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Studies on the influence of root systems of Parthenium plant on soil fungi in different localities of Guwahati, Assam

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A study was undertaken to determine the influence of the root systems of Parthenium (*Parthenium hysterophorus* L.) plant at different stages of the plant growth on soil fungi in different localities viz., Jalukbari and Noonmati area of Guwahati, Assam during the year 2004-2005. Analysis of rhizosphere and non-rhizosphere soil samples from both the localities revealed comparatively higher fungal populations in rhizosphere soil compared to non-rhizosphere soil. Variations in the number and types of fungal colonical were observed between the soils of the two localities. The physico-chemical properties of the soil from both the localities were analyzed. Higher numbers of fungal colonies (740 nos. of colonies) were isolated from the soil of Noonmati area (sandy-loam soil) than the soil (clay-loam) of Jalukbari area (497 nos. of colonies). In both the soil, the highest total fungal colonies (238 nos. of colonies in Noonmati area and 174 nos. of colonies in Jalukbari area) were recorded when the plant attained flowering stage. Species of *Aspergillus* were the most dominating fungi amongst the other isolated fungi. Some of the predominantly occurring rhizospheric fungi isolated were — *Aspergillus flavus, A. fumigatus, A. niger, Curvularia lunata, Fusarium oxysporum, F. moniliformae, Penicillium oxalicum* and *Trichoderma viride.* The various physico-chemical properties of the soils such as soil pH, temperature, moisture content, and relative humidity and rainfall were found to play an important role in the distribution of soil fungi in the two types of soil (sandy-loam and clay-loam) in the rhizosphere of Parthenium plant.

Key words : Parthenium plant, rhizosphere fungi, soil characteristics, Jalukbari, Noonmati, Guwahati

INTRODUCTION

Parthenium hysterophorous L. is an annual harb belonging to the family Asteraceae that is ubiquitous in distribution. It is commonly known as congress grass and now is found dominantly growing in every parts of India. It is a native of America now fairly naturalized in all Indian states. Parthenium is a noxious weed, which has remarkable power of regeneration, successfully invaded crop and fodder-field, horticulture and wastelands. It has been reported that the pollen grains of the plant cause skin diseases and some respiratory disorders insensitive persons in many parts of the world.

Soil is a complex system where several microogranisms survive together affecting growth of plant. Microorganisms play an important role in restoring the physico-chemical and biological properties of soil. The microbial population and activity in rhizosphere are always higher and more complex than in soil away from roots. The nature and activity of microorganisms in rhizosphere influence the growth and development of plant significantly (Anandapandian and Rajendran, 2003). The over all metabolic activity of the microorganism in the rhizosphere is several folds higher than in the soil further away from the influence of root zone (Rangaswami, 1988). The influence of roots extends to several millimeters to centimeters and the total area of the zone of influence varies with the nature of root growth and plant density (Singh, 1991 and Rangaswami, 1988). Wilhelm (1965) has reported that the biological complexity of the soil assures

associative, competitive and antagonistic relations, which limits population explosions and thus bring about balance. Singh and Singh (1982) have reported a high microbial population in rhizosphere soil than the non-rhizosphere soil of pigeon pea. Desai (1999) has studied on the rhizosphere microflora of mulberry and has reported relatively higher number of fungi in rhizosphere soil compared to non-rhizosphere soil. Anandapandian and Rajendran (2003) have studied extensively on the microbial diversity in rhizosphere of tree species who have reported that rhizosphere soil samples has more microbial population in comparison to non-rhizosphere soil samples. Rao and Reddy (1990) have made a comparative study in the rhizosphare of bhindi, sorghum and pigeon pea and have reported that the fungal population in the rhizosphare and non-rhizosphere soil varies with the types of crops and its age. The information about the qualitative and quantitative nature of rhizosphere mycoflora of Parthenium plant is not sufficiently available. Therefore, the present study has been carried out to determine the influence of root systems of Parthenium plants on the composition of the soil fungi in different localities of Guwahati, Assam.

