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Survey and identification of fungal plant diseases in important crops of Tamil Nadu

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Abstract
A field investigation was conducted in Coimbatore district of Tamil Nadu in the year 2020 to 2021 in order to identify the fungal plant diseases of some important crops (rice, maize, black gram, groundnut and cotton). The diseases were identified based on the development of characteristic disease symptoms on the plant and morphological studies of the associated micro-organism under the microscope and were identified as Blast of Rice (*Pyricularia oryzae*), Sheath blight of Rice (*Rhizoctonia solani*), Sheath rot of Rice (*Sarocladium oryzae*), False smut of Rice (*Ustilaginoidea virens*), Southern leaf blight of Maize (*Bipolaris maydis*), Powdery mildew of Blackgram (*Erysiphe polygoni*), Early Tikka leaf spot of Groundnut (*Cercospora arachidicola*) and Alternaria leaf spot of Cotton (*Alternaria alternata)*. The per cent disease incidence was assessed by recording the number of plants showing disease symptoms and the number of plants examined, where highest incidence of all the fungal diseases was recorded in Pollachi (North). It was also observed that Pollachi (North) block had the highest PDI (Per cent Disease Index) values for all diseases when compared to Udumalaipettai block.

Keywords: Survey, fungal diseases, disease incidence, disease severity, percent disease index

Introduction
An estimated 10 to 30% of crop productivity is lost to crop losses caused by pests, diseases and weeds. Therefore, any disease that affects agriculture will have an impact on our economy and the population that depends on it (Lakshimikanth, 2008) [13]. A form of plant pathogen symptom known as a fungal disease symptom is what causes significant plant diseases (Bhawan, 2009) [1]. To gather complete data on the disease distribution, severity and to recognise hotspots for genotype diagnostics in the disease resistance screening programme, a survey of the disease is required. Plant disease survey involves field survey of farmers' field, collection of samples and confirmation of the sample in the laboratory. Plant disease survey aims at identifying the causal organism from the symptoms observed and by laboratory confirmation. The survey area that was chosen is one of the 38 districts that make up the India state of Tamil Nadu is Coimbatore. After Chennai and Tiruvallur district, it is the third most populous district in the state as of the 2020 census (Kumar and Elangovan, 2009) [11] There are two Rural Development block in Coimbatore District viz. Udumalaipettai RD Block and Pollachi (North) RD Block. All of these blocks was surveyed and studied. Among the villages of Coimbatore District, three villages from each RD block were selected: Gollapatti, Ramapattinam, Rasakapalayam, Alampalayam, Reddipalayam and Gandhi Nagar.

Materials and Methods
A survey on fungal diseases of cereals (rice and maize), pulses (Black gram), oilseed (Groundnut) and fibre crop (cotton) in Coimbatore district, Tamilnadu was undertaken in farmer's field during *Kharif* and *Rabi* season of 2020-21. To identify the association of crop host and pathogen in the crop field in villages, three fields were chosen and for each crop, four trips were made to the field at different times, to coincide with the onset and progression of disease. The evaluation was made, based on plant components exhibiting characteristic symptoms and identification of pathogen was made based on their cultural and morphological characters. Colony characters, mycelium, conidiophores and conidia were recorded at regular interval up to a period of 10 days.
The extent of damage caused by the pathogen to the crop was also assessed. Disease severity rating was recorded periodically for each field at different crop growth stages. The visual rating for disease damage was made according to the values given in a scale (Phytopathometry) for different crops.

Survey sites were categorised into no/low (0-3 predominant), moderate (4-6 predominant) and high (7-9 predominant) based on disease incidence and severity. The per cent disease incidence was assessed by recording the number of plants showing disease symptoms and the number of plants examined. In each village, three fields were selected and in each field plants were examined randomly and scored for disease incidence by using the following formula.

$$\text{Disease incidence (\%)} = \frac{\text{No. disease plant}}{\text{Total no. of plant assessed}} \text{x} 100$$

The disease scoring scales as given by Mayee and Datar (1986) [16], Sangeetha and Siddaramaiah (2007) [21] was adopted for scoring pathogenicity.

