The Journal of Plant Protection Sciences, **1**(1) : 55-59, 2009

journal homepage: www.aappbckv.org/journal

Dynamics and severity model in managing fungal diseases

[1]P. P. Ghosh, [2] D. Mandal, [3] S. Laha and [4] M. K. Dasgupta

Department of Plant Protection, Visva-Bharati, Sriniketan - 731236, West Bengal, India

Keywords: Commercial ornamentals, indirect assessment of yield loss, post-appearance protection of apprehended loss, new reports, new state records

ABSTRACT

A survey was undertaken during 1996-1997 in different commercial perennial ornamentals in gardens and nurseries at Bolpur, Santiniketan and Sriniketan of Birbhum District, West Bengal, India, to study the fungal diseases of some commercial ornamentals. The leaf spot of *Ficus religiosa* (c.o. *Alternaria* sp.) is the first record. Fifteen fungal diseases have been formally described from West Bengal for the first time on these twelve ornamentals. Monthly dynamics was determined for occurrence, intensity and severity of these diseases. The diseases (referred as pathogens) that were the highest and fastest during warm and wet (rainy) months were: *Alternaria alternata* on *Polyanthes tuberosa*; *Alternaria alternata* and *Septoria chrysanthemella* on *Chrysanthemum indicum*; *Colletotrichum gloeosporioides* and *Alternaria* sp. on *Dracaena deremensis*; *Alternaria* sp. and *Cercospora hibisci-manihotis* on *Hibiscus rosa-sinensis*; *Colletotrichum gloeosporioides* on *Calathea ornata*; *Alternaria* sp. on *Ficus religiosa*; *Cercospora jasminicola* on *Jasminum sambac*; *Lasiodiplodia theobromae* and *Diplocarpon rosae* on *Rosa multiflora*. On the other hand, *Cercospora* sp. on *Pothos scindapsus aureus*; *Alternaria alternata* and *Cercospora gerberae* on *Gerbera jamesonii*; *Glomerella cingulata* on *Ficus elastica*; *Alternaria tenuissima* on *Bougainvillea glabra* were at their highest and fastest during hot and dry (summer to pre-rainy) months. A generalized 0-9 point scale was prepared and used to determine severity (= Percent Disease Index, PDI). Strongly predictive equations for severity in terms of intensity in all cases but one viz. *Alternaria* leaf spot of *Dracaena deremensis* in terms of occurrence were developed. Such relationships helped prior assessment of severity before the disease reaches the predicted level. Thus, although crop losses were neither determined nor sought to be predicted, a new methodology has been developed for indirect assessment in terms of severity as a direct function of yield loss in terms of occurrence or intensity but not yield or yield loss *per se*. These findings may help in building simple decision rules for management early in the season as soon as the disease appears in one case, and when some intensity has been achieved in all other cases. Where validated this approach may be a useful tool in plant protection, especially supervisory management and appropriate IPM.

Introduction

The ornamental plant industry has many unique features, which makes it different from the same based on other groups of plants. Introduction of new plant species and cultivars may bring a new plant pathogen species or more virulent strains. The seed trade and the breeders' needs continuously encourage introducing new species and cultivars threatening the whole enterprise itself (Maker & Linderman 1979; Dasgupta 1988). In West Bengal, there are four distinct belts where floriculture thrives, viz. Panskura-Kolaghat in Purba Medinipur, Ranaghat in Nadia, N & S 24 Parganas in Kolkata periurban, and in Siliguri, Darjeeling and Kalimpong in Darjeeling district. Susceptibility of ornamentals to various diseases is one of the major constraints of the floriculture industry. Researches on ornamental diseases have been carried out and reviews on management mainly on fungal diseases of rose have appeared (Mandal 1975; Mandal & Chaudhuri 1985, 1988; Dasgupta & Mandal 1995; Laha 1997; Mandal & Dasgupta 2000; Dasgupta *et al*. 2003).

