. resulting up to 70% yield loss. Anthracnose (*Colletotrichumorbiculare),* Phomopsis black stem *(Phomopsissclerotioides),* Phoma blight (*Phomaexigua),* Scab (*Cladosporiumcucumerinum),*gummy stem blight (*Didymellabryoniae),*Downy mildew and powdery mildews (*Erysiphecichoracearum and Pseudoperonosporacubensis*)*,Alternaria* leaf spot and leaf blight by *Alternaria*spp. as well asleaf spot *(Myrotheciumroridum)* aresome of the important destructive fungal diseases that attack cucurbits (Zitter *et al.,* 1996; Koike *et al.,* 2007). The moisture content of the seed, storage period, prevailing temperature and degree of seed invasion influence the development of seed-borne fungi (Anjorin and Mohammed, 2009). The pathogen may be present externally or internally or associated with the seed as contaminant. The pathogen may cause seed abortion and rot, necrosis, reduction or elimination of germination capacity as well as seedling damage at later stages of plant growth resulting in development of the disease as systemic or local infection (Khanzada *et al.,* 2002). The plants themselves get adapted to a wide variety of rainfall conditions. duToit and Hernandez-Perez (2005) confirmed that under optimal conditions presowing seed treatments such as priming and hot water soaking are required for successful seedling production.

In the present scenario, increasing fungal diseases result major crop losses. In view of this present study was conducted in major cucurbit growing

areas of Karnataka to determine the incidence of type of fungal pathogen that causes diseases to cucurbitaceae vegetable crops.

Materials and methods

The fungal infected seeds, fruits and infected plant materials of cucurbitaceae were collected from the farmers, their fields and seed markets covering four different agroclimatic zones (2009 to 2010) as shown in Table 1. The infected seeds were collected in sterilized polyethylene bags (Chehri *et al.,* 2010), brought to the laboratory and stored under refrigerator condition for further analysis.

In standard blotter method (SBM) seeds were surface sterilized with 2% sodium hypochlorite for 2 min followed by 3 to 4 times repeated wash with distilled water. Seeds were placed in a 9 cm diameter petriplates (10 seeds/plate) on three layers of moistened blotters and incubated at 24^{o}C for 12 h in an alternating cycle of light and darkness for 7 days (ISTA, 2005). In deep freezer method the seed plates (10 seeds/plate) were incubated at 25^{o}C for 24 h, the plates were kept in the deep freezer (-20^{o}C) for 24 h, afterwords the plates were incubated at 25 ±1^{o}C for 12 h light -12 h dark periods for five days (ISTA, 2005). The incubated seed samples were examined for fungal colonies under a stereomicroscope (Leica, Germany). They were identified by preparing semi-permanent slides and using standard monographs Barnett and Hunter (1987), Mathur and Kongsdal (2003), Nagamani *et al.*, (2006), Leslie and Summerell (2006). Single spore isolation was made on potato dextrose agar slants, incubated at 25°C for 5-6 days and the pure fungal colonies were subjected to further observation. The percentage frequency of each fungal colony was calculated (Shakoor *et al.,* 2011).

Seeds were evaluated for germination by paper towel method to know the effect of seed-borne fungi on seed quality. Hundred seeds were selected randomly, placed (10 seeds/row) on germination sheet rolled, incubated at 25^{0}C for 12 h light and 12 h darkness for 8 days. Germination percent and seedling vigour index were calculated according to Abdul-Baki and Anderson (1973).

Results

Total 19 different seed samples of gourds, pumpkin and cucumber were collected in a sterile polyethylene bag, during the field survey from different agroclimatic zones (Table 1). On the seed samples after plating, different types of fungal colonies were identified based on their morphological characters. The percentage infection and prevalence of individual fungus on cucurbits identified included- *Fusarium* spp., *Alternaria*spp.,*Chaetomium*spp., *Phoma*spp. and

*Cladosporium*spp. (Table 2 & Fig. 1); among these *Fusarium* spp. were dominant in the cucurbit seeds.

Ridge gourd fields were extensively infected with powdery mildew and downy mildew in southern areas. About 60% of gourd plants were infected with *Alternaria* spp. Powdery mildew appears like white powdery dews on leaves and stems, ultimately the infected parts wither and die. *Pseudoperonosporacubensis*, a downy mildew pathogen causes mottling, yellow spotting and small lesions coalescence on the leaves. Greyish white fungal growth was observed on lower surfaces, infected leaves later become dry and loss of foliage affects yield as well as size of fruit.