Disease severity value was converted to (PDI) percent disease index (Wheeler, 1969) [31]. The disease incidence was assessed by recording severity of disease in a locality by adopting 0-9 scale (Mayee and Datar, 1986) [16] and 0-5 scales (Sangeetha and Siddaramaiah, 2007) [21].

$$\text{PDI (\%)} = \frac{\text{Sum of individual ratings}}{\text{Total no. of plant observed x Max disease grade}} \text{ x } 100$$

Results

Association of crop host and pathogen

Blast of rice: Thorough observations of the rice field indicated that the disease was present in every component of the aerial plants. The leaves had large, spindle-shaped markings with ashy centres and brownish red borders that gave them their distinctive appearance. Conidiophore of the rice blast pathogen was found to be simple or in fascicles, rarely branched, showing sympodial growth when observed under the microscope. Pyriform, 3 celled Conidia (14-19 x 4.5–7.0 µm) formed singly at the tip of the condiophore, almost hyaline to pale olive in colour (Plate1).

Sheath blight of rice: The symptoms of sheath blight of rice in all the village under study showed large, irregular, oval to elliptical, green to grey, water-soaked lesions with a straw-colored centre and a wide reddish brown margin are the symptoms that first appear on the leaf sheath. The fungus were found to be long septate myceliums that are hyaline when young, yellowish brown when old. It also releases a large number of sclerotia, they are irregular, globose or hemispheric, flat tended at the base, white when young and turn brown or dark brown when older (Plate:2).

False smut of rice: The symptoms of false smut disease of rice in the entire village under study showed that the fungus transforms individual grains of the panicle in to greenish velvety spore balls. The spore balls are smooth and yellow and are covered with a membrane which becomes orange when the membrane bursts open. Chlamydospores were spherical or elliptical, yellowish brown to black brown with thick and compact walls. The surface of the chlamydospore had many varicose. The thin walled conidia were oval or oblong in shaped, size ranges from 2.6-8 x 2-5 µm, hyaline and smooth surfaces (Plate 3).

Sheath rot of rice: It was observed that the sheath rot occurs on upper most leaf sheath enclosing the young panicle, these lesions appear as oblong or somewhat irregular spots with brown margin with grey centre which enlarged and covered most of the leaf sheath, resulting in unmerged or partially emerged panicle having unfilled or partially filled grains. Conidia are one-celled, hyaline, thin-walled, smooth spheres that grow in slimy masses and have a 3.5-7.0 x 0.8-1.5 µm size. They are cylindrical with rounded ends and can occasionally become slightly curved (Plate 4).

Southern Leaf blight of Maize: Symptoms observed in the farmer's field were small, buff to brown colored elongated spots, which were scattered throughout the leaf lamina and were irregular in outline being vein limited and measured 2 mm to 2 cm length and 4-8 mm in breadth. The conidia were curved, fusiform and pale to dark golden brown in color measuring 27-103×7-20 µm with 3-10 septa (Plate 5).

Powdery mildew of Blackgram: Tiny, rounded, whitish, powder-like specks on the diseased leaf surface, petioles, stem and pods were observed in the field. The first places where symptoms emerged were on the crown leaves, shaded lower leaves and leaf under surfaces. The fungus generated barrel shaped conidia measuring 1.089 mm × 0.7131 mm (40x) and amphigenous dirty white hyaline mycelium (Plate 6).

Early Tikka leaf spot of Groundnut: Dark brown spots were observed on leaf surfaces. The spots varied in size from 3 to 5 mm round to irregular size and colour development from yellow to golden. Conidiophores were brown, continuous, sometimes 1-2 septate, unbranched and geniculate on the black Stroma. The conidia were obclavate or cylindrical, hyaline or light yellow in colour with a rounded to noticeably truncate base and a sub-acute tip (Plate 7).

Alternaria leaf spot of cotton: Following careful examination of the cotton field showed that the leaf is the most damaged, with small, dull to dark brown, round or irregular shaped spots ranging in diameter from 0.5 to 10 mm. On the upper surface, they frequently develop concentric ridges with a target board appearance. Conidia are usually born in long, branched chains, with an ovoid, obclavate, ellipsoidal, conical, or cylindrical apical beak that is less than the one length of the conidium, and one or two longitudinal septa at the lower part that measure 51 µm x 7.0-15.0 µm (Plate 8).

Association of crop host and pathogen in the crop field

A detailed survey was undertaken during *Kharif and Rabi* 2020-21 in parts of Coimbatore district to gather information on the association of host and pathogen, incidence, distribution and spread of fungal diseases of cereals, pulse, oilseed, vegetables, cash crop and fruit crops. From the survey it was revealed that the incidence of the diseases varied from one locality to another depending on the type of crop variety cultivated. The severity of disease was also dependent on inoculums load, agro-climatological situations prevailing in different localities. Assessment of the extent of damage caused by the pathogen to the crop under study is discussed below.