The amount of disease is generally referred to as disease intensity (Teng 1983). On the other hand disease severity is determined by a function of degree of affection, colonization and damage of host tissue. The reduction in the amount of host development and growth is a function of disease severity, and yield realization is a function of host development. Thus, measurement of severity based on lesion number or lesion area may be less related to yield, but more to disease progress. Measurement of both actual and visible disease (Rouse 1988) in terms of percent tissue affected and/or the green leaf area duration respectively, gives more precise conclusion on disease

1 Former M.Sc (Ag.) Student, E-mail:ppghosh_santiniketan@rediffmail.com
2 Former Ph. D. Student, E-mail:dhananoy17@rediffmail.com
3 Former M.Sc. (Ag.) Student
4 Former Professor of Plant Pathology, E-mail:oikos_santiniketan@rediffmail.com

and yield loss in the presence of a pathogen. However, as translation of disease severity into crop biomass loss or yield loss is generally done by actual estimation and regression, or by including host physiological variables in yield or yield loss for more precise functions (Gaunt 1995).

In order to determine disease dynamics, monthly survey on occurrence, intensity and severity was done during June 1996-May 1997 in different flower gardens and nurseries at Bolpur, Santiniketan and Sriniketan of Birbhum district of West Bengal, India (Laha 1997).

Materials and Methods

Survey has been done in the following gardens and nurseries viz. Horticultural Garden and Nursery (Sriniketan); Horticultural Garden and Nursery, Uttarayan Complex Garden and Nursery (Visva-Bharati, Santiniketan) and some private nurseries viz Sriniketan Nursery (Sriniketan); Selim Nursery and Subhas Nursery (Bolpur). For collection of diseased materials, symptoms, direct microscopy, isolation and multiplication of fungal pathogens, purification, micrometry and identification. Standard and popular methodologies were used (Dasgupta 1988). The extent of occurrence, intensity and severity were recorded by actual count and measurement of affected plant parts.

Monthly variations were assumed to be normal with respect to occurrence (± 5%), intensity (± 2%) and severity (± 1%): beyond which they were rated low or high. A disease progresses, due to an infectious pathogen as well as due to favourability of host factors (new infectible tissue, tissue susceptibility and age), weather factors (maximum temperature, minimum temperature and relative humidity), and epidemiological factors (new infections, rate of infection, rate of lesion expansion, availability of infectible tissues etc.). So, monthly variations in respect of occurrence, intensity and severity have been recorded in all the diseases studied. Oct'96 data could not be collected.

The occurrence, intensity and severity of a particular disease in a given area were based on the population size of a sample (sample size neither less than ten nor more than fifty of any size of population studied). Occurrence, intensity and severity were estimated by the following formulae:

$$\text{Occurrence} = \frac{\text{Sample Plants Infected}}{\text{Total No. of Sample}} \times 100$$

$$\text{Intensity} = \frac{\text{No. of Leaves or Units Infected}}{\text{Total No. of Leaves or Units of Infection}} \times 100$$

$$\text{Severity} = \frac{\text{Sum of all Ratings}}{\text{No. of Observation} \times \text{Highest Rating}} \times 100$$

(PDI=McKinney's Index)

For visual estimation of severity, 0 – 9 point scale (No infection – 0; 0 –10% leaf area infected – 1; 10 – 20% leaf area infected – 2; 20 – 30% leaf area infected – 3; 30 – 40% leaf area infected – 4; 40 – 50% leaf area infected – 5; 50 – 60% leaf area infected – 6; 60 – 70% leaf area infected – 7; 70 – 80% leaf area infected – 8; 80 – 90% or more leaf area infected – 9) were used for rating of all foliar diseases studied. In the case of die back of rose, a whole plant is considered a unit of infection. In calculating severity, lesion lengths or any part of the plant are summated as infected area.

Mathematical deterministic functions have been drawn to derive predictive models for severity in respect of intensity or occurrence of these diseases taken up in this study.

Results

The results of the survey presented in Table 1 revealed that 15 fungal diseases have been formally described from West Bengal for the first time on twelve ornamental plant species. Only one disease, leaf spot of *Ficus religiosa* L. : c.o. - *Alternaria* sp. (Nees,1816) has been described for first time. Strong predictive models for severity have been developed.