Table 1. Taluks covered in the agro-climatic zones of Karnataka for Survey

Agro-climatic zone	**Name of Taluk**
Eastern dry zone	Tumkur (SG1, RG3)
Southern dry zone	K.R.Nagar (RG2, BG3), Mysore (Cu1, P3, BG2), Mandya (BiG2, RG4), Pandavapura (Cu3, P2)
Southern transition zone	H.D.Kote (Cu2, BiG3), Hunsur (BG4), H.N.Pura (SG2)
Northern transition zone	Ranibennur (RG1, BG1, BiG1, P1)

BG- Bottle gourd, BiG-Bitter gourd, Cu-cucumber, P-Pumpkin, RG-Ridge gourd, SG-Spongegourd and 1, 2, 3 are the sample numbers (all samples are entries of the Department of Studies of Microbiology, University Of Mysore, Mysore.)

All the seed samples were tested for incidence of seed borne fungi by standard blotter method and deep freeze method. The per cent incidence of *F. oxysporum*(SG1-29.2%)and *F. verticillioides*(BG2-22.2%) was high in all seeds except sponge gourd. *F. oxysporum* growth was sparse to abundant, covering the entire seed with white to cream coloured mycelium and produced pale orange slimy mass of conidia. The mycelium of *F. solani* was creamish white with watery droplets sparse, floccose mycelium covering whole seed. The higher incidence of *Fusarium* spp., was observed in cucumber (Cu1-28.5%, Cu2-18.1%, Cu3-13.9%) and bottlegourd (BG1-15.6%, BG2-22.2%, BG3-16.2%) seeds. In our study we found that the infection ratio was more in seeds collected from farmer field. It is mainly wilt disease which decreased the yield rate of cucurbits.

Alternariaalternata(BG2-11.1%, BG3-16.6%) and *Alternaria cucumerina* (BG3-22.2%, BG4-8.2%) were most prevalent in all bottle gourds isolates (Fig 1A and 1B). *Cladosporium cucumeriana*, with pale olivaceous brown mycelia covered the whole seed. The ramoconidium was single cell, conidia was formed in long branched chains and ellipsoidal, fusiform or subspherical single cell without septum. Deep-rooted and slow growing fungi in the seed coat were

isolated using deep freezing method. In deep freezing method fungi like *Acremonium strictum,Rhizopus stolonifers*, *Aspergillusflavus*, *Penicillum*spp. and *Alternariacucumerina* were more prevalently isolated along with other fungi (Table 3).

Table 3. Percent incidence of fungi using deep freeze method on different cucurbitaceae seeds

Fungi	Bottlegourd	Bittergourd	Cucumber	Pumpkin	Ridgegourd	Spongegourd
Acremoniumstrictum	12.9	-	-	-	8.2	12.4
Alternariaalternata	-	6	12.2	9.6	11.4	8.2
Alternariacucumerina	-	9.4	10.2	8.2	14.4	-
Aspergillusflavus	8.7	13.9	-	-	-	-
Aspergillusoryzae	10.5	-	9.6	11.3	-	9.6
Chaetomiumglobosum	-	10.2	8.9	8.9	9.8	-
Chaetomiumindicum	9.8	6.4	-	9.2	-	8.1
Chaetomiumcrispatum	8.6	7.8	-	6.8	8.6	-
Cladosporiumcucumerinum	-	-	7.2	7.4		-
Curvularialunata	-	-	10.8	-	12.4	-
Drechslerademotidea	-	-	11.7	9.2	-	8.1
Drechsleratetramera	6.1	8.6	-		8.9	7.5
Fusariumoxysporum	10.3	-	10.6	-	10.3	-
Fusariumsemitectum	-	-	-	-	-	9.2
Fusariumsolani	-	-	-	8.7	-	12.3
Fusariumverticillioides	8.9	12.6	8.8	-	8.9	-
Penicillum spp.	5.3	14.8	-	8.3	7.3	11.7
Phoma spp.	-	10.3	-	12.9	-	-
Phomaterricola	6.2	-	-	-	-	
Rhizopusstolonifers	13.1	-	9.6	-	-	12.3

All samples are entries of the Department of Studies of Microbiology, University Of Mysore, Mysore

