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Distribution of Soil Microfungi in Various Soil Types of Chambal Ravines

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Distribution of soil mycoflora in four soil types under different plant cover from Chambal ravines of Bhind (M.P.) was studied. A total of 71 fungal species were isolated. Common soil fungi were represented by species of *Chaetomium*, *Khuskia*, *Acrophialophora*, *Alternaria*, *Aspergillus*, *Curvularia*, *Fusarium*, *Humicola*, *Monocillium*, *Monodictys*, *Myrothecium* and *Trichoderma*. A significant positive correlation was noted between fungal population and carbon and nitrogen contents of soils whereas clay contents of the soil, C/N ratio and exchangeable calcium exihibited a significant negative correlation with fungal population. Soils dominated by trees and perennial shrubs harboured higher mycopopulation as compared to the crop field. Specificity in fungal flora of each soil type was also noted.

Key Words: Fungal population, Plant cover, Edaphic factors

Introduction

Surface vegetation, physico-chemical characteristics and microclimate of the soil have been shown to influence the microbial distribution in soil (Tresner et al. 1954, Saksena 1955 and Pirozynski 1968). Lectard (1976), while emphasizing the importance of plant cover, has shown that the mycoflora depends upon the ecological variations which result in a zonation very characteristic of phanerogamic vegetation. Very few reports are available on the distribution of fungi in ravine soils (Joshi & Chauhan 1981). In the present investigation, an attempt is made to study the distribution of soil microfungi in four soil types of Chambal ravines and efforts are made to correlate with the physico-chemical characteristics of soil and plant cover.

Materials and Methods

The "Barhi forest range" of Bhind tehsil of district Bhind (M.P.), situated on the southern bank of Chambal river was selected as the study site. The ravinous area lies between 26°20′ to 26°50′ north latitudes and 78°30′ to 79°10′ east longitudes with m.s.l. varying from 150 to 240 m. Geologically the study area is a meeting ground of Vindhyan system and recent deposits of alluvium. The climate is semi-arid. Four distinctsoil types, designated in the text as soil A, B, C and D, were recognized on the basis of phytosociological studies (Joshi 1979).

Soil A was clayey and supported *Triticum vulgare* Vill., *Cicer arietinum* L. and *Brassica*

campastris L. Soil B was sandy clay loam and was dominated by *Commiphora mukul* Jacq., *Dichrostachys cinerea* L., *Grewia flavescens* Juss., *Capparis decidua* L., *Eclipta alba* L. and *Vernonia cineria* Schreb. Soil C was sandy clay loam and was dominated by *Prosopis juliflora* (SW) DC, *Dalbergia sissoo* Roxb., *Adhatoda vasica* Nees., *Capparis zeylanica* L., *Justicea simplex* L. and *Sporobolus diander* Beauv. Soil D was sandy loam and was dominated by *P. juliflora, D. cinerea, G. flavescens, C. decidua, S. diander* and *V. cineria.*

The soil samples were collected during the month of February 1975. Twenty five soil samples were collected from each soil type up to a depth of 15 cm. Estimation of soil fungi was done by soil plate method (Warcup 1950) using Martin's medium (Martin 1950). The identification of fungal isolates was confirmed from CMI, Kew, England.

Physico-chemical factors viz., soil mechanical composition, soil moisture, water holding capacity and organic carbon were determined by the methods suggested by Piper (1966) whereas total nitrogen, exchangeable calcium and potassium and available phosphorus were estimated by the methods outlined by Jackson (1967).

The data were subjected to statistical analysis for analysis of variance and correlation coefficient (Snedecor & Cochran 1967). The fungal flora of various soil types was compared for Similarity Quotient (Sorensen 1948).

Results and Discussion

Table 1 shows the distribution of 71 fungal species in four soil types. Tables 2 and 3 present the fungal population and the edaphic factors, and values of correlation coefficients 'r' and "F". Table 4 reveals the extent of similarity among fungal flora of various soil types.

Since a variety of inter-related factors like physico-chemical characteristics of soil, climate and plant cover are all effective in governing the microfungal distribution (Christensen 1969), it becomes difficult to elucidate the role played by individual factors. In the present investigation, all the four soil types differed in their edaphic conditions, plant cover and fungal population (table 2). Soil 'A' under *T. vulgare* harboured significantly lower fungal population as compared to other soil types. Attempt has been made to correlate various factors with fungal population separately so as to understand the role played by them in governing microfungal distribution in the present studies.