The disease dynamics in terms of monthly variations of occurrence, intensity and severity since June1996 to May 1997 (Figure 1) shows that the values of all the variables, respectively shown in parentheses, were highest during rainy months. The diseases were: leaf spots due to *Alternaria alternata* (Fr.) Keissler. (1912) (100, 30.30, 11.77 percent) on *Polyanthes tuberosa* L.; *Alternaria alternata* (Fr.) Keissler. (1912) (80, 41.79, 14.39 percent) and *Septoria chrysanthemella* Cavara. (1895) (100, 35.68, 8.79 percent) on *Chrysanthemum indicum* L.; *Colletotrichum gloeosporioides* Penz. and Sacc. (1884) (80, 25.52, 11.30 percent) and *Alternaria* sp. Nees. (1816) (100, 24.81, 9.57 percent) on *Dracaena deremensis* Vand. Ex L.; *Alternaria* sp. Nees. (1816) (60, 15.78, 0.048 percent) and *Cercospora hibisci-manihotis* P. Henn. (1904) (60, 9.22, 3.25 percent) on *Hibiscus rosa-sinensis* L.; *Colletotrichum gloeosporioides* Penz. and Sacc. (1884) (100, 69.95, 30.81 percent) on *Calathea ornata* Koern.; *Alternaria* sp. Nees. (1816) (100, 13.69, 4.42 percent) on *Ficus religiosa* L.; *Cercospora jasminicola* Muller. and Chupp. (1936) (100, 25.82, 3.24 percent) on *Jasminum sambac* (L.) Ait.; *Diplocarpon rosae* Wolf. (1912) (56, 42.14 and 56.00 percent) and die-back due to *Lasiodiplodia theobromae* (Pat.) Griffon. and Maubl. (1909)[= *Botryodiplodia theobromae* Pat. (1892) = *Diplodia rosarum* Fr. (1849)] (100, 10.94, 4.68 percent) on *Rosa multiflora* Thumb. During dry and hot (summer to pre-rainy) months (the corresponding values are mentioned in parentheses): in the leaf spots due to *Cercospora* sp. Fresen. (1863) (100, 35.82, 13.59 percent) on *Pothos scindapsus aureus* L.; *Alternaria alternata* (Fr.) Keissler (1912) (80, 42.5, 16.40 percent) and *Cercospora gerberae* Chupp. and Viégas. (1945) (93.33, 37.85, 12.95 percent) on *Gerbera jamesonii* Bolus. ex Hook. f.; *Glomerella cingulata* (Stoneman.) Spauld. & H. Schrenk. (1903) (100, 46.83, 15.03 percent) on *Ficus elastica* Roxb.; and *Alternaria tenuissima* (Kunze ex Fr.) Wiltshire (1933) (100, 54.43, 22.18 percent) on *Bougainvillea glabra* Cholsy.

On the other hand almost all the values were lowest during dry and cool (winter to pre-spring) months. Approximately, a few to all plants in a population remained infected through the year: 100 percent (*Alternaria alternata* on *Polyanthes tuberosa* ; *Colletotrichum gloeosporioides* on *Calathea ornata* and *Cercospora jasminicola* on *Jasminum sambac*); 86 percent (*Cercospora gerberae* on *Gerbera jamesonii*); 70 percent (*Alternaria alternata* on *Gerbera jamesonii*); 66.7 per cent (*Alternaria* sp. on *Ficus religiosa* and *Alternaria tenuissima* on *Bougainvillea glabra*); 60 percent (*Colletotrichum gloeosporioides* on *Dracaena marginata*; *Alternaria* sp. on *Dracaena deremensis* and *Lasodiplodia theobromae* on *Rosa multiflora*); 40 percent (*Alternaria alternata* and *Septoria chrysanthemella* on *Chrysanthemum indicum*); 33.3 percent (*Cercospora* sp. on *Pothos* sp.); 30 percent (*Cercospora hibisci-manihotis* on *Hibiscus rosa-sinensis*; *Glomerella cingulata* on *Ficus elastica* and *Diplocarpon rosae* on *Rosa multiflora*).