MATERIALS AND METHODS

The study was carried out during the period from April 2004 to March 2005. Parthenium (*P. hysterophorous* L.) plant grown in the two localities was taken for the investigations. Rhizosphere and non-rhizosphere mycoflora were analyzed at three different growth stages of the plant viz., seedling stage, flowering stage and fruiting stage. Soil samples from the two experimental sites were collected and the physico-chemical characteristics were also analyzed. Soil pH was determined in soil-water suspension (1:2.5) using a digital pH meter (Jackson, 1973), temperature was measured at month wise interval by inserting a soil thermometer into the soil, and soil moisture was estimated by Gravimetric method. Organic carbon percentage was estimated by Walkley and Black wet digestion method (Piper, 1966). Phosphorous was estimated colorimetrically empolying Vanado-molybddate method. Potassium was estimated by using Flame photometer with nautral normal ammonium acetate solution (Stanford and English, 1949). Nitrogen was determined by Kjeldahl method using Kjeltech autoanalyser 1030 (Piper, 1966).

Rhizosphere mycoflora of Parthenium plant was analyzed by Harley and Waid technique (1955). The root systems of Parthenium plants from the two localities were aseptically taken to the laboratory and were placed into 250 ml of conical flask containing 100 ml. sterile distilled water. The roots were subjected to constant washing in sterile water. Suitable dilutions were prepared from the suspension and 1 ml soil suspension from the 10^{-4} dilutions was poured in sterilized Petriplates containing 20 ml Czapek's Dox agar medium with added tetracycline (5 mg / 100 ml medium). Analysis of non-rhizosphere mycoflora was carried out by using dilution plate method (Warcup, 1951). Soil samples from both the localities were collected near the plants free from the influence of root system aseptically and 1 g soil was trnasferred into 100 ml sterile distilled water. Plating was done at 10^{-4} dilution using 20 ml Czapek's Dox agar medium with added tetracycline (5 m / 100 ml media). All the Petriplates were incubated at 28± 1°C and the fungal colonies were counted on the 4th day of incubation. Fungi were identified on the basis of their colony characters, morphological and reproductive characters in accordance with the manuals of Gilman (1957) and Barnett and Hunter (1987).

RESULTS AND DISCUSSION

The experimental results (Tables 3, 4 and Fig. 1) revealed the number and types of fungi in the rhizosphere and non-rhizosphere soils with the progressive growth stages of Parthenium plants in different localities. A total of 22 different fungi were isolated belonging to 13 genera from the soils of Noonmati area while 17 different fungi were isolated belonging to 12 genera from the soils of Jalukbari area during the investigation period. The predominantly occurring rhizosphere and non-rhizosphere fungi isolated from the soils of the two localities were *Aspergillus flavus, A. fumigatus, A. niger, Cladosporium herbarum, Curvularia lunata, Fusarium moniliformae, F. oxysporum, Mucor hiemalis, Penicillium oxalicum* and *Trichoderma viride*, while *Alternaria alternata, Alternaria* sp. *Helminthosporium* sp. *Mucor* sp., *Phoma* sp. and *Rhizopus* sp. occurred in lesser number in both of the rhizosphere and non-rhizosphere soils of the two localities. *Alternaria* sp. *Curvularia* sp. *Mucor* sp. *Nigrospora* sp. and *Penicillium citrinum* were only recorded in the soil of Noonmati area in both of the rhizosphere as well as non-rhizosphere. Higher number of fungal colonies (740 no. of colonies) were isolated from the soil of Noonmati area (sandy-loam soil) than the soil (clay-loam soil) of Jalukbari area (497 no. of colonies) (Fig. 1). It was revealed from

