Original Research Article

Morph-metric characterization of powdery mildew infecting diverse host plants of Southern Gujarat, India

ABSTRACT:

Powdery mildews are obligate biotrophic fungal pathogens that are responsible for disease on a wide range of host plants with white powdery patches on plant parts. An exhaustive survey in the Navsari region of south Gujarat showed powdery mildew symptoms on 39 hosts of 22 families. The symptoms were observed on leaves, stems, and pods/fruits on different crops with usual symptoms of white powdery/floury circular to irregular spots, specks, or patches either on the upper surface or lower surface or both the surface of the leaves. Majorly the genera like *Erysiphe*, *Golovinomyces*, *Leveillula*, *Oidium*, *Phyllactinia*, *Podosphaera*, *Micro-oidium* and *Sphaerotheca* were found on different hosts in this region. The maximum number of hosts were infected by the genus *Oidium* followed by *Erysiphe*. The highest percent disease incidence was observed on the asthma plant, black gram, green gram, and wild poinsettia between 75-100 per cent out of all the hosts.

Keywords: Biotrophic, powdery mildew pathogens, host range, per cent disease incidence

Comment [WU1]: Mention how to identify the pathogen.

Comment [WU2]: There are too many keywords.

1. INTRODUCTION

Powdery mildews are a group of fungal parasites belonging to order*Erysiphales* under the class *Leotiomycetes*. They are obligate biotrophs responsible for powderydiseases. These fungi grow superficially or epiphytically on plant surfaces. They cause various disease symptoms including chlorosis, stunted growth, early leaf drop and flower bud deformation on different plant parts including leaves, young stems, buds, flowers and fruits (5). The disease causes heavy losses to field crops and other plants. These fungi grow abundantly in dry and cool seasons. Leaves infected with powdery mildew may turn completely yellow, die, and fall off, which may expose fruit to sun burn. On some plants, powdery mildew may cause the leaves to twist, buckle, or otherwise distort. They are widespread on various hosts including agricultural crops, vegetables, trees, herbs, shrubs, grasses, ornamental plants and weeds (5).

Based on literature, throughout the world more than 7000 plant host species are attacked by powdery mildew (13).However, powdery mildews are more common on cultivated crops than on other plant hosts. The fungi infect almost every group of plants *i.e.* from grasses to higher angiosperms (2).Powdery mildews are easily recognizable on infected plant parts. The initial symptom appears as white powdery spots that may occur on both surfaces of leaves, shoots and sometimes on flowers and fruits. These spots gradually spread over a large area of the leaves and stems. Disease symptoms usually appear with the onset of summer and begin to disappear during scorching heat and rainy season (12).

The climatic conditions in Navsari district of south Gujarat encourage the initiation, growth and development of powdery mildew infection. The report of powdery mildews from the Navsari district is less explored therefore; an extensive survey of the area was carried out to study powdery mildew diversity and infection status of the disease on different hosts.

Comment [WU3]:

Comment [WU4]: Comment 1

2. MATERIALS AND METHODS

2.1 Survey and sampling

The samples were collected randomly using opportunistic survey from the Navsari region during March 2019 to March 2020 to know the diversity and incidence of powdery mildew on different hosts. For each sample 4-5 leaves showing white powdery symptom pattern were collected randomly fromdifferenthosts. The plant was tagged or marked to take observations regularly.

Comment [WU5]: The number and volume of the investigated community should be mentioned.

2.2 Morphological characterization of powdery mildew pathoge

Comment [WU6]: Pathogen

The studies on morphological features like mycelium, conidia, conidiophores, foot cell, conidial germ tubes, appressorium were observed under 10x and 40x objective binocular light microscope measuring its length and the breadth with the help of microscopic camera using scopephoto software atDepartment of Plant Pathology, N. M. College of Agriculture, Navsari Agricultural University, which is located at 20.95^0 North latitude (N) and 72.93^0 East longitude (E) under Agro climatic zone of South Gujarat, heavy rainfall zone, agroecological Situation-III.

Different methods were used to study the morphology of this pathogen suchasforidentifyingmycelium,conidiophoresandfootcell.Lactophenol (10CC)containing1.0percentcottonbluewasused.Crosssectionfromtheleafusingsharpbladefound tobeconvenientforconidiophores and foot cell. Whereastostudytheconidia, clear lactophenol solution was used. Glycerin was used to identify germ tube and appressorium. Foridentifyingfibrosinbodies3and10percentaqueoussolutionofKOHwasmountedon glass slidealong with fungalcolonies (Table2)(Figure 5).

Comment [WU7]: Candida??

Comment [WU8]: Refer to the article from which the protocol is adapted.

Disease incidence on different hosts studied using the formula given by (17).

$$\text{Incidence \%} = \frac{\text{Number of infected plant units}}{\text{Total number (healthy and infected) of units assessed}} \times 100$$

3. RESULTS AND DISCUSSION

The present study data revealed that 8 genera and 24 species of powdery mildew were known to attack different hosts in Navsari region of south Gujarat. These were recorded on about 39 plant host species (Figure 1) belonging to 36 genera and 22 families. The species richness of fungi was highest in *Oidium* (9 species), followed by *Erysiphe* (6 species), *Leveillula*, *Phyllactinia* and *Podosphaera* (2 each), *Golvinomyces*, *Sphaerotheca* and *Micro-oidium*(1 each). Eight hosts of family fabaceae were infected with powdery mildew followed by *Asteraceae* and *Cucurbitaceae* (4), *Malvaceae* (3), *Solanaceae* and *Euphorbiaceae* (2), *Rutaceae*, *Meliaceae*, *Brassicaceae*, *Convolvulaceae*, *Menispermaceae*, *Apiaceae*, *Boraginaceae*, *Oleaceae*, *Anacardiaceae*, *Moraceae*, *Phyllanthaceae*, *Apocyanaceae*, *Myrtaceae*, *Rosaceae*, *Pedaliaceae* and *Rhamnaceae* (1 each) (Table 1).