Discussion

Most of these diseases perhaps may have been occurring from long back as many hosts are among the common commercial ornamentals in West Bengal. This study has enabled indirect estimation and prediction of crop loss by developing significant ($P = 0.05$) linear prediction equations (Table 1) for severity in terms of intensity or occurrence, irrespective of the months of prevalence in leaf spots in general. In rose die-back and tar spot relation is linear between intensity and severity. Thus, severity can be predicted from intensity and/or occurrence. When r values exceed 0.75 the function of severity may be considered bold enough to take up preventive and protective measures against diseases causing apprehension. Losses can easily be predicted as the relations are linear. These mathematical functions of severity on intensity and even severity on occurrence, if and where validated, can help in predicting probable loss and forestalling further progress of disease through timely management measures as in supervisory management and appropriate IPM (Dasgupta 1988).

The methodology developed can be used as a simple technique to determine the diseases which are systemic or rapid and repolitive secondary infection (severity depends on occurrence), and local infection (severity depends on intensity). The mid-values would indicate the role of primary and secondary inoculum.

Literature Cited

Baker KF Linderman RC. 1979 Unique features of the pathology of ornamental plants. *Annual Review of Phytopathology* **17:** 253-77.

Bordoloi DN Ganguly D. 1963 Black spot of roses caused by *Diplocarpon rosae* Wolf. *Indian Phytopathology* **16:** 255-59.

Butler EJ Bisby GR. (Revised by RS Vasudeva) 1960 *The Fungi of India*. ICAR, New Delhi India, 552pp.

Chiddarwar PP. 1959 Contribution to our knowledge of Cercosporae of Bombay State II. *Indian Phytopatholgy* **12:** 110-21.

Dasgupta MK. 1988 *Principles of Plant Pathology*, Allied Publishers, New Delhi, 1035pp.

Dasgupta MK Mandal NC. 1995 Diseases and pests of rose and their management. *The Rose Annual* (Bengal Rose Society, Calcutta) **11**:67-81.

Dasgupta MK Laha S Mandal D. 2003 Strategy and tactics of appropriate IPM of rose. *The Rose Annual* (Bengal Rose Society, Calcutta) **56**:33-54.

Dayal R Ram A. 1967 Pathological studies of *Cercospora jasminicola* Muller. and Chupp. *Phytoppathoogische Zeitschrift* **59**: 33-38.

Gaunt RE. 1995 The relationship between plant disease severity and yield. *Annual Review of Phytopathology* **33**:119-44.

Gupta GK Sohi HS. 1967 New records of fungi from H P. *Research Bulletin of Panjab University* **18**:405-08.

Laha S. 1997 *Fungal Diseases of Perennial Ornamentals – Symptoms, Aetiology, Disease Dynamics and Loss Assessment.* M.Sc. (Ag.) Thesis, Visva-Bharati, Sriniketan, West Bengal, India, 238 pp.

Mallikarjunaiah RR Rao VG. 1972 A new leaf spot disease of passion flower from Maharastra. *Current Science* **41**:686.

Mandal NC Chaudhuri S. 1985 Is it possible to control die back of Rose (c.o. *Diplodia rosarum* Fris.) by systemic fungicides? *Pesticides* **19(**8):26-28.

Mandal NC Chaudhuri S. 1988 Studies on Die-Back of Rose in West Bengal. *Indian Journal of Mycology and Plant Pathology* **18**: 84-85.

Mandal NC Dasgupta MK. 2000 Black spot of rose. *Rose Bulletin* **41**:9-17.

Mandal NC. 1975 *Studies on Die-Back of Rose and Diseases of Some Winter Annuals* M.Sc. (Ag.) thesis, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India, 107 pp.

Mundkur BB and Ahamed S. 1946 Revision and addition to Indian fungi II. *Mycological Paper* **No.18**: 11.

Munjal RL Lall G Chona BL. 1961 Some *Cercospora* sprcies from India VII. *Indian Phytopathology* **14**: 79-90.