In *Chaetomium* spp., *(C. globosum, C. indicum, C. crispatum, C. funicola)* perithecia were superficial, attached to the seeds by rhizoids, ostiolate, translucent or dark coloured, oval or subglobose, hairs terminal and lateral. Mycelium was thread like, thick or thin walled, septate, hyaline to yellowish-brown. Thehighest incidence of *Phoma*spp.,was seen in cucumber (Cu1-12.6%, Cu3-11.4%), bittergourd (BiG1-9.5%) and pumpkin (P2-8.8%). They were pycnidia immersed or semi-immersed, unilocular rarely multilocular, globose, septate or aggregated, pale to medium brown, ostioles in centre, single or occasionally confluent and multiostiolate, variable in form and growth, olivaceous or black. The pycnidia of *Botrydiplodiatheobromae*was observed on Ridge gourd (RG1-11.1%, RG3-12.3%), bittergourd(BiG3- 12.5%, BiG1- 12.9%), sponge gourd (SG2-15.4%) and pumpkin (P3-16.5%) seeds submerged in the seed coat with white to black mycelium. Pycnidiospores in the beginning unicellular-hyaline, at maturity pycnidia was single septate and dark colored. Some of the major fungi also identified from the cucurbitaecae include *Acremonium strictum, Alternaria alternata, A. cucumerina,*

Botryodiplodia theobromae, Curvularia lunata, Chaetomium spp., *Cladosporium cucumerinum, Drechslera tetramera, D. demotidea, Fusarium* spp., *Nigrospora oryzae* and *Phoma* spp.

Secondary seed infection was avoided by the surface disinfection with 2% sodium hypochlorite, it lowered the incidence of *Aspergillus* spp., *Rhizopus*spp. and*Drechslera*spp., which showed brown rot symptoms on seed and seedlings. *A. alternata* and *Curvularialunata*caused delay or reduction in seed germination. The fungi present in the seedcoat as well as plumule decreased seed germination and seedling vigour, increased seed deterioration (Table 4).

Table 4. Germination and Vigour index of different cucurbitaceae seeds

Seed samples		MSL (cm)	MRL (cm)	Germination (%)	*Vigour index
Bottlegourd	BG1	9.22 ± 0.81	10.3 ± 0.96	54 ± 1.52	1048.18 ± 44.76
	BG2	9.16 ± 0.6	8.14 ± 0.7	65 ± 1.52	1131.60 ± 71.1
	BG3	9.17 ± 0.85	10.85 ± 0.45	55 ± 2.64	1100.24 ± 22.05
	BG4	8.55 ± 1.09	10.37 ± 0.75	76 ± 1.52	1431.38 ± 30.14
Bittergourd	BiG1	12.64 ± 0.33	11.42 ± 0.57	69 ± 0.57	1652.21 ± 31.23
	BiG2	14.93 ± 1.11	10.05 ± 0.92	56 ± 2.51	1406.84 ± 79.22
	BiG3	13.08 ± 0.59	10.67 ± 0.39	56 ± 0.57	1323.11 ± 57.51
Cucumber	Cu1	7.47 ± 0.9	11.75 ± 0.82	64 ± 2.51	1224.9 ± 87.29
	Cu2	10.36 ± 0.66	13.8 ± 0.55	63 ± 3.5	1530.53 ± 84.35
	Cu3	11.76 ± 0.73	13.71 ± 0.51	63 ± 4.58	1602.02 ± 52.11
Pumpkin	P1	10.25 ± 0.61	9.45 ± 0.95	61 ± 2.08	1196.11 ± 67.28
	P2	10.83 ± 0.35	8.97 ± 0.32	50 ± 2.64	989.86 ± 54.45
	P3	9.2 ± 0.51	9.34 ± 0.87	54 ± 2.08	991.5 ± 0.58
Ridgegourd	RG1	12.48 ± 0.48	11.2 ± 0.88	66 ± 4.04	1551.79 ± 13.45
	RG2	14.4 ± 0.75	11.33 ± 0.76	59 ± 2.08	1533.59 ± 40.12
	RG3	12.2 ± 0.9	13.5 ± 0.91	58 ± 2.08	1481.06 ± 20.55
	RG4	13.76 ± 0.14	15.42 ± 0.28	67 ± 2.51	1945.3 ± 66.44
Spongegourd	SG1	10.56 ± 0.85	10.09 ± 0.86	53 ± 1.15	1089.05 ± 90.65
	SG2	9.09 ± 0.2	11.03 ± 0.66	51 ± 1.52	1031.10 ± 13.7

BG-Bottlegourd, BiG-Bittergourd, Cu-cucumber, SG-Spongegourd, P-Pumpkin, RG-Ridge gourd and 1, 2, 3 are the sample number (all samples are entries of the Department of Studies of Microbiology, University Of Mysore, Mysore).