The powdery mildew symptoms were seen at different stages of the plant growth. Symptoms occurred in the initial stages in the case of jasmine, little gourd and ber; before flowering in gale of wind weed; between flowering and fruit setting stage in congress grass,

okra, black gram and green gram (Table 1). The per cent disease incidence also varied among different hosts ranging from 10-88% during the period of survey.

3.1 Morphological characterization of powdery mildew pathogen

The collected samples were taken for identification of causal organism usingmorphological features. The observations on morphology of the powdery mildewpathogen included the mycelium, length and breadth of conidia, conidiophores (Figure 2), appressorium (Figure 3), conidial germ tubes (Figure 4) and footcell (Figure 5). Morphological descriptions of powdery mildew pathogens collected from the differenthostaredescribedin the Table 2.

Navsari, being a coastal area of south Gujarat with heavy rainfall and dense vegetation,is favourable to powdery mildew fungi on various hosts(15). Symptoms differed from hosts to hosts. Common symptoms were circular to irregular white powdery patches ontheuppersurface of leavesin crops like mustard, little gourd, neem *etc*. and on lower surface of leaves in crops like pigeon pea, chilli, Indian rosewood, mulberry *etc*. or on both the surfaces of the leaves in wild poinsettia, field bindweed *etc*. High percent disease incidence *i.e*., 75-100 % was observed on different field crops such as okra, mustard, black gram, green gram, little gooseberry and little gourd and on weeds such as asthma plant, wild poinsettia *etc*.

Comment [WU9]: Favorable

Comment [WU10]: Chili!!

Powdery mildew caused by genus *Erysiphe* infected crops like okra, mustard, blackgram (15; 7; 6). The genus *Oidium* infected crops likeneem, broom creeper, mango, congress grass, little gooseberry, tamarind and ber which were also in consonance with the studies of the (1)and (16).The genus *Leveillula* infected crops like chilli, pigeon pea and a weed wild poinsettia which were in accordance with **(**14).

Mulberry and Indian rose wood were infected by the genus *Phyllactinia* which was also reported by (9) and (1), respectively. Powdery mildew pathogens infecting butternut squash, asthma plant, bitter gourd, bottle gourd, sesame and common cockle bur were infected with *Podospheara* genera which are in agreement with the findings of several workers (3; 11; 4; 8; 10; 16).