Water-holding Capacity and Fungal Population

The water-holding capacity of the soil is largely related to the mechanical composition and organic matter of the soil. Saksena (1955) claimed that soils with higher water holding capacity are better equipped to face dry conditions and so exhibit higher population. In the present investigation, clayey soils of type A showed significantly higher water holding capacity as compared to other soils (table 3) whereas reverse was true for fungal population (table 2). Ramakrishnan (1955) and Dwivedi (1965), however, have recorded a positive correlation between water-holding capacity and fungal population. It can, therefore, be suggested that the particle size appears to play a dominating role and thus poor aeration due to clayey nature of soil may be the reason for the lower fungal population in soil A whereas in other soils proper aeration due to higher proportions of sand and higher organic matter contents (table 3) might be the reason for higher fungal population.

Mechanical Composition and Fungal Population

The mechanical composition of the four soil types differed : soil A was clayey, soil B

Table 1 *Occurrence of fungi in four soil types.*

Fungus	Soil A	Soil B	Soil C	Soil D
PHYCOMYCETES				
Candida sp.	—	—	+	—
Cunninghamella echinulata (Thaxt.) Thaxt. ex Blakeslee	—	+	—	—
Mortierella camargensis W. Gams & R. Moreau	—	—	+	—
Mucor racemosus Fresenius	—	+	+	+
Rhizopus oryzae Went & Prinsen Geerlig	+	+	—	—
ASCOMYCETES				
Chaetomium sp.	+	—	—	—
C. jodhpurense Lodha	+	+	+	+
Khuskia oryzae Hudson	+	+	+	+
Microascus trigonosporus Emmons & B. Dodge	—	+	+	—
Neocosmospora vesinfecta E.F. Smith	—	+	+	—
Thielavia terricola (Gilman & Abbot) Emmons	—	+	—	—
FUNGI IMPERFECTI				
Acremonium kiliense Grutz	—	+	—	+
Acrophialophora fusispora (Saksena) Samson	+	+	+	+
Alternaria alternata (Fr.) Keissler	+	+	+	+
Aspergillus aculeatus Lizuka	—	—	+	—
A. flavipes (Bain. & Sart.) Thom & Church	—	—	—	+
A. flavus Link ex. Fr, Strain I	+	+	+	+
A. flavus Link ex. Fr. Strain II	—	—	+	—
A. fumigatus Fres. Strain I	+	+	+	+
A. fumigatus Fres. Strain II	+	+	+	+
A. fumigatus Fres. Strain III	—	+	+	+
A. nidulans (Eidam) Wint. Strain I	+	+	+	+
A. nidulans (Eidam) Wint. Strain II	—	+	+	—
A. niger Van Tieghem Strain I	+	+	+	+
A. niger Van Tieghem Strain II	+	+	+	+
A. niveus Blockwitz	+	+	+	—
A. ochraceous Wilhelm	—	+	—	—
A. pulverulentus (Mc Alpine) Thom	+	—	—	—
A. quercinus (Bainter) Thom & Church	+	—	—	—
A. stellatus Curzi	+	+	+	+
A. terreus Thom	+	+	+	+
A. ustus (Bainier) Thom & Church	+	+	+	+
Cladosporium oxysporium B. & C.	+	—	—	—
Coleophoma empetri (Rostrup) Petrak	—	+	+	+
Curvularia lunata (Wakker) Boedijn	+	+	+	+

(*Table Contd. on p. 516*)

Table 1 (*Contd.*)

Fungus	Soil A	Soil B	Soil C	Soil D
Cylindrocladium floridanum Sobers & Seymour	—	—	+	—
Fusarium oxysporum Schlecht	+	+	+	+
F. solani (Mart.) Sacc.	+	+	+	+
Helminthosporium sativum Pammel, King & Bakke	+	+	—	+
Humicola fusco-atra Traeen Strain I	+	+	+	+
H. fusco-atra Traeen Strain II	—	+	+	—
Macrophomina phaseolina (Tassi) Goid.	—	+	—	—
Monocillium constrictum W. Gams	+	+	+	+
Monodictys fluctuata (Tandon & Bilgrami) M.B. Ellis	+	+	+	+
Myrothecium leucotrichum (PK) Tulloch	+	—	—	+
M. verrucaria (Alb. & Schw.) Ditm. Ex. Fr.	+	+	+	+
Narasimhella hyalinospora (Kuehn, Orr & Ghosh) Von Arx.	—	+	—	—
Poecilomyces lilacinus (Thom) Samson	+	+	—	—
Paecilomyces sp.	—	—	+	—
Penicillium funiculosum Thom	+	—	+	—
P. implicatum Biourge	+	—	—	—
P. lapidosum Raper & Fennell	+	—	—	—
P. oxalicum Currie & Thom	+	—	+	+
P. spiculisporum Lehman	+	—	—	+
Periconia sp.	—	—	+	—
Phialaphora cyclaminis Beyma	—	+	+	—
Phoma herbarum Westd	—	+	+	+
P. multirostrata (Mathur, Menon & Thirum) Dorenbosch & Boerema	+	—	—	—
P. pomorum Thum	—	+	+	—
Pyrenochaeta abutilonis Mathur, Verma & Chauhan	—	+	—	—
Scolecobasidium terreus Abbott	—	+	+	—
Stachybotrys atra Corda	+	—	+	—
S. bisbyi (Srinivasan) Barron	—	+	+	+
Trichoderma aureoviride Rifai aggr.	+	+	+	+
Zalerion sp.	—	+	+	—
Unidentified Colony I	+	+	—	—
Unidentified Colony II	+	—	—	—
Unidentified Colony III	—	+	—	—
MYCELIA STERILIA				
Sterile Colony I (White)	+	—	—	—
Sterile Colony II (Black)	—	+	+	—
Sterile Colony III (Brown)	—	—	—	+