*Vigour index = (Mean root length + Mean shoot length) × percentage germination

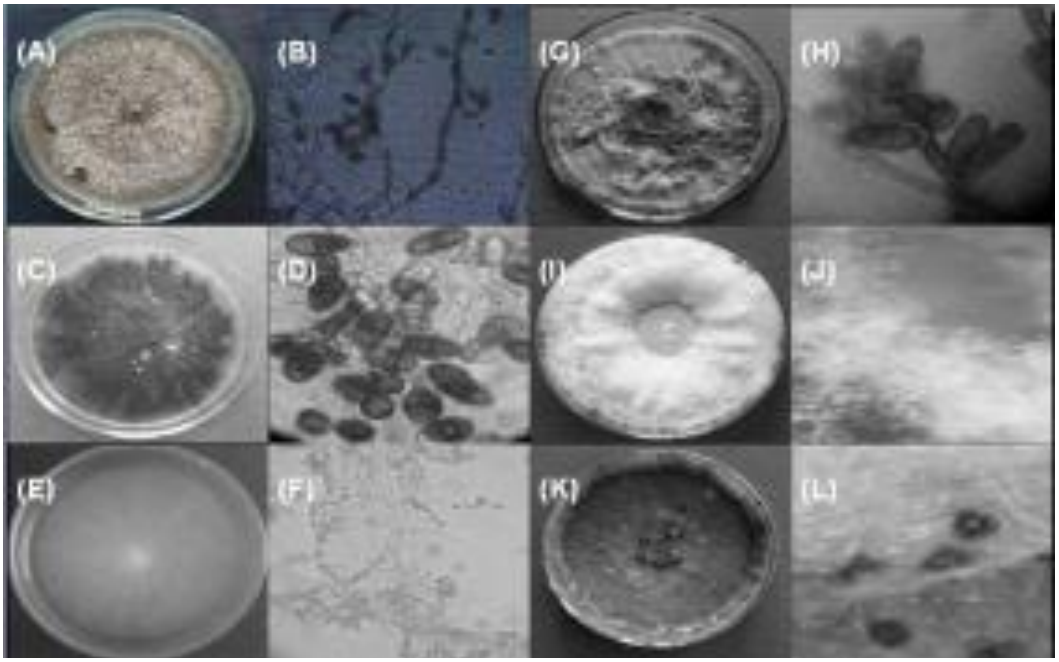

Fig. 1. Colony morphology and conidial characters of cucurbitaceous fungi isolated from seeds. *Alternariacucumerina*(A, B) with fasciculate to solitary, conidia apical or on conidiophores of bitter gourd.(C, D) *Botrydiplodiatheobromae*pycnidiospores unicellular-hyaline and mature single septate-dark of bitter gourd. (E, F) Sporogenous cells phialidic*Acremomiumstrictum* simple, conidia cylindrical of ridge gourd. (G, H) olivaceous*Drechsleratetramera* 3-septate, cylindric, end cells having sub-hyaline towards terminal portions of bottle gourd (I, J)*Fusariumoxysporum* with globose, intercalary or on short lateral chlamydospore of ridge gourd. (K, L) *Phoma* with pycnidiaunilocular or multilocular, brown, globose, septate or aggregated of bottle gourd.

Discussions

In the survey also most of the cucurbit plants were infected with some other types of leafy symptoms. The major infection was powdery mildew and Alternaria leaf spot of gourds. They were well spread and extensively prevalent in the southern region are favoured by the atmosphere condition to spread and infect. Kelaniyangoda *et al.,* (2002) have reported has their survey about the foliage diseases with lesions as also, higher incidence of collar rot and root rot in Sri Lankan nurseries. The seed-borne nature and transmission of *Alternariaalternata* and *Fusarium*spp., from seed to seedling were confirmed by seedling symptom test in maize (Basak and Lee, 2002).