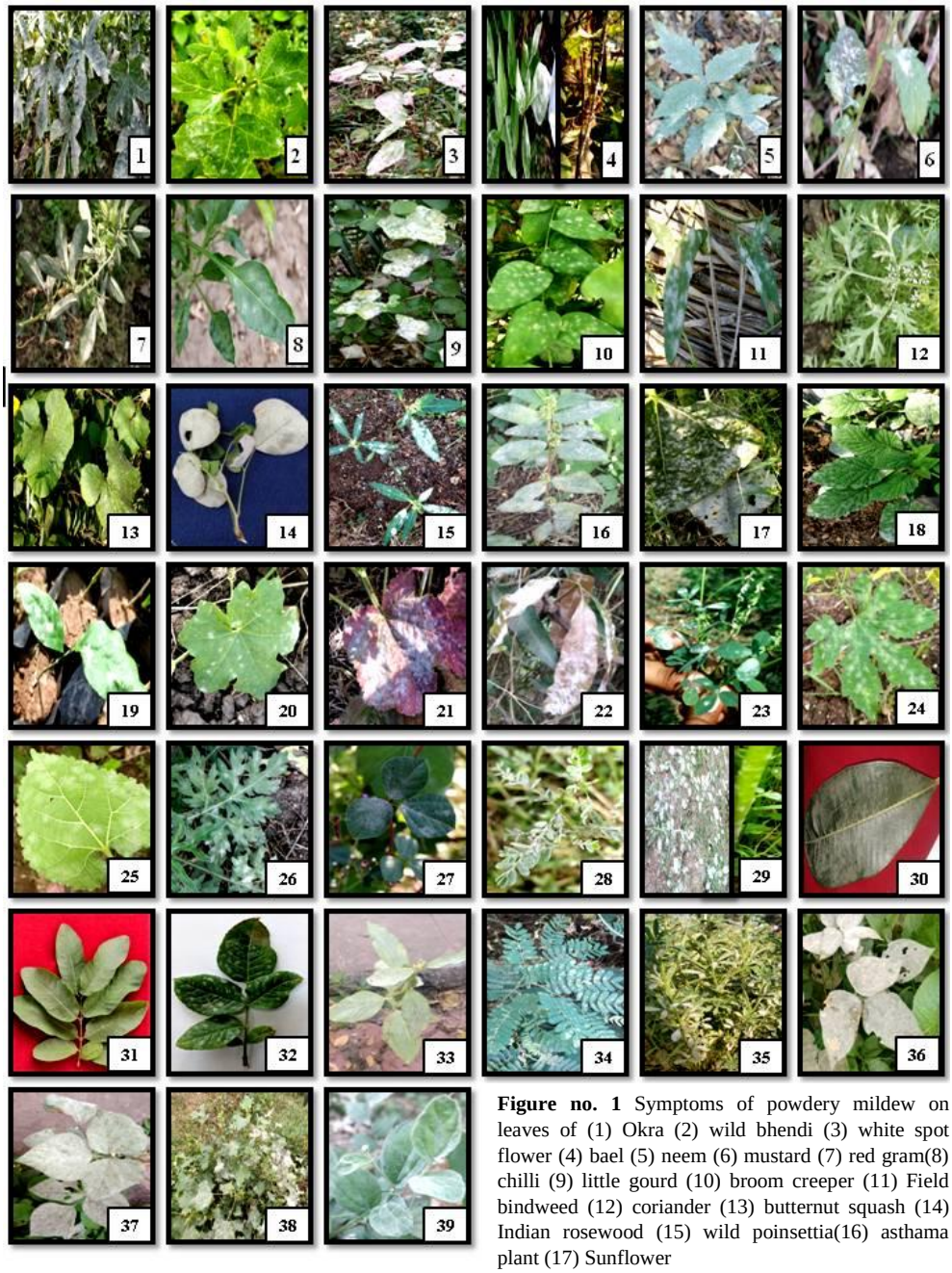

Figure no. 1 Symptoms of powdery mildew on leaves of (1) Okra (2) wild bhendi (3) white spot flower (4) bael (5) neem (6) mustard (7) red gram(8) chilli (9) little gourd (10) broom creeper (11) Field bindweed (12) coriander (13) butternut squash (14) Indian rosewood (15) wild poinsettia(16) asthama plant (17) Sunflower

(18) Indian heliotrope (19)jasmine (20) bottle gourd (21) vilayti bhendi (22) mango (23) white sweet clover (24) bittergourd (25) mulberry (26) parthenium (27)wild cocolmeca bean (28) gale of the wind (29) little gooseberry (30) Plumeria(31) guava (32) rose (33) sesame (34) tamarind (35) fenugreek (36) black gram (37) green gram (38) common cockle (39) ber

Table 1 Powdery mildew Symptoms and per cent disease incidence (PDI) on different hosts

Sl.No.	Host Range	Symptomson plants	Stagesof growth	Geographical co-ordinates		Year 2019-2020	
				Latitude	Longitude	Months	Incidence(%)
1.	Okra *Abelmoschusesculentus* L. Moench	Circular to irregular (CI) patches ontheuppersurface (US)oftheleaves,onstem, flowers andpods	Floweringand fruit setting	20° 55′ 38″ N	72° 53′ 54″ E	October–November	74.50
2.	Wildbhendi *Abelmoschus*Medik.	SmallwhiteCI patchesontheUSof theleaves	Floweringand fruit setting	20° 55′ 38″ N	72° 53′ 54″ E	October–November	51.32
3.	Whitespot-flower *Acmellaradicans*(Jacq.)R.K. Jansen	CI white patchesontheleavesand stem	Duringflowering andpodsetting	20° 55′ 38″ N	72° 53′ 54″ E	January – February	44.24
4.	Indianbael *Aeglemarmelos*L.	Circularwhitepatchesonboththesurfaceofleavesandontwigsand stem	Flowering andfruiting	20° 55′ 38″ N	72° 53′ 54″ E	December –January	47.33
5.	Neem *Azadirachtaindica* A.Juss	DirtywhiteflouryspecksonUS of leaves	Youngplant	20° 55′ 38″ N	72° 53′ 54″ E	January	34.42
6.	Mustard *Brassicajuncea*(L.) Czern.	CI patchesontheUS of olderleaves	Flowering and fruiting	20° 55′ 38″ N	72° 53′ 54″ E	January - February	77.50
7.	Pigeon pea *Cajanuscajan*(L.) Millsp.	Creamish white circular powdery patches on lower surface (LS) of the leaves, US the leaves turned pale	Before flowering, during flowerin	20° 55′ 38″ N	72° 53′ 54″ E	January – February	50.25

Comment [WU11]: Remove vertical lines in the table.

			g and pod formation				
8.	Chilli *Capsicumannuum*L.	Off white circular powdery patches on LS of the leaves, coalesced to form large patches	During flowering and fruiting	20° 55′ 38″ N	72° 53′ 54″ E	January – February	46.66
9.	Little guard *Cocciniacordifolia* L	CI white powdery mycelial mat on US of the leaves and stem	Initial stage of the plant, during flowering and also during fruit formation	20° 56′ 42.36″ N	72° 56′ 3.84″ E	November, December, January	84.62
10.	Broom creeper *Cocculushirsutus* (L.)Diels	White floury dust like pattern of mycelium on the US of the leaves	Before flowering and during flowering	20° 55′ 38″ N	72° 53′ 54″ E	November - December	49.82
11.	Field bindweed *Convolvulusarvensis* L.	White mat of dense mycelium on the LS of the leaves and on the US the circular white patches	Before flowering and during flowering	20° 55′ 38″ N	72° 53′ 54″ E	January - February	42.22
12.	Coriander *Coriandrumsativum*L.	White powder on older leaves and stem	At flowering and seed setting	20° 55′ 38″ N	72° 53′ 54″ E	February- March	38.50
13.	Butternut squash *Cucurbitamaxima*Du	White CI specks on LS of the leaves	Before flowering and	20.9053° N,	72.9173° E	December-	31.32