the results that the highest total fungal colonies (238 nos. of colonies in Noonmati area and 174 no. of colonies in Jalukbari area) were isolated from rhizosphere soil when the plant attained flowering stage; while the lowest total fungal colonies (112 nos. in Noonmati and 74 nos, in Jalukbari areas) were isolated from rhizosphere soil during seedling stage. *Aspergillus fumigatus* showed highest (24 nos. of colonies) number in the soil of Nonmati area and *Aspergillus niger* (23 nos. of colony) in Jalukbari area during the flowering stages. A significant differences were observed in the number and types of fungi between rhizosphere and non-rhizosphere soil as well as between the two localities. The result corroborate with the findings of Singh and Singh (1982) in the soil of pigeon pea. Similar observations were made by Pandey and Upadhaya (2000), Desai (1999) and Annandapandian and Rajaendran (2003). A gradual increase and proliferation of fungal population was observed during the advancing growth stages of the plant, which might be due to the gradual increrase in exudations of some chemicals by the plant roots, which is in agreement with the findings of Venkentson and Rangaswami (1964) and Kagti (1966). The results showed the species of *Aspergillus* to be the dominant fungi in the rhizosphere soil of Parthenium plant collected during the three growth stages from both the localities. This is in agreement with the findings of Upadhaya and Rai (1983), Pandey and Upadhaya (2000) and Deasi (1999). A positive correlation was observed with respect to the total number of fungi with the increase in the age of plant in both the localities. The variations of fungal population observed during the different growth stages of the plant might be due to the variation in the climatic factors and the physico-chemical properties of the two types of soil (Tables 1 and 2).

Table 1 : Meteorological data for the year 2004-05.

Month	Temperature (°C)		Relative humidity (%)		Rainfall (mm)
	Max.	Min.	Max. (8.30 A.M.)	Min. (5.30 P.M.)	
April '04	27.5	20.6	83.8	74.4	547.5
May	29.3	25.2	84.5	76.2	396.3
June	31.9	25.6	83.0	78.0	205.1
July	30.9	25.7	86.0	81.0	399.6
August	33.5	26.5	82.0	86.0	065.2
September	32.0	25.4	84.0	84.0	089.8
October	29.4	21.7	82.0	82.0	354.4
November	27.9	16.7	82.0	78.0	003.7
December	24.8	12.5	86.0	87.0	000.6
January '05	23.0	11.3	90.0	71.0	016.6
February	27.3	14.4	76.0	53.0	003.9
March	31.1	18.7	70.8	52.3	095.3

Table 2 : Analysis of Physico-chemical properties of the two types of soil collected from the two localities during the investigation periods.

Month	Noonmati area			Jalukbari area		
	pH	Temp (°C)	Moisture (%)	pH	Temp (°C)	Moisture (%)
April '04	5.81	24.0	74.0	5.72	22.0	77.5
May	5.73	25.0	77.0	5.78	23.0	79.4
June	5.42	27.0	78.0	5.38	26.0	82.6
July	5.17	30.0	86.4	4.91	29.0	85.9
August	5.80	32.0	84.8	5.12	28.0	87.4
September	5.74	29.0	82.7	5.83	26.0	81.1
October	6.12	26.0	78.1	5.92	24.0	77.5
November	6.05	24.0	75.2	6.08	21.0	73.0
December	6.41	18.0	73.4	6.31	19.0	70.0
January '05	6.62	17.0	72.4	6.56	18.0	73.0
February	6.34	18.0	71.1	6.19	20.0	74.0
March	6.02	23.0	71.9	6.10	21.0	75.0

Texture of soil	: Sandy-loam	Texture of soil	: Clay-loam
P_2O_5 content (Kg ha^{-1})	: 7.12	P_2O_5 content (Kg ha^{-1})	: 7.03
K_2O content (Kg ha^{-1})	: 135.10	K_2O content (Kg ha^{-1})	: 129.35
Organic Carbon (%)	: 0.82	Organic Carbon (%)	: 0.83
Total Nitrogen (%)	: 0.09	Total Nitrogen (%)	: 0.07