Cucurbits showed a high incidence of *Fusariumoxysporum*and *F. verticillioides* in all crops except sponge gourd and ash gourd. Transmission of the pathogenic *F. oxysporum, F. solani, F. moniliformae, Verticillum* spp. And

Cephalosporium spp. from seed to plant was confirmed in peanuts (El-Wakil and El-Metwally 2001).*Fusarium* spp. cause seed rot, seedling blight and wilt in a number of cucurbitaceous crops (Kelaniyangoda*et al.,* 2002; Koike *et al.,* 2007).Sultana and Ghaffar, 2009 reported that *F. semitectum, F. solani, F. graminearum*were isolatedfrom bitter gourd, bottle gourd and ridge gourd by blotter method. *Fusarium* spp. survive in soil in the form of chlyamadaspores for many years and when environment favours cause the disease to reduce yield also quality in cucurbits (Hatami*et al.,* 2013; Chehri*et al.,* 2010). *F. verticillioides*mycelium is white to pinkish and powdery due to abundant microconidia (Leslie and Summerell, 2006; Mathur and Kongsdal, 2003). Farrag and Mohram (2012) confirmed the location of *Fusarium* spp. in cucurbits in embryo, seed coat and cotyledon by the component plating method.

Sphaerothecafuliginea is a powdery mildew pathogen causing white, powdery growth on the side of leaves and stems. Loss of foliage caused by the disease affects yield by reducing the number and size of fruits. Cucurbits get infected by two species of Powdery mildew pathogens- *Sphaerothecafuliginea* and *Podosphaeraxanthii*(Zitter *et al.,* 1996; Koike*et al.,* 2007). Mildews are widespread, infect all types of crop plants causing total losses, in plant growth and crop yield (Agrios, 2005). *Transmission of seed borne pathogens like Phomopsisvexans*and *Alternariasolani*in brinjal seeds were studied by standard blotter method. The percent infection was varied the seed coat (2%), cotyledons (4%) and embryonic axis (4%) caused by *P. vexans(*Thippeswamy *et al., 2012).*

Alternaria leaf spot was prevalent on the ridge gourd, bottle gourd, bitter gourd and ash gourd as observed during the survey. Both *Alternaria cucumerina* and *A. alternata* infect almost all cucumbers worldwide, spores are transported by wind over long distances through rain, warm and 60-80% humid conditions which are favourable for infection development (Neeraj and Verma, 2010). In moist conditions greenhouse plants favour the growth of *Cladosporiumcucumerinum* on cucumber (Kwon *et al.,* 1999). Yield losses due to leaf necrosis and foliage loss are variable depending on the type of cucurbitaceae and the type of diseases.

Deep freezing method other than *Acremonium, Penicillum* and *Aspergillus* spp. other are predominat fungi isolated. In deep freezing method an increase in slow growing fungi was observed along with other fungi (Elwakil et al., 2007). Deep-rooted and slow growing fungi in the seed coat were identified by the deep freezing method. In the deep freezing method slow growing fungi like *Phoma, Myrothecium, Gliocladium, Penicillium* were observed. Sultana and Ghaffar (2007) reported that some *Fusarium* spp. along with *Myrothecium* and *Penicillium*isolated by deep freezing method.

The seed borne fungi were reported by earlier researchers include*Altenariaalternata, Botryodiplodiatheobromae, Chaetomium spp., Curvularialunata, Drechsleratetramera, Fusariumequiseti, F. moniliforme*and *F. solani* on gourd seeds (Richardson, 1990); on squash, muskmelon, cucumber, watermelon and bittergourd (Nair, 1982; Mathur,1990). Blotter paper method was found suitable for the detection of seed borne fungi of cucurbits (Begum and Momin, 2000; Elwakil and El-Metwally, 2001).

Germination capacity of cucurbitaceae seeds is influenced by both external and internal factors. Germination failure of seeds is mainly due to temperature, gas exchange, water activity as well as growth hormones involved in regulating germination. Nerson., 2007 reported that storage conditions, stage of harvest and extraction procedure decide seed quality in cucurbits. Farrag and Mohram 2012 reported that *F.solani* and *F.oxysporum* survives as conidia, mycelia, spore on the seed coat or seed surface. Invasion of the seed surface by pathogens germination was halted or slowed. The seed borne fungi have reduced the germination, vigour and quality of cotton seeds (Kavitha *et al*., 2005), melon seeds (Bharath *et al*., 2005) and gourd seeds (Sultana *et al.*, 2010).