	chesne		fruit setting			January	
14.	Indian rosewood *Dalbergiasissoo*Roxb.	Dirty white circular powdery patches on the LS of the leaves	On older leaves of the tree	20° 55′ 38″ N	72° 53′ 54″ E	November-February	56.22
15.	Wild poinsettia *Euphorbiageniculata* Ortega	White circular small to large patches on both leaf surfaces	On leaves and post flowering	20° 55′ 38″ N	72° 53′ 54″ E	August-March	87.50
16.	Asthma-plant *Euphorbiahirta*L.	White powdery specks on the US of the leaves	Younger leaves to older leaves, stem, flowers and pod	20° 55′ 38″ N	72° 53′ 54″ E	November	76.00
17.	Sunflower *Helianthusannuus*L.	Specks of white powdery mycelium on the US of older leaves which coalesced to form large patch	During flowering and pod setting	21.3351° N	72.6225° E	January-February	45.72
18.	Indian Heliotrope *Heliotropiumindicum* L.	Small CI white spots on both leaf surfaces	Initial stages onwards	20° 55′ 38″ N	72° 53′ 54″ E	February	26.84
19.	Jasmine *Jasminumsambac*(L.) Aiton	White CI patches on US of the leaf and stem	At the flowering	20° 55′ 38″ N	72° 53′ 54″ E	April	11.42
20.	Bottle gourd *Lagenariasiceraria*(Molina) Standl.	White circular patches on US of the leaves	Flowering and fruit setting	20° 55′ 38″ N	72° 53′ 54″ E	December-February	34.22

21.	Vilayati Bhendi *Malachracapitata* L.	Dirty white CI white mycelial mat on US of the leaves and on stem	Initial stages of the plant to flowering and fruit setting	20° 55′ 38″ N	72° 53′ 54″ E	October - December	69.78
22.	Mango *Mangiferaindica*L.	Grayish white powdery specks on the leaves	Post flowering and fruit setting	20° 55′ 38″ N	72° 53′ 54″ E	December	24.11
23.	White sweet clover *Melilotusalbus* Medik.	White CI floury dust like patches on the US of the leaves	Flowering	20° 55′ 38″ N	72° 53′ 54″ E	April	15.65
24.	Bitter gourd *Momordicacharantia* L.	White powdery specks on the US of the leaves	Flowering and fruit setting	20.9645° N,	72.9254° E	November-December	52.36
25.	Mulberry *Morusalba*L.	White circular powdery specks on the LS the leaves	Initial stages of the plant and during flowering and pod formation	20° 55′ 38″ N	72° 53′ 54″ E	December-January	32.44
26.	Parthenium grass *Partheniumhysterophorus* L.	White dusty mycelium on the leaves, stem and flowers	Flowering	21.3351° N	72.6225° E	December	26.89
27.	Wild Cocolmeca Bean *Phaseolusmaculatus* Scheele	CI white spots on the US of the leaves	Flowering and pod formation	21.3351° N	72.6225° E	January - February	27.11
28.	Gale of the wind *Phyllanthusniruri*L.	White powdery mycelium on the leaves, stem, flowers and pods	Flowering and pod formation	20° 55′ 38″ N	72° 53′ 54″ E	October -	82.65

						Decem ber	
29.	Little gooseberry *Physalisminima*L.	Dusty white powder like symptom on US of leaves, stem and fruits	Flowering And Fruit Setting	21.3351° N	72.6225° E	October - Decem ber	84.46
30.	Plumeria *Plumeriaalba*L.	White dusty symptom was seen on US of leaves	Flowering	21.3351° N	72.6225° E	January	15.24
31.	Guava *Psidiumguajava*L.	Circular powdery patches on the US of the leaves	Flowerin g and Fruiting	20° 55′ 3 8″ N	72° 53′ 5 4″ E	Novem ber- Decem ber	15.22
32.	Rose *Rosaindica*L.	Grayish white irregular spots on the US of the leaves, buds and flowers	Flowerin g	20° 55′ 38″ N	72° 53′ 54″ E	Novem ber- Decem ber	35.25
33.	Sesame *Sesamumindicum* L.	White powdery mycelial mat on the leaves and pods	Pod formatio n	20° 55′ 38″ N	72° 53′ 54″ E	Decem ber- January	27.48
34.	Tamarind *Tamarindusindica*L.	CI whitish specks on the US of the leaves	Before flowerin g	20° 55′ 38″ N	72° 53′ 54″ E	Novem ber- Decem ber	12.32
35.	Fenugreek *Trigonellafoenum-graecum*L.	Dusty white powder on leaves and on stem	Flowerin g to seed setting	20° 55′ 38″ N	72° 53′ 54″ E	Februar y- March	49.62
36.	Green gram *Vignaradiata*(L.)Wilc	Irregular dirty white patches on the US of the lower leaves	During flowerin	20° 55′ 38″ N	72° 53′ 54″ E	Novem ber-	78.22

	zek		g and pod formation			December	
37.	Black gram *Vignamungo*(L.)Hepper	Irregular dirty white patches on the US of the lower leaves	During flowering and pod formation	20° 55′ 38″ N	72° 53′ 54″ E	November-December	77.84
38.	Common cocklebur *Xanthiumstrumarium* L.	White CI specks on the US of the leaves	On the leaves, pods	20° 55′ 38″ N	72° 53′ 54″ E	January - December	69.32
39.	Ber *Zizyphusmauritiana*Lam.	White dusty powder on the US of the leaves and on stem	Early stage of the plant and fruit formation	20° 55′ 38″ N	72° 53′ 54″ E	November-March	38.80