+ Species present
— Species absent.

Table 2 *Statistical analysis of fungal population for analysis of variance (F) and critical difference (C.D.)*

Fungal population (per mg soil)	Soil A	41.425
	Soil B	77.146
	Soil C	80.317
	Soil D	84.463
Calculated F		7.792**
C.D. at different levels of proximity (p)	p_1	29.287**
	p_2	30.894**
	p_3	31.759**

** Significant at 1% level

and C were sandy clay loam whereas soil D was sandy loam (table 3). A significant negative correlation was noted between the fungal population and clay contents (table 3). Earlier, similar correlation has been obtained by Joshi and Chauhan (1981) which, however, was not statistically significant. Parr and Norman (1964) and Griffin (1967) have also recorded reduced fungal activity in soils with smaller particle system and attributed it to the poor aeration. Significantly the lower fungal population in clayey soils (Soil A), therefore, may be due to poor aeration.

Soil Moisture and Fungal Population

The importance of moisture in relation to fungal population has been enumerated by many workers (Tresner et al. 1954, Saksena 1955, Dwivedi 1965 and Zoberi 1979) though in some cases such a clear correlation was not observed (Ramakrishnan 1955 and Orpurt & Curtis 1957). In the present investigation (table 3), soil A, inspite of showing significantly higher moisture contents, exhibited significantly lower fungal population. Stover (1953), dealing with the effect of soil moisture on *Fusarium* spp., summarised that their population might be greatly reduced by maintaining the soil in a saturated condition in the absence of hosts. Menon and Williams (1957) recovered maximum number of fungi at low than at high moisture level. It can, therefore, be suggested here that though the moisture plays an important role in the fungal distribution, its effect, in the present investigation seems to be modified by the particle size and thus clayey soils of soil 'A' exhibit lower fungal population inspite of higher moisture contents (tables 2 & 3), Further, lower fungal population in soil 'A' can also be related to the lower amount of carbon and nitrogen contents in this soil.

Carbon and Fungal Population

The investigations of Tresner et al. (1954), Saksena (1955), Kiem et al. (1975), Chmel and Vlacilikova (1977) and Kanazawa (1979) confirmed the view that organic matter had a great influence on fungal abundance. The present study reveals a significant positive correlation between the organic carbon contents of soil and fungal population (table 3). Vandecaveye and Katznelson (1940) and Zoberi (1979), however, could not observe any correlation between fungal population and carbon contents of the soil.

Nitrogen and Fungal Population

The nitrogen contents of four soil types showed a significant positive correlation with the fungal population (table 3). Saksena (1955), Mishra (1966), Zoberi (1979) and Joshi and Chauhan (1981) also observed that the quantity of nitrogen affect the fungal number in a positive direction.

C/N Ratio and Fungal Population

The present investigation reveals a significant negative correlation between C/N ratio and fungal population (table 3). Kaufman and Williams (1963), have also recorded more fungi from soils with narrow C/N ratios. Jabbar Miah et al. (1980), however, have recorded increased number of fungal species in soils with higher C/N ratios.

Table 3 *Physico-chemical characters of soil, calculated values of 'F' and correlation coefficients (r) between number of fungal propagules and the physico-chemical characters*

Factors		Soil A	Soil B	Soil C	Soil D	F	r
Mechanical composition	Sand (%)	13.86	41.73	40.80	60.73	8.50**	+0.933
	Silt (%)	26.23	25.24	22.69	10.33	1.71	—0.586
	Clay (%)	52.65	22.69	20.57	17.77	19.35**	—0.999**
	$CaCO_3$ (%)	8.40	10.33	9.00	4.50	6.14**	—0 237
Soil Moisture (%)		8.88	3.03	4.29	4.68	16.69**	—0.911
Water-holding capacity (%)		58.76	40.50	43.40	39.64	11.66**	—0 980*
Carbon (%)		0.346	0.577	0.637	0.665	2.52	+0 993**
Nitrogen (%)		0.036	0.084	0.096	0.114	3.00	+0.975*
C/N ratio		11.383	7.002	6.635	5.833	1.99	—0.999**
Exchangeable calcium (mg/100 gm soil)		356. 25	135.45	147.92	125.00	36.87**	—0.992**
Exchangeable potassium (mg/100 gm soil)		41	45	50	50	1.37	+0.899
Available phosphorus (ppm)		12	8	13	10	1.15	—0.326

* Significant at 5% level
**Significant at 1% level

Calcium and Fungal Population

A statistically significant negative correlation was noted between the fungal population and the calcium contents of the soil (table 3). Mishra (1966) did not observe any correlation between calcium and fungal population whereas Joshi and Chauhan (1981) observed a negative correlation which, however, was not statistically significant.