Table 3 : Number and type of fungi isolated from rhizosphere and non-rhizosphere soils (Noonmati area) of Parthenium plants at the three different growth stages. (Results represent the average number of fungal colonies/mg soil)

Fungal types	Seedling stage		Flowering stage		Fruiting stage	
	RS	NRS	RS	NRS	RS	NRS
Alternaria alternata	3	–	10	3	5	3
Alternaria sp.	–	1	5	–	1	–
Aspergillus flavus	8	2	17	8	15	6
A. fumigatus	14	6	24	11	23	10
A. niger	6	–	23	12	20	9
Cladosporium herbarum	14	5	16	6	14	3
Curvularia lunata	10	3	18	7	12	5
Curvularia sp.	2	–	3	–	–	4
Fusarium moniliformae	6	3	12	5	9	6
F. oxysporum	8	4	18	7	14	–
Helminthosporium sp.	2	–	5	2	3	–
Mucor hiemalis	4	2	8	2	6	3
Mucor sp.	2	–	6	–	2	1
Nigrospora sp.	–	1	–	2	2	4
Penicillium citrinum	4	2	8	3	6	2
P. italicum	3	1	8	4	5	–
P. oxalicum	15	6	19	7	15	7
Phoma sp.	2	–	2	–	2	–
Rhizopus sp.	3	1	12	5	8	4
Trichoderma viride	4	3	13	6	10	4
Dark sterile mycelia	–	–	5	4	3	–
Unidentified group	2	1	6	2	4	3
Total no. of fungal colonies	112	41	238	96	179	74
Percentage of total colonies	15.1	5.5	32.1	12.9	24.1	10

RS — Rhizosphere soil NRS — Non rhizosphere soil

Table 4 : Number and type of fungi isolated from rhizosphere and non-rhizosphere soils (Jalukbari area) of Parthenium plants at the three different growth stages. (Results represent the average number of fungal colonies/mg soil)

Fungal types	Seedling stage		Flowering stage		Fruiting stage	
	RS	NRS	RS	NRS	RS	NRS
Alternaria alternata	3	–	8	3	4	2
Aspergillus flavus	7	3	14	6	11	4
A. fumigatus	12	4	21	10	17	5
A. niger	8	3	23	8	14	4
Cladosporium herbarum	3	1	12	5	8	3
Curvularia lunata	4	1	12	5	9	4
Fusarium moniliformae	5	2	12	4	6	3
F. oxysporum	8	3	15	4	11	4
Helminthosporium sp.	2	–	4	1	3	1
Mucor hiemalis	3	1	8	3	5	2
P. italicum	2	–	6	–	3	–
P. oxalicum	10	3	12	4	9	4
Phoma sp.	–	–	4	1	3	–
Rhizopus sp.	2	1	6	2	5	2
Trichoderma viride	3	2	10	3	6	3
Dark sterile mycelia	–	–	4	–	3	–
Unidentified group	2	–	3	2	4	2
Total no. of fungal colonies	74	24	174	61	121	43
Percentage of total colonies	14.8	4.8	35.0	12.2	24.3	8.6

RS — Rhizosphere soil NRS — Non rhizosphere soil

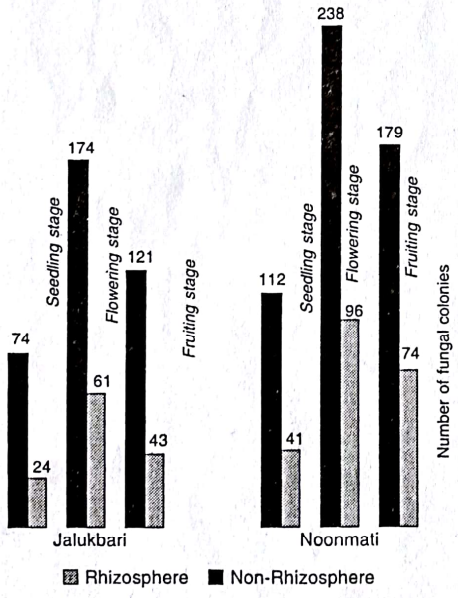

Fig. 1 : Total number of fungal colonies isolated from the two localities at different growth stages of Parthenium plant.