* CI - Circular to irregular LS- lower surface US- upper surface

Table 2 Description of powdery mildew genera identified from different hosts with their morphological features

Sl. No.	Genera	Hosts	Mycelia	Conidia and conidiophores (Cp) morphology	Germ tube and appresorium	Fibrosin bodies	Conidialsize(µm)			Conidiophore L(µm)	Foot cell Length
I	***Oidium***						Length (L)	Breadth (B)	L/B index		
a	*O. azadirachte*	Neem	Epiphytic	Conidia long ovoid, cylindrical in shape, borne singly on conidiophores(Cp).Cp erect, foot cells straight, curved to flexuous, followed by 2-3 smaller cells	simple with slightly swollen appressoria	-	38.03	12.42	3.06	112.32	37.44
b	*Oidium sp.*	White spot flower	White amphigenous	Ellipsoidal-cylindrical long conidia, borne singly. Cps were simple, slightly curved	simple slightly swollen nipple shaped appressorium.	-	30.71	16.05	1.91	90.07	39.63
c	*O. cocculus*	Broom creeper	White amphigenous	Conidia ovoid, ellipsoid borne singly or in short chains .Cp straight on foot cell composed of 3-4 cells	simple, slightly swollen appressorium	-	35.28	16.88	2.08	73.01	32.13
d	*O. mangiferae*	Mango	Superficial	Elliptical barrel shaped conidia borne singly or in chains. Slightly long with two to more basal cells Cp	simple	-	33.44	15.17	2.20	80.30	20.62
e	*o. ziziphin*	Ber	Septate white	Cylindrical to barrel shaped conidia. Upright and short Cp	simple	-	34.62	11.40	3.03	86.36	36.56

f	*O. tamarindii*	Tamarind	White cylindrical	Conidia cylindrical, formed singly or in chains. Cp Short and erect	arose from the end of conidia	-	30.02	14.60	2.05	52.23	32.72
g	*O. heliotropeindici*	Indian heliotrope	Ectophytic	Ovoid to ellipsoid in shape formed singly or in short chains. Cp erect, straight, slightly curved and cylindrical	produced from the lateral sides of the conidia. Appressorium was nipple shaped.	-	28.92	18.44	1.56	54.20	20.62
h	*O. malachaera*	Vilayati bhendi	White amphigenous mycelium	Ellipsoid to ovoid in shape, borne singly or in chains. Cp curved 6-8 celled, foot cell was straight	simple	-	35.70	17.75	2.01	97.98	42.65
i	*O. parthenii*	Partheniu m grass	Amphigenous	Barrel shaped conidia, Cp slightly swollen at the base and branched made up of 3-4 cells followed by foot cell	simple	-	22.77	13.93	1.63	85.05	39.60
j	*Oidium sp.*	Indian bael	White amphigenous mycelium persistent, effuse or patches	Conidia obovoid-ellipsoid to doliform subcylindrical borne singly, Cp simple, erect foot cells cylindrical 1–3 shorter cells	slightly swollen lobed or hooked appressorium	-	27.11	25.5	1.063	56.70	28.64
k	*Oidium sp.*	Plumeria	White, dense, superficial masses of mycelium,	Ellipsoid to oblong-elliptical conidia, produced singly, Cp unbranched, foot cells were cylindric, nearly straight and long, followed by 2-3 shorter cells	formed at the terminal position of the conidium.	-	25.6	18.23	1.40	72.47	18.68
l	*Oidium sp.*	Guava	White ectophytic	Conidia cylindrical, oblong-elliptical in shape. Cp straight	simple	-	15.30	14.93	1.02	66.67	29.80

				and slightly swollen at the base							
m	*Oidium sp.*	Little gooseberry	Ectophytic branched and septate mycelium	Conidia ovoid-ellipsoid and formed in short chains. Cp branched, short composed of 3-4 cells followed by foot cell	simple, appressorium slightly swollen or lobed	-	26.27	13.76	1.90	87.52	28.70
II	***Erysiphe***										
a	*E. cichoracearum*	Okra	Epiphytic hyaline, whitish, slightly flexuous and profuse	Conidia ellipsoidal-cylindrical (oblong/ barrel) long in shape borne singly or in short chains on slightly straight Cp	simple (non-forked) emerging apically or basally and it formed unlobed appressorium	-	47.22	20.88	2.26	112.26	35.40
b	*E. cichoracearum*	Wild bhendi	-do-	-do-	-do-	-	29.61	16.48	1.79	94.74	30.29
c	*E. polygoni*	Coriander	Amphigenous dirty white hyaline	Conidia borne singly or in chains which were barrel or cylindrical in shape. Cp slightly straight, foot cells were straight followed by 5-6 cells	simple (non-forked) emerging apically or basally and it formed unlobed appressorium.	-	26.14	15.65	1.67	87.63	16.95
d	*E. polygoni*	Fenugreek	-do-	-do-	-do-	-	27.42	16.23	1.68	88.32	18.04
e	*E. polygoni*	Black gram	-do-	-do-	-do-	-	25.7	16.1	1.59	62.27	38.00
f	*E. polygoni*	Green gram	-do-	-do-	-do-	-	28.97	17.54	1.65	102.16	13.74
g	*E. polygoni*	Wild cocolme	Epiphytic white	-do-	-do-	-	27.57	16.45	1.67	80.74	12.56