Palaniswamy A Ranganathan K Jagannathan T Narayanaswamy P. 1973 Control of *Cercospora* leaf spot disease of Jasmine. *South Indian Horticulture* **21**: 33-34.

Ramakrishnan TS Sundaram NV. 1953 Additions to the fungi of Madras XVII. *Proceedings of the Indian Academy of Sciences* **14(B)**:189-95.

Rangaswami G Seshadri VS Lucy Channamma KA. 1970 *Fungi of South India*. University of Agricultural Science, Bangalore, 193pp.

Rao VG. 1963 The genus *Phyllosticta* in Bombay, Mahrastra II, *Mycopathology Mycology Applied* **20**: 60-67.

Rao VG. 1964 The genus *Phyllosticta* in Bombay, Mahrastra IV, *Mycopathology Mycology Applied* **22**:125-28.

Rouse DL. 1988 Use of crop growth models to predict the effect of disease. *Annual Review of Phytopathology* 26:183-201.

Shinde PA Agashe NC. 1963 New record of *Cercospora jasminicola* Muller and Chuup. *Indian Phytopathology* **16**:307-09.

Sohi HS Prakash Om. 1974 Reaction of rose varieties against black spot (*Diplocarpon rosae*) diseases. *Indian Phytopathology* **27**: 119-23.

Sohi HS. 1992 *Diseases of Ornamental Plants in India*. Publications and Information Dvision, ICAR, New Delhi, 195pp.

Srivastava DN. 1961 Controlling die back in roses. *Indian Phytopathology* **5**: 24-25.

Sydow H Butler EJ. 1916 Fungi Inaiae Orientalis Pers. V. *Annual Mycology* **14**: 177-220.

Sydow H McRae W 1929. Hyphomycetes Indiae Orientali. *Annual Crypt. Exot.* **2**: 262-71

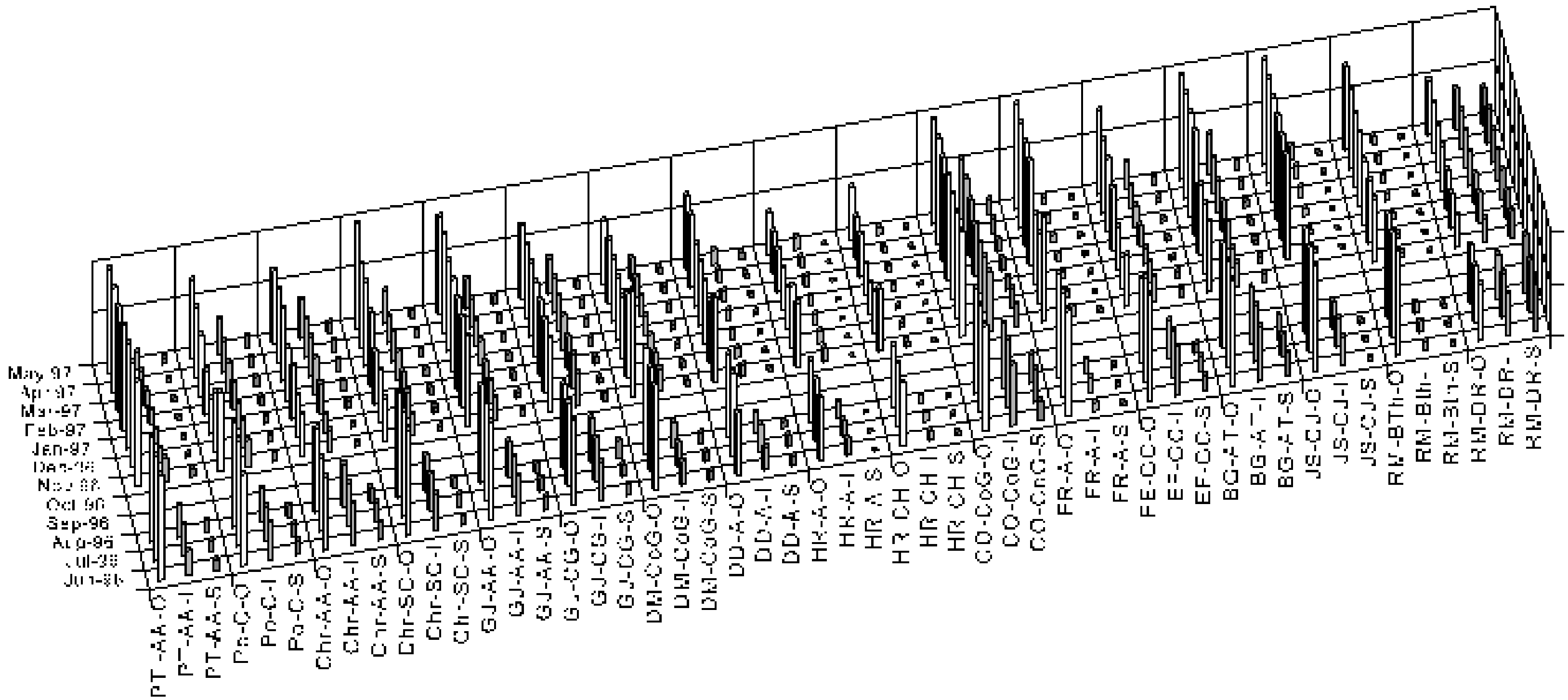
Teng PS. 1983 Estimating and interpreting disease intensity and loss in commercial fields. *Phytopathology* **73**:1587-90.