It may be assumed that the predominantly occurring rhizosphere fungi such as *Aspergillus flavus, A. fumigatus, A. niger, Cladosporium herbarum, Curvularia lunata, Fusarium moniliformae, F. oxysporum, Mucor hiemalis, Penicillium oxalicum* and *Trichoderma viride* may have some antagonistic effects against other rhizospheric fungi. It may be stated that there is a significant difference in the diversity of rhizospheric and non-rhizospheric soil fungi in the two types of soil. Factors such as pH, temperature and moisture content of soil, relative humidity and rainfall of the area also have significant role on the composition and concentration of soil mycoflora.

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REFERENCES

Anandapandian, K. T. K. and Rajendran, K. 2003. Assessment of microbial diversity in rhizosphere of tree species in South Tamil Nadu. *Nature Environ. Poll. Technol.* **2**(2) : 153-156.

Barnett. H. L. and Hunter, B. B. 1987. *Illustrated genera of Imperfect fungi*, 4th ed. Macmillan Publishing Co. New York.

Desai, P. 1999. Rhizosphere microflora of Mulberry. *J. Mycol. Pl. Pathol.* **29**(1) : 113-114.

Gilman, J. C. 1957. *A manual of soil fungi*. 2nd ed. Iowa State University press, USA.

Harley, J. L. and Waid, J. S. 1955. A method of studying active mycelia of living roots and other surface in the soil. *Trans. Mycol. Soc.* **38**(2) : 104-118.

Jackson, M. L. 1973. *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd. New Delhi.

Kagti, L. C. 1966. Studies on the distribution of the microorganisms in the rhizosphere of wheat *J. Assam. Sci. Soc.* **9** : 48-66.

Pandey, K. K. and Upadhaya, J. P. 2000. Microbial population of rhizosphere and non-rhizosphere soil of pigeon pea : Screening for resident antagonist and mode of mycoparasitism. *J. Mycol. Pl. Pathol.* **30**(1) : 7-10.

Piper, C. S. 1966. *Soil and Plant Analysis*. Hans Publishers, Bombay.

Rangaswami, G. 1988. Soil plant microbes interrelationship. *Indian Phytopath.* **42**(2) : 165-172.

Rao, C. G. and Reddy, K. S. 1990. Studies on the influence of the rhizosphere of various crops on soil mycoflora. *Indian Phytopath.* **43** : 258-259.

Singh, R. S. 1991. *Introduction to the Principle of Plant pathology*. Oxford and IBH Publishing Co. Pvt. Ltd.

Singh, N. and Singh, R. S. 1982. Effect of oil cake amended soil atmosphere on pigeon pea wilt pathogen. *Indian Phytopth.* **35** : 300.

Stanford, S. and English, L. 1949. Use of flame photometer in rapid soil test of K and Ca. *Agron. J.* **41** : 446-447.

Upadhaya, R. S. and Rai, B. 1983. Competitive saprophytic ability of *Fusarium udum* in relation to some microfungi of root region of pigeon pea. *Indian Phytopath.* **36** : 259.

Venkentson, R. and Rangaswami, G. 1964. Studies on the microbial population of paddy soil influenced by moisture percentage in the crops. *Indian J. Exptl. Biol.* **3** : 30-33.

Warcup, J. H. 1951. The ecology of soil fungi. *Trans. Brit. Mycol. Soc.* **34** : 376-399.

Wilhelm, S. 1965. *Introduction to Principle of Plant Pathology*. Oxford and IBH Publishing Co. Pvt. Ltd.

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