		ca bean									
h	*E. cruciferarum*	Mustard	Amphigenous white	Oblong to cylindrical or oval borne conidia borne singly or in short chains. Cp cylindrical composed of 3-4 cells	simple (non-forked) emerging apically or basally	-	38.90	14.90	2.60	114.25	40.20
i	*E. convolvuli*	Field bindweed	White dense	Conidia cylindrical to ellipsoid borne either singly or in chains. Cp with cylindrical foot cells, slightly curved composed of 3-4 cells	Arises laterally, with lobed appressorium	-	34.62	17.52	1.95	79.42	29.35
j	*E. trifoliorum*	White sweet clover	Epiphytic	Conidia solitary, cylindrical to doliiform, borne singly or in chains and Cp were single, hyaline and erect	terminal or subterminal with well-developed lobed appressoria	-	30.65	18.64	1.64	68.92	37.80
k	*Erysiphe sp.*	Jasmine	White ectophytic	Conidia ellipsoid-ovoid to subcylindrical in shape and formed singly. Erect and unbranched Cp with cylindrical foot-cells	arises laterally, with lobed appressorium	-	33.22	18.64	1.78	65.71	25.64
III	***Podosphaera***										
a	*P. xanthii*	Butternut squash	Mycelium flexuous to straight branched and septate	Ellipsoid-ovoid to barrel shaped conidia, formed in chains and straight Cp, foot-cells were cylindrical with slightly swollen base	simple to forked laterally, appressoria on the mycelium were nipple-shaped.	+	30.99	18.53	1.67	86.20	47.95
b	*P. xanthii*	Bottle gourd	Mycelium flexuous to branched and septate.	Conidia ellipsoid-ovoid to sub-cylindrical in shape, borne in chains. Cp were unbranched, erect and cylindrical	simple, nipple-shaped to almost absent with appressoria.	+	26.14	18.31	1.49	101.79	47.58

c	*P. xanthii*	Bitter gourd	Amphigenous	Ellipsoid to ovoid, doliform to sub-cylindrical in shape.Cp were erect, straight and cylindrical to flexuous, foot-cell followed by 1 to 4 shorter cells	simple germ tube, appressoria were indistinct to slightly nipple-shaped, and solitary.	+	27.89	15.63	1.78	104.86	49.20
d	*P. xanthii*	Sesamum	Amphigenous white mycelium	Conidia ovoid to dolliform, formed in short chains. Cp were simple, erect, foot-cells straight, followed by 1-3 short cells	arises from the end of the conidium	+	25.08	15.04	1.66	90.86	38.65
e	*P. xanthii*	Common cocklebur	Mycelium was flexuous to straight branched and septate	Conidia ellipsoid-ovoid to sub-cylindrical in shape, borne in chains. Unbranched, erect and cylindrical Cp.	simple, nipple-shape	+	33.00	16.4	2.01	71.74	45.23
f	*P. fusca*	Asthma plant	Hyphae were branched, septate and straight	Conidia ellipsoid to ovate in shape formed in 5-6 chains. Cp unbranched, long and straight	produced laterally, formed nipple-shaped to almost absent appressoria	+	25.10	18.53	1.34	84.62	42.22
IV	***Leveillula***										
a	*L. taurica*	Pigeon pea	Endophytic	Conidia pyriform, long, borne singly. Cp were long, slender, erect, unbranched, composed of 3- 4 cells followed by foot cell	long erect tail-like arising at the end of the conidia	-	59.10	19.88	2.97	130.99	33.21
b	*L. taurica*	Chilli	-do-	-do-	-do-	-	61.19	15.79	3.87	104.40	47.89

c	*L. clavata*	Wild poinsettia	Endophytic	Clavate, long conidia, borne singly at the apex. Long and slender Cp composed of 5-6 cells	formed near the end of conidium	-	72.8	16.6	4.38	135.64	40.84
V	***Golvonomyces***										
a	*G. orontii*	Little gourd	Amphigenous	Long cylindrical conidia, borne in chains. Cp erect composed of 4-5 cells followed by foot cell	simple and formed apically or basally at the end of the conidia; appressoria was bilobed	-	32.98	14.81	2.22	103.24	41.42
b	*G. orontii*	Sunflower	Amphigenous mycelium	Ellipsoid to round conidia formed in chains. Cp mostly erect containing a foot cell followed by 2 or 3 shorter cells	erect and long arising from the side with well developed nipple-shaped appressoria	-	32.22	18.44	1.74	65.41	25.62
VI	***Phyllactinia***										
a	*P. dalbergiae*	Indian rose wood	Endophytic mycelium	Pyriform, long conidia borne singly. Cp were long, erect, unbranched and composed of 5-6 cells followed by foot cell	long erect tail-like arising at the end of the conidia	-	75.05	16.06	4.67	141.25	50.72
b	*P. corylea*	Mulberry	Andophytic unbranched hyaline, erect	-do-	-do-	-	61.66	17.61	3.50	159.50	52.34
VII	***Microidium***										
a	*Microidium phyllanthi*	Gale of the wind	Amphigenous	Conidia were small, doliiform, ellipsoid to cylindrical in shape, produced in chains. Catenescent Cp; foot-cells were curved with a twist at the	microidium type on conidia. Appressoria on mycelium was lobed or nipple shaped	-	19.81	8.45	2.34	49.95	15.26

				base.							
VIII	***Sphaerotheca***										
a	*S. pannosa*	Rose	Epiphytic mycelia.	Ellipsoid-ovoid to doliiform conidia and produced in chains. Cp were erect, septate, hyaline and unbranched	appressoria in mycelia were simple and nipple-shaped	+	26.32	17.39	1.51	90.40	36.24