Thirumalachar MJ Mishra JW. 1953 Contributions to the study of fungi of Bihar I. *Sydowia* **7**: 29.

Table 1:
Diseases of some commercial ornamentals : survey, status and severity models (Birbhum, West Bengal, 1996-97)

Crop	Family	Causal organism	Severity prediction models (S)	Reports from India* Place**	Authors
Polyanthes tuberosa	Amaryllidaceae	*Alternaria alternata*	**S = - 3.03 + 0.473 I (*r* = 0.91)**	COT (TN)	Mariappan *et al*.1977; Sohi 1992; Laha 1997
Pothos scindapsus aurens	Araceae	*Cercospora* sp.	**S = - 6.26 + 0.552 I (*r* = 0.96)**	MS	Laha 1997
Chrysanthemum indicum	Compositae (Asteraceae)	*Alternaria alternata*	**S = -6.64 + 0.516 I (*r* = 0.83)**	BGR, PNE	Rao 1965; Mallikarjunaiah and Rao 1972; Sohi 1992; Laha 1997
		Septoria chrysanthemella	**S = - 3.01 + 0.357 I (*r* = 0.80)**	BR, DDN (UN)	Sydow and Butler 1916; Sohi 1992; Laha 1997
Gerbera jamesonii	Compositae (Asteraceae)	*Alternaria alternata*	**S = - 16.47 + 0.73 I (*r* = 0.86)**	MS	Rao 1963; Laha 1997
		Cercospora gerberae	**S = - 4.38 + 0.0445 I (*r* = 0.89)**	DL, MS	Chiddarwar 1959; Munjal *et al*. 1961; Laha 1997.
Dracaena marginata	Liliaceae	*Colletotrichum gloeosporioides*	**S = - 2.45 + 0.517 I (*r* = 0.94)**	UP	Sohi 1992, Laha 1997
Dracaenaderemenis	Liliaceae	*Alternaria* sp.	**S = - 6.61 + 0.642 O (*r* = 0.81)**	ALD (UP)	Sohi 1992; Laha 1997
Hibiscusrosa-sinensis	Malvaceae	*Alternaria* sp.	**S = - 0.023 + 0.004 I (*r* = 0.86)**	MS, PB	Sohi 1992; Laha 1997
		Cercospora hibisci-manihotis	**S = - 1.19 +0.503 I (*r*= 0.93)**	RJ	Thirumalachar and Misra 1953; Sohi 1992; Laha 1997
Calathea ornata	Marantaceae	*Colletotrichum gloeosporioides*	**S = - 39.32 + 1.02 I (*r* = 0.63)**	OR, CGR, BGR	Sohi 1992; Laha 1997
Ficus religiosa	Moraceae	*Alternaria* sp.	**S = 0.14 + 0.300 I (*r* = 0.85)**	FIRST RECORD	Laha, 1997
Ficus elastica	Moraceae	*Glomerella cingulata*	**S = - 3.45 + 0.386 I (*r* = 0.91)**	PNE, CGR	Sohi 1992; Laha 1997
Bougainvillea glabra	Nyctaginaceae	*Alternaria tenuissima*	**S = - 6.17 + 0.487 I (*r* = 0.79)**	MP	Laha 1997
Jasminum sambac	Oleaceae	*Cercospora jasminicola*	**S = 0.78 +0.107 I (*r* = 0.96)**	CGR, LDA, BGR, PNE,BR, DL, AP, RJ,TN	Sohi 1992; Mundkur and Ahamad 1946; Dayal and Ram 1967; Palaniswamy *et al.* 1973; Ramkrishnan and Sundaram 1955; Shinde and Agashe 1963; Laha 1997
Rosa multiflora	Rosaceae	*Lasiodiplodia theobromae*	**S = - 0.401 + 1.027 I (*r* = 0.96)**	DL, JM, KK, KL, MS, WB	Bordoloi and Ganguly 1963; Sohi and Prakash 1974; Sohi 1992; Laha 1997
		Diplocarpon rosae	**S = 0.141 + 0.300 I (*r* = 0.85)**	DL, SOL, TN, WB	Srivastava 1961; Gupta and Sohi 1967; Rangaswami *et al.*1970; Butler and Bisby 1960; Sydow and McRae 1929; Mandal1975; Laha, 1997