Among Rice diseases, highest disease incidence of all the four diseases i.e., Blast (*Pyricularia oryzae*), Sheath blight (*Rhizoctonia solani*), Sheath rot (*Sarocladium oryzae)* and False smut (*Ustilaginoidea virens*) was recorded in Pollachi (North) block with 10.87%, 12.17%, 10.50% and 6.00%

respectively (Table 1). In case of Maize, Southern leaf blight (*Bipolaris maydis*), Powdery mildew of Blackgram (*Erysiphe polygoni)*, Early tikka leaf spot of Groundnut (*Cercospora arachidicola)*and Alternaria leaf spot of cotton (*Alternaria alternata*) highest disease incidence was again recorded in Pollachi (North) block with 13.55%, 17.06%, 25.01%and 14.00% respectively (Table 1).

Plant Disease severity of all the diseases were also studied in Pollachi (North) and Udumalaipettai blocks. In case of diseases of Rice, the highest PDI of Blast (*Pyricularia oryzae*), Sheath blight (*Rhizoctonia solani)*, Sheath rot (*Sarocladium oryzae)* and False smut (*Ustilaginoidea virens)* were observed in Pollachi (North) block with 3.97%, 6.87%, 5.54% and 5.41% respectively (Table 2). The PDI for all the diseases was also recorded to be highest for the rest of the diseases as well in the Pollachi (North) block as shown in Table 2.

Discussion

The observations of symptoms recorded for blast of rice in the field were similar to the observations made by Verma and Sengupta (2008), Ghose *et al*. 2016 and Padmanabhan *et al.*, 2018. Description of blast of rice under microscope by earlier workers (Sueda, 2018; Nishikado, 2020) corroborates with the findings and thus the fungus was identified as *Pyricularia oryzae.* For sheath blight of rice, the findings corroborate with the study of other workers like Rangaswami, 2017 [20] and Xiao *et al.*, 2018 [29]. Swain *et al.*, 2009 [24] and Ahlawat, 2017 who also reported that the fungus was found to be long septate myceliums that are hyaline when young, yellowish brown when old. Symptoms of false smut disease of rice observed in the study were also found to be in agreement with typical symptoms of the disease described earlier by Lee and Gunnell, 2012 [15] and Kumar, 2015 [10]. Lee and Gunnell, 2013 also reported that chlamydospores were spherical or elliptical, yellowish brown to black brown with thick and compact walls which corroborates with the present findings. The field symptoms of sheath rot of rice were also found to be in agreement with other workers like Girish, 2010 and Tasugi and Ikeda, 2016. Description of sheath rot of rice by earlier workers (Naing *et al*., 2009 and Gams and Hawksworth, 2015) [4] corroborates with the findings of the present study and thus the sheath rot fungi were identified as *Sarocladium oryzae.* The symptoms of Southern Leaf blight of Maize observed in the farmers field were found to be in agreement with typical symptoms of the disease described earlier by Laxminarayana and Shankerlingam (2006) [14], Dharandendra (2010) [2] and Wani (2015) [28]. Description of southern leaf blight of maize by earlier workers (Gowda *et al.*, 2008 and Gates *et al*., 2016) [8, 15] corroborates with the findings of the present study and thus the southern leaf blight fungi were identified as *Bipolaris maydis.* Typical symptoms of the powdery mildew disease of blackgram described earlier by Mir *et al.* 2011 [18], Veena *et al*. 2014 [26] and Kumar *et al*. 2016 [9] were found to be in agreement with the present finding. The findings of present study corroborates with the findings of earlier workers like Kumar *et al*. (2005) [12] and Dinesh *et al.* (2013) [3] and thus the powdery mildew fungi were identified as *Erysiphe polygoni.* Early tikka disease of groundnut as described by Gibbons (2012) [6], Sturgeon (2013) [22] and Velusamy *et al*. (2017) [27] were found to be in agreement with the present findings. Description was also made by Subrahmanyam *et al*. 2015 [23] which corroborates the present finding and thus the early tikka leaf spot of fungi was identified as *Cercospora arachidicola.* Description of Alternaria leaf spot of cotton by earlier worker (Zhu *et al*. 2018) [30] corroborates with the findings of the present study and thus the Alternaria leaf spot fungi were identified as *Alternaria alternata.*

For the association of crop host and pathogen in the crop field, in the present study, the highest disease incidence was found in Pollachi (North) block for all the diseases. This may be attributed to the environmental conditions, susceptibility of the cultivars used and also because of the seed-borne nature of the pathogen. The present observation was in agreement with Bhatt and Chauhan (2009) who carried out intensive survey work on blast of rice. Ogliari *et al*. (2005) described temperature between 20 °C to 25 °C, relative humidity from 90 to 100% and low luminosity favours the corn diseases. Bardin *et al*., 2005 reported the severity of powdery mildew of 9 to 36% from four of the regions in France. Kumar, 2013 reported that anthracnose disease are favored by high rainfall, optimum temperature and relative humidity, moisture conditions that might have flavoured the build-up of inoculum and subsequently showing increase in disease severity.