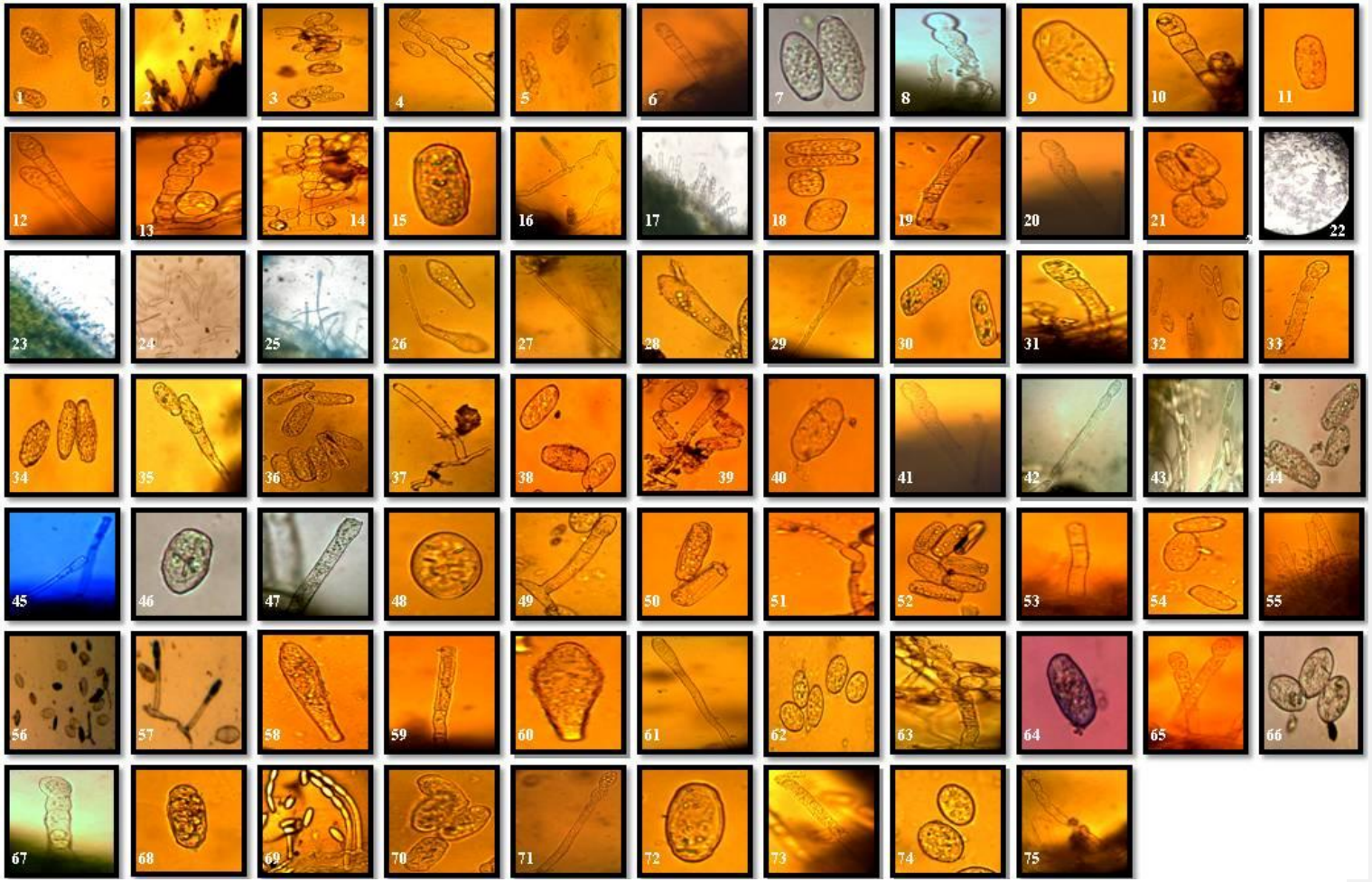

Figure 2 Conidia and conidiophores of (1&2) *E. cichoracearum* (Source: okra); (3&4) *E. cichoracearum* (Source: wild bhendi); (5 & 6) *E. convolvuli* (Source: field bindweed); (7 & 8) *E. cruciferarum* (Source: mustard) (9 & 10) *E. polygoni* (Source: coriander); (11 & 12) *E. polygoni* (Source: wild cocolmeca); (13) *E. polygoni* (Source: fenugreek); (14) *E. polygoni* (Source: black gram); (15 & 16) *E. polygoni* (Source: green gram) (17 & 18) *Erysiphe sp.* (Source: jasmine); (19 & 20) *E. trifolium* (Source: white sweet clover); (21 & 22) *G. orontii* (Source: little gourd); (23 & 24) *G.cichoracearum* (Source: sun flower); (25& 26) *L. clavata* (Source: wild poinsettia) of (27 & 28) *L. taurica* (Source: pigeon pea); (29 & 30) *L. taurica* (Source: chilli); (31 & 32) *M. phyllanthi* (Source: gale of the wind); (33 & 34) *Oidium sp.* (Source: white spot flower); (35 & 36) *Oidium sp.* (Source: bael) of (37 & 38) *O. azadirchtae* (Source: neem); (39 & 40) *Oidium sp.* (Source: broom creeper); (41 & 42) *O. heliotrope-indicum* (Source: Indian heliotrope); (43 & 44) *O. malachaera* (Source: vilayti bhendi) (45 & 46) *O. mangiferae* (Source: mango); (47 & 48) *O. parthenii* (Source: parthenium grass); (49 & 50) *Oidium sp.* (Source: little goose berry); (51 & 52) *Oidium sp.* (Source: plumeria); (53 & 54) *Oidium sp.* (Source: guava) (55 & 56) *O. tamarindi* (Source: tamarind); (c & d) *Oidium ziziphi* (Source: ber); (57 & 58) *P. corylea* (Source: mulberry); (59 & 60) *P. dalbergiae* (Source: Indian rosewood) (61 & 62) *P. fusca* (Source: asthma plant); (63 & 64) *P. xanthii* (Source: butternut squash);(66 & 67) *P. xanthii* (Source: bottle gourd); (68 & 69) *P. xanthii* (Source: bitter gourd) (70 & 71) *P. xanthii* (Source: sesame); (72 & 73) *P. xanthii* (Source: common cockle bur); (74 & 75) *Sphaerotheca pannosa* (Source: Rose)