Biotic and abiotic factors clarify that loss of germination capacity is the final manifestation of seed deterioration. This can be confirmed precisely by blotter method which is effective for detection of most infectious fungi of cucurbits.

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Table 2. Percent incidence of fungi using blotter test on different cucurbitaceae seeds

Fungi	Bottle gourd				Bitter gourd			Cucumber			Pumpkin			Ridge gourd				Sponge gourd	
	BG1	BG2	BG3	BG4	BiG1	BiG2	BiG3	Cu1	Cu2	Cu3	P1	P2	P3	RG1	RG2	RG3	RG4	SG1	SG2
Acremoniumstrictum	-	-	-	-	-	-	-	-	-	-	-	13.4	-	6.2	-	-	-	-	-
Alternariaalternata	-	11.1	16.6	6	-	12.9	-	10.5	4.8	2.5	15.6	-	-	-	13.4	-	-	-	13.8
Alternariacucumerina	-	-	22.2	8.2	-	16.9	-	-	19	22.8	10	-	-	-	-	24.6	13.2	26.4	-
Botryiscinerea	-	-	-	-	-	-	-	3.8	-	-	-	-	-	-	-	-	-	11.2	-
Botryodiplodiatheobromae	-	-	-	-	12.9	-	12.5	-	-	-	-	-	16.5	11.1	-	12.3	-	-	15.4
Chaetomiumglobosum	18.6	-	16.3	12.2	8.8	-	14.8	10.6	-	-	-	-	13.4	9.8	-	-	8.9	-	-
Chaetomiumindicum	11.9	22.2	11	10	14	-	-	-	-	-	-	-	19.1	9.8	13.4	-	-	-	-
Chaetomiumcrispatum	20.3	-	-	7.8	4.7	-	-	-	8.1	16.4	-	7.4	-	16.6	-	-	16.5	-	-
Chaetomiumfunicola	13.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cladosporiumcucumerinum	-	12	-	11.4	-	-	-	-	13.1	10.1	13.8	19.6	9.7	4.9	-	-	13.2	-	-
Colletotrichumorbiculare	-	-	-	-	-	-	-	6.6	-	6.3	10.5	-	-	-	-	-	-	-	-
Curvularialunata	-	17.6	-	-	11.7	-	9.7	-	11.9	8.9	-	14	7.6	-	17.6	-	17.6	-	12.8
Drechslerademotidea	-	-	-	-	-	13.2	-	5.7	-	-	-	-	-	-	-	-	-	-	-
Drechsleratetramera	-	-	-	9.9	-	14.5	-	11.4	-	-	11.3	-	-	9.9	-	-	-	-	29.8
Fusariumoxysporum	15.6	14.8	-	-	-	19.3	-	28.5	18.1	13.9	10.3	14.3	10	12.3	20.2	17.7	13.2	29.2	-
Fusariumpoae	-	-	-	-	4.7	12.6	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusariumsemitectum	-	-	16.2	-	-	-	14.9	-	-	-	-	-	-	-	-	17.9	-	-	-
Fusariumsolani	13.5	-	-	8.7	9.3	-	13.6	-	-	-	-	-	8.6	-	-	9.3	-	-	18.6
Fusariumverticillioides	-	22.2	11.5	12.3	13	-	14.8	5.7	8.6	-	14.4	20.5	-	12.9	-	18.5	8.8	-	-
Fusariumgraminearum	-	-	-	-	-	10.9	-	4.9	-	-	-	-	15.1	-	10.1	-	-	-	-
Nigrosporaoryzae	-	-	-	6.1	10.7	-	-	-	-	-	-	-	-	-	15.1	-	-	-	-
Phoma sp.	6.8	-	-	8.7	9.5	-	-	12.6	-	11.4	8.8	-	-	-	-	-	8.2	33.4	9.6
Phomaterricola	-	-	-	-	-	-	-	-	-	-	5	10.2	-	6.2	-	-	-	-	-
Phytoptoracapcici	-	-	5.6	-	-	-	19.4	-	15.9	7.6	-	-	-	-	10.1	-	-	-	-

BG- Bottle gourd, BiG-Bitter gourd, Cu-cucumber, P-Pumpkin, RG-Ridge gourd, SG-Spongegourd and 1, 2, 3,4 is the sample numbers, - = no growth (all samples are entries of the Department of Studies of Microbiology, University Of Mysore, Mysore). *Percentage frequency of fungi = (No. of seeds infected / Total no. of seed plated) × 100