S = Severity, I = Intensity, O = Occurrence; *All the diseases except rose die back and tar spot are new in WB. **ALD = Allahabad, AP = Andhra Pradesh, BGR = Bangalore, BR = Bihar, CGR = Chandigarh, COT = Coimbatore, DDN = DehraDun, DL = Delhi, JM = Jammu, KK = Karnataka, KL = Kerala, LDA = Ludhiana, MP = Madhya Pradesh, MS = Maharashtra, OR = Orrissa, PNE = Pune, PB = Punjab, RJ = Rajasthan, SOL = Solan, TN = Tamil Nadu, UA = Uttaranchal, UP = Uttar Pradesh, WB = West Bengal.



X Axis denotes – Months (Jun96 to May97); **Y axis denotes** pathogenic activity on host [PT-AA = *Alternaria alternata* on *Polyanthes tuberosa*; Po-C = *Cerospora* sp. on *Pothos scindapsus aurens*; Chr-AA = *Alternaria alternata* on *Chrysanthemum indicum*; Chr-SC = *Septoria chrysanthemella* on *Chrysanthemum indicum*; GJ-AA – *Alternaria alternata* on *Gerbera jamesonii*; GJ-CG = *Cercospora gerberae* on *Gerbera jamesonii*; DM-CoG = *Colletotrichum gloeosporioides* on *Dracaena merginata*; DD-A = *Alternaria* sp. on *Dracaena deremensis*; HR-A = *Alternaria* sp. on *Hibiscus rosa-sinensis*; HR-CH = *Cercospora hibisci-manihotis* on *Hibiscus rosa-sinensis*; CO-CoG = *Colletotrichum gloeosporioides* on *Calathea ornata*; FR-A = *Alternaria* sp. on *Ficus religiosa*; FE-GC = *Glomerella cingulata* on *Ficus elastica*; BG-AT = *Alternaria tenuissima* on *Bougainvillea glabra*; JS-CJ = *Cercospora jasmonicola* on *Jasminum sambac*; RM-Bth = *Lasodiplodia theobromae* on *Rosa multiflora*; RM-DR = *Diplocarpon rosae* on *Rosa multiflora*.] and **Z axis denotes** Disease Score (%)

Figure – 1 : Monthly variation of Occurrence (O), Intensity (I) and Severity (S) of different fungal pathogens on different host