Conclusion

With the exception of the Grey Blight of Mango where the disease incidence was found highest in Udumalaipettai block, the highest disease incidence was found in the Coimbatore district's Pollachi (North) block for all other diseases. The Pollachi (North) block had the highest PDI (Percent Disease Index) reading for all the diseases when compared to Udumalaipettai block.

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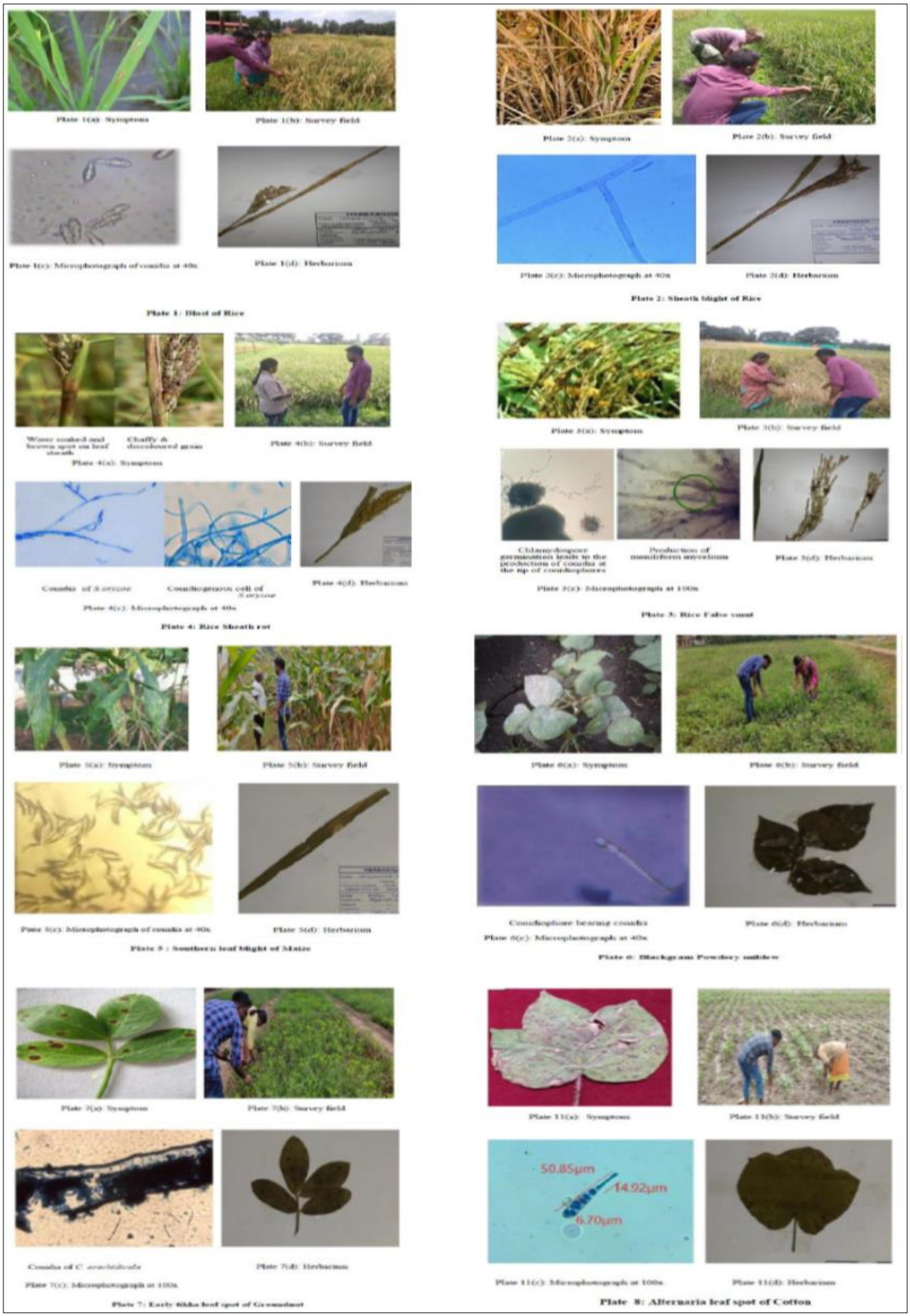