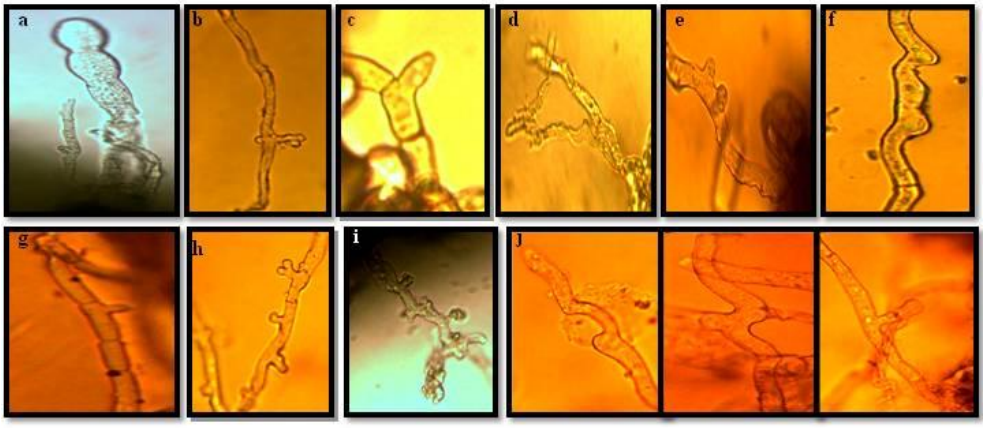

Figure 3 Appressorium formation in (a) *E. cruciferarum* (Source: mustard); (b) *G. orontii* (Source: little gourd); (c) *M. phyllanthi* (Source: gale of the wind); (d) *O. azadirachtae* (Source: neem); (e) *Oidium* sp. (Source: white spot flower); (f) *Oidium* sp. (Source: little goose berry) (g) *Oidium* sp. (Source: plumeria) (h) *P. corylea* (Source: mulberry); (i) *P. dalbergiae* (Source: Indian rosewood) ; (j) *P. xanthii* (Source: butternut

Figure 4 Conidial germination of (a) *E. cichoracearum* (Source: okra); (b) *Oidium* sp. (Source: white spot flower); (c) *G. orontii* (Source: little gourd); (d) *P. xanthii* (Source: butternut squash); (e) *L. taurica* (Source: pigeon pea);(f) *L. clavata* (Source: wild poinsettia); (g) *M. phyllanthi* (Source: gale of the wind

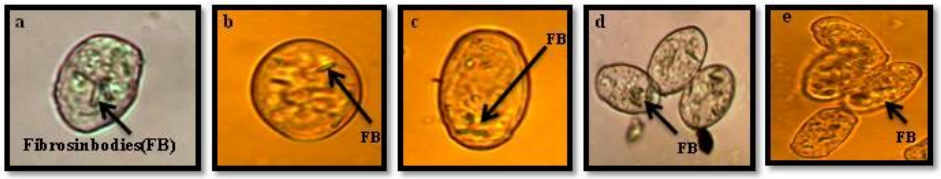

Figure 5 Fibrosin bodies of (a) *O. parthenii* (Source: congress grass); (b) *Oidium* sp. (Source: little goose berry; (c) *P. xanthii* (Source: bottle gourd); (d) *P. xanthii* (Source: sesame); (e) *P. xanthii* (Source: common cockle bur)

4. CONCLUSION

An extensive morphological detail of anamorphic stage of powdery mildew fungi is much important along with telomorph as the conidia acts as main source of dispersal and causes disease. Huge morphological variability exists among the genus of powdery mildew on different hosts. Therefore, paves a way to study more in detail for its obligate living nature and as morphological studies are extensively carried out but molecular studies of powdery mildew fungi are still required besides morphological taxonomy, which will not only help in

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revision and reassessment of the existing fungal species, but also help to find their correct taxonomic position as well.

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