Potassium and Fungal Population

The stimulatory effects of potassium on soil fungi have been confirmed by many mycologists (Saksena 1955 and Guillemat & Montegut 1958). The present study also reveals a positive correlation between the potassium contents and fungal population which, however, was not statistically significant (table 3).

Phosphorus and Fungal Population

A positive correlation was noted between fungal population and phosphorus contents of soil by Ramakrishnan (1955). The four soil types, in the present investigation, neither exhibited any significant variation in their phosphorus contents nor showed any correlation between phosphorus contents and fungal population (table 3).

Plant Cover and Fungal Distribution

The four soil types which differed with regard to their plant cover also showed variations in their soil mycoflora (tables 1 & 2). Soil A whichs upport*T. vulgare*, *C. arietinum* and *B. campastris* as plant cover harboured significantly lower fungal population due to the lower amount of carbon and nitrogen contents in these soils (table 3). On the other hand soils B, C and D, which were dominated by trees and perennial shrubs like *P. juliflora*, *D. sissoo*, *D. cinerea*, *G. flavescens*, *A. vasica* and *C. decidua*, showed significantly higher fungal population due to the higher amount of carbon and nitrogen contents in these soils (table 3). Widdes and Parkinson (1973), Pependorf (1976) and Manoharachary (1977), have found differences in the number of fungal species isolated from soil types under different plant cover, though Cohen and

Table 4 *Similarity Quotients (S.Q.) between soil fungi of various soil types*

Combinations	S.Q.
A vs. B	59.09%
A vs. C	58.14%
A vs. D	68.49%
B vs. C	76.60%
B vs. D	69.14%
C vs D	68.35%

Alexander (1978) could not observe any significant difference. Present investigation, however, revealed differences in the extent of similarity among the mycoflora of four soil types (table 4). The mycoflora of cultivated soil A exhibited lesser similarity to the mycoflora of soils B and C (dominated by trees and shrubs) which showed maximum similarity between their mycoflora (S.Q.=76.60%). Physico-chemical characteristics of soils B and C also exhibited greater similarities (table 3). This, however, suggests that both the nature of the plant cover and physico-chemical characteristics of the soil are effective in determining the distribution of soil mycoflora. The higher extent of similarities among the fungal flora of four soil types (S.Q.=58.14–76.60%) may probably be due to similar climatic conditions and cosmopolitan nature of the soil fungi.

In the present investigation, the common soil fungi were represented by species of *Chaetomium*, *Khuskia*, *Acrophialophora*, *Alternaria*, *Aspergillus*, *Curvularia*, *Fusarium*, *Humicola*, *Monocillium*, *Monodictys*, *Myrothecium* and *Trichoderma* (table 1). Several workers (Wicklow et al. 1974, Manoharachary 1977, Joshi & Chauhan 1981) have noted restricted occurrence of certain fungal species in different soil types. In the present study, out of the 71 fungal species isolated, only 20 species showed their wider ecological amplitude due to their common occurrence in four soil types (table 1). The obvious differences in the microenvironments of the four soil types due to differences in the nature of their plant cover and edaphic conditions (table 2) gave rise to a specificity to the fungal flora of each soil type (table 1). Thus *Chaetomium* sp., *Aspergillus pulverulentus*, *A. quercinus*, *Cladosporium oxysporum*, *Penicillium implicatum*, *P. lapidosum*, *Phoma multirostrata*, sterile colony I and unidentified colony II were specific to soil A; *Cunninghamella echinulata*, *Thielavia terricola*, *Aspergillus ochraceous*, *Macrophomina phaseolina*, *Narasimhella hyalinospora*, *Pyrenochaeta abutilonis* and unidentified colony III were restricted to soil B; *Candida* sp., *Mortierella camargensis*, *Aspergillus aculeatus*, *A. flavus* III, *Cylindrocladium floridanum*, *Paecilomyces* sp. and *Periconia* sp. were confined to soil C; whereas *Aspergillus flavipes* and sterile colony III were isolated exclusively from soil D. The restricted distribution of these fungal species renders them as valuable indicators of certain specific soil environments (Cohen 1949).

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