Fig 1: Major fungal Diseases in Tamil Nadu

Table 1: Percent Disease Incidence in different villages and blocks under Coimbatore district, Tamil Nadu, 2020-21

Block	Village	Fields	Rice											
			DI (%)	Mean incidence of blast disease of rice		DI (%)	Mean incidence of sheath blight disease of rice		DI (%)	Mean incidence of false smut disease of rice		DI (%)	Mean incidence of sheath rot disease of rice	
				Village	Block		Village	Block		Village	Block		Village	Block
Pollachi (North)	Gollapatti	F1	29.16	16.61	10.87	25.00	16.94	12.17	8.33	6.11	6.00	16.66	11.67	10.50
		F2	9.00			13.33			5.00			10.00		
		F3	11.67			12.50			5.00			8.33		
	Ramapattinam	F1	16.11	11.03		19.44	12.87		9.44	6.42		13.88	11.57	
		F2	10.00			12.50			5.50			13.50		
		F3	7.00			6.66			4.33			7.33		
	Rasakapalayam	F1	5.64	4.98		5.13	6.70		5.64	5.48		11.79	8.29	
		F2	5.71			10.00			6.66			10.00		
		F3	3.60			4.98			4.15			3.04		
Udumalai Pettai	Alampalayam	F1	5.26	3.42	2.93	12.98	7.18	4.56	4.21	3.25	3.26	4.21	2.77	3.68
		F2	2.89			4.34			3.44			2.17		
		F3	2.11			4.23			2.11			1.94		
	Reddipalayam	F1	1.56	2.43		1.91	3.52		2.60	3.87		3.65	4.75	
		F2	1.94			1.76			2.46			3.70		
		F3	3.79			6.90			6.55			6.89		
	Gandhinagar	F1	4.78	2.92		2.39	2.98		3.69	2.67		5.00	3.52	
		F2	1.58			3.17			2.11			3.35		
		F3	2.40			3.40			2.20			2.20		

Block	Village	Fields	Maize			Blackgram			Groundnut			Cotton		
			DI (%)	Mean incidence of southern leaf blight disease of maize		DI (%)	Mean incidence of powdery mildew disease of Blackgram		DI (%)	Mean incidence of Cercospora leaf spot disease of brinjal		DI (%)	Mean incidence of Alternaria leaf spot disease of cotton	
				Village	Block		Village	Block		Village	Block		Village	Block
Pollachi (North)	Gollapatti	F1	22.22	22.00	13.55	42.85	34.95	17.06	42.85	32.89	25.01	33.33	21.30	14.00
		F2	31.25			50.00			50.00			14.58		
		F3	12.50			12.00			5.83			16.00		
	Ramapattinam	F1		10.60		7.50	9.27		35.71	32.93		17.50	13.50	
		F2	11.25			8.09			33.75			11.90		
		F3	12.20			12.22			29.33			11.11		
	Rasakapalayam	F1	11.50	8.05		6.50	6.67		11.50	9.20		5.00	7.08	
		F2	7.00			3.676			10.00			7.00		
		F3	5.64			10.76			6.11			9.23		
Udumalai Pettai	Alampalayam	F1	5.71	4.30	4.10	10.47	7.05	5.62	6.00	5.21	6.37	17.61	10.90	8.00
		F2	3.32			3.32			4.00			6.64		
		F3	3.85			7.36			5.64			8.42		
	Reddipalayam	F1	3.80	3.66		9.13	5.25		10.00	7.61		4.78	5.05	
		F2	3.70			2.61			5.81			2.38		
		F3	3.47			4.00			7.01			8.00		
	Gandhinagar	F1	4.05	4.33		3.25	4.56		10.00	6.30		5.50	7.84	
		F2	6.55			8.26			4.52			8.57		
		F3	2.39			2.17			4.40			9.44		

Table 2: Per cent Disease Index of the diseases in different blocks under Coimbatore district of Tamil Nadu during 2020-21

Block	Village	Mean PDI							
		Blast disease of rice	Sheath blight of rice	False smut of rice	Sheath rot of rice	Southern leaf blight of maize	Powdery mildew of black gram	Early tikka leaf spot of groundnut	Alternaria leaf spot of cotton
Pollachi (North)	Gollapatti	3.97	6.87	5.41	5.54	12.97	16.02	18.72	12.58
	Ramapattinam								
	Rasakapalayam								
Udumalai Pettai	Alampalayam	2.04	3.17	2.23	2.24	3.13	3.18	4.36	6.68
	Reddipalayam								
	Gandhinagar								

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